



Eagle Dam Removal Technical Feasibility Study

Wrentham, MA

PREPARED FOR:

Town of Wrentham
360 Taunton St
P.O. Box 658
Wrentham, MA 02093

and

Charles River Watershed Association
190 Park Road
Weston, MA 02493

PREPARED BY:

ESS Group, Inc.
404 Wyman Street, Suite 375
Waltham, Massachusetts 02451

ESS Project No. W350-000

April 19, 2021



TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION.....	1
2.0 FIELD DATA COLLECTION	4
2.1 Topography, Bathymetry, and Dam Site Review	4
2.2 Habitat Assessment and Wetland Delineation	6
3.0 SEDIMENT ASSESSMENT	8
3.1 Sample Collection.....	8
3.2 Sediment Quality	10
4.0 CULTURAL RESOURCES	13
5.0 HYDROLOGIC AND HYDRAULIC ANALYSIS.....	15
5.1 Hydrologic & Hydraulic Methodology	16
5.2 Model Results Based on Historic Precipitation Data.....	17
5.3 Model Results Based on Current Precipitation Data.....	19
6.0 CONCEPTUAL RENDERINGS	20
7.0 DESCRIPTION OF DAM REMOVAL ALTERNATIVE AND CONCEPTUAL DESIGN.....	24
7.1 Project Description and Benefits	24
7.2 Permit Identification	26
7.3 Cost Estimate	27
8.0 NEXT STEPS.....	28
9.0 REFERENCES.....	29

TABLES

Table 1.0	Sediment Grain Size Summary
Table 2.0	Sediment Sampling Results
Table 3.0	Historic Rainfall Frequency Values
Table 4.0	Current Rainfall Frequency Values
Table 5.0	Summary of Modelling Results (Historic Rainfall Frequency Values)
Table 6.0	Summary of Modelling Results (Current Rainfall Frequency Values)
Table 7.0	Permits Required for Removing Eagle Dam
Table 8.0	Opinion of Probable Cost

FIGURES

Figure 1	Eagle Dam Spillway
Figure 2	Locus Map
Figure 3	Eagle Dam Failure, c.a. 1972
Figure 4	Bathymetry
Figure 5	Sediment Depth
Figure 6	The Eagle Mill (Wrentham Historical Commission)
Figure 7	The Back of Eagle Mill (Wrentham Historical Commission)
Figure 8	Eagle Dam Impoundment, Current Conditions
Figure 9	Eagle Dam Impoundment, Water Level Reduced by 2-Feet
Figure 10	Eagle Dam Impoundment, Removal of Dam

APPENDICES

Appendix A	Photolog
------------	----------



Appendix B	Conceptual Design Plans
Appendix C	Natural Heritage Correspondence
Appendix D	Laboratory Results
Appendix E	Hydrologic and Hydraulic Analysis



1.0 INTRODUCTION

The Town of Wrentham has partnered with Charles River Watershed Association (CRWA) and ESS Group Inc. (ESS) to undertake an initial feasibility assessment to identify any major barriers to removing Eagle Dam, a structure which have been documented to be in failing condition. Failure of the dam was determined to be a hazard to downstream residents and infrastructure. This project is funded by a Municipal Vulnerability Preparedness (MVP) grant awarded to the Town in 2019.

The mill pond on Eagle Brook is an approximately 6.5-acre artificially-created shallow pond (impounded system). The mill pond lies just downstream of Red Dam at the outlet of the much larger 245-acre Lake Pearl (Figures 1 and 2). Eagle Dam is located roughly 200 feet upstream of the Route 140 crossing of the waterway. Eagle Brook connects with the Mill River, which in turn flows into the Charles River. The pond is located in a medium-density residential area, and is bordered by Lake Pearl to the southwest, undeveloped land to the west, Gilmore Road to the east and southeast, and Franklin Street (Route 140) to the north. The only surface water input to the impoundment is the outflow from the Red Dam, which enters the pond at its southwestern end and exits the pond via the spillway at the northeastern end of the mill pond.



Figure 1. Spillway at Eagle Dam (Wrentham, Massachusetts)

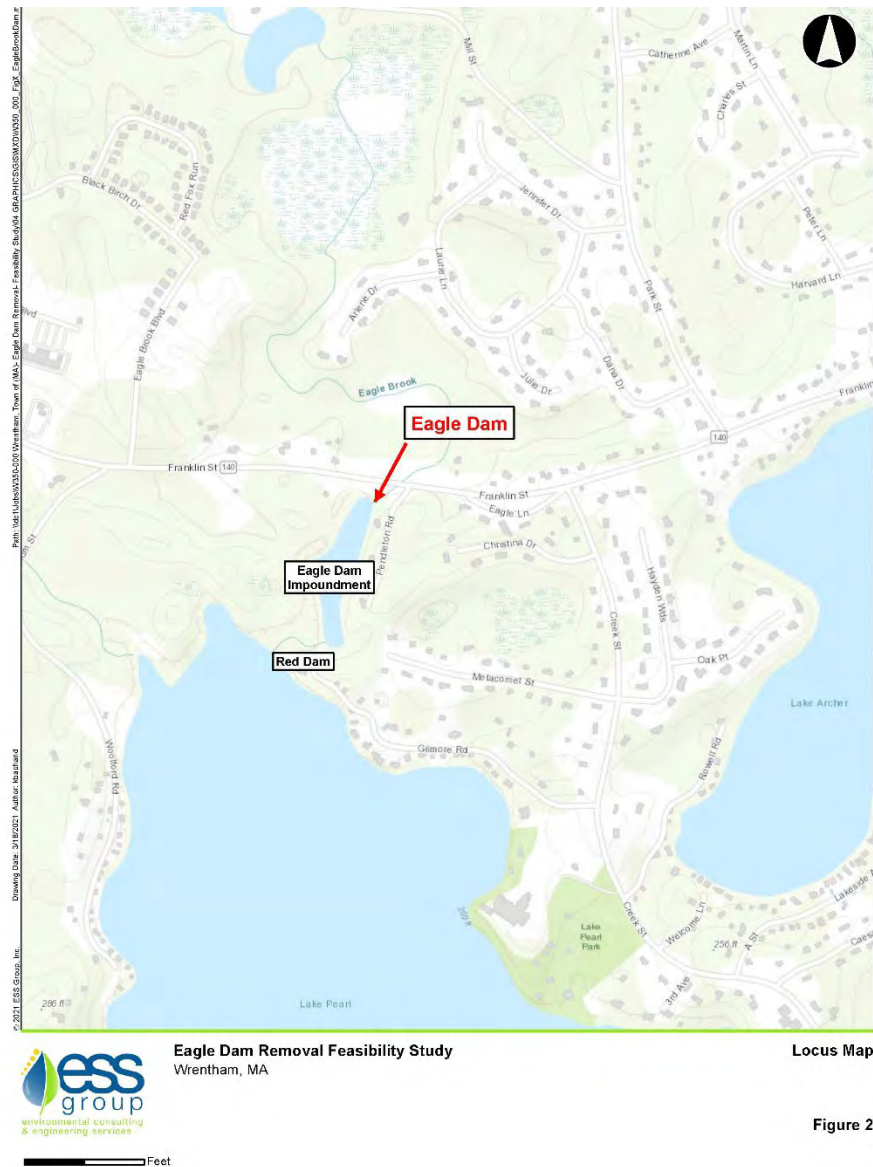


Figure 2. Locus Map

Total depth: 4.94 m., the Town of Wrentham has identified Eagle Dam as a potential vulnerability because of its current degraded condition, ongoing maintenance requirements, and future climatic conditions (MAPC 2018). Failure of this dam could create significant damage to the Town, particularly residential areas, adjacent cranberry bogs, Route 140, buildings, and municipal infrastructure downstream. Owned by the Town, Eagle Dam is currently rated as a low hazard dam in poor condition based on a 2012 Phase I Inspection/Evaluation Report (Pare Corporation 2012). According to the Report, the current dam does not comply with numerous elements of 302 CMR 10 including, but not limited to, a low-level outlet 10.14(7), method of seepage control 10.14(8), slope stability, and global stability 10.14(9). The report recommended the Town either breach (or remove) the dam to eliminate the risk of failure or repair the dam. Breaching or removing the dam would provide an opportunity to restore more natural stream conditions. Due to current

public safety concerns along with the potential for enforcement actions by Bureau of Dam Safety, the status quo is not an option for the Town.

Originally built to power Wrentham's burgeoning manufacturing industry, Eagle Dam serves no functional purpose today and due to its failing condition and the expected impacts of climate change it presents a threat to downstream communities and infrastructure, and is a financial burden on the Town (Figure 3). Following its most recent failure, which is estimated to have occurred in the early 2000s, an amateur repair was made to the spillway to keep the dam intact (M. Lavin, DPW Director, pers. comm.). Both Eagle Dam and the shoreline immediately surrounding the impoundment are owned by the Town. Red Dam, which was reconstructed in 2002, is owned by the Town as well. The Town also owns a large parcel abutting the western shoreline of the impoundment which contains several municipal wells. There are several residences along Gilmore Road (a private drive) which have views of the impoundment. At least one residence constructed a small dock along the waterfront. A parking area off Route 140 near the crossing of Eagle Brook provides informal access to the impoundment and to Lake Pearl along an unofficial network of foot paths and municipal maintenance woods roads. The shallow nature of the impoundment along with the lack of a launch site limits fishing and paddle-craft opportunities. However, some evidence of past fishing activity (in the form of discarded fishing line, lures, and bobbers) was observed along the shoreline. Fishermen are known to utilize this parking to access Lake Pearl which is a popular fishing destination for stocked trout, bass, pickerel and panfish populations.



Figure 3. Eagle Dam Failure c.a. 1972 (source Town of Wrentham)

The Town currently undertakes some management activities at Red Dam (primarily the removal of young woody growth) to keep it in compliance with Massachusetts Bureau of Dam Safety regulations. Following decades of neglect along with amateur repairs to the spillway, the work needed to bring Eagle Dam into compliance is well beyond routine maintenance. Eagle Dam was one of three dams identified through the MVP planning process for possible removal. In 2019, the Town identified Eagle Dam as the top priority among the three due to its small impoundment size, its failing condition, and its proximity to Route 140, town water supply infrastructure, and other important downstream properties and residences. Due to these factors in combination with the increased frequency of extreme rain events, the Town is actively working to address this hazard.

This initial, high-level assessment on the site sought to identify potential barriers to dam removal and to begin to chart a path toward restoring natural flow patterns and re-establish the floodplain along the Eagle Brook as well as possibly enhancing public access to nearby Lake Pearl. The Town has sent a survey to abutters of the impoundment and held a public meeting to describe the goals of the project and seek feedback from abutters and other concerned citizens. To date, no major technical barriers to dam removal have been identified, but additional community conversations are planned before any decisions can be made.

The feasibility analysis includes the following:

- Field Data Collection - site inspection, limited topographic survey, bathymetric survey, wetland delineation, review of potential rare or endangered species.
- Sediment Assessment and Management Recommendations - due diligence review, sediment sampling plan, sample collection and analysis, and management recommendation, if necessary.
- Cultural Assessment - review of the historic significance of the dam within the community.
- Hydrology and Hydraulics - hydrologic and hydraulic modeling of the site, dam impoundment, and the portion of Eagle Brook affected by either dam removal or a lowered spillway elevation.
- Conceptual Renderings – oblique aerial renderings of the impoundment under several water surface lowering scenarios.
- Description of Dam Removal Concept and Cost Estimate.
- Discussion of next steps necessary to inform subsequent project phases.

2.0 FIELD DATA COLLECTION

2.1 Topography, Bathymetry, and Dam Site Review

The uplands surrounding the Eagle Dam impoundment consist of steeply sloping coarse glacial stratified (ice contact) deposits (Stone et al. 2008). These well-sorted gravel and sand deposits, laid down by flowing meltwater in glacial streams and lakes, can be important drinking water sources as evidenced by the nearby municipal well field.

ESS undertook a bathymetric survey of the Eagle Dam impoundment in November of 2019. Bathymetric contours were generated by converting recorded water depths to elevations derived from known elevations obtained from the 1982 reconstruction plans for the Route 140 crossing over Eagle Brook (provided by the Massachusetts Department of Transportation District 5 office).

The bathymetry of the impoundment as well as the elevations derived from Commonwealth of Massachusetts LiDAR for the surrounding uplands are shown on Figure 4. Including emergent wetlands bordering the pond, the water body is approximately 6.5 acres in size with an average depth of approximately 4 feet and a maximum depth near the Eagle Dam spillway of 5.5 feet. The normal pool volume of the impoundment below the spillway elevation is roughly 22 acre-feet. Photographs of the project site are contained in the photolog (Appendix A).



Figure 4. Bathymetry

The Phase I Inspection/Evaluation Report (Pare Corporation 2012) reports the dam as being 8-feet in height with a normal pool elevation of 3.5 feet below the dam crest. In theory, if the crest were to be lowered by 2.5 feet, the dam could be brought under the Dam Safety jurisdictional dam height of 6 feet without impacting the elevation of the current spillway and altering water levels under current conditions. Becoming non-jurisdictional would also require the maximum impoundment volume (up to the dam crest elevation) to be below the jurisdictional volume threshold of 15 acre-feet.

While establishing controls for the conversion of water depths to known elevations, ESS recorded the approximate elevations of the crest, spillway and channel thalweg at the downstream toe of the existing dam. This data indicated the height of the dam is closer to 12 feet (roughly elevations 203 to 191.5 feet¹) in contrast to the 8-foot height reported in the Phase I study.

Subsequent to this finding, ESS staff met on site with Ed Hughes (Office of Dam Safety) on February 5, 2020. The question of dam height was discussed and it was agreed, in general terms, that the dam appears to be greater than the previously reported 8-foot height and an instrument survey identifying the location of grade shots would resolve the apparent discrepancy. Mr. Hughes also responded favorably to the evaluation of an alternative that results in lowering the dam to less than 6-feet in height and less than 15 acre-feet in impoundment volume, and therefore becoming non-jurisdictional. Mr. Hughes also stated a dam breach alternative would be a reasonable consideration.

Using the topographic and bathymetric base mapping, ESS determined that a lowering of the dam crest approximately 8 feet (to elevation 195.2 feet) provides a maximum impoundment volume of 14.8 acre-feet and a dam height of 3.7 feet. Allowing 9 inches (0.75 feet) of freeboard between the lowered crest elevation of 195.2 feet results in a new spillway/normal pool elevation of 194.5 feet, or roughly a two-foot drop in the current normal pool elevation. This lowering alternative, resulting in a non-jurisdictional dam along with an alternative involving a complete dam breach were carried forward in the Hydrologic and Hydraulic (H&H) analysis.

Due to the failing condition of many higher hazard dams in the Commonwealth, the Town has been informed that Eagle Dam would not receive funding from the Massachusetts Dam and Seawall Repair or Removal Program to repair the dam. Therefore, rebuilding the dam in its current configuration is not considered a viable option at this time.

2.2 Habitat Assessment and Wetland Delineation

An identification of Massachusetts Wetlands Protection Act Resource Areas was performed within the anticipated work zone to support future permitting efforts. The flagged boundaries are shown on the Existing Conditions Plan (Appendix B). The flagging demarcates the transition from Land under Water to upland Bank associated with the impoundment or Eagle Brook in the case below the dam. Land under Water is defined at 310 CMR 10.56 as the land below the mean annual low water level of a waterbody or waterway. Land under Water provides substrate for aquatic plant growth and habitat for aquatic animals. Inland Bank is defined at 310 CMR 10.54 as the land which contains water within a waterbody or waterway, and is

¹ All elevations in this report are reported in North American Vertical Datum of 1988 (NAVD 88).

located between the mean annual low water level and the mean annual high water level of a waterbody or waterway.

Due to the steep slopes of the earthen embankment and the presence of retaining walls near the spillway, there are no Bordering Vegetated Wetlands along the northern edge of the impoundment. A small forested wetland lies within the brook just downstream of the dam. It is likely that the sediment which formed this small forested wetland “island” was the result of sediment deposition from past dam failures. Bordering Vegetated Wetland is defined at 310 CMR 10.55 as freshwater wetlands that border creeks, rivers, streams, and ponds, and include wet meadows, bogs, marshes, and swamps. Bordering Vegetated Wetland provides habitat for a diverse array of plant and animal species and functions to retain stormwater and attenuate pollutants.

There is also a 100-foot buffer from the Bank and a 200-foot Riverfront Area associated with Eagle Brook. Riverfront Area is defined in 310 CMR 10.58 as the land between a river’s mean annual high water line and a parallel line measured horizontally outward from the river to 200 feet. A river, as defined in 310 CMR 10.58(2)(a)(1), is any naturally flowing body of water that empties into any ocean, lake, pond, or other river and which flows throughout the year. Riverfront Areas serve to protect surface and groundwater supplies, control flooding, and provide wildlife habitat.

The project area is also contained within the 100-year floodplain which is regulated as Bordering Land Subject to Flooding. Per the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), the project area is located within Flood Zone A, which is defined as the one-percent-annual-chance flood area (the 100-year flood zone). No base flood elevations have been established for this zone. Bordering Land Subject to Flooding is defined at 310 CMR 10.57 as an area which floods from a rise in a bordering waterway or waterbody. Bordering Land Subject to Flooding is significant to flood control and storm damage prevention.

The northern portion of the impoundment does include a relatively narrow fringe of emergent marsh or wooded swamp. Shrubs and saplings along the perimeter of the impoundment showed substantial evidence of harvesting by beaver. The marsh immediately downstream of the Red Dam is dominated by non-native common reed (*Phragmites australis*) which, without control measures, would likely expand with a drawdown of the impoundment. No other aquatic invasive plants were observed; however, the field work was conducted outside of the growing season. Much of the relatively shallow impoundment (average depth of approximately 4 feet) appeared to support beds of submerged aquatic vegetation.

There are reported populations of 10 warm-water fish of interest to anglers within Lake Pearl including Largemouth Bass, Chain Pickerel, Bluegill, Pumpkinseed, Yellow Perch, White Perch, Black Crappie, Brown Bullhead, and American Eel. Lake Pearl is also stocked with trout each year by the town. It is possible any of these species could be present from time to time within the downstream impoundment associated with Eagle Dam. However, habitat conditions within the shallow impoundment are not well-suited to support self-sustaining populations of these species for anglers. Benthic invertebrate sampling conducted by Charles River Watershed Association suggests aquatic habitat quality upstream of Eagle Dam is negatively impacted by the warmer water temperatures associated with the relatively shallow impoundment. These impacts also typically include lower dissolved oxygen levels and possible nutrient sources.

With the exception of American Eel, no diadromous species are found in the waterbodies. Historical records indicate that Atlantic salmon once made their way from the ocean all the way up Eagle Brook. Due to this dam and many barriers along the Charles River, along with the regional collapse of Atlantic salmon stocks, they are no longer present. However, Eagle Dam still presents a barrier to native fish that would otherwise move along the stream system. There have been anecdotal references to the presence of reproducing native brook trout within Eagle Brook downstream of the dam. According to state survey records there are no Brook Trout, or any other coldwater fish species, in Eagle Brook. There is however a diverse assemblage of warmwater species, including Bridle Shiner, which is a species of special concern in Massachusetts (Adam Kautza PhD, Coldwater Fisheries Project Leader, MassDFW, pers. comm.). The Natural Heritage and Endangered Species Program confirmed the project site, or a portion thereof, is located within Priority Habitat 814 (PH 814) and Estimated Habitat 667 (EH 667) as indicated in the Massachusetts Natural Heritage Atlas (14th Edition) for this special concern species (Appendix C). There are no other known state-listed rare species within the project area.

3.0 SEDIMENT ASSESSMENT

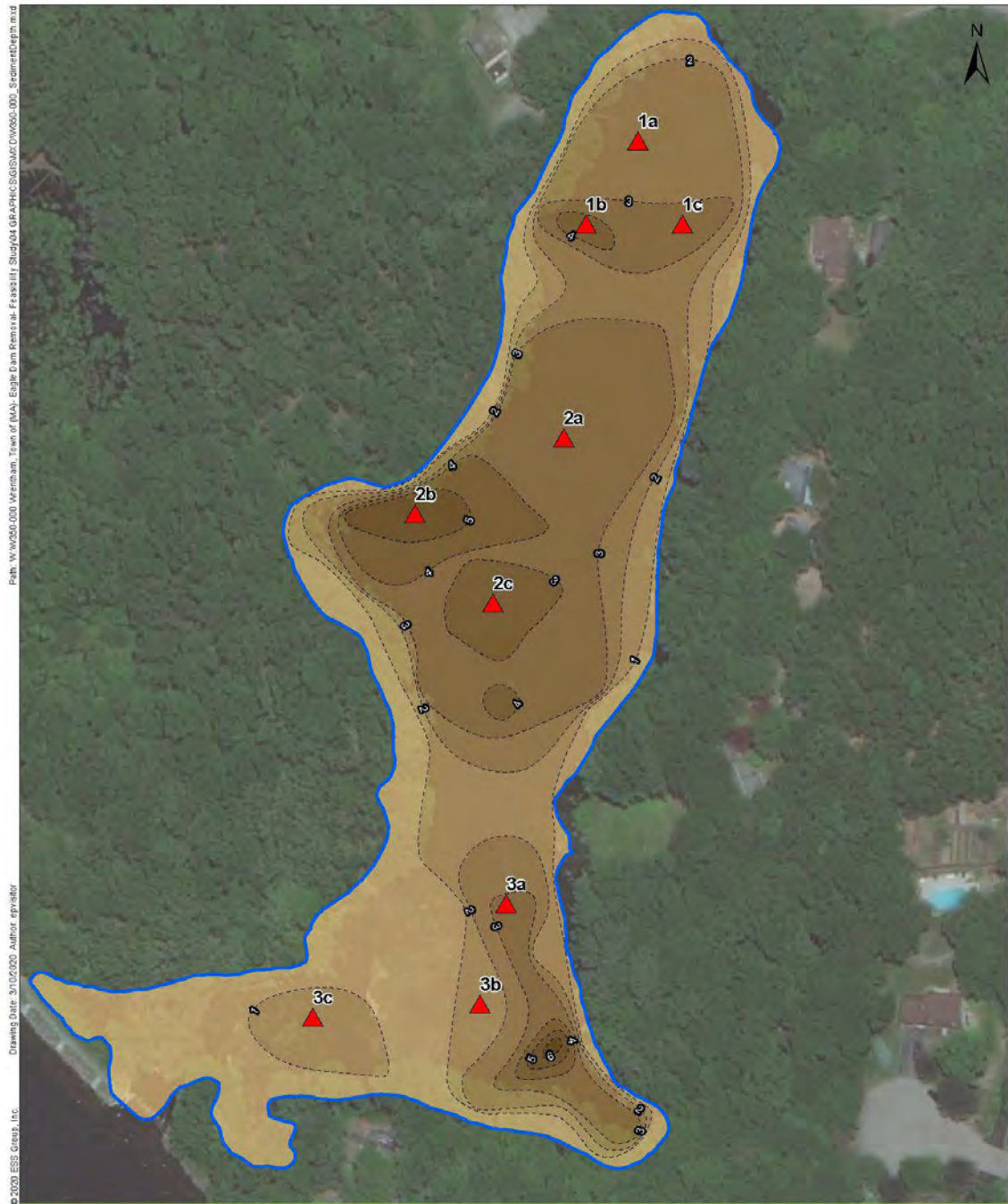
This section summarizes the findings of the focused sediment sample collection and laboratory analysis efforts performed in support of the Technical Feasibility Study for the potential removal of Eagle Dam.

3.1 Sample Collection

A total of nine sediment cores were collected on September 25, 2019 from representative locations and composited into 3 sediment samples for laboratory analysis, in accordance with 314 CMR 9.07(2)(b) of the Water Quality Certification Regulations. Cores collected from the same geographic area were composited. Approximate locations of the collected sediment samples are shown on Figure 5. A sub-meter accurate Trimble GPS receiver was used to collect location data for each sediment core. It is anticipated that the depth of sample collection will be representative of the depth of soft sediments that could be disturbed by dam removal based on the findings of the bathymetric and soil probing evaluations completed within the current Eagle Dam impoundment.

Samples were collected using an extendable Russian peat corer with a 1.65-foot (0.5-meter) long coring segment to characterize the vertical profile of soft sediments at each location. To prevent cross-contamination of the samples, the peat corer was decontaminated in the field just prior to sampling using an Alconox solution, followed by a rinse with isopropyl alcohol and then distilled water. At each location, the peat corer was hand-driven to a depth sufficient to collect the first 1.65 feet of sediment and retrieved for logging and photographing. Accurate sample depth representation was ensured by following pre-measured increments inscribed on the extension rods of the sampler.




Material in the core barrel was removed with a decontaminated stainless-steel spoon and placed in a decontaminated stainless-steel bowl after each portion of the core was retrieved. If shallow refusal was encountered at a particular location, the corer was repositioned, and sampling was re-attempted. ESS measured, photographed, and described each individual core, including sediment depth, grain size, color, and other characteristics.



Eagle Dam Removal
Wrentham, MA
1 inch = 130 feet

0 25 50 100 Feet

Source: 1) ESRI, World Imagery, 2019
2) ESS, Bathymetry Survey, 11/11/2019

-  Sediment Sample Locations
-  Pond Outline (198.7 MSL)
-  Sediment Depth Contour (1-ft Interval)

Sediment Depth

Figure 5

Figure 5. Sediment Depth

3.2 Sediment Quality

The composite sediment samples from the Eagle Brook impoundment were submitted for chemical analysis to Phoenix Environmental Laboratories, Inc in Manchester, Connecticut. Sediment chemical analysis included metals (arsenic, chromium, copper, lead, mercury, nickel, and zinc), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and total phosphorus. The sediment samples were submitted for physical analysis (moisture content, total organic carbon, and grain size) to GeoTesting Express, Inc. in Acton, Massachusetts. Sediment physical analysis included sediment grain size, organic content, and moisture content. The full laboratory reports are found in Appendix D.

Grain size analysis results demonstrated that all three samples contained greater than 10% fines. A breakdown of the grain size results is provided below.

Table 1: Sediment Grain Size Summary

Sample	%Sand and Gravel	%Silt and Clay
Eagle Sed Comp 1	12%	88%
Eagle Sed Comp 2	44%	56%
Eagle Sed Comp 3	78%	22%

Total Organic Carbon (TOC) results for the three composite samples ranged from 3.13% (Comp 3) to 19.5% (Comp 1). Percent solids ranged from 16.5% (Comp 1) to 46.2% (Comp 3).

To support the evaluation of the sediment quality, the analytical results for the three composite sediment samples were compared to the following criteria.

- Massachusetts Department of Environmental Protection (MassDEP) Massachusetts Contingency Plan (MCP; 310 CMR 40.000) RCS-1 Reportable Concentrations (RCs).
- Ecological thresholds including threshold effect concentrations (TECs) and probable effect concentrations (PECs; NOAA SQUIRTs Quick Reference Tables, 2008).
- MassDEP MCP Method 1 risk thresholds for S-1/GW-3, S-2/GW-3, and S-3/GW-3 scenarios [40.0975(6)(a,b,c)].

The following conclusions have been drawn based on a review of the sediment analytical results as detailed on Table 1 and comparison to the above-listed regulatory thresholds.

- All of the detected sediment concentrations are less than the applicable MCP RCS-1 criteria, where available, indicating that the upland placement of the sediment on-site is acceptable. The RCS-1 reporting category is the more stringent category applied to soil samples collected at or within 500 feet of a residential dwelling, a residentially-zoned property, school, playground, recreational area, or park.
- All of the detected sediment concentrations are less than the applicable MCP Method 1 S-1/GW-3, S-2/GW-3, and S-3/GW-3 risk thresholds. This result supports that the sediment will not pose a risk to human health if it is mobilized downstream as a result of the proposed dam removal and gets deposited in the floodplain or becomes exposed within the current impoundment area as a result of lowered surface water levels following dam removal.

- Method 1 thresholds were not available for certain analytes as shown on Table 2. These thresholds could be developed using the Method 2 approach as detailed in the MCP, if necessary.
- Exceedances of applicable TECs were identified for select metals (lead and nickel) and select PAHs (benzo(a)anthracene, benzo(a)pyrene, chrysene and dibenz(a,h)anthracene) based on the analytical results for samples Eagle Sed Comp 1 and Eagle Sed Comp 3. However, all concentrations were below PECs. In *Sediment Management for Dam Removal Projects in Massachusetts* (a soon to be released guidance document jointly produced by MassDEP and the Division of Ecological Restoration), an in-stream approach of passive sediment management is considered likely feasible from an ecological risk perspective when there are no PEC exceedances.
- The somewhat elevated levels of certain metals are typical of New England background levels. If warranted, downstream sediment samples can be collected and analyzed to verify this condition in a subsequent design phase.



TABLE 2 - SUMMARY OF SEDIMENT ANALYTICAL RESULTS
Eagle Dam, Wrentham, MA

Eagle Dam Removal
Technical Feasibility Study
April 19, 2021

Parameters	Ecological Thresholds (aquatic)						Human Exposure (upland/floodplain)			MCP RCS-1	CF15233 1/15/2020		CF15234 1/15/2020		CF15235 1/15/2020	
	Units	Freshwater		Direct Contact Method 1 (S-1/GW-3)	Direct Contact Method 1 (S-2/GW-3)	Direct Contact Method 1 (S-3/GW-3)	EAGLE SED 1 COMP Sediment Result	RL	EAGLE SED 2 COMP Sediment Result		RL	EAGLE SED 3 COMP Sediment Result	RL			
		TEC/TEL	PEC/PEL													
Metals, Total [mg/kg or ppm]																
Arsenic	mg/kg	9.79	33	30	30	30	20	3.7	1.3	2.39	0.98	4.52	0.32			
Chromium (Total)	mg/kg	43.4	111	1000	2500	5000	100	22.9	0.66	18.4	0.49	13.2	0.16			
Copper	mg/kg	31.6	149				1000	15.6	0.66	9.53	0.49	12.8	0.16			
Lead	mg/kg	35.6	128	300	600	600	200	40	0.66	20.4	0.49	48.4	0.16			
Mercury	mg/kg	0.18	1.06	20	60	60	20	< 0.34	0.34	< 0.25	0.25	< 0.15	0.15			
Nickel	mg/kg	22.7	48.6	300	700	700	600	25.3	0.66	17	0.49	17.1	0.16			
Zinc	mg/kg	121	459	2500	2500	5000	1000	76.9	0.66	53.3	0.49	83.9	0.16			
PAHs [ug/kg]																
2-Methylnaphthalene	ug/kg			500000	500000	300000	700	< 22	22	< 14	14	< 10	10			
Acenaphthene	ug/kg	7	89	1000000	2500000	4000000	4000	< 22	22	< 14	14	< 10	10			
Acenaphthylene	ug/kg	6	128	100000	1000000	1000000	1000	< 22	22	< 14	14	< 10	10			
Anthracene	ug/kg	57	845	1000000	2500000	5000000	1000000	< 22	22	< 14	14	< 10	10			
Benz[a]anthracene	ug/kg	108	1050	700	1000	4000	7000	140	22	< 14	14	79	10			
Benzo[a]pyrene	ug/kg	150	1450	700	700	700	2000	180	22	< 14	14	69	10			
Benzo[b]fluoranthene	ug/kg			700	1000	4000	7000	170	22	< 14	14	67	10			
Benzo[g,h,i]perylene	ug/kg			1000000	2500000	2500000	1000000	140	22	< 14	14	35	10			
Benzo[k]fluoranthene	ug/kg			7000	10000	40000	70000	160	22	< 14	14	70	10			
Chrysene	ug/kg	166	1290	7000	10000	40000	70000	190	22	< 14	14	86	10			
Dibenz[a,h]anthracene	ug/kg	33	135	700	700	800	700	34	22	< 14	14	11	10			
Fluoranthene	ug/kg	423	2230	1000000	1000000	1000000	1000000	< 22	22	< 14	14	140	10			
Fluorene	ug/kg	77	536	1000000	2000000	4000000	1000000	< 22	22	< 14	14	< 10	10			
Indeno[1,2,3-cd]pyrene	ug/kg			700	1000	4000	7000	160	22	< 14	14	42	10			
Naphthalene	ug/kg	176	561	100000	1000000	1000000	4000	< 22	22	< 14	14	< 10	10			
Phenanthrene	ug/kg	204	1170	100000	100000	100000	10000	70	22	< 14	14	32	10			
Pyrene	ug/kg	195	1520	700000	2000000	5000000	1000000	190	22	< 14	14	130	10			
Total PAHs	ug/kg	1610	22800					1434		ND		761				
PCBs By SW8082A																
PCB-1016	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1221	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1232	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1242	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1248	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1254	ug/kg	60	340					< 440	440	< 280	280	< 500	500			
PCB-1260	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1262	ug/kg							< 440	440	< 280	280	< 500	500			
PCB-1268	ug/kg							< 440	440	< 280	280	< 500	500			
Total	ug/kg	34.1	277	1000	4000	4000	1000	ND		ND		ND				
Pesticides By SW8081B																
4,4' -DDD	ug/kg						8000	< 44	44	< 28	28	< 20	20			
4,4' -DDE	ug/kg						6000	< 44	44	< 28	28	< 20	20			
4,4' -DDT	ug/kg						6000	< 44	44	< 28	28	< 20	20			
a-BHC	ug/kg						50000	< 44	44	< 28	28	< 20	20			
Alachlor	ug/kg							< 44	44	< 28	28	< 20	20			
Aldrin	ug/kg			80	500	3000	80	< 22	22	< 14	14	< 10	10			
b-BHC	ug/kg						10000	< 44	44	< 28	28	< 20	20			
Chlordane	ug/kg	3.24	17.6	5000	30000	60000	5000	< 220	220	< 140	140	< 100	100			
d-BHC	ug/kg							< 44	44	< 28	28	< 20	20			
Dieldrin	ug/kg	1.9	61.8	80	500	3000	80	< 22	22	< 14	14	< 10	10			
Endosulfan I	ug/kg			1000	1000	1000	500	< 44	44	< 28	28	< 20	20			
Endosulfan II	ug/kg			1000	1000	1000	500	< 44	44	< 28	28	< 20	20			
Endosulfan sulfate	ug/kg							< 44	44	< 28	28	< 20	20			
Endrin	ug/kg	2.22	207	10000	20000	20000	10000	< 44	44	< 28	28	< 20	20			
Endrin aldehyde	ug/kg							< 44	44	< 28	28	< 20	20			
Endrin ketone	ug/kg							< 44	44	< 28	28	< 20	20			
g-BHC	ug/kg							< 8.8	8.8	< 5.6	5.6	< 4.0	4.0			
Heptachlor	ug/kg			300	2000	10000	300	< 44	44	< 28	28	< 20	20			
Heptachlor epoxide	ug/kg	2.47	16	100	900	1000	100	< 44	44	< 28	28	< 20	20			
Methoxychlor	ug/kg			200000	400000	400000	200000	< 220	220	< 140	140	< 100	100			
Toxaphene	ug/kg							< 880	880	< 560	560	< 400	400			
Total Phosphorous by SM4500PE-11																
Phosphorous, total	mg/kg							320	3.3	190	2.2	200	1.5			

NOTES

Reporting limits may vary by sample due to moisture content

Bold values indicate a detected analyte

Values with an "<" denote analyte not detected at laboratory reporting limit

Shaded values indicate a concentration detected in exceedance of one or more threshold

MCP RCS-1 and Method 1 standards per 310 CMR 40.000, 2019 version

TEC - Threshold Effect Concentration (SQuIRTS Screening Quick Reference Tables, NOAA, 2008)

PEC - Probable Effect Concentration (SQuIRTS Screening Quick Reference Tables, NOAA, 2008)

Based on these results, additional sediment testing is likely not warranted to further evaluate the potential for future ecological risk as a result of the mobilization of sediment that is currently within the impoundment behind Eagle Dam. An in-stream approach of passive sediment management is considered a likely feasible approach from an ecological risk perspective. As mentioned above, the collection of downstream sediment samples may be warranted to document similar conditions below the dam.

4.0 CULTURAL RESOURCES

The following narrative is excerpted from a document prepared by the Charles River Watershed Association entitled Eagle Brook Dam Historical Research Summary Memo and a draft report prepared by the Wrentham Historical Commission entitled History of Lake Pearl also known as Whiting's Pond and Wolomonopog.

The land including present day Wrentham was originally territory of the Wampanoag Indian Tribe which was purchased from King Phillip in 1660. Wrentham has a well-documented history of Native American habitation. A documented prehistory cooking and fishing site along Lake Pearl in the vicinity of the project area has been dated to at least 6,000 years ago. Between the late 1940's and early 1950's Wrentham historian, Stephen Keighley, located 50 old fire pits associated with this site. As this early occupation predated the construction of dams along Eagle Brook, additional archaeological resources may lie below the current water levels. The Wrentham Historical Commission has received reports of arrowheads and stone tools collected from around Lake Pearl.

In the late 1600s, Wrentham was a small frontier town; it grew during the early 18th century and developed into the major town in the area. Wrentham's climate made it attractive because it was warm relative to the immediate coast. The census of 1765 listed 2,030 inhabitants in 347 families and 293 houses. In the 1700s, Wrentham had a predominantly agricultural economy, primarily poultry, hay, corn, and cattle farming. Toward the end of the century the economy became increasingly varied.

Wrentham historian, Stephen Keighley, described the Eagle Brook area as a "good resource of spring water for drinking" as well as abundant game within the woodlands. The Native Americans referred to Lake Pearl as Lake Wollomonopaug, "the place of shells" presumed to be a reference to the abundance of freshwater bivalve mollusks. According to Wrentham's Historical Commission, fishing was during this time because there were no dams to prevent fish from passing through.

Eagle Dam is located along Eagle Brook downstream of the Red Dam which creates Lake Pearl. When European settlers arrived in Wrentham, they identified Lake Pearl's outlet as a good source for powering saw and corn mills. What is believed to be the first mill in Wrentham, a corn mill, was built in the 1660s in a location about 100 feet upstream of the current Red Dam site, but lower (6-8') than present day Red Dam. The first rights for a corn mill were granted to the elder Crossmen. The water rights were then transferred to the Whiting Family, who were the original proprietors already because of their longtime residence in Wrentham. The Mill was constructed immediately next to Eagle Brook and Eagle Dam (Figures 6 and 7). At that time, the waterbody was called Whiting's Pond. The Whiting family also had mills in other towns and continuously ran mills in Wrentham for next 100 years.



Figure 6. The Eagle Mill, also called the Eagle Manufacturing Company, was located between Franklin Street and Eagle Dam. All that remains is part of the rear foundation wall, now serving as a low retaining wall. The Whiting home can be seen at the right rear (source Wrentham Historical Commission).



Figure 7. The Back of Eagle Mill with Eagle Brook to the right. Route 140 pictured to the left. No date recorded (source Wrentham Historical Commission).

This dam experienced a catastrophic collapse on April 18, 1876. There was significant damage from Wrentham to Millis, which resulted in legal action. After the failure of the original Eagle Dam, a dam was constructed at the present day location of Red Dam. The construction of Red Dam caused Lake Pearl to roughly double in size. Following the construction of Red Dam, Eagle Dam was reconstructed. Having two dams in such close proximity was partially intended as a failsafe to protect Lake Pearl from draining if one of the dams were to breach.

Lake Pearl has long been a local source of recreation and amusement. In the 1850s, the nearby land of Lake Pearl was sold to a Wrentham businessman who used it as a venue for parties, outings and open air concerts, and a military encampment during the Civil War. When the railroad was built in the 1800s, access to Lake Pearl increased and residents from surrounding communities began to visit regularly. The Lake offered up a great location for people to camp, gather, and boat. William Enegren bought the land in 1880 and improved the property into a resort with an amusement park. The name Lake Pearl came about as a tribute to Pearl Enegren, a child of William, who passed at a very young age. As the automobile age came, Lake Pearl Park became an auto park with year-round entertainment and fine dining.

Sometime in the 1800s, the Whiting family sold their property including two dams and the water rights to owners of two downstream textile mills, the Buckley and Mann mill site at Norfolk. Subsequent owners include Lapdam Inc., City Mill Realty Corp., and American Felt Co. It is suspected that the Red Dam went through some major repairs in about 1920 and the newest version of Red Dam was constructed after 1950.

According to Wrentham's Department of Public Works, Eagle Dam failed again in 1968 due to tree roots. The roots cracked the concrete and created channels through the fill adjacent to the structure. As, the private ownership did not have the ability to repair or maintain the dams, the Town of Wrentham acquired the remaining land and water rights.

The former bridge crossing of Route 140 (Franklin Street) was inventoried by the Massachusetts Historical Commission (MHC) in August of 1980. MHC reported that the bridge was itself not significant. However, the site located at the outlet of Lake Pearl has had an important industrial history as well as having prehistory potential. The Wrentham Historical Commission has stated that demolition of Eagle Dam will not affect known archaeological sites that they are aware of. However, any construction must not disturb any suspected undisturbed riverbed or other ground beyond the minimum distance required to accomplish the project. The Commission assumes that the entirety of Town-owned land between the present location of Eagle Dam, the original corn mill dam site and Sweatt Beach should be considered as an area of archeological sensitivity.

5.0 HYDROLOGIC AND HYDRAULIC ANALYSIS

This section summarizes the findings of a feasibility study level Hydrologic and Hydraulic (H&H) analysis of Eagle Dam. The modelling was performed to determine the upstream effects on Red Dam as well as the downstream effects on the Route 140 stream crossing, classified as a Principal Arterial by MassDOT, from the following two alternatives in addition to existing conditions:

- Lowering the dam crest and spillway to reduce the water elevation in the impoundment by two feet resulting in a non-jurisdiction dam.
- The removal of Eagle Dam.

The existing Eagle Dam spillway elevation is modeled at 196.5 feet while the proposed lowered dam model reduces the elevation of the Eagle Dam spillway by two feet to 194.5 feet and the dam removal model results in a proposed stream thalweg of 191.5 feet. This elevation is slightly above the existing stream thalweg elevations immediately downstream of the dam infrastructure.

5.1 Hydrologic & Hydraulic Methodology

The hydrologic model created to analyze the project was developed using the Soil Conservation Service (SCS) Technical Release No. 20 (SCS unit hydrograph procedures) and SCS Technical Release No. 55 (for times of concentration and curve numbers). HydroCAD® software (developed by Applied Microcomputer Systems) was used to perform the hydrologic analysis. The HydroCAD® program calculates runoff based on rainfall and watershed characteristics and produces a runoff hydrograph (a runoff rate versus time curve). The stage-storage-discharge curves for a specific detention area are used to compute an outflow hydrograph by hydraulically routing an inflow hydrograph through an impoundment with specific storage values assigned. This procedure calculates the relationship of the inflow hydrograph with the characteristics of the detention area to determine the outflow, stage, and storage capacity of the detention area for a given time during the specified storm event. All drainage analyses utilized 24-hour rainfall data used in the 1992 Hydrologic & Hydraulic Calculations for the Restoration of Red Dam provided by the Massachusetts Department of Conservation & Recreation (DCR) Office of Dam Safety (referred to as 1992 Report).

Hydrographs were generated based on watershed area, cover characteristics, hydrologic soil group, CN values, times of concentration (Tc), and rainfall amount. The CN values for each watershed and drainage area were estimated by using the proposed conditions information included in the 1992 Report. These results were calibrated with those reported in the 1992 Report which was followed by stormwater model simulations for the 24-hour rainfall for the 25-, 50- and 100-year storm events using a Type III storm distribution including both historic and current precipitation data. Historic precipitation values match those used in the 1992 Report. Since that time, predicted rainfall amounts have increased substantially. The current precipitation data used for this modeling was derived from the Northeast Regional Climate Center (NRCC) and the Natural Resources Conservation Service's (NRCS) web tool "Extreme Precipitation in New York and New England" for Wrentham, Massachusetts. Tables 3 and 4 show the historic and current rainfall data used for the hydrologic models, respectively.

Table 3: Historic Rainfall Frequency Values

Storm Event	24-Hour Precipitation (Inches)
25-year	5.50
50-year	6.10
100-year	6.80

Table 4: Current Rainfall Frequency Values

Storm Event	24-Hour Precipitation (Inches)
25-year	6.27
50-year	7.51
100-year	9.01

The proposed conditions data presented in the 1992 Report were used to re-create the present day hydrologic & hydraulic relationships between Red Dam, Eagle Dam, and the Route 140 bridge crossing. The hydraulic model presented herein as the Existing Calibrated Model was adjusted to closely match the proposed conditions data presented in the 1992 Report. The Existing Calibrated Model was then utilized to model the two proposed condition alternatives at Eagle Dam (a lowering of the spillway by two feet and dam removal). The supporting documentation for the Hydrologic and Hydraulic Analysis is found in Appendix F.

5.2 Model Results Based on Historic Precipitation Data

During a major precipitation event, both the Existing Conditions model and the Lowered Eagle Dam model exhibit a backwater (technically a tailwater) condition at the upstream Red Dam spillway due to the elevated water levels within the Eagle Dam impoundment. In other words, the elevated water levels just downstream of the Red Dam spillway reduce the amount of water flowing over it. When compared to existing conditions, lowering the Eagle Dam spillway elevation in turn lowers the water level within the Eagle Dam impoundment and allows more flow and volume to pass over Red Dam. The peak 100-year outflow at Eagle Dam increases 32% from 641 cfs. to 848 cfs. (Table 5). This increased discharge at both Red and Eagle Dam associated with a lowered spillway also has an effect on water surface elevations at the downstream Route 140 crossing.

Since the Route 140 is classified by MassDOT as a Principal Arterial, it is subject to the following design criteria: 1) the water surface elevation associated with the 50-year storm event should be below the roadbed elevation (typically 18 inches below the roadway surface or approximately 194.5 feet at Route 140) and 2) the water surface elevation associated with the 100-year storm event should not overtop the roadway surface (approximately 196.0 feet at Route 140). Even with the 32% increase in peak outflow, the Lowered Eagle Dam model complies with both of these design criteria at the Route 140 crossing (193.5 and 195.4 feet for the 50- and 100-year storm respectively).

In comparison to the Lowered Dam alternative, the modelled peak outflow discharge with the Removed Dam alternative only increased slightly for the 100-year storm event (512 cfs. to 518 cfs., Table 5). Similar to the Lowered Dam alternative, the additional discharge increases the modeled water surface elevations associated with both the 50-year and 100-year storm event at the Route 140 crossing. However, the modelled elevations still comply with the MassDOT Principal Arterial design criteria.

While meeting MassDOT design criteria, both the Lowered Eagle Dam and Dam Removal alternatives raise the 50-year and 100-year storm event water surface elevations at the Route 140 crossing in comparison to

existing conditions which would require a revision of the Federal Emergency Management Agency (FEMA) flood map.

It is important to note that Pearl Lake is lowered over winter months to increase floodwater storage capacity. The model did not take this factor into consideration as the rainfall amounts could occur at any time of year and therefore the results are considered conservative.

Table 5: Summary of Modelling Results (Historic Rainfall Frequency Values)

HISTORIC PRECIPITATION RESULTS				
Calibrated Existing Model (Existing Eagle Dam Spillway Crest = 196.50)				
<i>Storm Event</i>	<i>Q & Water Surface</i>	<i>Red Dam</i>	<i>Eagle Dam</i>	<i>Route 140 Culvert</i>
25 yr. Storm (5.5)	Peak Outflow, cfs.	265	264	264
	WSEL, FT	200.03	199.44	192.34
50 yr. Storm (6.1")	Peak Outflow, cfs.	324	324	324
	WSEL, FT	200.34	199.87	192.86
100 yr. Storm (6.8")	Peak Outflow, cfs.	395	395	395
	WSEL, FT	200.73	200.35	193.65

Lowered Eagle Dam Model (Proposed Eagle Dam Spillway Crest = 194.50)				
<i>Storm Event</i>	<i>Q & Water Surface</i>	<i>Red Dam</i>	<i>Eagle Dam</i>	<i>Route 140 Culvert</i>
25 yr. Storm (5.5)	Peak Outflow, cfs.	287	286	286
	WSEL, FT	200.02	197.60	192.54
50 yr. Storm (6.1")	Peak Outflow, cfs.	385	384	384
	WSEL, FT	200.29	198.27	193.51
100 yr. Storm (6.8")	Peak Outflow, cfs.	514	512	512
	WSEL, FT	200.63	199.09	195.42

Removed Eagle Dam Model (Proposed Eagle Dam Spillway Crest = 191.50)				
<i>Storm Event</i>	<i>Q & Water Surface</i>	<i>Red Dam</i>	<i>Eagle Dam</i>	<i>Route 140 Culvert</i>
25 yr. Storm (5.5)	Peak Outflow, cfs.	287	287	287
	WSEL, FT	200.02	194.66	192.54
50 yr. Storm (6.1")	Peak Outflow, cfs.	385	384	384
	WSEL, FT	200.29	195.47	193.51
100 yr. Storm (6.8")	Peak Outflow, cfs.	516	518	518
	WSEL, FT	200.63	197.77	195.53

5.3 Model Results Based on Current Precipitation Data

As presented in Table 4, the current rainfall frequency values are substantially greater than the data used in the 1992 Report (an increase of 23 and 32% for the 50- and 100-year storm, respectively). As a result, all three compiled models (Existing Conditions, Lowered Dam and Dam Removal) resulted in substantially greater discharge values downstream of Eagle Dam with the additional precipitation (Table 6).

Only the Existing Conditions 50-year design storm model which resulted with an elevation of 194.7 versus 194.5 feet was close to MassDOT design criteria for a Principal Arterial at this location. The modelled water surface elevation associated with the 50-year storm event for both the Lowered Dam and Dam Removal alternatives exceeded the Route 140 roadbed elevation (196.75 and 197.0 feet, respectively). All three compiled models failed to meet the MassDOT Principal Arterial design criteria of 196.0 feet for the modelled 100-year design storm, with 196.8, 197.25, and 197.5 feet, respectively (Table 6).

As this initial H&H analysis has identified a potential design constraint under existing conditions, a more robust analysis is warranted during the next phase of design to confirm the initial results and coordinate with MassDOT to determine the extent of increased hydraulic capacity required at the Route 140 crossing to provide a safe climate resilient travel corridor.

Table 6: Summary of Modelling Results (Current Rainfall Frequency Values)

CURRENT PRECIPITATION RESULTS				
Existing Model (Existing Eagle Dam Spillway Crest = 196.50)				
<i>Storm Event</i>	<i>Q & Water Surface</i>	<i>Red Dam</i>	<i>Eagle Dam</i>	<i>Route 140 Culvert</i>
25 yr. Storm (6.27")	Peak Outflow, cfs.	341	341	341
	WSEL, FT	200.43	199.99	193.02
50 yr. Storm (7.51")	Peak Outflow, cfs.	471	470	470
	WSEL, FT	201.15	200.82	194.73
100 yr. Storm (9.01")	Peak Outflow, cfs.	669	641	641
	WSEL, FT	202.09	201.81	196.8

Lowered Eagle Dam Model (Proposed Eagle Dam Spillway Crest = 194.50)				
<i>Storm Event</i>	<i>Q & Water Surface</i>	<i>Red Dam</i>	<i>Eagle Dam</i>	<i>Route 140 Culvert</i>
25 yr. Storm (6.27")	Peak Outflow, cfs.	415	414	414
	WSEL, FT	200.38	198.47	193.90
50 yr. Storm (7.51")	Peak Outflow, cfs.	626	625	625
	WSEL, FT	201.01	199.88	196.75
100 yr. Storm (9.01")	Peak Outflow, cfs.	848	848	848
	WSEL, FT	201.88	201.10	197.25

Removed Eagle Dam Model (Proposed Eagle Dam Spillway Crest = 191.50)				
<i>Storm Event</i>	<i>Q & Water Surface</i>	<i>Red Dam</i>	<i>Eagle Dam</i>	<i>Route 140 Culvert</i>
25 yr. Storm (6.27")	Peak Outflow, cfs.	415	414	414
	WSEL, FT	200.38	195.75	193.90
50 yr. Storm (7.51")	Peak Outflow, cfs.	668	720	720
	WSEL, FT	200.99	198.25	197.00
100 yr. Storm (9.01")	Peak Outflow, cfs.	1,013	1012	1012
	WSEL, FT	201.78	199.86	197.53

6.0 CONCEPTUAL RENDERINGS

To assist with public outreach efforts, ESS prepared conceptual renderings of both the dam lowering and dam removal alternatives depicting existing conditions and the anticipated changes to habitat and open water features within the altered landscape (Figures 8-10). 302 CMR 10.03 defines a dam as “any barrier, including appurtenant works, which impounds or diverts water, and which: any barrier which is not more than six feet in height, regardless of storage capacity.” Modifications to the dam crest and spillway necessary to have a non-jurisdiction dam (less than 6-feet in height and less than 15 acre-feet in impoundment volume) would result in a new spillway/normal pool elevation of 194.5, or roughly a two-foot drop in the current normal pool elevation. As conceptually shown in an oblique aerial view (Figure 9), this lowering of the water surface elevation would substantially increase the amount of emergent wetland fringing the impoundment, especially at the northern end where both an emergent fringe and dense beds of submerged aquatic vegetation are already present as shown on Figure 8. The average depth of the lowered impoundment would be roughly 2 feet and a maximum depth near the Eagle Dam spillway of 3.5 feet. The normal pool volume of the impoundment below the spillway elevation would be lowered to roughly 11 acre-feet.

The overall benefit of undertaking this action is the dam would no longer be subject to the Dam Safety Regulation, 302 CMR 10. After construction, the Town would no longer be required to bring the dam into regulatory compliance and perform periodic Phase I Dam Inspections. However, there are several anticipated negative ecological consequences of this option. The resulting shallower impoundment would be further less suited to support sustainable populations of water species found in Lake Pearl and Eagle Brook. The impacts of warmer water temperatures and lower dissolved oxygen associated with the shallower impoundment could be magnified. However, shorter residence time would be expected to counteract the shallower water depth to a varying degree depending on flow rate and season. Additionally, the elevation differential at the new lowered spillway would maintain the existing obstruction of fish passage between downstream and upstream waters. As this alternative does not meet the project objectives, it was not carried forward to conceptual design.

Figure 10 displays the rendering of the Dam Breach alternative which essentially limits open water features to the tread of a meandering channel within a much larger stream-side wetland complex consisting of wooded wetlands along the upland bordering and emergent marsh habitat bordering the restored Eagle Brook. This alternative is described in more detail in the following section.

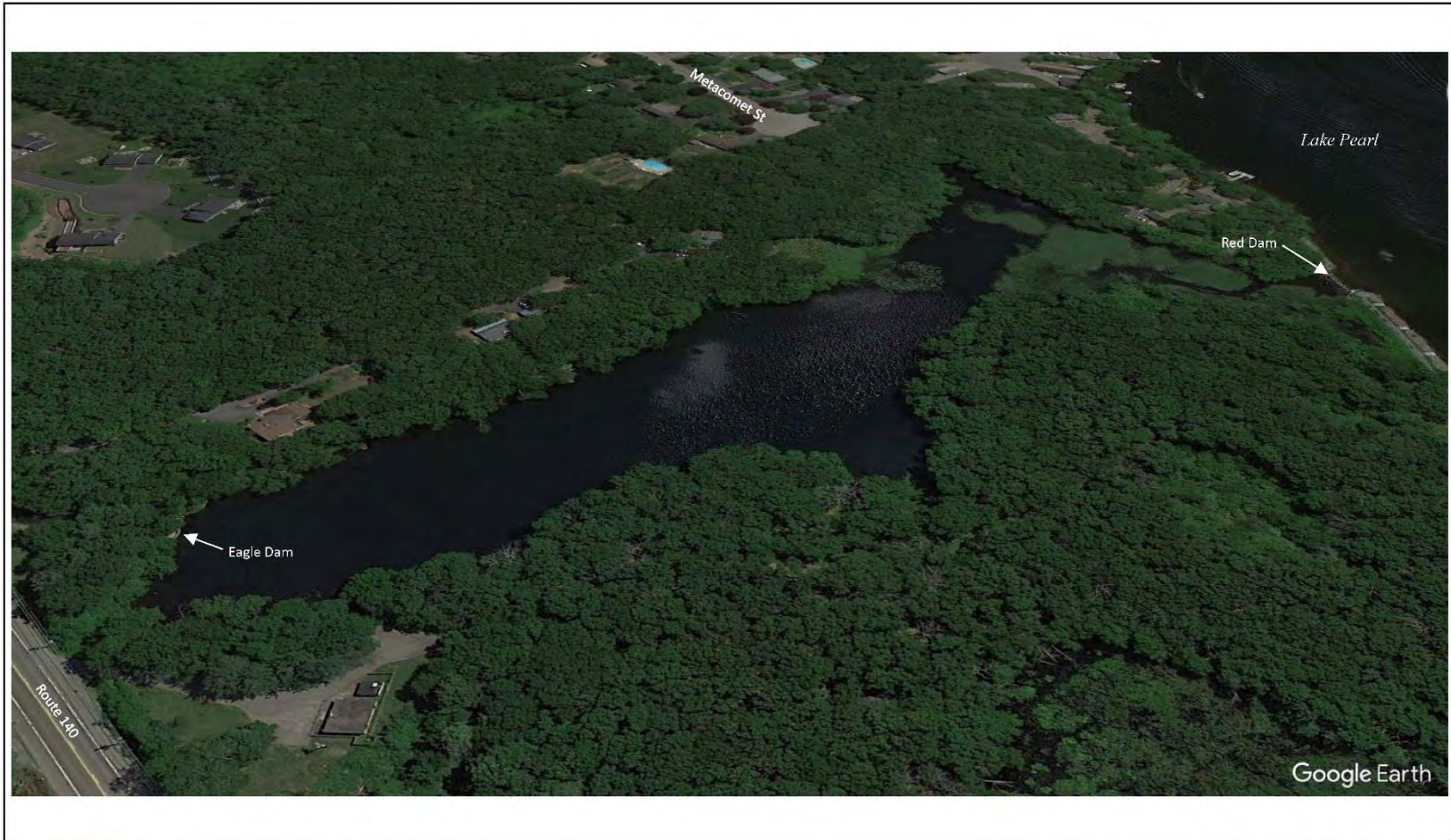


Figure 8. Eagle Dam Impoundment, Current Conditions



Figure 9. Eagle Dam Impoundment, Water Level Reduced by 2-Feet



Figure 10. Eagle Dam Impoundment, Removal of Dam



7.0 DESCRIPTION OF DAM REMOVAL ALTERNATIVE AND CONCEPTUAL DESIGN

7.1 Project Description and Benefits

Eagle Dam is an earthen embankment structure approximately 200 feet long with a stone masonry spillway. The dam is currently classified as a small sized, low (Class III) hazard potential dam (Pare, 2012). According to Pare (2012), the presence of Route 140 would typically indicate a significant hazard potential, however, based on conversations with the Town and observations at the site it did not appear road would be overtopped during a dam failure. The Pare report adds “should additional studies indicate that the roadway is impacted during a storm event, this hazard classification should be reviewed and revised.” The results of the initial H&H analysis, reported herein, suggest the roadway would be overtopped during a 100-year design storm (using current Extreme Precipitation estimates) under both the existing conditions and the dam removal scenarios. Further analysis and coordination with MassDOT and Office of Dam Safety will be necessary to determine the extent of increased hydraulic capacity required at the Route 140 crossing to provide a safe climate resilient travel corridor.

A Chapter 253 permit application would need to be filed with Department of Conservation and Recreation Office of Dam Safety. Accompanying documentation includes full calculations, engineering drawings, and technical specifications. Included will be a hydraulic model presenting the proposed condition which will convey the 100-year storm event with retaining any water. The Office of Dam Safety will also likely require presentation that the resulting storm flow will not cause additional damage to downstream facilities, including the Route 140 crossing.

The watershed area has been delineated to be 7.5 square miles comprised of varying uses and extends approximately 3.2 miles south to Sheldonville. The hydrologic analysis for Eagle Dam watershed produces a 100-year storm of 198 cubic feet per second. A breach of this dam will require the passage of this flow rate without impoundment. This would require a 16-foot wide breach and lowering of the earthen embankment along both sides of the spillway (see Conceptual Design Plans, Appendix B). The dam breach would be opened at the spillway and resemble a natural stream cross section. The deepest section will mimic that of the downstream channel, narrow stone lined with channelized flow. The floodway would be 16 feet wide at the base and slope up at a stable 4 horizontal to 1 vertical slope.

The impoundment would be dewatered through a controlled drawdown to control the release of sediments downstream. As reported previously, an in-stream approach of passive sediment management is considered a likely feasible approach from an ecological risk perspective.

With the dam breached, the impoundment footprint would be restored to a condition very similar to that which is assumed to exist before Eagle Dam was constructed (Figure 10). The two primary ecological benefits to breaching the Dam include restoration of passage for fish and other aquatic organisms between downstream and upstream waters (including the state-listed Bridle Shiner). Restoration of this riparian corridor would likely benefit other aquatic and wetland fish and wildlife species. Removing the dam will restore roughly 1,500 linear feet of the impounded stream channel to more natural conditions, improving habitat and water quality by increasing flushing and oxygenation, and reducing water temperatures. As stated in the Town’s MVP report, improving water quality and building resilience to flooding are priority actions for the community. The second primary benefit of this option would be the restoration and expansion of vegetated wetland habitats along the newly created stream channel upstream of the existing dam. The expansion of emergent and scrub-shrub wetlands in this area would provide additional habitat for a variety

of wildlife species (e.g., veery and American woodcock). The restoration of the riparian vegetated wetland community will increase the capacity of the area to provide water quality enhancement in the form of nutrient uptake and transformation.

ESS recommends conducting a plant survey of the system during the growing season following the completion of construction to document the nature of the plant community that establishes itself on the newly exposed sediments and soils and determine whether non-native or invasive species are present. An invasive plant management program could then be developed if conditions warrant such an approach. It will be important to ensure that species such as common reed and purple loosestrife do not become established before native species can take hold.

Removal of Eagle Dam will provide multiple benefits to the community. These include eliminating the risk of dam failure which threatens downstream infrastructure such as Route 140, a cranberry bog, and other properties in Wrentham and Norfolk. Route 140 is a major connector into, out of, and through the eastern part of Wrentham, connecting to both Route 1 and I495. Disruption to this major artery would pose a threat to emergency access and would limit the ability of residents to get to work and medical appointments. If the dam were to fail and washout Route 140 it would disrupt travel to the King Philip Regional High School, Maple Rehabilitation and Nursing Home, Wrentham District Court and other important business and services in Wrentham Center.

Upon removal of the dam, the site would no longer be subject to the Dam Safety Regulation, 302 CMR 10 and the Town would no longer be required to bring the dam into regulatory compliance and perform periodic Phase I Dam Inspections and required maintenance. Additionally, at the present time there is limited public access to one of the region's great recreational resources, Lake Pearl. During future planning phases the team will investigate adding a nature trail or boardwalk through the restored site to provide an established connection between existing parking at the Route 140 crossing to the shores of Lake Pearl. The team will work closely with the Wrentham Historical Commission to avoid any areas of archaeological sensitivity along the shoreline.

The negative consequences of implementing this action would be the nearly complete loss of existing open water habitats at the mill pond. Species which require open water lentic habitats would no longer be found within the immediate project site. Fishing and paddle-craft use would also decline (though in its current state, the pond does not provide high-quality public recreational opportunities).

Another consideration requiring further study is the potential consequences of the loss of the mill pond on nearby public water supply wells. Wrentham Wells #2 and #3 are located less than 750 feet and less than 150 feet, respectively, from the pond. These wells are also located approximately 800 feet (Well #2) and 1,000 feet (Well #3) from a much larger surface water feature, Lake Pearl. Given the highly permeable nature of the regionally extensive unconsolidated deposits (e.g., sand and gravel) in the vicinity of these two water supply wells, it is possible that a percentage of the water pumped from these wells is derived from induced infiltration from these two surface water features. However, given the extensive nature of the permeable unconsolidated deposits in this area and the presence of larger, more significant recharge sources (Lake Pearl, Lake Archer), the impact on the yields of Wrentham Wells #2 and #3 may be nominal if Eagle Dam was breached.

A review of any available hydrogeologic information related to Wrentham Wells #2 and #3, such as available borings logs, pumping test records and reports, and other local and regional hydrogeologic information should be performed to further assess the potential impact of the removal of Eagle Dam on the yields of these two wells.

7.2 Permit Identification

Removing Eagle Dam will require approval by local, state, and federal agencies under a variety of regulatory programs. The need for most permits required under this option is triggered by work in or near wetlands, generation of stormwater discharges during construction, and the fact that the work will involve a dam (Table 7).

Table 7. Permits Required for Removing Eagle Dam

Jurisdiction	Regulatory Program	Issuing Agency	Permit Name	Dam Removal Action
Local	Massachusetts Wetlands Protection Act (State) & Wrentham Wetlands Protection Bylaw (Local)	Wrentham Conservation Commission	Order of Conditions	Required
Local	Municipal Bylaws and Ordinances	Municipal Boards and Committees	Planning, Building, Site Plan Review Permits	Required
State	Massachusetts Environmental Policy Act (MEPA) (State)	Massachusetts Executive Office of Energy and Environmental Affairs	Secretary's Certificate	Required
State	Massachusetts Dam Safety Regulations	Massachusetts Department of Conservation and Recreation - Office of Dam Safety	Jurisdictional Determination	Required
State	Massachusetts Dam Safety Regulations	Massachusetts Department of Conservation and Recreation - Office of Dam Safety	Chapter 253 Dam Safety Permit	Required
State	Section 401 of the Clean Water Act (Federal) & Massachusetts Clean Waters Act (State)	Massachusetts Department of Environmental Protection (MassDEP)	Section 401 Water Quality Certification	May be Required.
State	Chapter 91, the Massachusetts Public Waterfront Act	Massachusetts Department of Environmental Protection (MassDEP)	Chapter 91 Permit	Not Required.
Federal	Section 404 of the Clean Water Act (Federal) & Section 10 of the Rivers and Harbors Act (Federal)	United States Army Corps of Engineers (USACE)	Authorization under the Massachusetts General Permit or Individual Permit Authorization	Required

Jurisdiction	Regulatory Program	Issuing Agency	Permit Name	Dam Removal Action
Federal	National Pollutant Discharge Elimination System (NPDES) (Federal)	United States Environmental Protection Agency (USEPA)	NPDES Permit	May be required

The need for permits issued under the WPA, MEPA, Section 404 of the CWA, and Section 10 of the Rivers and Harbors Act is triggered by the fact that removing the dam will 1) entail physical construction work in and around wetland resource areas associated with the mill pond, and 2) alter the size and nature of the pond.

Local permits such as planning, building, and site plan review permits would likely be required for the proposed project by local ordinances and by-laws to ensure that the work is conducted in accordance with these regulations and does not lead to negative consequences for downstream properties.

A Jurisdictional Determination request must be filed with the Massachusetts Office of Dam Safety for any work on a dam other than regular maintenance. The Office of Dam Safety reviews the Jurisdictional Determination request to decide whether the proposed work would require a permit from their office. Given the nature of the work proposed under this option and the associated alterations to the mill pond, a permit would be required from the Office of Dam Safety.

Section 401 Water Quality Certification (WQC) may be required based on the extent of wetlands and Land under Water alteration proposed during final design.

A NPDES permit issued by the United States Environmental Protection Agency (EPA) would likely be required for this option due to the potential for stormwater discharges during the construction phase. A construction stormwater pollution prevention plan (SWPPP) would need to be prepared for the project in accordance with EPA regulations.

7.3 Cost Estimate

The following opinion of probable costs has been developed for the dam breaching and removal action. These costs are an approximation based on ESS's experience on other similar sized projects and not based on detail design or quantities. The estimate includes construction costs, contingencies, engineering, and environmental permitting (Table 8). A line item has been included for the construction of a nature trail or boardwalk through the restored site, however no details are available at this time. Following further investigation and advancement of the design, the scope of work may change affecting the construction cost.

Table 8. Opinion of Probable Cost

Description	Total
Mobilization	\$18,000
Staging/Access/Restoration	\$25,000
Site Preparation (Clearing)	\$15,000
Erosion and Pollution Control	\$25,000

Water Control	\$15,000
Earthwork	\$80,000
Spillway Demolition/Removal	\$55,000
Embankment Armoring/Stabilization	\$75,000
Streambed Restoration	\$35,000
Trail Enhancements	\$45,000
Subtotal	\$388,000
25% Contingency	\$97,000
Construction Total	\$485,000
Engineering Design	\$75,000
Environmental Permitting	\$75,000
Construction Administration	\$30,000
Compliance and Monitoring	\$15,000
Alternative Project Total	\$680,000

8.0 NEXT STEPS

During this preliminary phase of project planning, the team has ruled out common barriers to dam removal such as sediment quality and historical status. Additionally, the team gained an important understanding of site conditions which will inform any future design steps (i.e., mill pond bathymetry, sediment quality, physical dam characteristics, and initial hydraulic and hydrologic modelling results to determine potential up- and downstream impacts). The team has also initiated conversations with direct abutters (those that live along the impoundment or own property immediately downstream) to listen to their concerns as well as the community at large.

The next steps toward a more comprehensive evaluation of dam removal will need to include a more detailed hydrologic and hydraulic assessment of Eagle Brook to more closely evaluate potential flooding impacts at the downstream Route 140 crossing. The next phase of work will also focus on building and expanding stakeholder and community outreach and engagement around the project to include MassDOT and the Town of Norfolk.

A more detailed level of modeling is needed at the site due to the close upstream proximity of Red Dam and the close downstream proximity of Route 140. Eagle Dam is located immediately upstream of two box culverts that convey Eagle Brook underneath Route 140 (Franklin St). Based on initial modelling, the primary spillway for Red Dam experiences a tailwater conditions in the Eagle Dam impoundment. Eagle Brook downstream of Eagle Dam and Route 140 is a low slope channel. As a result, flow through the twin box culverts under Route 140 likely experience tailwater conditions as well. In order to correctly establish existing conditions in Eagle Brook, additional data and more extensive modeling are necessary. The team will engage MassDOT, who owns Route 140 crossing over Eagle Brook and the Town of Norfolk, located downstream of the dam, in the modeling efforts to ensure that the appropriate scenarios are assessed and reported on to answer questions about future conditions at the Route 140 crossing and further downstream.



Project modeling will also inform decision making at MassDOT regarding resilience planning for the road crossing.

Further investigation during the next planning phase is also warranted to assess the potential impact of the removal of Eagle Dam on the yields of two nearby public water supply wells (Wrentham Wells #2 and #3).

9.0 REFERENCES

Metropolitan Area Planning Council. 2018. Town of Wrentham Municipal Vulnerability Preparedness Program. Community Resilience Building Workshop Summary of Findings. Wrentham, Massachusetts.

Pare Corporation. 2012. Phase I Inspection/Evaluation Report Eagle Dam State Dam ID#: 6-11-350-2, NID ID#: MA02263. Wrentham, Massachusetts

Stone, B.D., Stone, J.R., and DiGiacomo-Cohen, M.L. 2008. Surficial geologic map of the Worcester North-Oxford-Wrentham-Attleboro nine-quadrangle area in south-central Massachusetts. U.S. Geological Survey Open-File Report 2006-1260-D.

Appendix A

Photolog





Photograph No.: 1
Eagle Brook just below the spillway



Photograph No.: 2
Erosion behind western retaining wall-Eagle Dam



Photograph No.: 3
Downstream view of spillway-Eagle Dam



Photograph No.: 4
Rubble and debris within channel below spillway-Eagle Dam



Photograph No.: 5
Wetland “island” within Eagle Brook just downstream of dam



Photograph No.: 6
Shoreline development within mill pond



Photograph No.: 7
Eagle Brook viewing upstream from Route 140



Photograph No.: 8
Route 140 crossing over Eagle Brook



Photograph No.: 9
Red Dam spillway during drawdown



Photograph No.: 10
Phragmites stand within mill pond just below Red Dam



Photograph No.: 10
Aquatic plant bed (likely *Polygonum amphibium* - water smartweed) within upper reaches of the mill pond



Photograph No.: 11
Beaver browsing on woody stems within the mill pond

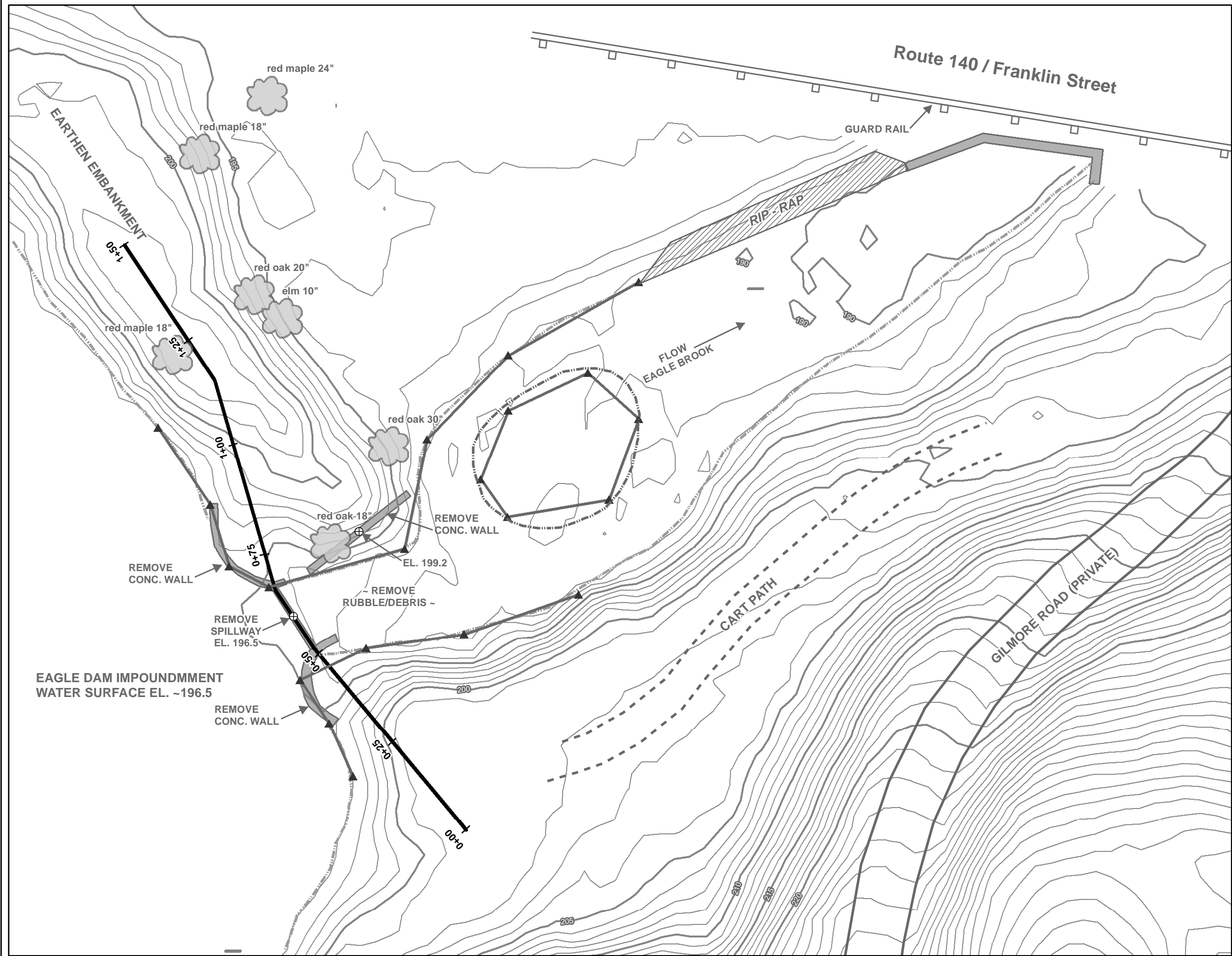


Photograph No.: 12
Example of sediment core collected for laboratory analysis

Appendix B

Conceptual Design Plans





Legend

- Wetland Flag
- Spot Elevation
- Flagged Wetland Boundary
- Profile Line
- Contours (5-Ft Interval), Existing Conditions
- Contours (1-Ft Interval), Existing Conditions
- Water Line

Notes & Sources:

- 1) Vertical Datum NAVD 88 feet
- 2) Pare Corporation, Eagle Dam Phaes 1 Report Site Sketch, 2012
- 3) Map Grid is Massachusetts State Plane Mainland NAD83 feet
- 4) MassGIS, LiDAR Elevation Data, 2010

404 Wyman Street
Suite 375 (Center Pod)
Waltham, MA 02451
(781) 419-7696

No.	REVISION	DATE	APP BY

DRAWN BY: SD

CHECKED BY: SC

DESIGNED BY: CW

APPROVED BY: CW

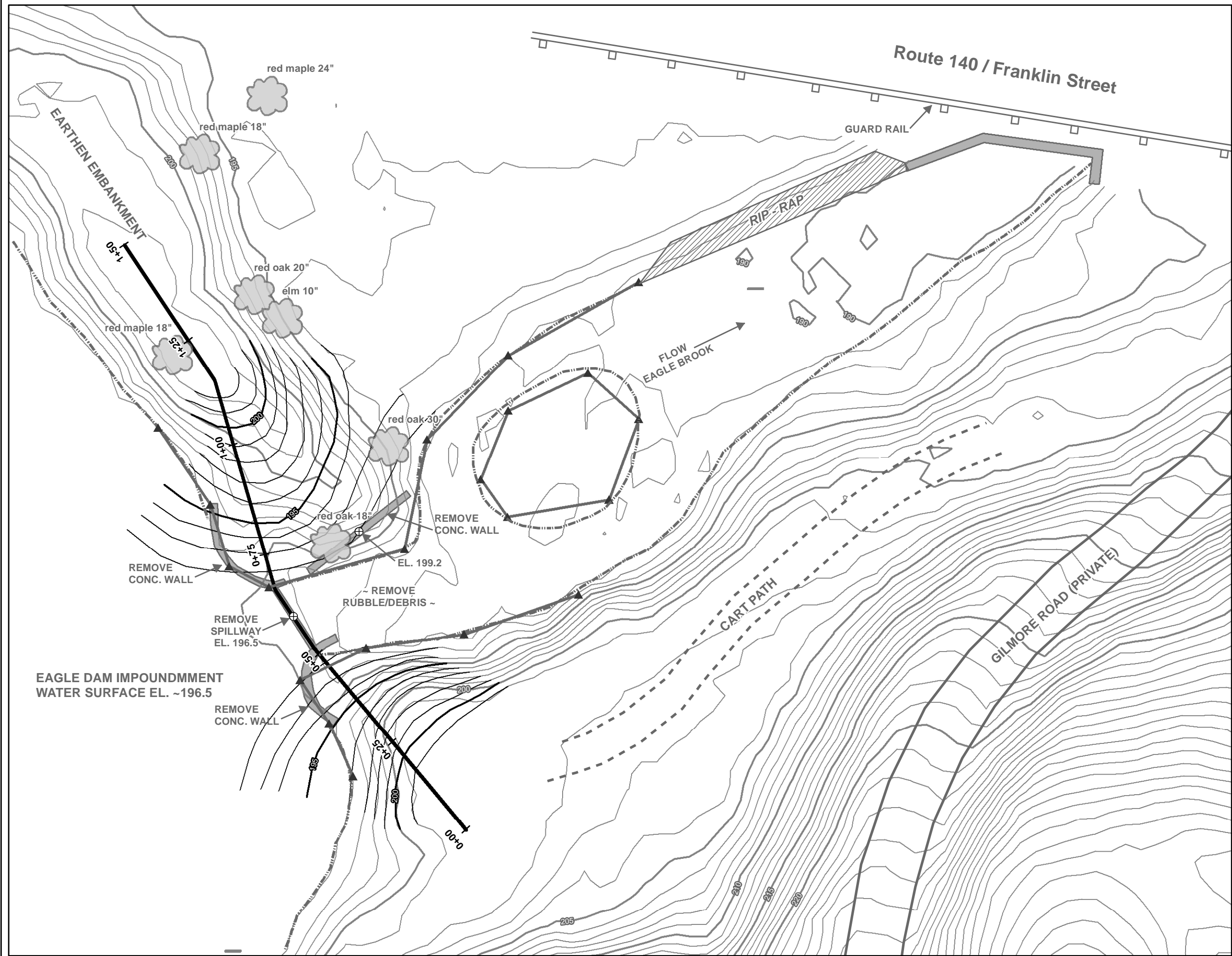
EAGLE DAM
DAM REMOVAL ALTERNATIVE
WRENTHAM, MASSACHUSETTS

EXISTING CONDITIONS PLAN

DATE: 03/09/2021

State Dam ID#: 6-11-350-2
NID ID#: MA02263

SHEET 1 OF 3



Legend

▲

Wetland Flag

⊕

Spot Elevation

—

Flagged Wetland Boundary

—

Profile Line

—

Contours (5-Ft Interval), Proposed Conditions

—

Contours (1-Ft Interval), Proposed Conditions

—

Contours (5-Ft Interval), Existing Conditions


—

Contours (1-Ft Interval), Existing Conditions

Water Line

Notes & Sources:
1) Vertical Datum NAVD 88 feet
2) Pare Corporation, Eagle Dam Phaes 1 Report Site Sketch, 2012
3) Map Grid is Massachusetts State Plane Mainland NAD83 feet
4) MassGIS, LiDAR Elevation Data, 2010





404 Wyman Street
Suite 375 (Center Pod)
Waltham, MA 02451
(781) 419-7696

No.	REVISION	DATE	APP BY

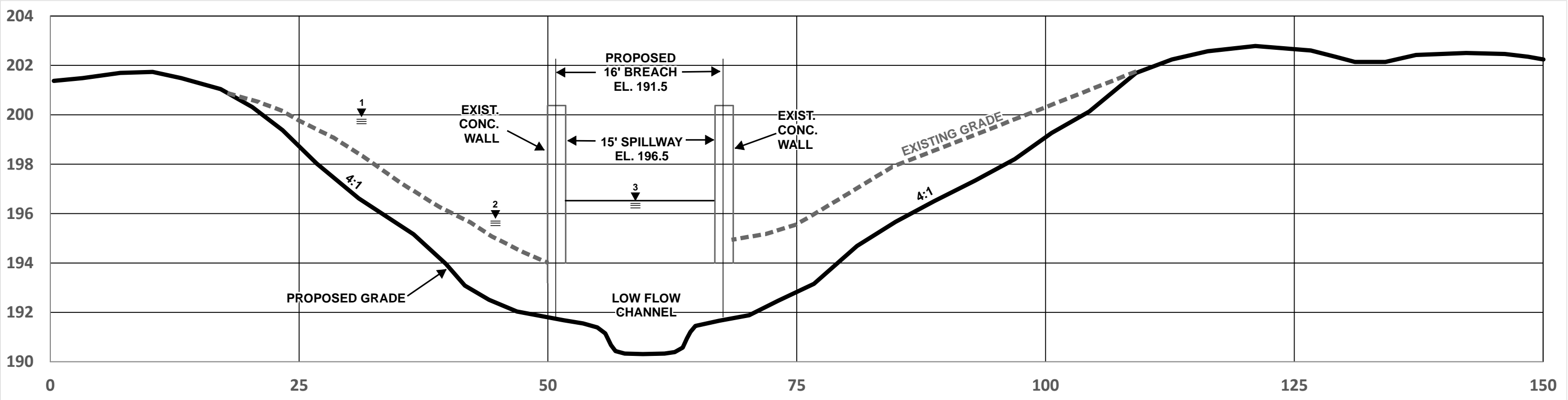
DRAWN BY: SD	CHECKED BY: SC
DESIGNED BY: CW	APPROVED BY: CW

EAGLE DAM
DAM REMOVAL ALTERNATIVE
WRENTHAM, MASSACHUSETTS

PROPOSED GRADING PLAN

DATE: 03/09/2021	State Dam ID#: 6-11-350-2 NID ID#: MA02263
------------------	---

SHEET 2 OF 3



- 1

▼

≡

Modeled 100 yr Water Surface
(EL. 199.86)
- 2

▼

≡

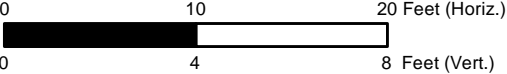
Modeled 25 yr Water Surface
(EL. 195.75)
- 3


▼

≡

Approximate Impoundment
Water Surface Elevation 196.5

Notes & Sources:
1) Vertical Datum NAVD 88 feet
2) Pare Corporation, Eagle Dam Phaes 1 Report Site Sketch, 2012
3) Horizontal and vertical units in feet





404 Wyman Street
Suite 375 (Center Pod)
Waltham, MA 02451
(781) 419-7696

No.	REVISION	DATE	APP BY

DRAWN BY: SD	CHECKED BY: SC
DESIGNED BY: CW	APPROVED BY: CW

EAGLE DAM
DAM REMOVAL ALTERNATIVE
WRENTHAM, MASSACHUSETTS

PROFILE VIEW

DATE: 03/09/2021	State Dam ID#: 6-11-350-2 NID ID#: MA02263
------------------	---

SHEET 3 OF 3

Appendix C

Natural Heritage Correspondence





MASSWILDLIFE

DIVISION OF FISHERIES & WILDLIFE

1 Rabbit Hill Road, Westborough, MA 01581

p: (508) 389-6300 | f: (508) 389-7890

MASS.GOV/MASSWILDLIFE

December 13, 2019

Delilah Bethel
Charles River Watershed Association
190 Park Road
Weston MA 02493

RE: Project Location: Eagle Brook Dam
Town: WRENTHAM
NHESP Tracking No.: 19-39062

To Whom It May Concern:

Thank you for contacting the Natural Heritage and Endangered Species Program of the MA Division of Fisheries & Wildlife (the "Division") for information regarding state-listed rare species in the vicinity of the above referenced site. Based on the information provided, this project site, or a portion thereof, is located **within** *Priority Habitat 814* (PH 814) and *Estimated Habitat 667* (EH 667) as indicated in the *Massachusetts Natural Heritage Atlas* (14th Edition) for the following state-listed rare species:

<u>Scientific name</u>	<u>Common Name</u>	<u>Taxonomic Group</u>	<u>State Status</u>
<i>Notropis bifrenatus</i>	Bridle Shiner	Fish	Special Concern

The species listed above is protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.mass.gov/nhesp).

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. If the purpose of your inquiry is to generate a species list to fulfill the federal Endangered Species Act (16 U.S.C. 1531 et seq.) information requirements for a permit, proposal, or authorization of any kind from a federal agency, we recommend that you contact the National Marine Fisheries Service at (978)281-9328 and use the U.S. Fish and Wildlife Service's Information for Planning and Conservation website (<https://ecos.fws.gov/ipac>). If you have any questions regarding this letter please contact Emily Holt, Endangered Species Review Assistant, at (508) 389-6385.

Sincerely,

Everose Schlüter, Ph.D.
Assistant Director

MASSWILDLIFE

Appendix D

Laboratory Results





Technologies to manage risk
for infrastructure

Boston
Atlanta
Chicago
Los Angeles
New York

www.geotesting.com

Transmittal

TO:

Craig Wood

ESS Group, Inc.

10 Hemingway Drive, 2nd floor

East Providence, RI 02915

DATE: 2/6/2020


GTX NO: 311202

RE: Eagle Dam

COPIES	DATE	DESCRIPTION
	2/6/2020	January and February 2020 Laboratory Test Report

REMARKS:

SIGNED:


Jonathan Campbell, Laboratory Manager

APPROVED BY:


Joe Tomei, Director of Testing Services



*Technologies to manage risk
for infrastructure*

Boston
Atlanta
Chicago
Los Angeles
New York

www.geotesting.com

February 6, 2020

Craig Wood
ESS Group, Inc.
10 Hemingway Drive, 2nd floor
East Providence, RI 02915

RE: Eagle Dam, Wrentham, MA (GTX-311202)

Dear Craig:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received three samples from you on 1/17/2020. These samples were labeled as follows:

Sample Number
Eagle Sed 1 Comp
Eagle Sed 2 Comp
Eagle Sed 3 Comp

GTX performed the following tests on each of these samples:

ASTM D2216 - Moisture Content
ASTM D422 - Grain Size Analysis - Sieve Only

GTX also subcontracted Alpha Analytical of Westborough, MA to perform Total Organic Carbon on each of these samples. See the attached Alpha test report for results.

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,
Jonathan Campbell
Laboratory Manager



*Technologies to manage risk
for infrastructure*

Boston
Atlanta
Chicago
Los Angeles
New York

www.geotesting.com

Geotechnical Test Report

2/6/2020

GTX-311202

Eagle Dam

Wrentham, MA

Client Project No.: W350-000

Prepared for:

ESS Group, Inc.



Client:	ESS Group, Inc.	Project No:	GTX-311202
Project:	Eagle Dam		
Location:	Wrentham, MA		
Boring ID:	---	Sample Type:	---
Sample ID:	---	Test Date:	01/30/20
Depth :	---	Test Id:	540698
		Tested By:	ckg
		Checked By:	jsc

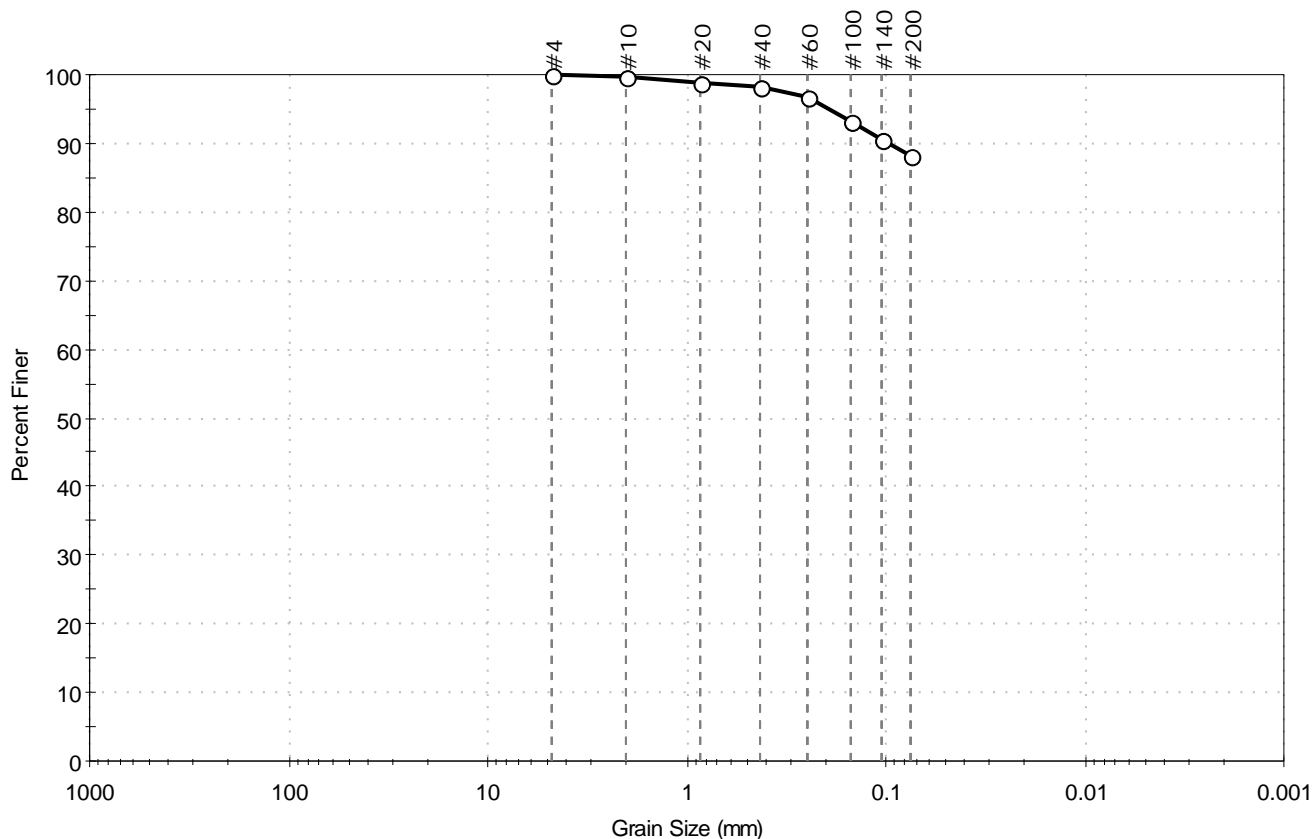
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
---	Eagle Sed 1 Comp	---	Moist, very dark brown silt	575.3
---	Eagle Sed 2 Comp	---	Moist, very dark brown sandy silt	342.9
---	Eagle Sed 3 Comp	---	Moist, very dark brown silty sand	133.6

Notes: Temperature of Drying : 110° Celsius

Client: ESS Group, Inc.	Project No: GTX-311202	
Project: Eagle Dam		
Location: Wrentham, MA		
Boring ID: ---	Sample Type: bag	Tested By: ckg
Sample ID: Eagle Sed 1 Comp	Test Date: 02/03/20	Checked By: jsc
Depth: ---	Test Id: 540693	
Test Comment: ---		
Visual Description: Moist, very dark brown silt		
Sample Comment: ---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	11.7	88.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	98		
#60	0.25	97		
#100	0.15	93		
#140	0.11	91		
#200	0.075	88		

Coefficients

D ₈₅ = N/A	D ₃₀ = N/A
D ₆₀ = N/A	D ₁₅ = N/A
D ₅₀ = N/A	D ₁₀ = N/A
C _u = N/A	C _c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

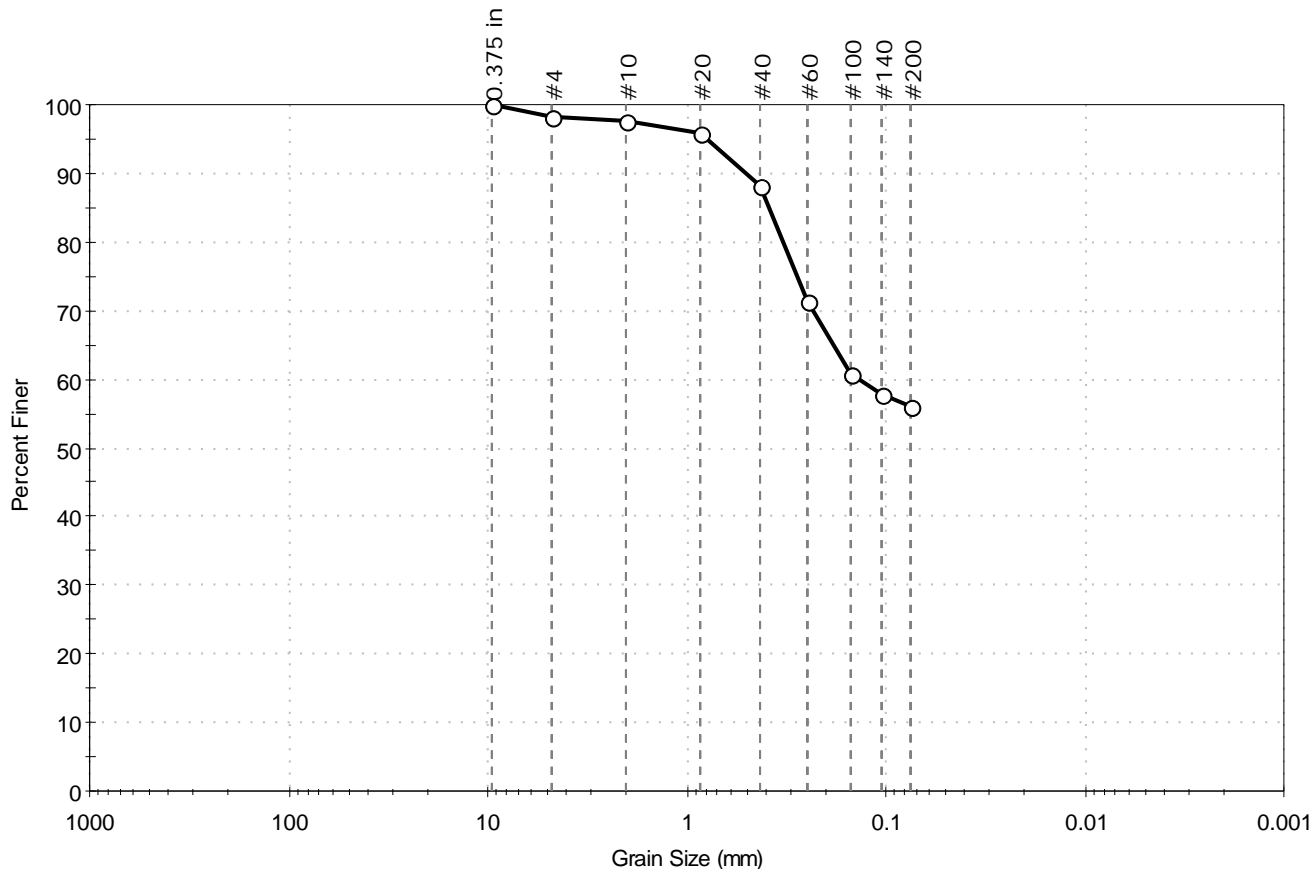
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client: ESS Group, Inc.	Project No: GTX-311202	
Project: Eagle Dam		
Location: Wrentham, MA		
Boring ID: ---	Sample Type: bag	Tested By: ckg
Sample ID: Eagle Sed 2 Comp	Test Date: 02/03/20	Checked By: jsc
Depth: ---	Test Id: 540694	
Test Comment: ---		
Visual Description: Moist, very dark brown sandy silt		
Sample Comment: ---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	1.8	42.1	56.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	98		
#20	0.85	96		
#40	0.42	88		
#60	0.25	71		
#100	0.15	61		
#140	0.11	58		
#200	0.075	56		

Coefficients

$D_{85} = 0.3843 \text{ mm}$ $D_{30} = \text{N/A}$
 $D_{60} = 0.1366 \text{ mm}$ $D_{15} = \text{N/A}$
 $D_{50} = \text{N/A}$ $D_{10} = \text{N/A}$
 $C_u = \text{N/A}$ $C_c = \text{N/A}$

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

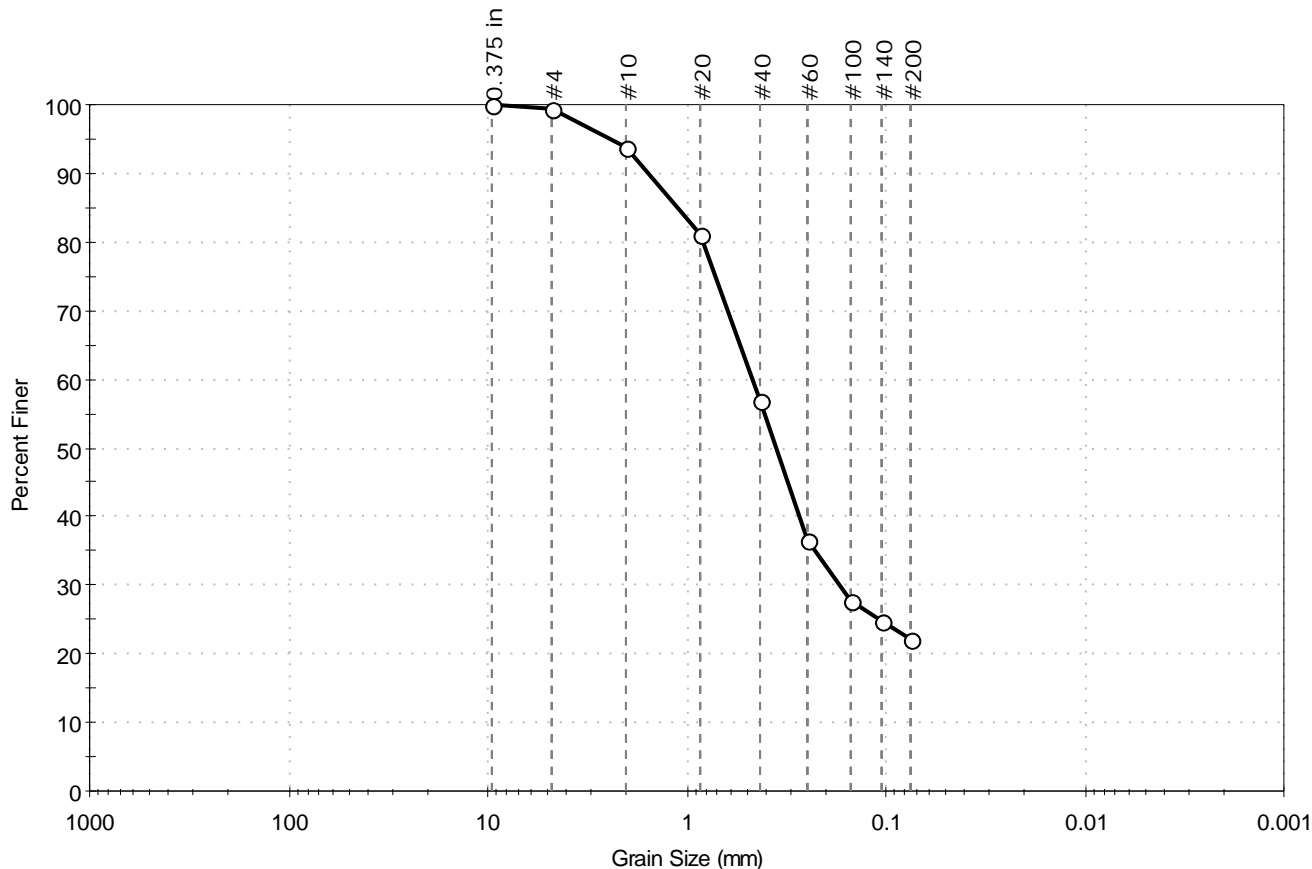
Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

Client: ESS Group, Inc.	Project No: GTX-311202	
Project: Eagle Dam		
Location: Wrentham, MA		
Boring ID: ---	Sample Type: bag	Tested By: ckg
Sample ID: Eagle Sed 3 Comp	Test Date: 02/03/20	Checked By: jsc
Depth: ---	Test Id: 540695	
Test Comment: ---		
Visual Description: Moist, very dark brown silty sand		
Sample Comment: ---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.5	77.4	22.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	94		
#20	0.85	81		
#40	0.42	57		
#60	0.25	36		
#100	0.15	28		
#140	0.11	25		
#200	0.075	22		

Coefficients

$D_{85} = 1.1098 \text{ mm}$ $D_{30} = 0.1703 \text{ mm}$
 $D_{60} = 0.4646 \text{ mm}$ $D_{15} = \text{N/A}$
 $D_{50} = 0.3552 \text{ mm}$ $D_{10} = \text{N/A}$
 $C_u = \text{N/A}$ $C_c = \text{N/A}$

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR
 Sand/Gravel Hardness : HARD



ANALYTICAL REPORT

Lab Number:	L2002843
Client:	Geo Testing Express 125 Nagog Park Acton, MA 01720
ATTN:	Ethan Marro
Phone:	(978) 635-0424
Project Name:	EAGLE DAM
Project Number:	311202
Report Date:	01/28/20

The original project report/data package is held by Alpha Analytical. This report/data package is paginated and should be reproduced only in its entirety. Alpha Analytical holds no responsibility for results and/or data that are not consistent with the original.

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com



Project Name: EAGLE DAM
Project Number: 311202

Lab Number: L2002843
Report Date: 01/28/20

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2002843-01	EAGLE SED 1 COMP	SOIL	WRENTHAM, MA	01/21/20 00:00	01/21/20
L2002843-02	EAGLE SED 2 COMP	SOIL	WRENTHAM, MA	01/21/20 00:00	01/21/20
L2002843-03	EAGLE SED 3 COMP	SOIL	WRENTHAM, MA	01/21/20 00:00	01/21/20

Project Name: EAGLE DAM
Project Number: 311202

Lab Number: L2002843
Report Date: 01/28/20

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name: EAGLE DAM
Project Number: 311202

Lab Number: L2002843
Report Date: 01/28/20


Case Narrative (continued)

Sample Receipt

L2002843-01, -02, and -03: The sample was received in an inappropriate container for the Total Organic Carbon - Lloyd Kahn analysis (plastic bag). An aliquot was taken from the bag and transferred to glass/refrigeration prior to analysis.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:

 Elizabeth Porta

Title: Technical Director/Representative

Date: 01/28/20

INORGANICS & MISCELLANEOUS

Project Name: EAGLE DAM

Project Number: 311202

Lab Number: L2002843

Report Date: 01/28/20

SAMPLE RESULTS

Lab ID: L2002843-01

Client ID: EAGLE SED 1 COMP

Sample Location: WRENTHAM, MA

Date Collected: 01/21/20 00:00

Date Received: 01/21/20

Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	20.1		%	0.050	--	1	-	01/28/20 11:38	13,-	SP
Total Organic Carbon (Rep2)	19.0		%	0.050	--	1	-	01/28/20 11:38	13,-	SP
Total Organic Carbon (Average)	19.5		%	0.050	--	1	-	01/28/20 11:38	13,-	SP
General Chemistry - Westborough Lab										
Solids, Total	16.5		%	0.100	NA	1	-	01/22/20 11:01	121,2540G	RI



Project Name: EAGLE DAM

Project Number: 311202

Lab Number: L2002843

Report Date: 01/28/20

SAMPLE RESULTS

Lab ID: L2002843-02

Client ID: EAGLE SED 2 COMP

Sample Location: WRENTHAM, MA

Date Collected: 01/21/20 00:00

Date Received: 01/21/20

Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	10.4		%	0.050	--	1	-	01/28/20 11:50	13,-	SP
Total Organic Carbon (Rep2)	8.49		%	0.050	--	1	-	01/28/20 11:50	13,-	SP
Total Organic Carbon (Average)	9.44		%	0.050	--	1	-	01/28/20 11:50	13,-	SP
General Chemistry - Westborough Lab										
Solids, Total	24.1		%	0.100	NA	1	-	01/22/20 11:01	121,2540G	RI



Project Name: EAGLE DAM

Project Number: 311202

Lab Number: L2002843

Report Date: 01/28/20

SAMPLE RESULTS

Lab ID: L2002843-03

Client ID: EAGLE SED 3 COMP

Sample Location: WRENTHAM, MA

Date Collected: 01/21/20 00:00

Date Received: 01/21/20

Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab										
Total Organic Carbon (Rep1)	2.97		%	0.050	--	1	-	01/28/20 12:13	13,-	SP
Total Organic Carbon (Rep2)	3.28		%	0.050	--	1	-	01/28/20 12:13	13,-	SP
Total Organic Carbon (Average)	3.13		%	0.050	--	1	-	01/28/20 12:13	13,-	SP
General Chemistry - Westborough Lab										
Solids, Total	46.2		%	0.100	NA	1	-	01/22/20 11:01	121,2540G	RI



Project Name: EAGLE DAM

Lab Number: L2002843

Project Number: 311202

Report Date: 01/28/20

Method Blank Analysis Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Organic Carbon - Mansfield Lab for sample(s): 01-03 Batch: WG1332746-1										
Total Organic Carbon (Rep1)	ND		%	0.050	--	1	-	01/28/20 10:05	13,-	SP
Total Organic Carbon (Rep2)	ND		%	0.050	--	1	-	01/28/20 10:05	13,-	SP
Total Organic Carbon (Average)	ND		%	0.050	--	1	-	01/28/20 10:05	13,-	SP



Lab Control Sample Analysis

Batch Quality Control

Project Name: EAGLE DAM

Project Number: 311202

Lab Number: L2002843

Report Date: 01/28/20

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Total Organic Carbon - Mansfield Lab Associated sample(s): 01-03 Batch: WG1332746-2								
Total Organic Carbon (Rep1)	109		-		75-125	-		25
Total Organic Carbon (Rep2)	113		-		75-125	-		25
Total Organic Carbon (Average)	111		-		75-125	-		25

Project Name: EAGLE DAM
Project Number: 311202

Lab Duplicate Analysis
Batch Quality Control

Lab Number: L2002843
Report Date: 01/28/20

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-03 QC Batch ID: WG1332635-1 QC Sample: L2002839-01 Client ID: DUP Sample						
Solids, Total	73.2	74.1	%	1		20

Project Name: EAGLE DAM**Lab Number:** L2002843**Project Number:** 311202**Report Date:** 01/28/20**Sample Receipt and Container Information**

Were project specific reporting limits specified?

YES

Cooler Information**Cooler** **Custody Seal**

A Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2002843-01A	Bag	A	NA		3.2	Y	Absent		A2-TOC-LK-2REPS(14)
L2002843-01B	Glass 60ml unpreserved split	A	NA		3.2	Y	Absent		TS(7)
L2002843-02A	Bag	A	NA		3.2	Y	Absent		A2-TOC-LK-2REPS(14)
L2002843-02B	Glass 60ml unpreserved split	A	NA		3.2	Y	Absent		TS(7)
L2002843-03A	Bag	A	NA		3.2	Y	Absent		A2-TOC-LK-2REPS(14)
L2002843-03B	Glass 60ml unpreserved split	A	NA		3.2	Y	Absent		TS(7)

Project Name: EAGLE DAM**Lab Number:** L2002843**Project Number:** 311202**Report Date:** 01/28/20

GLOSSARY

Acronyms

DL	- Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LOD	- Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
LOQ	- Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
	Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Footnotes

Report Format: Data Usability Report

Project Name: EAGLE DAM**Lab Number:** L2002843**Project Number:** 311202**Report Date:** 01/28/20

- 1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA, this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

- A** - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.
- B** - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).
- C** - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.
- D** - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.
- E** - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
- G** - The concentration may be biased high due to matrix interferences (i.e., co-elution) with non-target compound(s). The result should be considered estimated.
- H** - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.
- I** - The lower value for the two columns has been reported due to obvious interference.
- J** - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).
- M** - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.
- ND** - Not detected at the reporting limit (RL) for the sample.
- NJ** - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.
- P** - The RPD between the results for the two columns exceeds the method-specified criteria.
- Q** - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less

Report Format: Data Usability Report



Project Name: EAGLE DAM**Project Number:** 311202**Lab Number:** L2002843**Report Date:** 01/28/20**Data Qualifiers**

than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.**RE** - Analytical results are from sample re-extraction.**S** - Analytical results are from modified screening analysis.

Project Name: EAGLE DAM
Project Number: 311202

Lab Number: L2002843
Report Date: 01/28/20

REFERENCES

- 13 Determination of Total Organic Carbon in Sediment. U.S. EPA, Region II. July 27, 1988.
- 121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.



Alpha Analytical, Inc.Facility: **Company-wide**Department: **Quality Assurance**Title: **Certificate/Approval Program Summary**ID No.: **17873**

Revision 15

Published Date: 8/15/2019 9:53:42 AM

Page 1 of 1

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility**EPA 624/624.1:** m/p-xylene, o-xylene**EPA 8260C:** NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.**EPA 8270D:** NPW: Dimethylnaphthalene, 1,4-Diphenylhydrazine; SCM: Dimethylnaphthalene, 1,4-Diphenylhydrazine.**SM4500:** NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO₂, NO₃.**Mansfield Facility****SM 2540D:** TSS**EPA 8082A:** NPW: PCB: 1, 5, 31, 87, 101, 110, 141, 151, 153, 180, 183, 187.**EPA TO-15:** Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene,

3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.

Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:**Drinking Water****EPA 300.0:** Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2:** Nitrate-N, Nitrite-N; **SM4500NO3-F:** Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE,****EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B****EPA 332:** Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.**Microbiology:** **SM9215B; SM9223-P/A, SM9223B-Colilert-QT, SM9222D.****Non-Potable Water****SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH:** Ammonia-N and Kjeldahl-N, **EPA 350.1:**Ammonia-N, **LACHAT 10-107-06-1-B:** Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2:** Nitrate-N, **SM4500P-E, SM4500P-B, E, SM4500SO4-E,****SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300:** Chloride, Sulfate, Nitrate.**EPA 624.1:** Volatile Halocarbons & Aromatics,**EPA 608.3:** Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs**EPA 625.1:** SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045:** PCB-Oil.**Microbiology:** **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603.****Mansfield Facility:****Drinking Water****EPA 200.7:** Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.**EPA 522.****Non-Potable Water****EPA 200.7:** Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.**EPA 200.8:** Al, Sb, As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.**EPA 245.1** Hg.**SM2340B**

For a complete listing of analytes and methods, please contact your Alpha Project Manager.



CHAIN OF CUSTODY

GeoTesting Express, Inc.
125 Nagog Park
Acton, MA 01720
800-434-1062 Toll Free
978-635-0424 Phone
978-635-0266 Fax

Sales Order No.:
GTX No.:

Company Name: ESS Group Address: 10 HUMPHREY DRIVE, 2ND FLOOR EAST PROVIDENCE, RI 02915 Contact: CRAIG WOOD e-mail: CWOOD@ESSGROUP.COM Phone Number: Fax Number: Project Name: Eagle Dam Project Number: W350-000 Project Location: WINTHROP, MA					Analysis																							
					Sample Type 1. Soil 2. Geosynthetic 3. Rock 4. Concrete 5. Other	Container Type 1. Bucket 2. Bag 3. Jar 4. Tube 5. Roll																						
						Grain Size					% moisture					% organic												
Sample Identification					Container Size Type		Sampling Date Time		Sample Type		Comments																	
Eagle sed 1 comp					10-A1 Z		11/15/20		1155		5. Sediment		X		X		X											
Eagle sed 2 comp					↓ Z		↓		1225		↓		↓		↓		↓											
Eagle sed 3 comp					↓ Z		↓		1300		↓		↓		↓		↓											
Relinquished By: Mike MATHNEY (ESS Group)							Date: 11/16/20 Time: 1030			Received By: 							Date: 11/17/2020 Time: 10:45			Turn-Around Time Requested:								
Relinquished By:							Date: Time:			Received By:							Date: Time:			No. of Business Days: 5-7 Business Days								
Relinquished By:							Date: Time:			Received By:							Date: Time:			Special Instructions:								
SHIPPED VIA:																												

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$	S_r	Post cyclic undrained shear strength
B	pore pressure parameter for $\Delta\sigma_3$	T	temperature
CAI	CERCHAR Abrasiveness Index	t	time
CIU	isotropically consolidated undrained triaxial shear test	U, UC	unconfined compression test
CR	compression ratio for one dimensional consolidation	UU, Q	unconsolidated undrained triaxial test
CSR	cyclic stress ratio	u_a	pore gas pressure
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$	u_e	excess pore water pressure
C_u	coefficient of uniformity, D_{60}/D_{10}	u, u_w	pore water pressure
C_c	compression index for one dimensional consolidation	V	total volume
C_a	coefficient of secondary compression	V_g	volume of gas
c_v	coefficient of consolidation	V_s	volume of solids
c	cohesion intercept for total stresses	V_s	shear wave velocity
c'	cohesion intercept for effective stresses	V_v	volume of voids
D	diameter of specimen	V_w	volume of water
D	damping ratio	V_o	initial volume
D_{10}	diameter at which 10% of soil is finer	v	velocity
D_{15}	diameter at which 15% of soil is finer	W	total weight
D_{30}	diameter at which 30% of soil is finer	W_s	weight of solids
D_{50}	diameter at which 50% of soil is finer	W_w	weight of water
D_{60}	diameter at which 60% of soil is finer	w	water content
D_{85}	diameter at which 85% of soil is finer	w_c	water content at consolidation
d_{50}	displacement for 50% consolidation	w_f	final water content
d_{90}	displacement for 90% consolidation	w_l	liquid limit
d_{100}	displacement for 100% consolidation	w_n	natural water content
E	Young's modulus	w_p	plastic limit
e	void ratio	w_s	shrinkage limit
e_c	void ratio after consolidation	w_o, w_i	initial water content
e_o	initial void ratio	α	slope of q_f versus p_f
G	shear modulus	α'	slope of q_f versus p_f'
G_s	specific gravity of soil particles	γ_t	total unit weight
H	height of specimen	γ_d	dry unit weight
H_R	Rebound Hardness number	γ_s	unit weight of solids
i	gradient	γ_w	unit weight of water
I_s	Uncorrected point load strength	ϵ	strain
$I_{s(50)}$	Size corrected point load strength index	ϵ_{vol}	volume strain
H_A	Modified Taber Abrasion	ϵ_h, ϵ_v	horizontal strain, vertical strain
H_T	Total hardness	μ	Poisson's ratio, also viscosity
K_o	lateral stress ratio for one dimensional strain	σ	normal stress
k	permeability	σ'	effective normal stress
LI	Liquidity Index	σ_c, σ'_c	consolidation stress in isotropic stress system
m_v	coefficient of volume change	σ_h, σ'_h	horizontal normal stress
n	porosity	σ_v, σ'_v	vertical normal stress
PI	plasticity index	σ'_{vc}	Effective vertical consolidation stress
P_c	preconsolidation pressure	σ_1	major principal stress
p	$(\sigma_1 + \sigma_3) / 2, (\sigma_v + \sigma_h) / 2$	σ_2	intermediate principal stress
p'	$(\sigma'_1 + \sigma'_3) / 2, (\sigma'_v + \sigma'_h) / 2$	σ_3	minor principal stress
p'_c	p' at consolidation	τ	shear stress
Q	quantity of flow	ϕ	friction angle based on total stresses
q	$(\sigma_1 - \sigma_3) / 2$	ϕ'	friction angle based on effective stresses
q_f	q at failure	ϕ'_r	residual friction angle
q_o, q_i	initial q	ϕ_{ult}	ϕ for ultimate strength
q_c	q at consolidation		



Monday, January 27, 2020

Attn: Mr Matt Ladewig
ESS Group Inc.
10 Hemingway Drive 2nd Floor
Riverside, RI 02915-2224

Project ID: EAGLE DAM
SDG ID: GCF15233
Sample ID#s: CF15233 - CF15235

This laboratory is in compliance with the NELAC requirements of procedures used except where indicated.

This report contains results for the parameters tested, under the sampling conditions described on the Chain Of Custody, as received by the laboratory. This report is incomplete unless all pages indicated in the pagination at the bottom of the page are included.

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

A scanned version of the COC form accompanies the analytical report and is an exact duplicate of the original.

If you are the client above and have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext.200. The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Phyllis Shiller".

Phyllis Shiller

Laboratory Director

NELAC - #NY11301
CT Lab Registration #PH-0618
MA Lab Registration #M-CT007
ME Lab Registration #CT-007
NH Lab Registration #213693-A,B

NJ Lab Registration #CT-003
NY Lab Registration #11301
PA Lab Registration #68-03530
RI Lab Registration #63
UT Lab Registration #CT00007
VT Lab Registration #VT11301



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

Sample Id Cross Reference

January 27, 2020

SDG I.D.: GCF15233

Project ID: EAGLE DAM

Client Id	Lab Id	Matrix
EAGLE SED 1 COMP	CF15233	SEDIMENT
EAGLE SED 2 COMP	CF15234	SEDIMENT
EAGLE SED 3 COMP	CF15235	SEDIMENT



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

Analysis Report

January 27, 2020

FOR: Attn: Mr Matt Ladewig
ESS Group Inc.
10 Hemingway Drive 2nd Floor
Riverside, RI 02915-2224

Sample Information

Matrix: SEDIMENT
Location Code: ESSGRPRI
Rush Request: Standard
P.O.#:

Custody Information

Collected by:
Received by: SW
Analyzed by: see "By" below

Date

01/15/20
01/17/20

Time

11:55
15:46

Laboratory Data

SDG ID: GCF15233
Phoenix ID: CF15233

Project ID: EAGLE DAM
Client ID: EAGLE SED 1 COMP

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
Arsenic	3.7	1.3	mg/Kg	1	01/21/20	TH	SW6010D
Chromium	22.9	0.66	mg/Kg	1	01/21/20	TH	SW6010D
Copper	15.6	0.66	mg/Kg	1	01/21/20	TH	SW6010D
Mercury	< 0.34	0.34	mg/kg	5	01/21/20	RS	SW7471B
Nickel	25.3	0.66	mg/Kg	1	01/21/20	TH	SW6010D
Lead	40.0	0.66	mg/Kg	1	01/21/20	TH	SW6010D
Zinc	76.9	0.66	mg/Kg	1	01/21/20	TH	SW6010D
Percent Solid	15.1	1	%		01/17/20		SW846-%Solid
Total Solids @ 104C	15.1	0.1	%	1	01/17/20	AP/ARG	SM2540B-11
Phosphorus, Total	320	3.3	mg/Kg	1	01/20/20	JR	SM4500PE-11
Soil Extraction for PCB	Completed				01/20/20	MM/L	SW3545A
Soil Extraction for Pesticide	Completed				01/20/20	MM/L	SW3545A
Extraction for SVOA SIM	Completed				01/22/20	BV/AL	SW3545A
Mercury Digestion	Completed				01/21/20	Q/LS	SW7471B
Total Metals Digest	Completed				01/17/20	JJ/AG	SW3050B

Polychlorinated Biphenyls

PCB-1016	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1221	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1232	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1242	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1248	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1254	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1260	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1262	ND	440	ug/Kg	2	01/21/20	SC	SW8082A
PCB-1268	ND	440	ug/Kg	2	01/21/20	SC	SW8082A

QA/QC Surrogates

% DCBP	62	%	2	01/21/20	SC	30 - 150 %
--------	----	---	---	----------	----	------------

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
% DCBP (Confirmation)	69		%	2	01/21/20	SC	30 - 150 %
% TCMX	51		%	2	01/21/20	SC	30 - 150 %
% TCMX (Confirmation)	57		%	2	01/21/20	SC	30 - 150 %

Pesticides

4,4' -DDD	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
4,4' -DDE	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
4,4' -DDT	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
a-BHC	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Alachlor	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Aldrin	ND	22	ug/Kg	2	01/23/20	CG	SW8081B
b-BHC	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Chlordane	ND	220	ug/Kg	2	01/23/20	CG	SW8081B
d-BHC	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Dieldrin	ND	22	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan I	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan II	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan sulfate	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Endrin	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Endrin aldehyde	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Endrin ketone	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
g-BHC	ND	8.8	ug/Kg	2	01/23/20	CG	SW8081B
Heptachlor	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Heptachlor epoxide	ND	44	ug/Kg	2	01/23/20	CG	SW8081B
Methoxychlor	ND	220	ug/Kg	2	01/23/20	CG	SW8081B
Toxaphene	ND	880	ug/Kg	2	01/23/20	CG	SW8081B

QA/QC Surrogates

% DCBP	52		%	2	01/23/20	CG	30 - 150 %
% DCBP (Confirmation)	56		%	2	01/23/20	CG	30 - 150 %
% TCMX	42		%	2	01/23/20	CG	30 - 150 %
% TCMX (Confirmation)	44		%	2	01/23/20	CG	30 - 150 %

Polynuclear Aromatic HC (SIM)

2-Methylnaphthalene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Acenaphthene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Acenaphthylene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Anthracene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Benz(a)anthracene	140	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Benzo(a)pyrene	180	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Benzo(b)fluoranthene	170	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Benzo(ghi)perylene	140	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Benzo(k)fluoranthene	160	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Chrysene	190	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Dibenz(a,h)anthracene	34	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Fluoranthene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Fluorene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Indeno(1,2,3-cd)pyrene	160	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Naphthalene	ND	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Phenanthrene	70	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)
Pyrene	190	22	ug/Kg	1	01/23/20	WB	SW8270D (SIM)

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
<u>QA/QC Surrogates</u>							
% 2-Fluorobiphenyl	28		%	1	01/23/20	WB	30 - 130 %
% Nitrobenzene-d5	57		%	1	01/23/20	WB	30 - 130 %
% Terphenyl-d14	34		%	1	01/23/20	WB	30 - 130 %

3 = This parameter exceeds laboratory specified limits.

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

QA/QC Surrogates: Surrogates are compounds (preceded with a %) added by the lab to determine analysis efficiency. Surrogate results(%) listed in the report are not "detected" compounds.

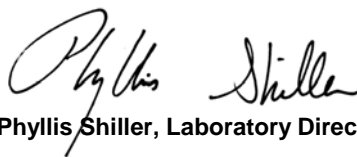
Comments:

Semi-Volatile Comment:

Poor surrogate recovery was observed for one acid and/or one base surrogate. The other surrogates associated with this sample were within QA/QC criteria. No significant bias suspected.

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If you are the client above and have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext.200. The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.



Phyllis Shiller, Laboratory Director

January 27, 2020

Reviewed and Released by: Rashmi Makol, Project Manager



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

Analysis Report

January 27, 2020

FOR: Attn: Mr Matt Ladewig
ESS Group Inc.
10 Hemingway Drive 2nd Floor
Riverside, RI 02915-2224

Sample Information

Matrix: SEDIMENT
Location Code: ESSGRPRI
Rush Request: Standard
P.O.#:

Custody Information

Collected by:
Received by: SW
Analyzed by: see "By" below

Date

01/15/20
01/17/20

Time

12:25
15:46

Laboratory Data

SDG ID: GCF15233
Phoenix ID: CF15234

Project ID: EAGLE DAM
Client ID: EAGLE SED 2 COMP

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
Arsenic	2.39	0.98	mg/Kg	1	01/21/20	TH	SW6010D
Chromium	18.4	0.49	mg/Kg	1	01/21/20	TH	SW6010D
Copper	9.53	0.49	mg/Kg	1	01/21/20	TH	SW6010D
Mercury	< 0.25	0.25	mg/kg	5	01/21/20	RS	SW7471B
Nickel	17.0	0.49	mg/Kg	1	01/21/20	TH	SW6010D
Lead	20.4	0.49	mg/Kg	1	01/21/20	TH	SW6010D
Zinc	53.3	0.49	mg/Kg	1	01/21/20	TH	SW6010D
Percent Solid	23.2	1	%		01/17/20		SW846-%Solid
Total Solids @ 104C	23.2	0.1	%	1	01/17/20	AP/ARG	SM2540B-11
Phosphorus, Total	190	2.2	mg/Kg	1	01/20/20	JR	SM4500PE-11
Soil Extraction for PCB	Completed				01/20/20	MM/L	SW3545A
Soil Extraction for Pesticide	Completed				01/20/20	MM/L	SW3545A
Extraction for SVOA SIM	Completed				01/21/20	BB/AL	SW3545A
Mercury Digestion	Completed				01/21/20	Q/LS	SW7471B
Total Metals Digest	Completed				01/17/20	JJ/AG	SW3050B

Polychlorinated Biphenyls

PCB-1016	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1221	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1232	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1242	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1248	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1254	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1260	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1262	ND	280	ug/Kg	2	01/22/20	SC	SW8082A
PCB-1268	ND	280	ug/Kg	2	01/22/20	SC	SW8082A

QA/QC Surrogates

% DCBP	66	%	2	01/22/20	SC	30 - 150 %
--------	----	---	---	----------	----	------------

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
% DCBP (Confirmation)	71		%	2	01/22/20	SC	30 - 150 %
% TCMX	65		%	2	01/22/20	SC	30 - 150 %
% TCMX (Confirmation)	64		%	2	01/22/20	SC	30 - 150 %

Pesticides

4,4' -DDD	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
4,4' -DDE	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
4,4' -DDT	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
a-BHC	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Alachlor	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Aldrin	ND	14	ug/Kg	2	01/23/20	CG	SW8081B
b-BHC	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Chlordane	ND	140	ug/Kg	2	01/23/20	CG	SW8081B
d-BHC	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Dieldrin	ND	14	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan I	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan II	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan sulfate	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Endrin	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Endrin aldehyde	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Endrin ketone	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
g-BHC	ND	5.6	ug/Kg	2	01/23/20	CG	SW8081B
Heptachlor	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Heptachlor epoxide	ND	28	ug/Kg	2	01/23/20	CG	SW8081B
Methoxychlor	ND	140	ug/Kg	2	01/23/20	CG	SW8081B
Toxaphene	ND	560	ug/Kg	2	01/23/20	CG	SW8081B

QA/QC Surrogates

% DCBP	68		%	2	01/23/20	CG	30 - 150 %
% DCBP (Confirmation)	69		%	2	01/23/20	CG	30 - 150 %
% TCMX	55		%	2	01/23/20	CG	30 - 150 %
% TCMX (Confirmation)	58		%	2	01/23/20	CG	30 - 150 %

Polynuclear Aromatic HC (SIM)

2-Methylnaphthalene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Acenaphthene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Acenaphthylene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Anthracene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benz(a)anthracene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(a)pyrene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(b)fluoranthene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(ghi)perylene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(k)fluoranthene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Chrysene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Dibenz(a,h)anthracene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Fluoranthene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Fluorene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Indeno(1,2,3-cd)pyrene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Naphthalene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Phenanthrene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Pyrene	ND	14	ug/Kg	1	01/22/20	WB	SW8270D (SIM)

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
<u>QA/QC Surrogates</u>							
% 2-Fluorobiphenyl	33		%	1	01/22/20	WB	30 - 130 %
% Nitrobenzene-d5	51		%	1	01/22/20	WB	30 - 130 %
% Terphenyl-d14	27		%	1	01/22/20	WB	30 - 130 %

3

3 = This parameter exceeds laboratory specified limits.

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

QA/QC Surrogates: Surrogates are compounds (preceded with a %) added by the lab to determine analysis efficiency. Surrogate results(%) listed in the report are not "detected" compounds.

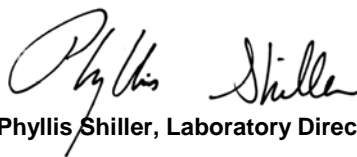
Comments:

Semi-Volatile Comment:

Poor surrogate recovery was observed for one acid and/or one base surrogate. The other surrogates associated with this sample were within QA/QC criteria. No significant bias suspected.

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If you are the client above and have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext.200. The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.



Phyllis Shiller, Laboratory Director

January 27, 2020

Reviewed and Released by: Rashmi Makol, Project Manager



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

Analysis Report

January 27, 2020

FOR: Attn: Mr Matt Ladewig
ESS Group Inc.
10 Hemingway Drive 2nd Floor
Riverside, RI 02915-2224

Sample Information

Matrix: SEDIMENT
Location Code: ESSGRPRI
Rush Request: Standard
P.O.#:

Custody Information

Collected by:
Received by: SW
Analyzed by: see "By" below

Date

01/15/20
01/17/20

Time

13:00
15:46

Laboratory Data

SDG ID: GCF15233
Phoenix ID: CF15235

Project ID: EAGLE DAM
Client ID: EAGLE SED 3 COMP

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
Arsenic	4.52	0.32	mg/Kg	1	01/21/20	TH	SW6010D
Chromium	13.2	0.16	mg/Kg	1	01/21/20	TH	SW6010D
Copper	12.8	0.16	mg/Kg	1	01/21/20	TH	SW6010D
Mercury	< 0.15	0.15	mg/kg	5	01/21/20	RS	SW7471B
Nickel	17.1	0.16	mg/Kg	1	01/21/20	TH	SW6010D
Lead	48.4	0.16	mg/Kg	1	01/21/20	TH	SW6010D
Zinc	83.9	0.16	mg/Kg	1	01/21/20	TH	SW6010D
Percent Solid	32.6	1	%		01/17/20		SW846-%Solid
Total Solids @ 104C	32.6	0.1	%	1	01/17/20	AP/ARG	SM2540B-11
Phosphorus, Total	200	1.5	mg/Kg	1	01/20/20	JR	SM4500PE-11
Soil Extraction for PCB	Completed				01/20/20	MM/L	SW3545A
Soil Extraction for Pesticide	Completed				01/20/20	MM/L	SW3545A
Extraction for SVOA SIM	Completed				01/21/20	BB/AL	SW3545A
Mercury Digestion	Completed				01/21/20	Q/LS	SW7471B
Total Metals Digest	Completed				01/17/20	JJ/AG	SW3050B

Polychlorinated Biphenyls

PCB-1016	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1221	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1232	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1242	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1248	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1254	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1260	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1262	ND	500	ug/Kg	5	01/21/20	SC	SW8082A
PCB-1268	ND	500	ug/Kg	5	01/21/20	SC	SW8082A

QA/QC Surrogates

% DCBP	101		%	5	01/21/20	SC	30 - 150 %
--------	-----	--	---	---	----------	----	------------

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
% DCBP (Confirmation)	112		%	5	01/21/20	SC	30 - 150 %
% TCMX	92		%	5	01/21/20	SC	30 - 150 %
% TCMX (Confirmation)	103		%	5	01/21/20	SC	30 - 150 %

Pesticides

4,4' -DDD	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
4,4' -DDE	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
4,4' -DDT	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
a-BHC	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Alachlor	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Aldrin	ND	10	ug/Kg	2	01/23/20	CG	SW8081B
b-BHC	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Chlordane	ND	100	ug/Kg	2	01/23/20	CG	SW8081B
d-BHC	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Dieldrin	ND	10	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan I	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan II	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Endosulfan sulfate	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Endrin	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Endrin aldehyde	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Endrin ketone	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
g-BHC	ND	4.0	ug/Kg	2	01/23/20	CG	SW8081B
Heptachlor	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Heptachlor epoxide	ND	20	ug/Kg	2	01/23/20	CG	SW8081B
Methoxychlor	ND	100	ug/Kg	2	01/23/20	CG	SW8081B
Toxaphene	ND	400	ug/Kg	2	01/23/20	CG	SW8081B

QA/QC Surrogates

% DCBP	88		%	2	01/23/20	CG	30 - 150 %
% DCBP (Confirmation)	85		%	2	01/23/20	CG	30 - 150 %
% TCMX	70		%	2	01/23/20	CG	30 - 150 %
% TCMX (Confirmation)	71		%	2	01/23/20	CG	30 - 150 %

Polynuclear Aromatic HC (SIM)

2-Methylnaphthalene	ND	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Acenaphthene	ND	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Acenaphthylene	ND	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Anthracene	ND	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benz(a)anthracene	79	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(a)pyrene	69	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(b)fluoranthene	67	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(ghi)perylene	35	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Benzo(k)fluoranthene	70	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Chrysene	86	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Dibenz(a,h)anthracene	11	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Fluoranthene	140	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Fluorene	ND	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Indeno(1,2,3-cd)pyrene	42	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Naphthalene	ND	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Phenanthrene	32	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)
Pyrene	130	10	ug/Kg	1	01/22/20	WB	SW8270D (SIM)

Parameter	Result	RL/ PQL	Units	Dilution	Date/Time	By	Reference
<u>QA/QC Surrogates</u>							
% 2-Fluorobiphenyl	37		%	1	01/22/20	WB	30 - 130 %
% Nitrobenzene-d5	48		%	1	01/22/20	WB	30 - 130 %
% Terphenyl-d14	42		%	1	01/22/20	WB	30 - 130 %

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

QA/QC Surrogates: Surrogates are compounds (preceded with a %) added by the lab to determine analysis efficiency. Surrogate results(%) listed in the report are not "detected" compounds.

Comments:

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If you are the client above and have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext.200.
The contents of this report cannot be discussed with anyone other than the client listed above without their written consent.



Phyllis Shiller, Laboratory Director

January 27, 2020

Reviewed and Released by: Rashmi Makol, Project Manager



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

QA/QC Report

January 27, 2020

QA/QC Data

SDG I.D.: GCF15233

Parameter	Blank	Blk RL	Sample Result	Dup Result	Dup RPD	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
-----------	-------	-----------	------------------	---------------	------------	----------	-----------	------------	---------	----------	-----------	--------------------	--------------------

QA/QC Batch 515151 (mg/kg), QC Sample No: CF14874 2X (CF15233, CF15234, CF15235)

Mercury - Soil	BRL	0.02	<0.03	<0.03	NC	105	113	7.3	102	114	11.1	70 - 130	30
----------------	-----	------	-------	-------	----	-----	-----	-----	-----	-----	------	----------	----

Comment:

Additional Mercury criteria: LCS acceptance range for waters is 80-120% and for soils is 70-130%. MS acceptance range is 75-125%.

QA/QC Batch 514879 (mg/kg), QC Sample No: CF15240 (CF15233, CF15234, CF15235)

ICP Metals - Soil

Arsenic	BRL	0.67	1.39	0.79	NC	90.6	98.2	8.1	96.2			75 - 125	30
Chromium	BRL	0.33	6.05	5.62	7.40	96.4	104	7.6	99.1			75 - 125	30
Copper	BRL	0.67	14.4	12.4	14.9	101	109	7.6	95.0			75 - 125	30
Lead	BRL	0.33	5.67	6.79	18.0	89.8	96.6	7.3	96.0			75 - 125	30
Nickel	BRL	0.33	7.32	7.02	4.20	94.9	103	8.2	94.0			75 - 125	30
Zinc	BRL	0.67	36.4	32.9	10.1	90.1	96.5	6.9	95.9			75 - 125	30



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

QA/QC Report

January 27, 2020

QA/QC Data

SDG I.D.: GCF15233

Parameter	Blank	Blk RL	Sample Result	Dup Result	Dup RPD	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
QA/QC Batch 514844 (%), QC Sample No: CF15042 (CF15233, CF15234, CF15235)													
Total Solids	BRL	0.1	18.4	18.5	0.50	100						85 - 115	30
QA/QC Batch 514993 (mg/Kg), QC Sample No: CF15233 (CF15233, CF15234, CF15235)													
Phosphorus, Total as P	BRL	0.50	320	294	8.50	96.7			NC			75 - 125	30
Comment:													
Additional criteria matrix spike acceptance range is 75-125%.													



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823

QA/QC Report

January 27, 2020

QA/QC Data

SDG I.D.: GCF15233

Parameter	Blank	Blk RL	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
QA/QC Batch 515034 (ug/Kg), QC Sample No: CF16074 2X (CF15233, CF15234, CF15235)										
<u>Polychlorinated Biphenyls - Sediment</u>										
PCB-1016	ND	33	84	81	3.6	52	60	14.3	40 - 140	30
PCB-1221	ND	33							40 - 140	30
PCB-1232	ND	33							40 - 140	30
PCB-1242	ND	33							40 - 140	30
PCB-1248	ND	33							40 - 140	30
PCB-1254	ND	33							40 - 140	30
PCB-1260	ND	33	85	82	3.6	53	62	15.7	40 - 140	30
PCB-1262	ND	33							40 - 140	30
PCB-1268	ND	33							40 - 140	30
% DCBP (Surrogate Rec)	73	%	98	94	4.2	55	66	18.2	30 - 150	30
% DCBP (Surrogate Rec) (Confirm)	73	%	97	90	7.5	52	60	14.3	30 - 150	30
% TCMX (Surrogate Rec)	68	%	88	83	5.8	50	60	18.2	30 - 150	30
% TCMX (Surrogate Rec) (Confirm)	69	%	90	84	6.9	50	60	18.2	30 - 150	30
QA/QC Batch 515037 (ug/Kg), QC Sample No: CF16074 2X (CF15233, CF15234, CF15235)										
<u>Pesticides - Sediment</u>										
4,4' -DDD	ND	1.7	73	93	24.1	50	78	43.8	40 - 140	30 r
4,4' -DDE	ND	1.7	66	79	17.9	33	61	59.6	40 - 140	30 r
4,4' -DDT	ND	1.7	69	88	24.2	46	79	52.8	40 - 140	30 r
a-BHC	ND	1.0	66	73	10.1	41	61	39.2	40 - 140	30 r
Alachlor	ND	3.3	NA	NA	NC	NA	NA	NC	40 - 140	30
Aldrin	ND	1.0	60	70	15.4	41	58	34.3	40 - 140	30 r
b-BHC	ND	1.0	92	105	13.2	60	87	36.7	40 - 140	30 r
Chlordane	ND	3.3	62	78	22.9	45	65	36.4	40 - 140	30 r
d-BHC	ND	3.3	75	86	13.7	49	72	38.0	40 - 140	30 r
Dieldrin	ND	1.0	71	85	17.9	47	73	43.3	40 - 140	30 r
Endosulfan I	ND	3.3	72	83	14.2	48	71	38.7	40 - 140	30 r
Endosulfan II	ND	3.3	79	93	16.3	55	79	35.8	40 - 140	30 r
Endosulfan sulfate	ND	3.3	89	109	20.2	57	88	42.8	40 - 140	30 r
Endrin	ND	3.3	69	81	16.0	48	69	35.9	40 - 140	30 r
Endrin aldehyde	ND	3.3	75	94	22.5	49	74	40.7	40 - 140	30 r
Endrin ketone	ND	3.3	84	101	18.4	57	81	34.8	40 - 140	30 r
g-BHC	ND	1.0	71	75	5.5	43	62	36.2	40 - 140	30 r
Heptachlor	ND	3.3	65	71	8.8	42	61	36.9	40 - 140	30 r
Heptachlor epoxide	ND	3.3	69	75	8.3	42	62	38.5	40 - 140	30 r
Methoxychlor	ND	3.3	73	97	28.2	56	84	40.0	40 - 140	30 r
Toxaphene	ND	130	NA	NA	NC	NA	NA	NC	40 - 140	30
% DCBP	82	%	75	94	22.5	53	77	36.9	30 - 150	30 r
% DCBP (Confirmation)	91	%	81	94	14.9	54	78	36.4	30 - 150	30 r
% TCMX	77	%	61	69	12.3	43	61	34.6	30 - 150	30 r
% TCMX (Confirmation)	78	%	63	71	11.9	43	61	34.6	30 - 150	30 r

QA/QC Data

SDG I.D.: GCF15233

Parameter	Blank	Blk RL	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
QA/QC Batch 515210 (ug/kg), QC Sample No: CF15234 (CF15234, CF15235)										
Polynuclear Aromatic HC - Sediment										
2-Methylnaphthalene	ND	3.3	45	47	4.3	45	50	10.5	30 - 130	30
Acenaphthene	ND	3.3	46	41	11.5	45	50	10.5	30 - 130	30
Acenaphthylene	ND	3.3	46	41	11.5	46	51	10.3	30 - 130	30
Anthracene	ND	3.3	51	48	6.1	51	58	12.8	30 - 130	30
Benz(a)anthracene	ND	3.3	53	51	3.8	52	58	10.9	30 - 130	30
Benzo(a)pyrene	ND	3.3	53	50	5.8	52	56	7.4	30 - 130	30
Benzo(b)fluoranthene	ND	3.3	48	49	2.1	46	46	0.0	30 - 130	30
Benzo(ghi)perylene	ND	3.3	44	49	10.8	46	49	6.3	30 - 130	30
Benzo(k)fluoranthene	ND	3.3	50	49	2.0	46	46	0.0	30 - 130	30
Chrysene	ND	3.3	48	46	4.3	46	51	10.3	30 - 130	30
Dibenz(a,h)anthracene	ND	3.3	45	51	12.5	48	53	9.9	30 - 130	30
Fluoranthene	ND	3.3	47	41	13.6	44	57	25.7	30 - 130	30
Fluorene	ND	3.3	48	40	18.2	47	59	22.6	30 - 130	30
Indeno(1,2,3-cd)pyrene	ND	3.3	43	49	13.0	45	49	8.5	30 - 130	30
Naphthalene	ND	3.3	42	38	10.0	46	49	6.3	30 - 130	30
Phenanthrene	ND	3.3	48	45	6.5	47	53	12.0	30 - 130	30
Pyrene	ND	3.3	49	42	15.4	45	59	26.9	30 - 130	30
% 2-Fluorobiphenyl	42	%	44	37	17.3	40	45	11.8	30 - 130	30
% Nitrobenzene-d5	45	%	41	37	10.3	52	48	8.0	30 - 130	30
% Terphenyl-d14	49	%	41	38	7.6	36	41	13.0	30 - 130	30

Comment:

Additional 8270 criteria: 20% of compounds can be outside of acceptance criteria as long as recovery is at least 10%. (Acid surrogates acceptance range for aqueous samples: 15-110%, for soils 30-130%)

QA/QC Batch 515356 (ug/kg), QC Sample No: CF16552 (CF15233)

Polynuclear Aromatic HC - Sediment

2-Methylnaphthalene	ND	3.3	52	51	1.9	48	43	11.0	30 - 130	30
Acenaphthene	ND	3.3	48	53	9.9	48	55	13.6	30 - 130	30
Acenaphthylene	ND	3.3	48	54	11.8	35	32	9.0	30 - 130	30
Anthracene	ND	3.3	55	65	16.7	52	60	14.3	30 - 130	30
Benz(a)anthracene	ND	3.3	56	65	14.9	56	55	1.8	30 - 130	30
Benzo(a)pyrene	ND	3.3	52	64	20.7	56	56	0.0	30 - 130	30
Benzo(b)fluoranthene	ND	3.3	43	51	17.0	48	49	2.1	30 - 130	30
Benzo(ghi)perylene	ND	3.3	44	56	24.0	48	51	6.1	30 - 130	30
Benzo(k)fluoranthene	ND	3.3	44	52	16.7	50	50	0.0	30 - 130	30
Chrysene	ND	3.3	50	57	13.1	50	50	0.0	30 - 130	30
Dibenz(a,h)anthracene	ND	3.3	46	58	23.1	52	55	5.6	30 - 130	30
Fluoranthene	ND	3.3	51	59	14.5	54	69	24.4	30 - 130	30
Fluorene	ND	3.3	51	56	9.3	50	54	7.7	30 - 130	30
Indeno(1,2,3-cd)pyrene	ND	3.3	43	55	24.5	46	48	4.3	30 - 130	30
Naphthalene	ND	3.3	45	49	8.5	44	48	8.7	30 - 130	30
Phenanthrene	ND	3.3	51	60	16.2	71	120	51.3	30 - 130	30 r
Pyrene	ND	3.3	53	61	14.0	54	67	21.5	30 - 130	30
% 2-Fluorobiphenyl	44	%	45	46	2.2	36	31	14.9	30 - 130	30
% Nitrobenzene-d5	46	%	44	47	6.6	52	46	12.2	30 - 130	30
% Terphenyl-d14	48	%	46	51	10.3	39	54	32.3	30 - 130	30 r

Comment:

Additional 8270 criteria: 20% of compounds can be outside of acceptance criteria as long as recovery is at least 10%. (Acid surrogates acceptance range for aqueous samples: 15-110%, for soils 30-130%)

r = This parameter is outside laboratory RPD specified recovery limits.

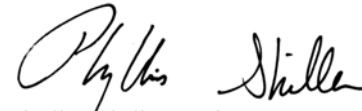
QA/QC Data

SDG I.D.: GCF15233

Parameter	Blank		LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
		Blk RL								

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

RPD - Relative Percent Difference
LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS - Matrix Spike
MS Dup - Matrix Spike Duplicate
NC - No Criteria
Intf - Interference



Phyllis Shiller, Laboratory Director
January 27, 2020

Monday, January 27, 2020

Criteria: None
State: CT

Sample Criteria Exceedances Report
GCF15233 - ESSGRPRI

SampNo	Acode	Phoenix Analyte	Criteria	Result	RL	Criteria	RL Criteria	Analysis Units
--------	-------	-----------------	----------	--------	----	----------	----------------	-------------------

*** No Data to Display ***

Phoenix Laboratories does not assume responsibility for the data contained in this exceedance report. It is provided as an additional tool to identify requested criteria exceedences. All efforts are made to ensure the accuracy of the data (obtained from appropriate agencies). A lack of exceedence information does not necessarily suggest conformance to the criteria. It is ultimately the site professional's responsibility to determine appropriate compliance.



Environmental Laboratories, Inc.
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045
Tel. (860) 645-1102 Fax (860) 645-0823



Analysis Comments

January 27, 2020

SDG I.D.: GCF15233

The following analysis comments are made regarding exceptions to criteria not already noted in the Analysis Report or QA/QC Report:

PEST Narration

AU-ECD7 01/23/20-1: CF15233, CF15234, CF15235

The following Continuing Calibration compounds did not meet % deviation criteria:

Samples: CF15233, CF15234, CF15235

Preceding CC 123A037 - None.

Succeeding CC 123A050 - Endrin 25%L (20%)

A low "1A" standard was run after the samples to demonstrate capability to detect any compounds outside of the CC acceptance criteria. All reported samples were ND for the affected compounds.

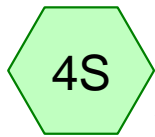
CHAIN OF CUSTODY RECORD

[illegible][illegible]

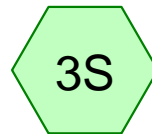
Relinquished by:	Accepted by:	Date:	Time:	RI	CT	MA	Data Format
Dick RABANEY	[Signature]	11/17/20	9:35	<input type="checkbox"/> (Residential) Direct Exposure <input type="checkbox"/> (Comm./Industrial) Direct Exposure <input type="checkbox"/> SA Leachability <input type="checkbox"/> GB Leachability <input type="checkbox"/> GA-GW <input type="checkbox"/> Objectives <input type="checkbox"/> GB-GW Objectives	<input type="checkbox"/> RCP Cert <input type="checkbox"/> GW Protection <input type="checkbox"/> SW Protection <input type="checkbox"/> GA Mobility <input type="checkbox"/> GB Mobility <input type="checkbox"/> Residential DEC <input type="checkbox"/> I/C DEC <input type="checkbox"/> Other	<input type="checkbox"/> MOP Certification <input type="checkbox"/> GW-1 <input type="checkbox"/> MWRA eSMART <input type="checkbox"/> GW-2 <input type="checkbox"/> GW-3 <input type="checkbox"/> S-1 GW-1 <input type="checkbox"/> S-1 GW-2 <input type="checkbox"/> S-1 GW-3 <input type="checkbox"/> S-2 GW-1 <input type="checkbox"/> S-2 GW-2 <input type="checkbox"/> S-2 GW-3 <input type="checkbox"/> S-3 GW-1 <input type="checkbox"/> S-3 GW-2 <input type="checkbox"/> S-3 GW-3 <input type="checkbox"/> SW Protection	<input checked="" type="checkbox"/> Excel <input checked="" type="checkbox"/> PDF <input type="checkbox"/> GIS/Key <input type="checkbox"/> EQuIS <input type="checkbox"/> Other Data Package <input type="checkbox"/> Tier II Checklist <input type="checkbox"/> Full Data Package* <input type="checkbox"/> Phoenix Sid Report <input type="checkbox"/> Other
Comments, Special Requirements or Regulations:				State where samples were collected: <u>MA</u>			
Turnaround Time: <input type="checkbox"/> 1 Day* <input type="checkbox"/> 2 Days* <input type="checkbox"/> 3 Days* <input checked="" type="checkbox"/> Standard <input type="checkbox"/> Other				* SURCHARGE APPLIES			

Appendix E

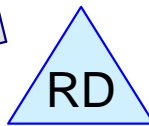
Hydrologic and Hydraulic Analysis



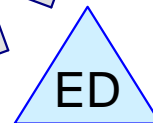
Red Dam Upstream
Summary



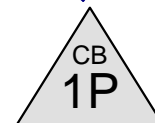
Eagle Brook



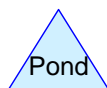
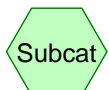
Red Dam



Eagle Dam - Existing
Spillway = 196.50



Existing Route 140
Culvert Opening



Routing Diagram for W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc., Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 2

Project Notes

Rainfall events imported from "W350 Lowered Eagle Dam Proposed Model_REV2.hcp"

W350 Existing Calibrated Model_REV2*Type III 24-hr 25yr Rainfall=5.50"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 3

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=3.53"
Tc=50.0 min CN=82 Runoff=18.03 cfs 2.942 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=1.60"
Tc=50.0 min CN=60 Runoff=3,540.99 cfs 626.416 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=192.34' Inflow=264.48 cfs 480.203 af
Primary=264.48 cfs 480.203 af Secondary=0.00 cfs 0.000 af Outflow=264.48 cfs 480.203 af

Pond ED: Eagle Dam - Existing

Peak Elev=199.44' Storage=44.375 af Inflow=265.70 cfs 487.871 af
Outflow=264.48 cfs 480.203 af

Pond RD: Red Dam

Peak Elev=200.03' Storage=418.099 af Inflow=3,540.99 cfs 626.416 af
Outflow=264.74 cfs 484.930 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 629.357 af Average Runoff Depth = 1.61"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25yr Rainfall=5.50"

Printed 4/6/2020

Page 4

Summary for Subcatchment 3S: Eagle Brook

Runoff = 18.03 cfs @ 12.68 hrs, Volume= 2.942 af, Depth= 3.53"

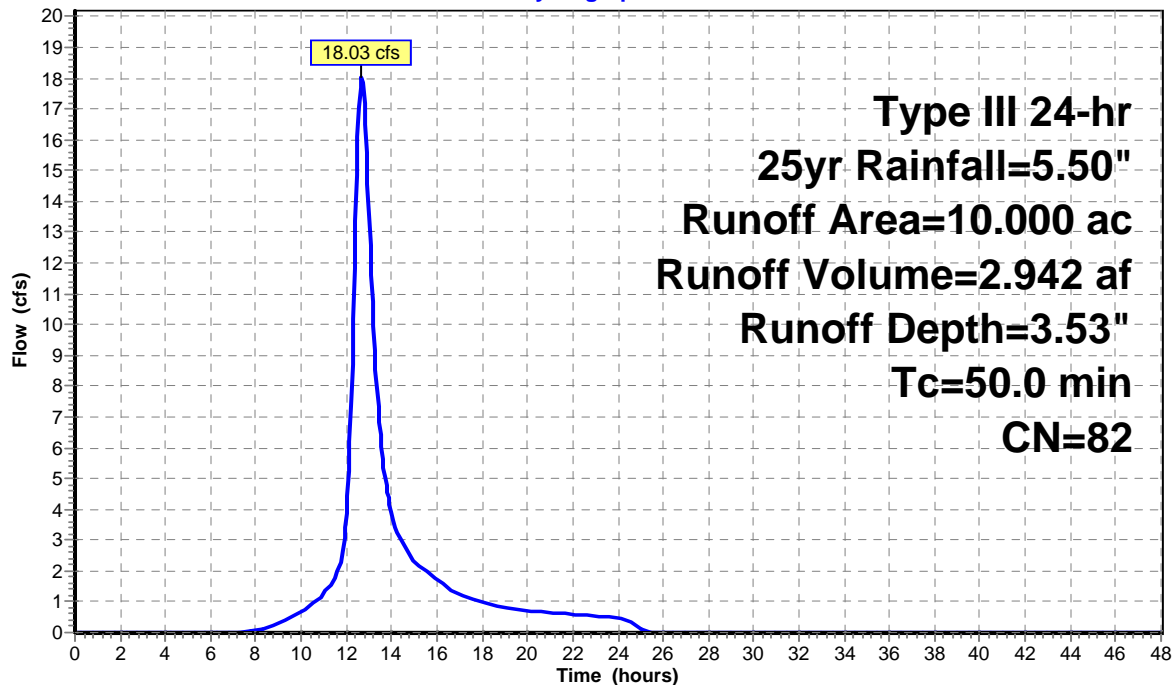
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=5.50"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25yr Rainfall=5.50"

Printed 4/6/2020

Page 5

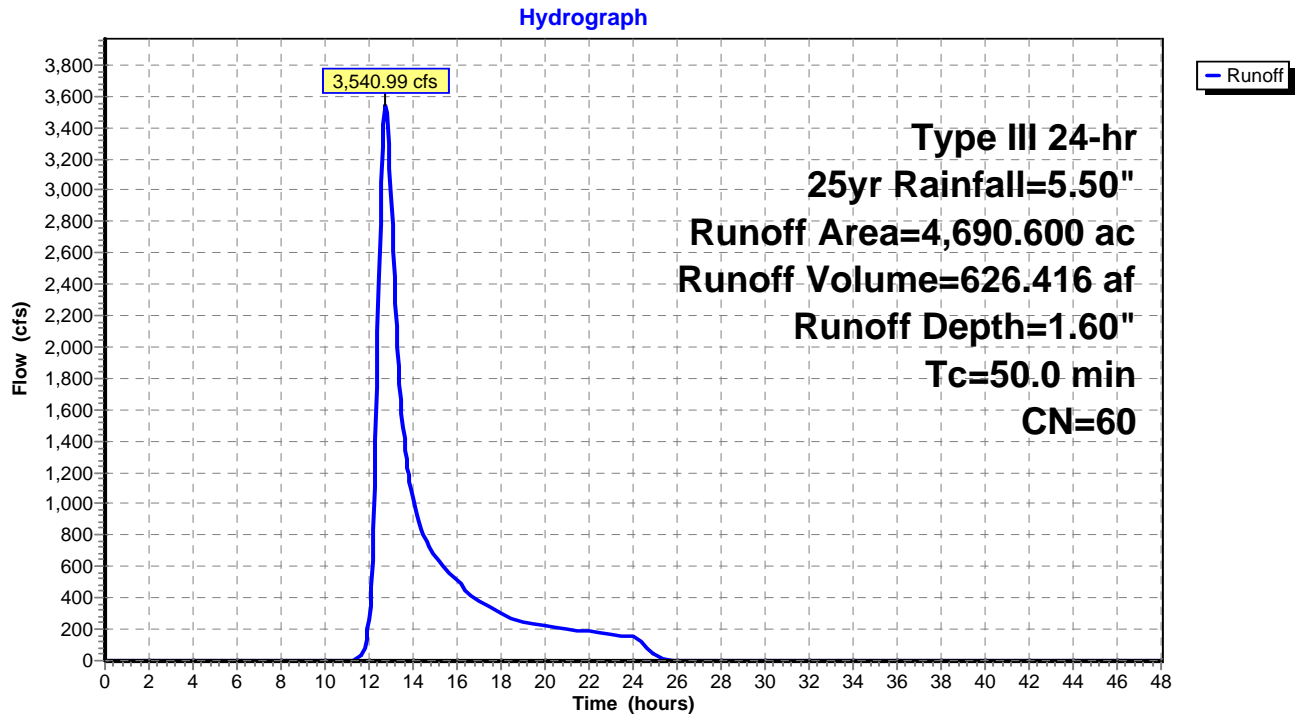
Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 3,540.99 cfs @ 12.75 hrs, Volume= 626.416 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=5.50"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25yr Rainfall=5.50"

Printed 4/6/2020

Page 6

Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.23" for 25yr event
Inflow = 264.48 cfs @ 19.06 hrs, Volume= 480.203 af
Outflow = 264.48 cfs @ 19.06 hrs, Volume= 480.203 af, Atten= 0%, Lag= 0.0 min
Primary = 264.48 cfs @ 19.06 hrs, Volume= 480.203 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 192.34' @ 19.06 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=264.48 cfs @ 19.06 hrs HW=192.34' (Free Discharge)

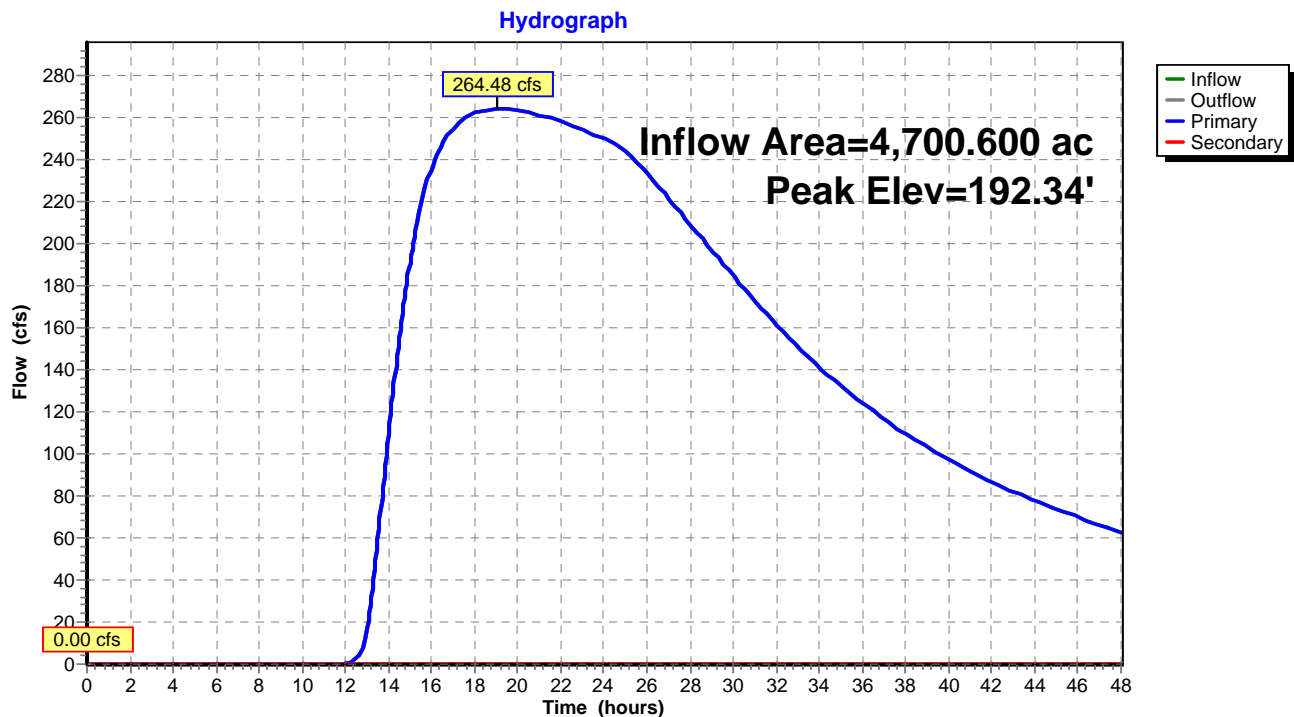
↑ **2=Culvert** (Passes 264.48 cfs of 305.56 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 264.48 cfs @ 4.70 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



W350 Existing Calibrated Model_REV2

Type III 24-hr 25yr Rainfall=5.50"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 7

Summary for Pond ED: Eagle Dam - Existing Spillway = 196.50

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.25" for 25yr event
 Inflow = 265.70 cfs @ 18.07 hrs, Volume= 487.871 af
 Outflow = 264.48 cfs @ 19.06 hrs, Volume= 480.203 af, Atten= 0%, Lag= 59.3 min
 Primary = 264.48 cfs @ 19.06 hrs, Volume= 480.203 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Starting Elev= 196.50' Surf.Area= 6.380 ac Storage= 22.321 af
 Peak Elev= 199.44' @ 19.06 hrs Surf.Area= 8.552 ac Storage= 44.375 af (22.054 af above start)

Plug-Flow detention time= 158.0 min calculated for 457.882 af (94% of inflow)
 Center-of-Mass det. time= 46.2 min (1,627.1 - 1,580.9)

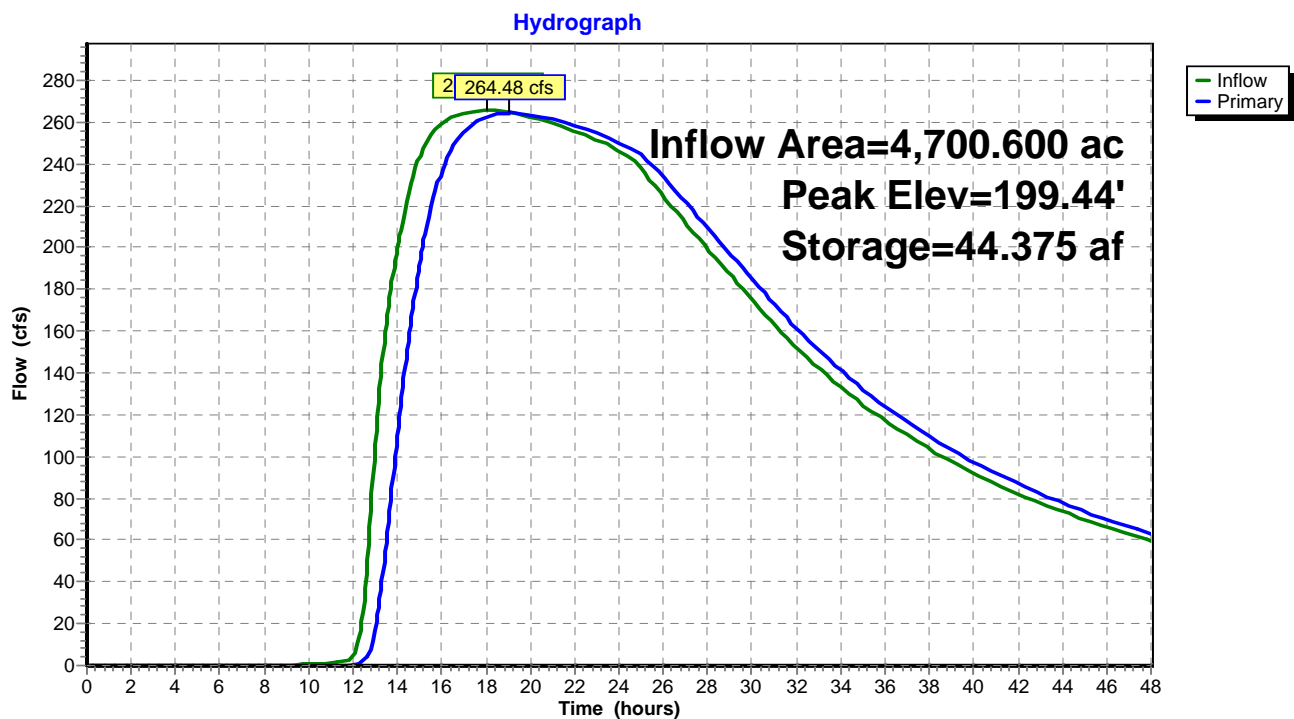
Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	196.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=264.48 cfs @ 19.06 hrs HW=199.44' TW=192.34' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 264.48 cfs @ 5.62 fps)

Pond ED: Eagle Dam - Existing Spillway = 196.50



W350 Existing Calibrated Model_REV2

Type III 24-hr 25yr Rainfall=5.50"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 9

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 1.60" for 25yr event
 Inflow = 3,540.99 cfs @ 12.75 hrs, Volume= 626.416 af
 Outflow = 264.74 cfs @ 18.15 hrs, Volume= 484.930 af, Atten= 93%, Lag= 324.1 min
 Primary = 264.74 cfs @ 18.15 hrs, Volume= 484.930 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.03' @ 18.56 hrs Surf.Area= 0.000 ac Storage= 418.099 af

Plug-Flow detention time= 765.3 min calculated for 484.930 af (77% of inflow)
 Center-of-Mass det. time= 676.0 min (1,585.4 - 909.4)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

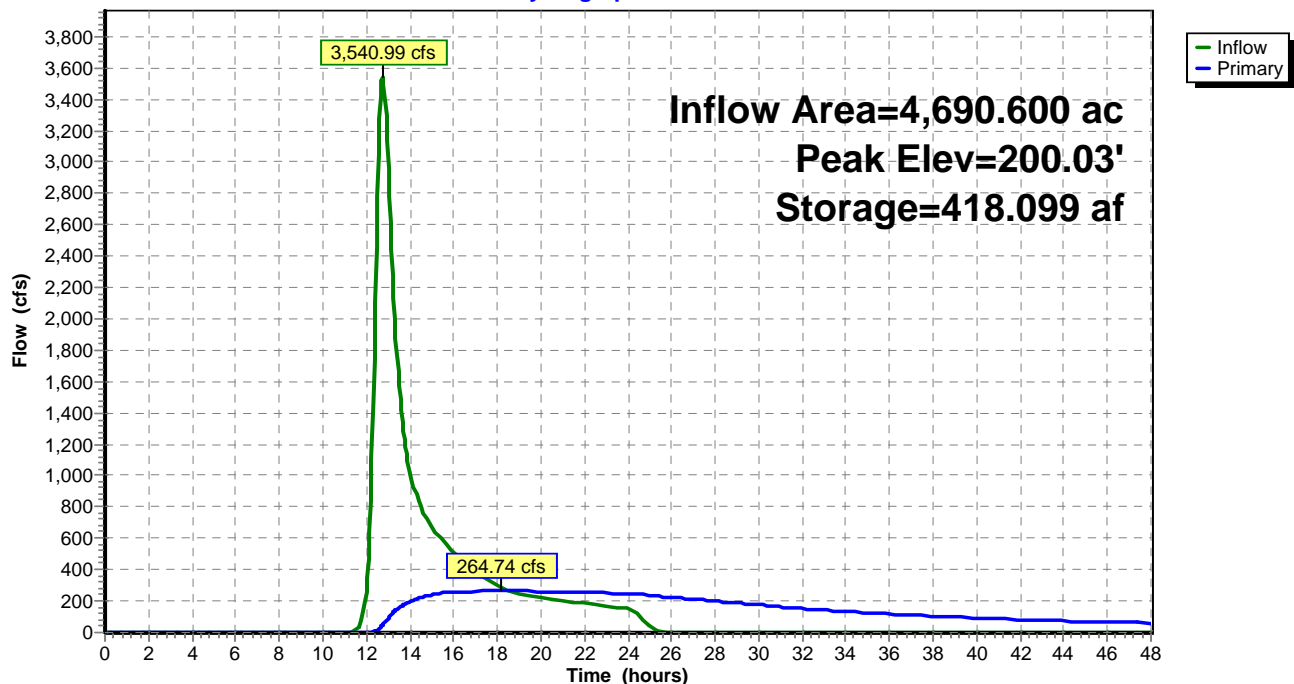
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=264.74 cfs @ 18.15 hrs HW=200.03' TW=199.43' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 264.74 cfs @ 3.40 fps)

Pond RD: Red Dam

Hydrograph



W350 Existing Calibrated Model_REV2*Type III 24-hr 50yr Rainfall=6.10"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 11

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.08"
Tc=50.0 min CN=82 Runoff=20.77 cfs 3.399 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=1.99"
Tc=50.0 min CN=60 Runoff=4,500.53 cfs 776.790 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=192.86' Inflow=324.39 cfs 607.494 af
Primary=324.39 cfs 607.494 af Secondary=0.00 cfs 0.000 af Outflow=324.39 cfs 607.494 af

Pond ED: Eagle Dam - Existing Peak Elev=199.87' Storage=48.068 af Inflow=325.50 cfs 616.436 af
Outflow=324.39 cfs 607.494 af

Pond RD: Red Dam Peak Elev=200.34' Storage=518.936 af Inflow=4,500.53 cfs 776.790 af
Outflow=324.38 cfs 613.036 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 780.190 af Average Runoff Depth = 1.99"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 50yr Rainfall=6.10"

Printed 4/6/2020

Page 12

Summary for Subcatchment 3S: Eagle Brook

Runoff = 20.77 cfs @ 12.67 hrs, Volume= 3.399 af, Depth= 4.08"

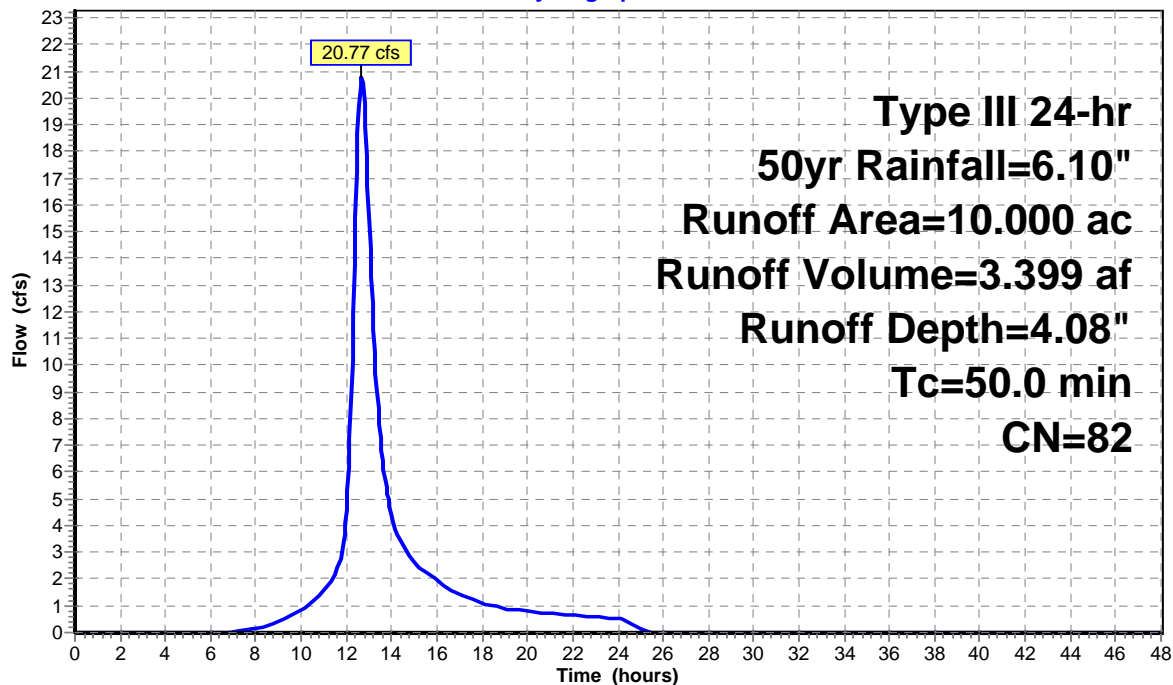
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 50yr Rainfall=6.10"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 50yr Rainfall=6.10"

Printed 4/6/2020

Page 13

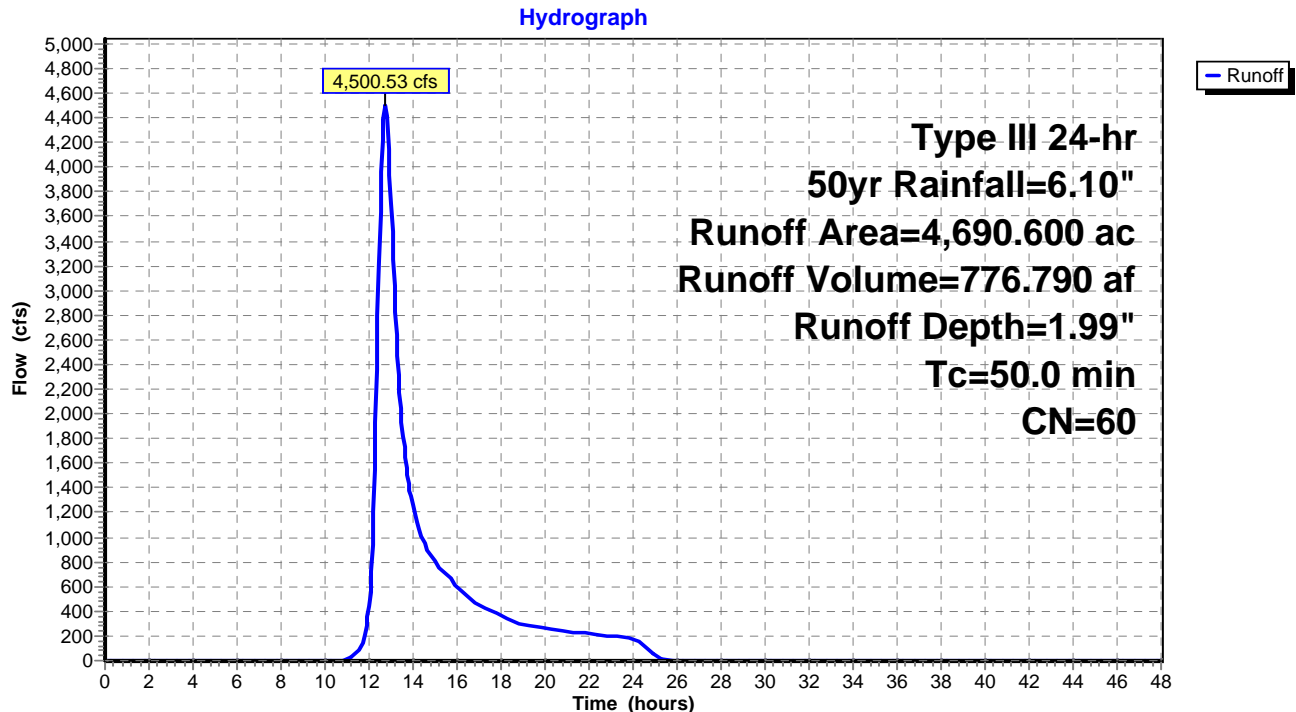
Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 4,500.53 cfs @ 12.74 hrs, Volume= 776.790 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 50yr Rainfall=6.10"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 50yr Rainfall=6.10"

Printed 4/6/2020

Page 14

Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.55" for 50yr event
Inflow = 324.39 cfs @ 18.72 hrs, Volume= 607.494 af
Outflow = 324.39 cfs @ 18.72 hrs, Volume= 607.494 af, Atten= 0%, Lag= 0.0 min
Primary = 324.39 cfs @ 18.72 hrs, Volume= 607.494 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 192.86' @ 18.72 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=324.39 cfs @ 18.72 hrs HW=192.86' (Free Discharge)

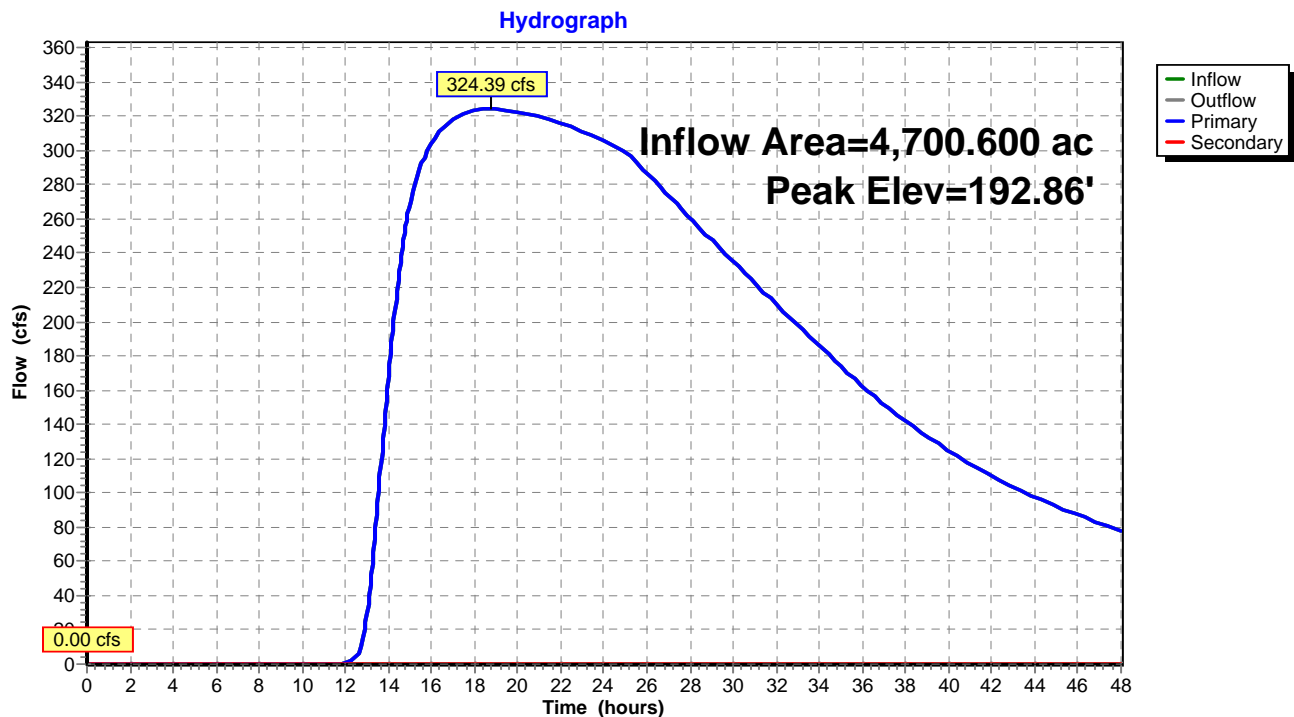
↑ **2=Culvert** (Passes 324.39 cfs of 368.32 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 324.39 cfs @ 5.07 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



W350 Existing Calibrated Model_REV2

Type III 24-hr 50yr Rainfall=6.10"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 15

Summary for Pond ED: Eagle Dam - Existing Spillway = 196.50

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.57" for 50yr event
 Inflow = 325.50 cfs @ 17.91 hrs, Volume= 616.436 af
 Outflow = 324.39 cfs @ 18.72 hrs, Volume= 607.494 af, Atten= 0%, Lag= 48.2 min
 Primary = 324.39 cfs @ 18.72 hrs, Volume= 607.494 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Starting Elev= 196.50' Surf.Area= 6.380 ac Storage= 22.321 af
 Peak Elev= 199.87' @ 18.72 hrs Surf.Area= 8.659 ac Storage= 48.068 af (25.746 af above start)

Plug-Flow detention time= 136.1 min calculated for 585.173 af (95% of inflow)
 Center-of-Mass det. time= 44.1 min (1,626.4 - 1,582.3)

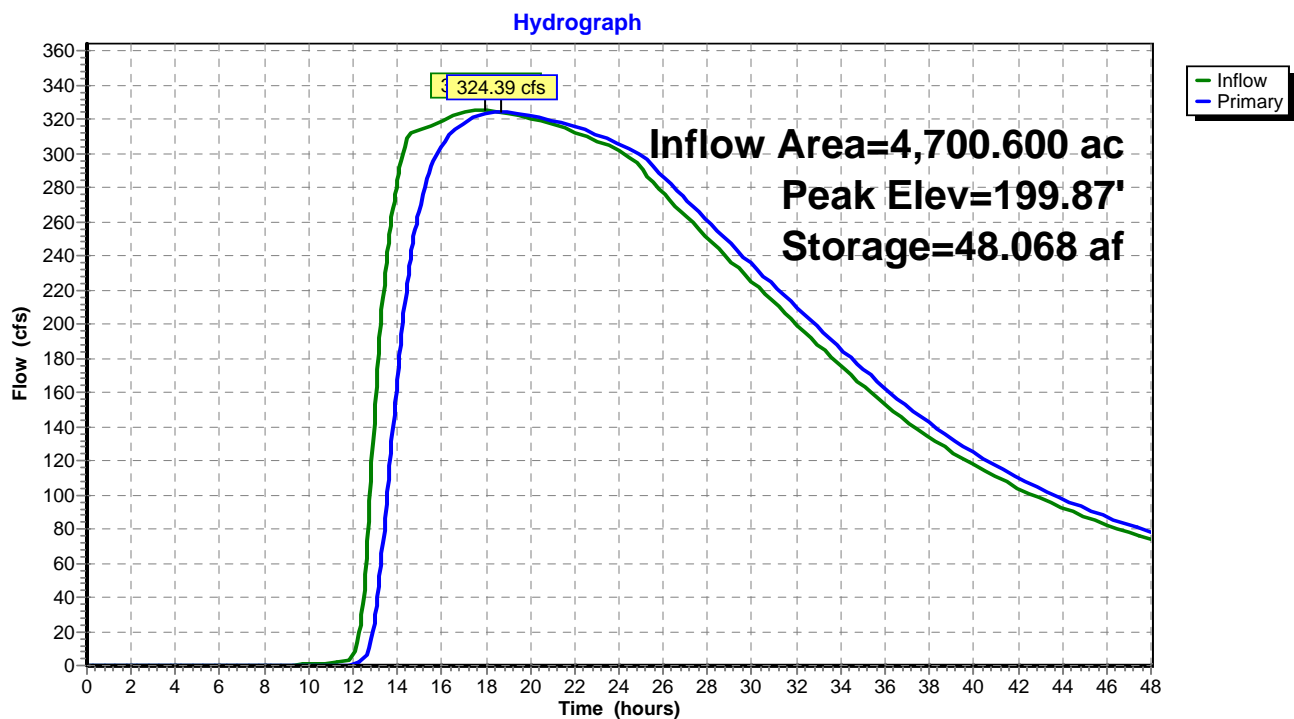
Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	196.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=324.39 cfs @ 18.72 hrs HW=199.87' TW=192.86' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 324.39 cfs @ 6.01 fps)

Pond ED: Eagle Dam - Existing Spillway = 196.50



W350 Existing Calibrated Model_REV2

Type III 24-hr 50yr Rainfall=6.10"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 17

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 1.99" for 50yr event
 Inflow = 4,500.53 cfs @ 12.74 hrs, Volume= 776.790 af
 Outflow = 324.38 cfs @ 17.99 hrs, Volume= 613.036 af, Atten= 93%, Lag= 315.0 min
 Primary = 324.38 cfs @ 17.99 hrs, Volume= 613.036 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.34' @ 18.41 hrs Surf.Area= 0.000 ac Storage= 518.936 af

Plug-Flow detention time= 768.5 min calculated for 613.036 af (79% of inflow)
 Center-of-Mass det. time= 683.8 min (1,586.4 - 902.6)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

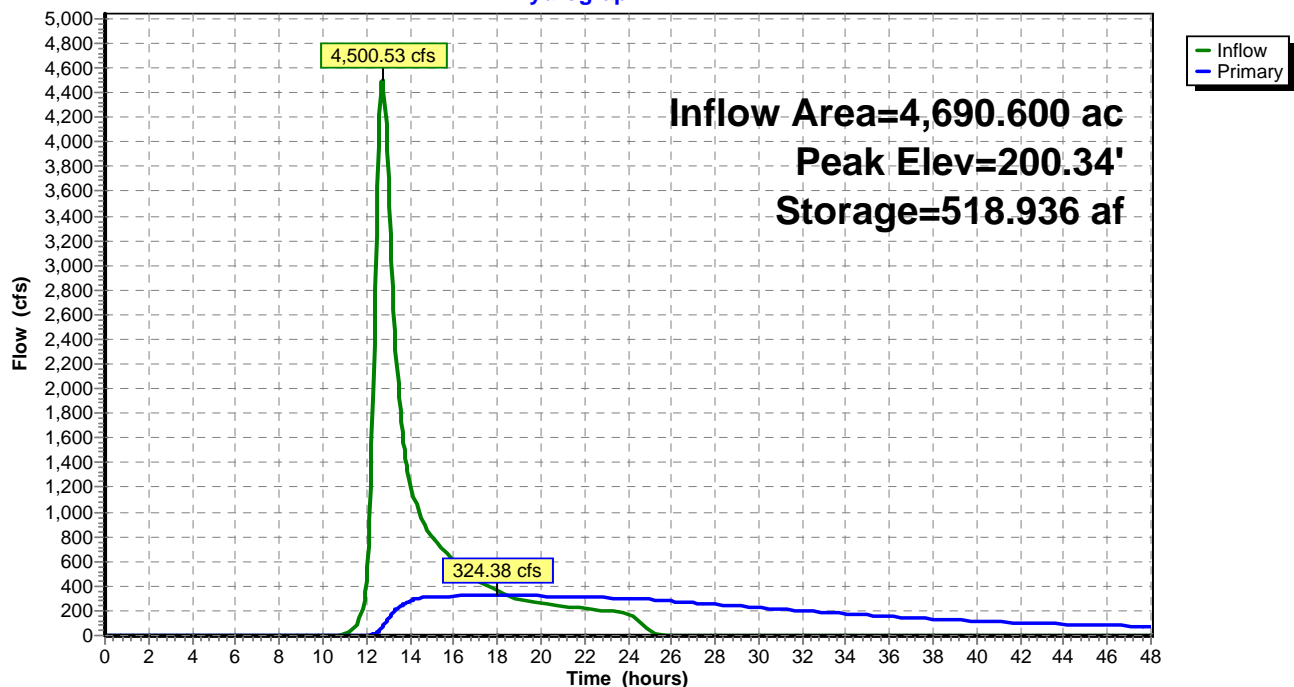
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=324.39 cfs @ 17.99 hrs HW=200.34' TW=199.86' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 324.39 cfs @ 3.37 fps)

Pond RD: Red Dam

Hydrograph



W350 Existing Calibrated Model_REV2

Type III 24-hr 100yr Rainfall=6.80"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 19

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.73"
Tc=50.0 min CN=82 Runoff=23.99 cfs 3.941 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.46"
Tc=50.0 min CN=60 Runoff=5,685.64 cfs 962.747 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=193.65' Inflow=395.16 cfs 762.904 af
Primary=395.16 cfs 762.904 af Secondary=0.00 cfs 0.000 af Outflow=395.16 cfs 762.904 af

Pond ED: Eagle Dam - Existing Peak Elev=200.35' Storage=52.200 af Inflow=396.29 cfs 773.535 af
Outflow=395.16 cfs 762.904 af

Pond RD: Red Dam Peak Elev=200.73' Storage=646.824 af Inflow=5,685.64 cfs 962.747 af
Outflow=394.97 cfs 769.594 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 966.688 af Average Runoff Depth = 2.47"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 100yr Rainfall=6.80"

Printed 4/6/2020

Page 20

Summary for Subcatchment 3S: Eagle Brook

Runoff = 23.99 cfs @ 12.67 hrs, Volume= 3.941 af, Depth= 4.73"

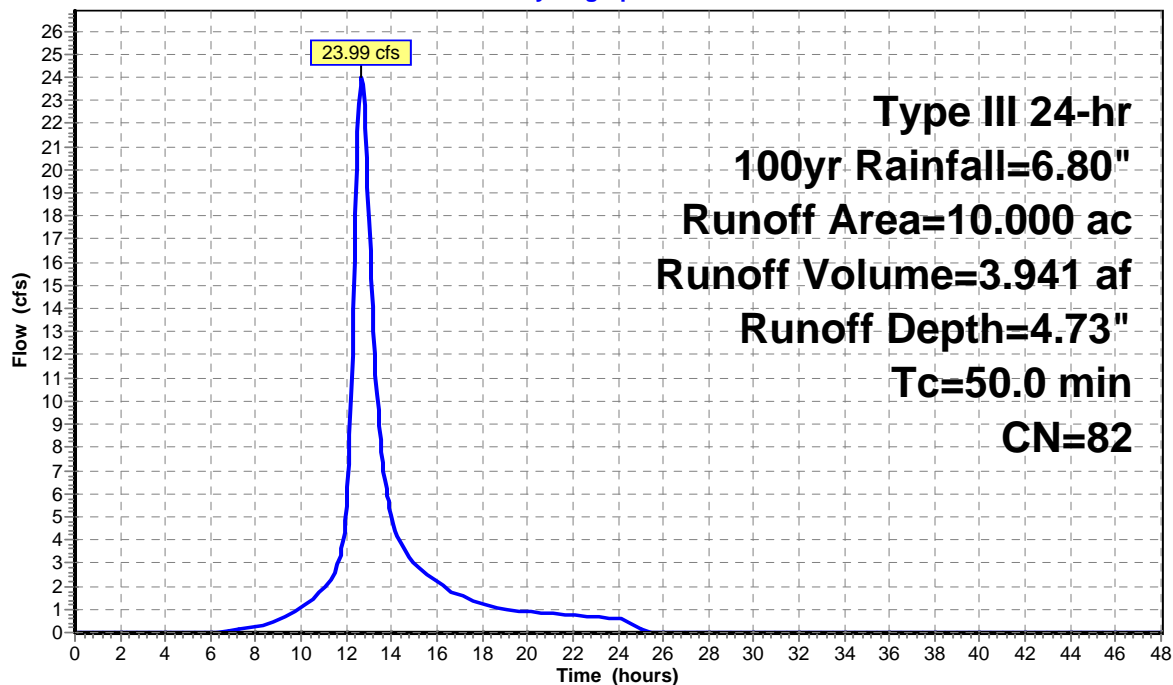
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=6.80"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 100yr Rainfall=6.80"

Printed 4/6/2020

Page 21

Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 5,685.64 cfs @ 12.73 hrs, Volume= 962.747 af, Depth= 2.46"

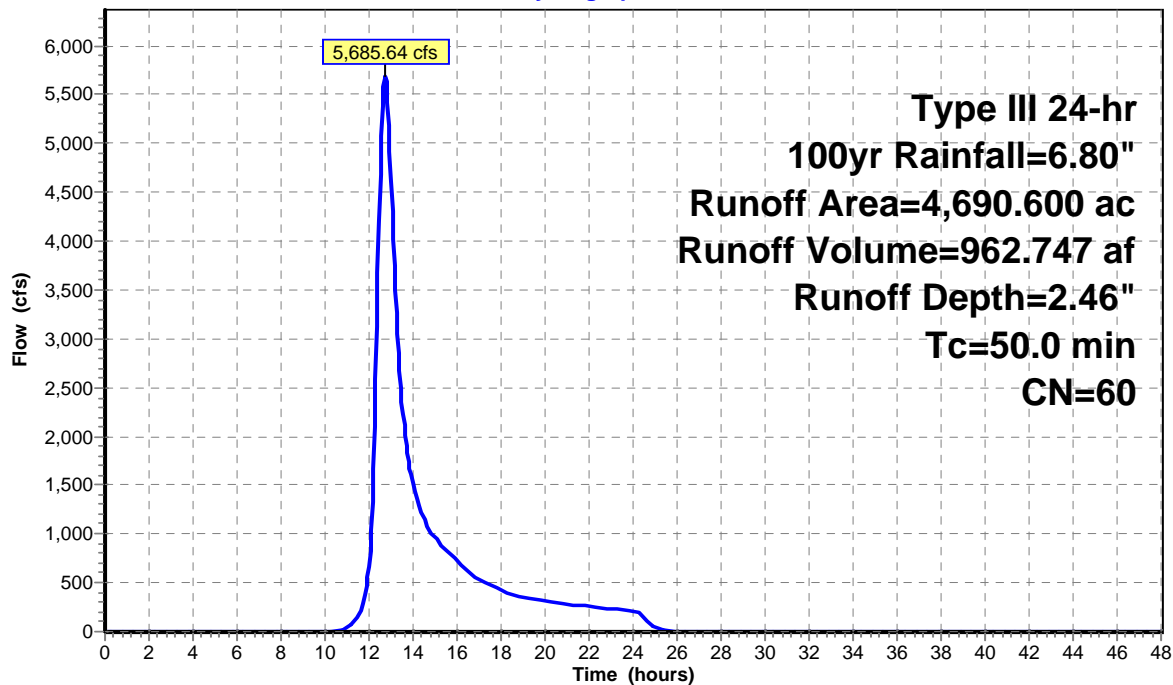
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=6.80"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

Hydrograph



W350 Existing Calibrated Model_REV2

Prepared by ESS Group, Inc.

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 100yr Rainfall=6.80"

Printed 4/6/2020

Page 22

Summary for Pond 1P: Existing Route 140 Culvert Opening

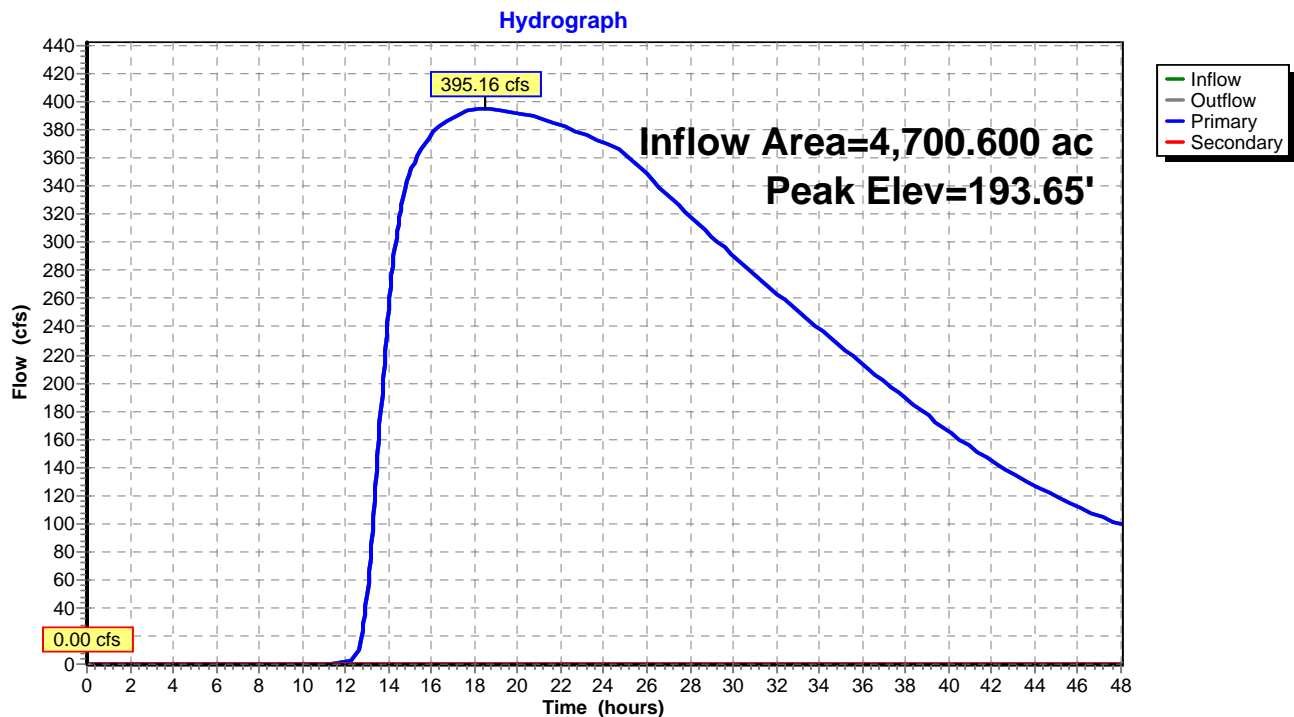
Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.95" for 100yr event
 Inflow = 395.16 cfs @ 18.51 hrs, Volume= 762.904 af
 Outflow = 395.16 cfs @ 18.51 hrs, Volume= 762.904 af, Atten= 0%, Lag= 0.0 min
 Primary = 395.16 cfs @ 18.51 hrs, Volume= 762.904 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 193.65' @ 18.51 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=395.16 cfs @ 18.51 hrs HW=193.65' (Free Discharge)↑ **2=Culvert** (Passes 395.16 cfs of 471.99 cfs potential flow)↑ **1=Route 140 Culvert Opening** (Orifice Controls 395.16 cfs @ 6.17 fps)**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)**Pond 1P: Existing Route 140 Culvert Opening**

W350 Existing Calibrated Model_REV2

Type III 24-hr 100yr Rainfall=6.80"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 23

Summary for Pond ED: Eagle Dam - Existing Spillway = 196.50

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.97" for 100yr event
 Inflow = 396.29 cfs @ 17.78 hrs, Volume= 773.535 af
 Outflow = 395.16 cfs @ 18.51 hrs, Volume= 762.904 af, Atten= 0%, Lag= 44.0 min
 Primary = 395.16 cfs @ 18.51 hrs, Volume= 762.904 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 196.50' Surf.Area= 6.380 ac Storage= 22.321 af

Peak Elev= 200.35' @ 18.51 hrs Surf.Area= 8.777 ac Storage= 52.200 af (29.879 af above start)

Plug-Flow detention time= 118.5 min calculated for 739.812 af (96% of inflow)

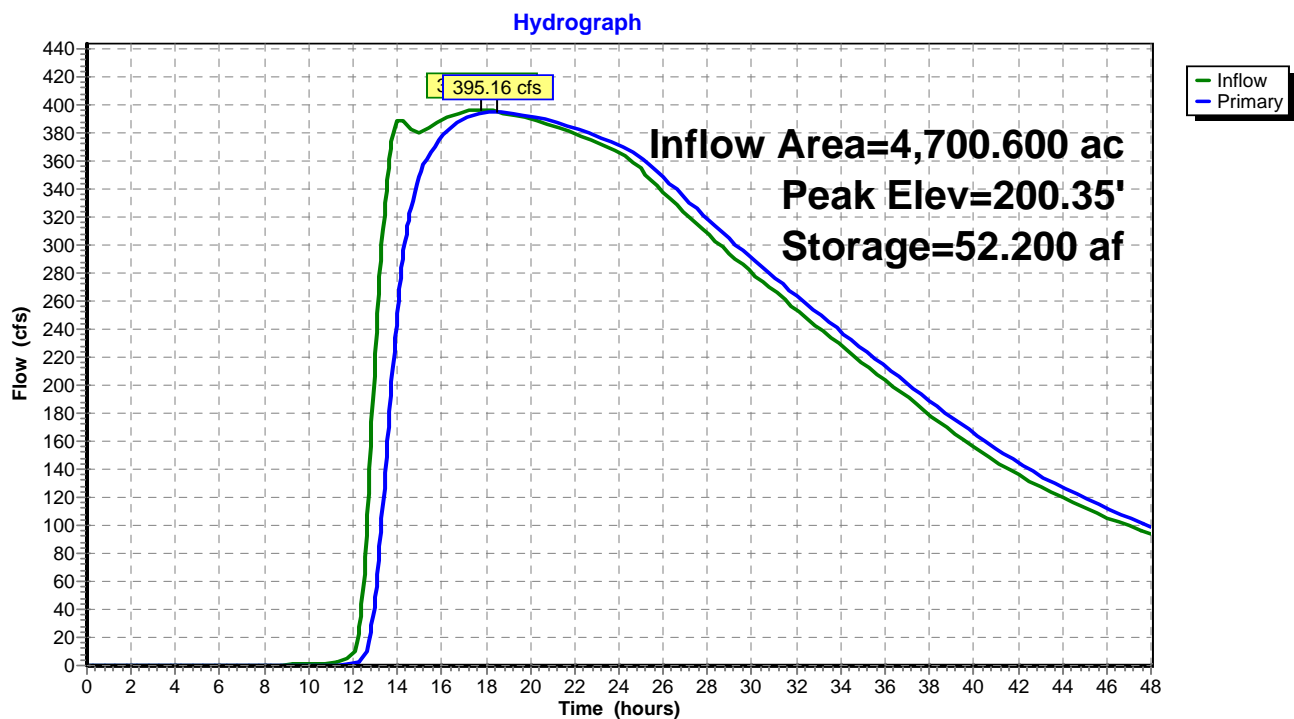
Center-of-Mass det. time= 41.9 min (1,633.0 - 1,591.1)

Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	196.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=395.16 cfs @ 18.51 hrs HW=200.35' TW=193.65' (Dynamic Tailwater)↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 395.16 cfs @ 6.42 fps)

Pond ED: Eagle Dam - Existing Spillway = 196.50



W350 Existing Calibrated Model_REV2

Type III 24-hr 100yr Rainfall=6.80"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 25

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.46" for 100yr event
 Inflow = 5,685.64 cfs @ 12.73 hrs, Volume= 962.747 af
 Outflow = 394.97 cfs @ 17.86 hrs, Volume= 769.594 af, Atten= 93%, Lag= 307.9 min
 Primary = 394.97 cfs @ 17.86 hrs, Volume= 769.594 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.73' @ 18.31 hrs Surf.Area= 0.000 ac Storage= 646.824 af

Plug-Flow detention time= 779.2 min calculated for 768.793 af (80% of inflow)
 Center-of-Mass det. time= 699.0 min (1,595.0 - 896.0)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

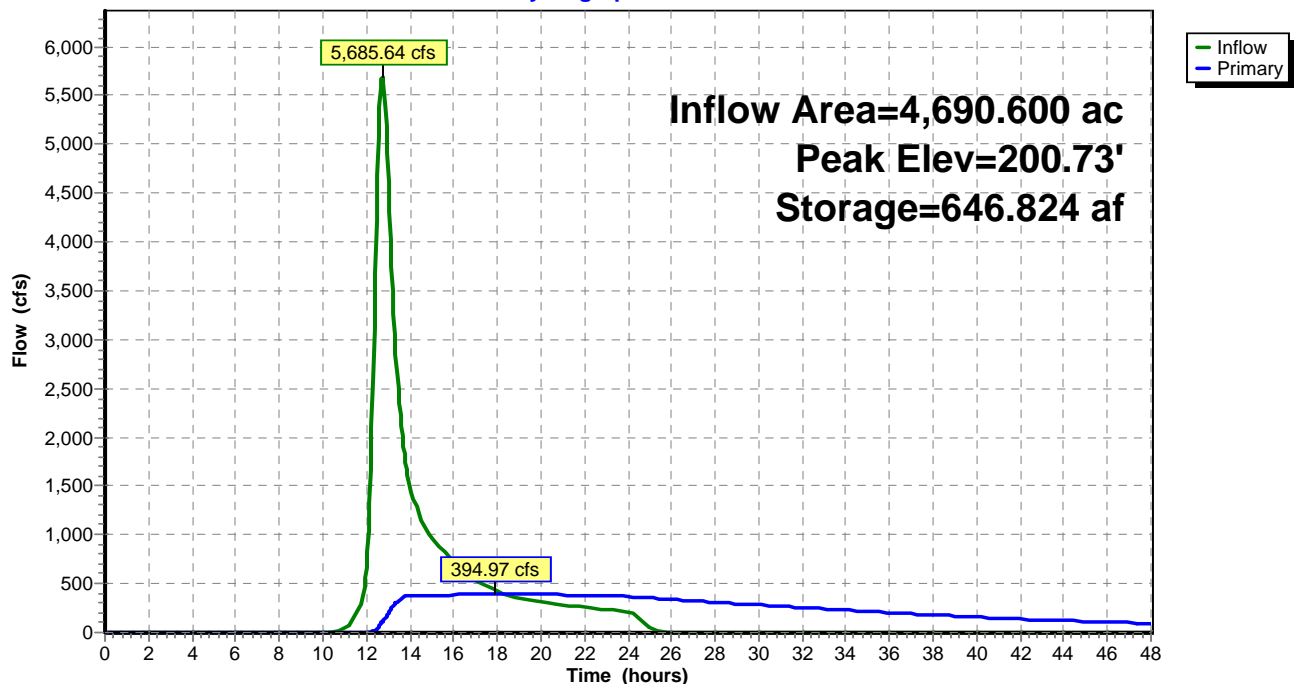
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=395.03 cfs @ 17.86 hrs HW=200.73' TW=200.34' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 395.03 cfs @ 3.30 fps)

Pond RD: Red Dam

Hydrograph



W350 Existing Calibrated Model_REV2

Type III 24-hr CURRENT 25yr Rainfall=6.27"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 27

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.24"
Tc=50.0 min CN=82 Runoff=21.55 cfs 3.530 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.10"
Tc=50.0 min CN=60 Runoff=4,782.35 cfs 820.979 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=193.02' Inflow=341.36 cfs 644.617 af
Primary=341.36 cfs 644.617 af Secondary=0.00 cfs 0.000 af Outflow=341.36 cfs 644.617 af

Pond ED: Eagle Dam - Existing

Peak Elev=199.99' Storage=49.079 af Inflow=342.48 cfs 653.946 af
Outflow=341.36 cfs 644.617 af

Pond RD: Red Dam

Peak Elev=200.43' Storage=549.092 af Inflow=4,782.35 cfs 820.979 af
Outflow=341.30 cfs 650.416 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 824.509 af Average Runoff Depth = 2.10"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

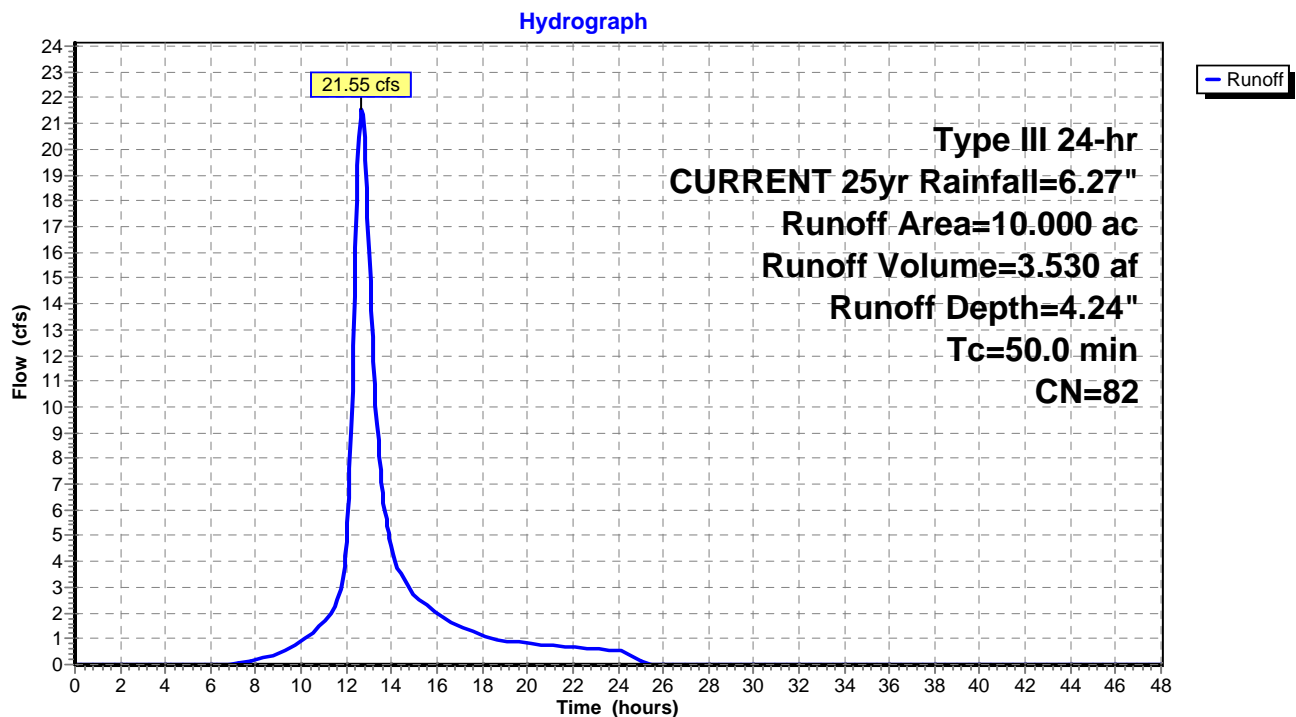
Runoff = 21.55 cfs @ 12.67 hrs, Volume= 3.530 af, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 25yr Rainfall=6.27"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

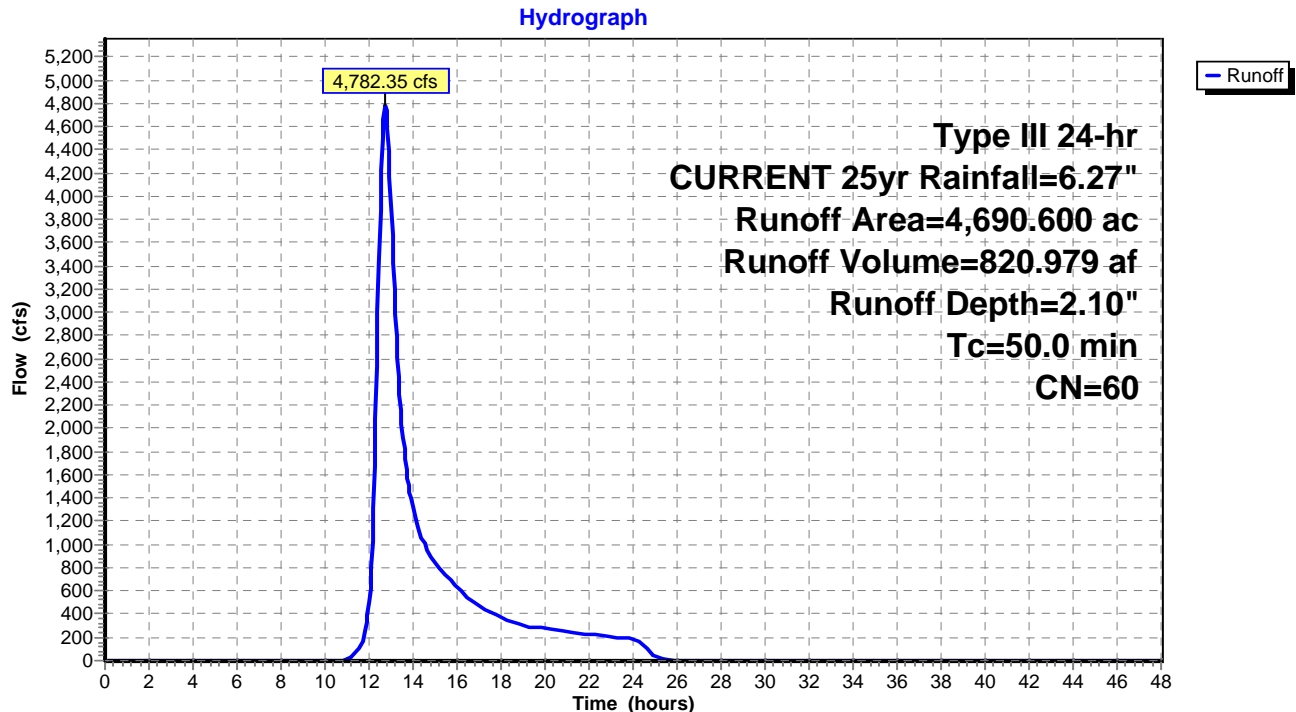
Runoff = 4,782.35 cfs @ 12.73 hrs, Volume= 820.979 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 25yr Rainfall=6.27"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.65" for CURRENT 25yr event
 Inflow = 341.36 cfs @ 18.66 hrs, Volume= 644.617 af
 Outflow = 341.36 cfs @ 18.66 hrs, Volume= 644.617 af, Atten= 0%, Lag= 0.0 min
 Primary = 341.36 cfs @ 18.66 hrs, Volume= 644.617 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 193.02' @ 18.66 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=341.36 cfs @ 18.66 hrs HW=193.02' (Free Discharge)

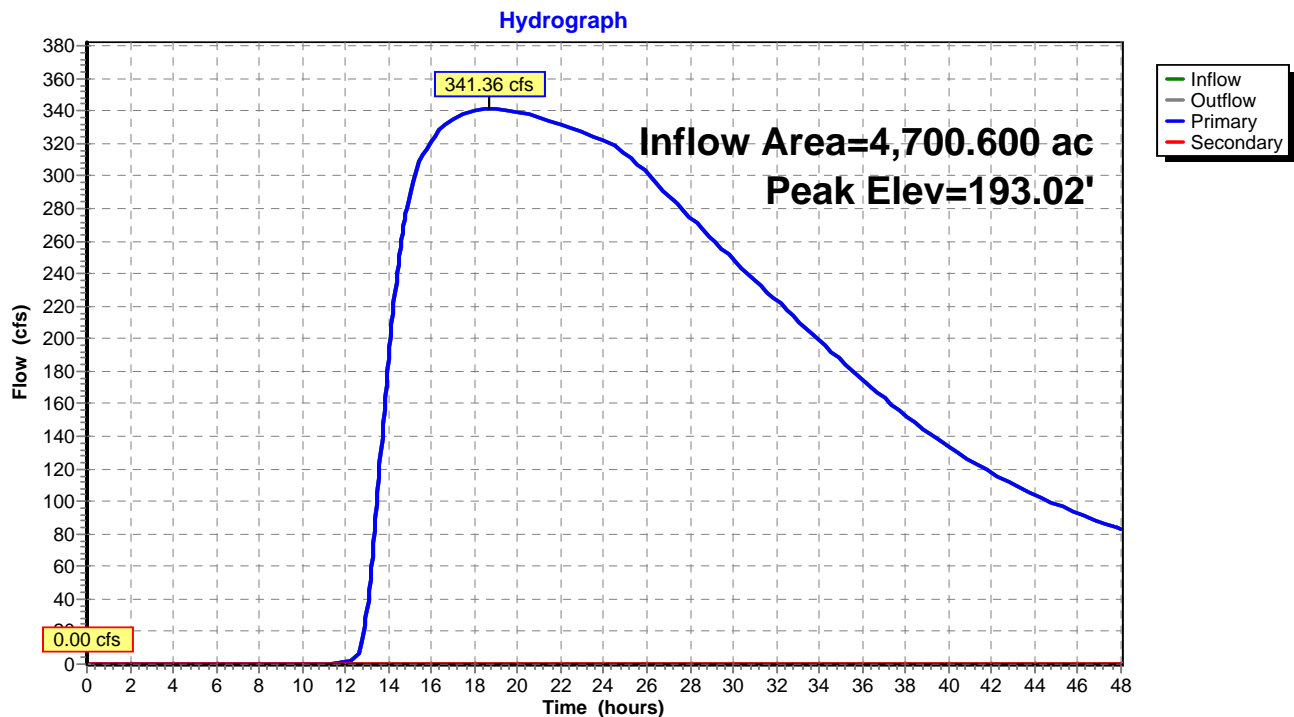
↑ **2=Culvert** (Passes 341.36 cfs of 389.28 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 341.36 cfs @ 5.33 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Existing Spillway = 196.50

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.67" for CURRENT 25yr event
 Inflow = 342.48 cfs @ 17.87 hrs, Volume= 653.946 af
 Outflow = 341.36 cfs @ 18.66 hrs, Volume= 644.617 af, Atten= 0%, Lag= 47.5 min
 Primary = 341.36 cfs @ 18.66 hrs, Volume= 644.617 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 196.50' Surf.Area= 6.380 ac Storage= 22.321 af

Peak Elev= 199.99' @ 18.66 hrs Surf.Area= 8.688 ac Storage= 49.079 af (26.758 af above start)

Plug-Flow detention time= 131.2 min calculated for 622.296 af (95% of inflow)

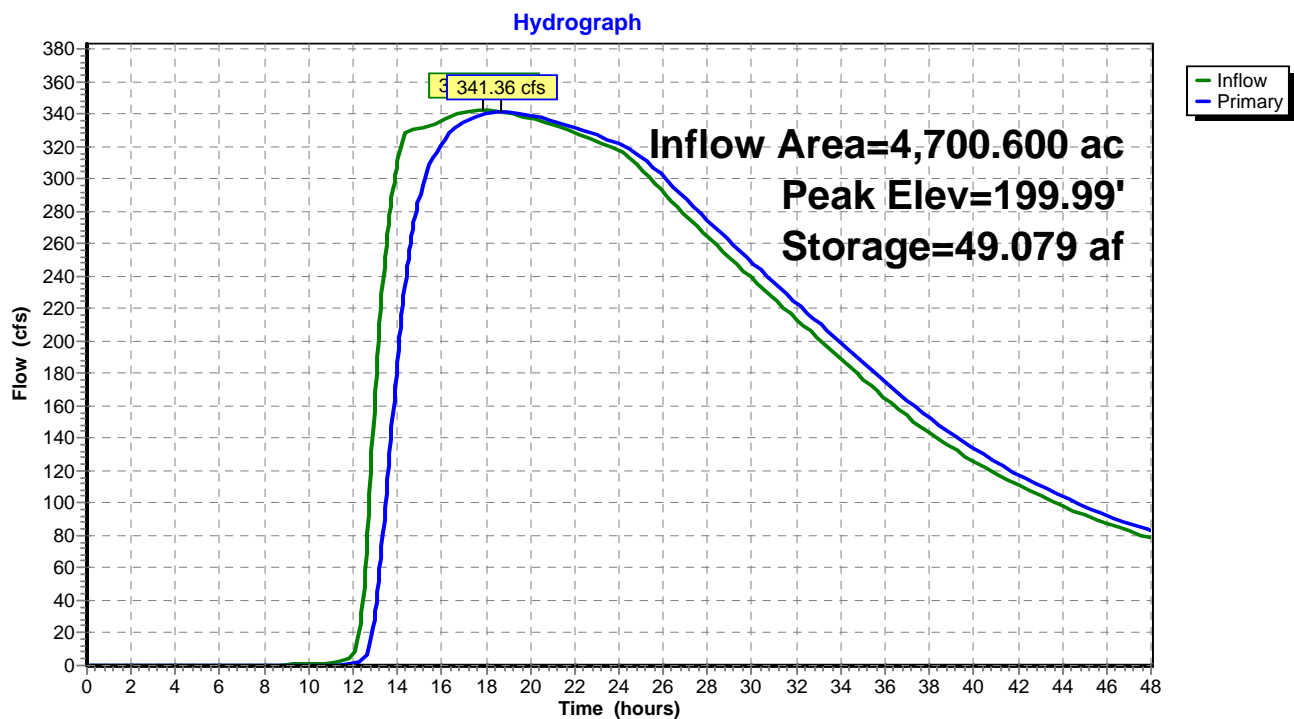
Center-of-Mass det. time= 43.5 min (1,627.7 - 1,584.1)

Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	196.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=341.36 cfs @ 18.66 hrs HW=199.99' TW=193.02' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 341.36 cfs @ 6.12 fps)

Pond ED: Eagle Dam - Existing Spillway = 196.50

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.10" for CURRENT 25yr event
 Inflow = 4,782.35 cfs @ 12.73 hrs, Volume= 820.979 af
 Outflow = 341.30 cfs @ 17.95 hrs, Volume= 650.416 af, Atten= 93%, Lag= 312.9 min
 Primary = 341.30 cfs @ 17.95 hrs, Volume= 650.416 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.43' @ 18.39 hrs Surf.Area= 0.000 ac Storage= 549.092 af

Plug-Flow detention time= 769.8 min calculated for 649.739 af (79% of inflow)
 Center-of-Mass det. time= 687.3 min (1,588.1 - 900.9)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

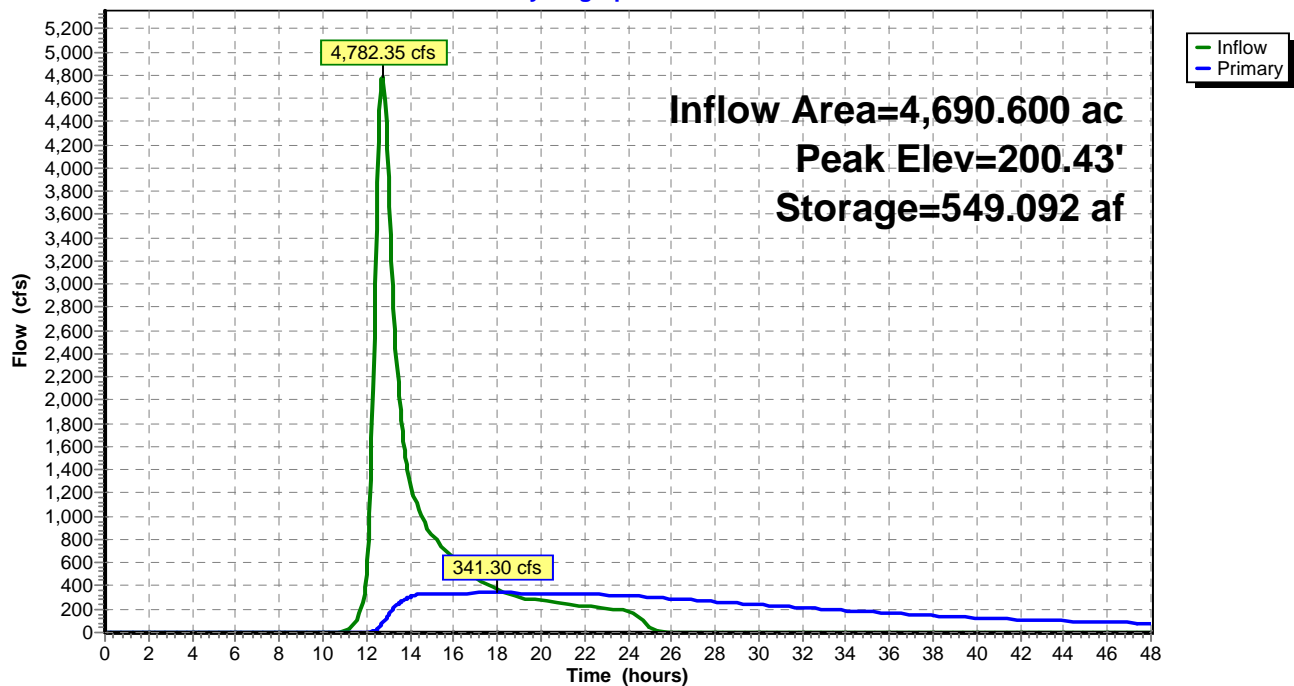
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=341.32 cfs @ 17.95 hrs HW=200.43' TW=199.98' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 341.32 cfs @ 3.35 fps)

Pond RD: Red Dam

Hydrograph



W350 Existing Calibrated Model_REV2*Type III 24-hr CURRENT 50yr Rainfall=7.51"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 35

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=5.40"
Tc=50.0 min CN=82 Runoff=27.27 cfs 4.497 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.97"
Tc=50.0 min CN=60 Runoff=6,948.19 cfs 1,161.122 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=194.73' Inflow=470.35 cfs 926.345 af
Primary=470.35 cfs 926.345 af Secondary=0.00 cfs 0.000 af Outflow=470.35 cfs 926.345 af

Pond ED: Eagle Dam - Existing

Peak Elev=200.82' Storage=56.384 af Inflow=478.42 cfs 938.955 af
Outflow=470.35 cfs 926.345 af

Pond RD: Red Dam

Peak Elev=201.15' Storage=785.028 af Inflow=6,948.19 cfs 1,161.122 af
Outflow=471.49 cfs 934.459 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 1,165.618 af Average Runoff Depth = 2.98"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

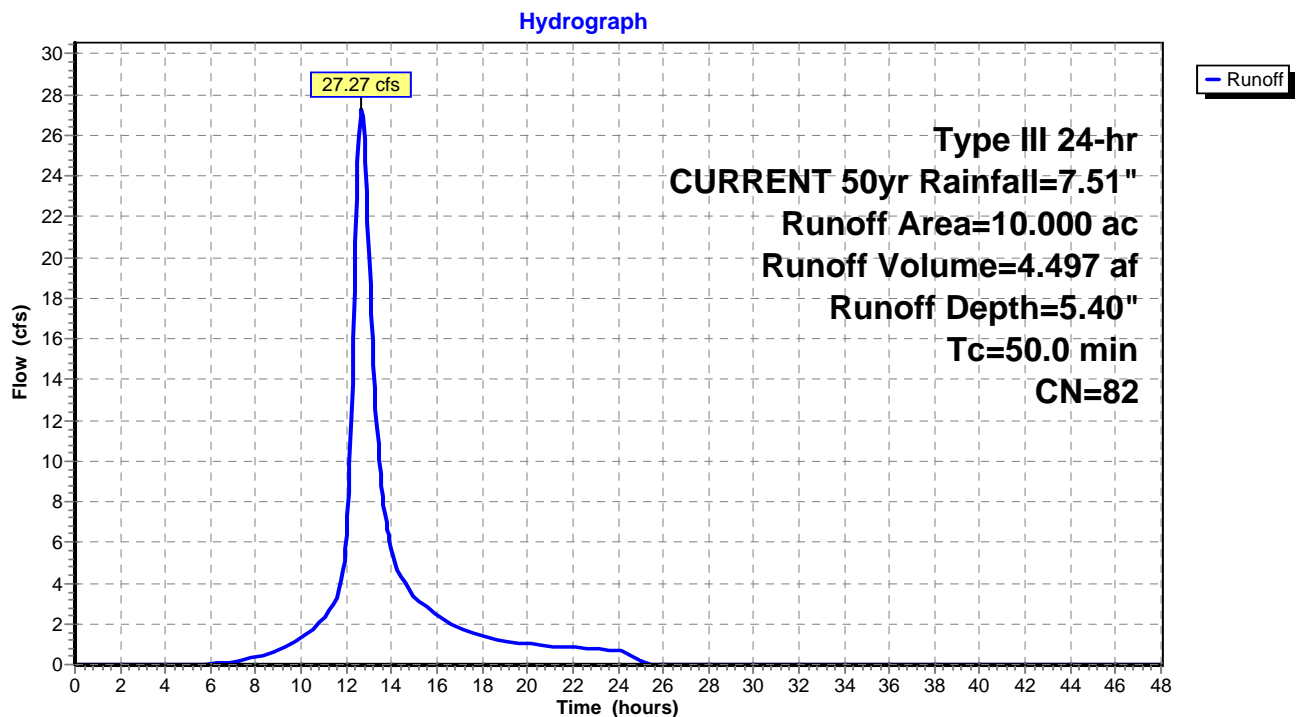
Runoff = 27.27 cfs @ 12.67 hrs, Volume= 4.497 af, Depth= 5.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 50yr Rainfall=7.51"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



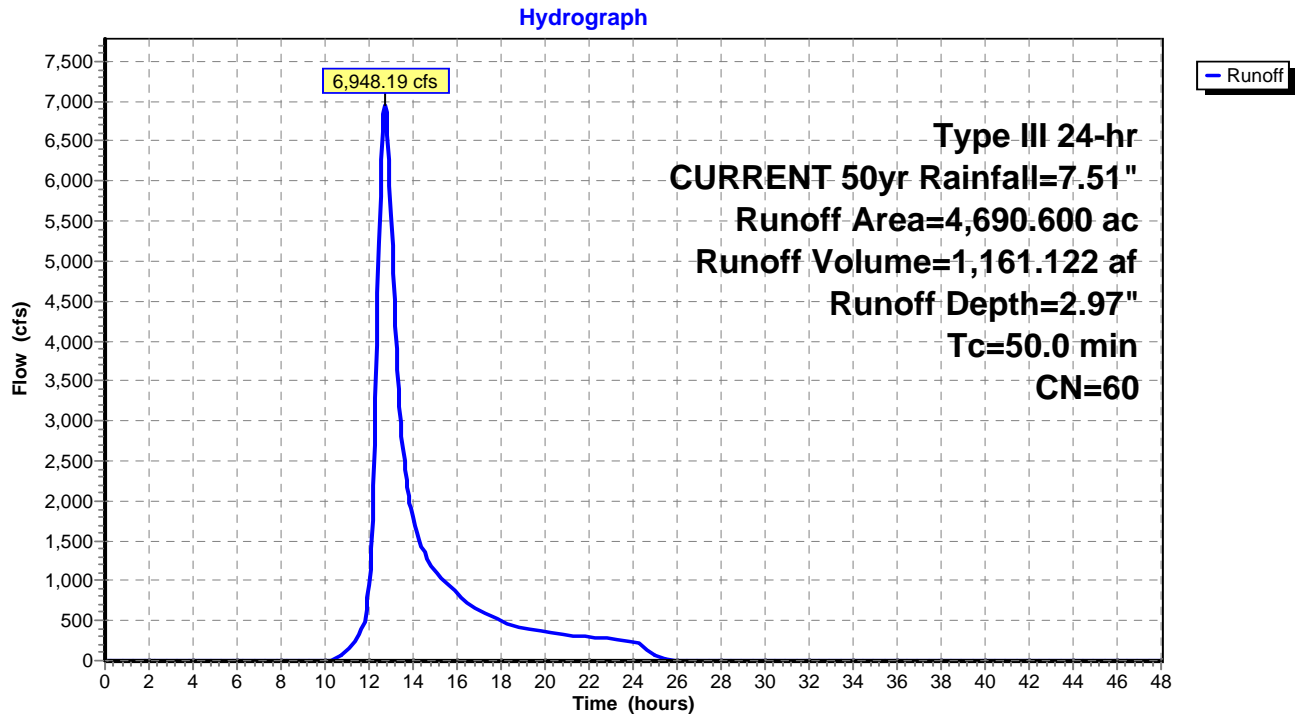
Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 6,948.19 cfs @ 12.72 hrs, Volume= 1,161.122 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 50yr Rainfall=7.51"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.36" for CURRENT 50yr event
 Inflow = 470.35 cfs @ 18.37 hrs, Volume= 926.345 af
 Outflow = 470.35 cfs @ 18.37 hrs, Volume= 926.345 af, Atten= 0%, Lag= 0.0 min
 Primary = 470.35 cfs @ 18.37 hrs, Volume= 926.345 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 194.73' @ 18.37 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 ' / ' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=470.34 cfs @ 18.37 hrs HW=194.73' (Free Discharge)

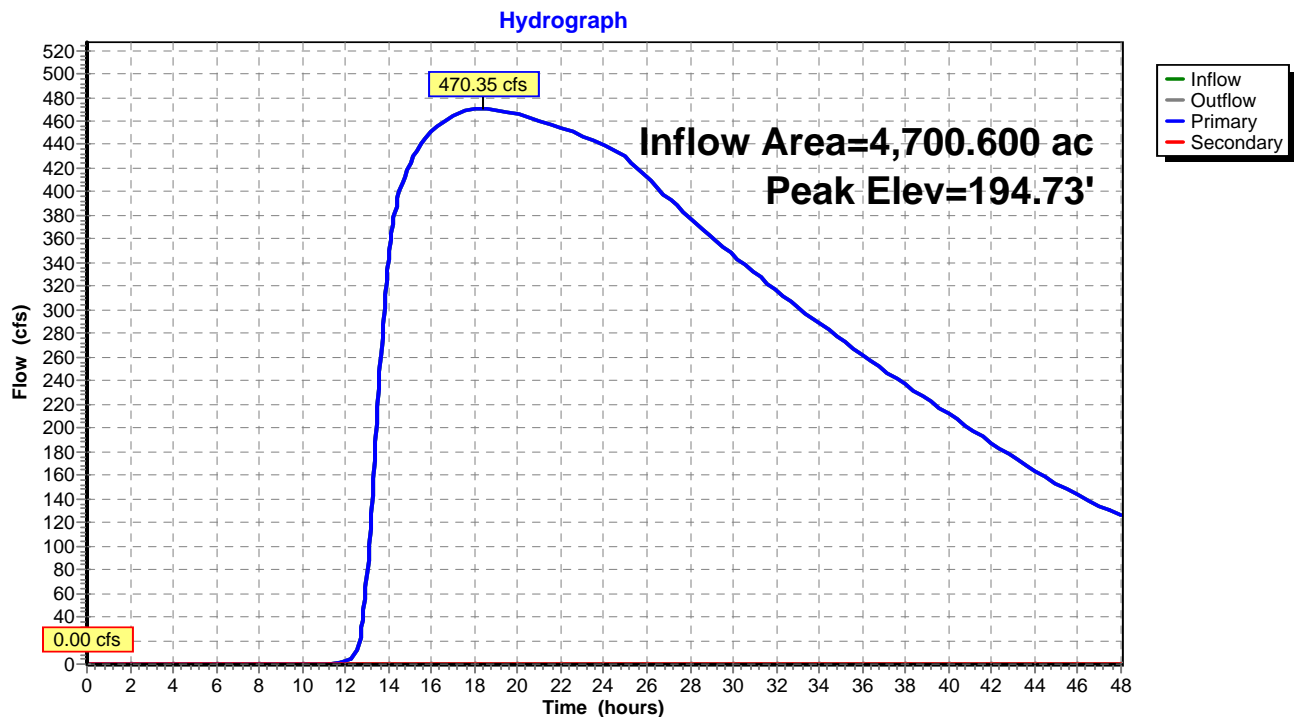
↑ **2=Culvert** (Passes 470.34 cfs of 601.72 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 470.34 cfs @ 7.35 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Existing Spillway = 196.50

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.40" for CURRENT 50yr event
 Inflow = 478.42 cfs @ 13.75 hrs, Volume= 938.955 af
 Outflow = 470.35 cfs @ 18.37 hrs, Volume= 926.345 af, Atten= 2%, Lag= 276.9 min
 Primary = 470.35 cfs @ 18.37 hrs, Volume= 926.345 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 196.50' Surf.Area= 6.380 ac Storage= 22.321 af

Peak Elev= 200.82' @ 18.37 hrs Surf.Area= 8.896 ac Storage= 56.384 af (34.063 af above start)

Plug-Flow detention time= 106.1 min calculated for 904.024 af (96% of inflow)

Center-of-Mass det. time= 39.8 min (1,640.2 - 1,600.4)

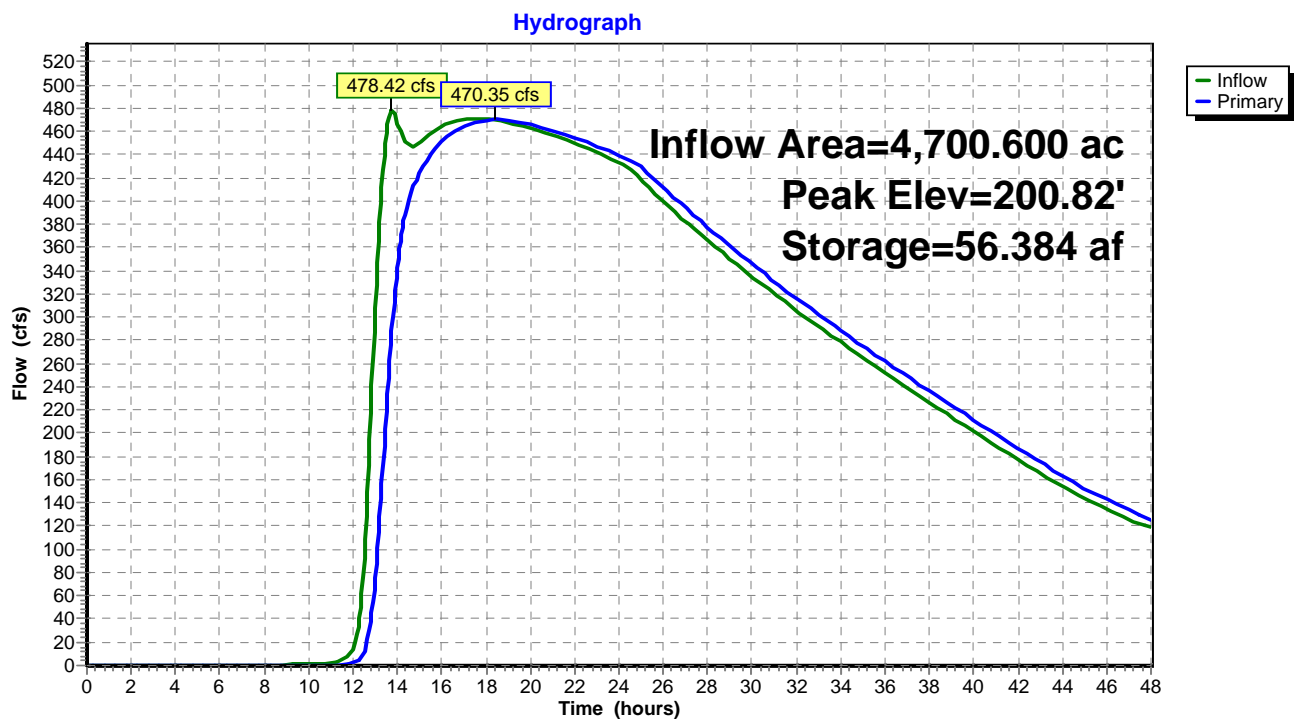
Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	196.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=470.34 cfs @ 18.37 hrs HW=200.82' TW=194.73' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 470.34 cfs @ 6.81 fps)

Pond ED: Eagle Dam - Existing Spillway = 196.50

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.97" for CURRENT 50yr event
 Inflow = 6,948.19 cfs @ 12.72 hrs, Volume= 1,161.122 af
 Outflow = 471.49 cfs @ 13.77 hrs, Volume= 934.459 af, Atten= 93%, Lag= 63.0 min
 Primary = 471.49 cfs @ 13.77 hrs, Volume= 934.459 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 201.15' @ 18.21 hrs Surf.Area= 0.000 ac Storage= 785.028 af

Plug-Flow detention time= 793.0 min calculated for 934.459 af (80% of inflow)
 Center-of-Mass det. time= 713.7 min (1,604.1 - 890.4)

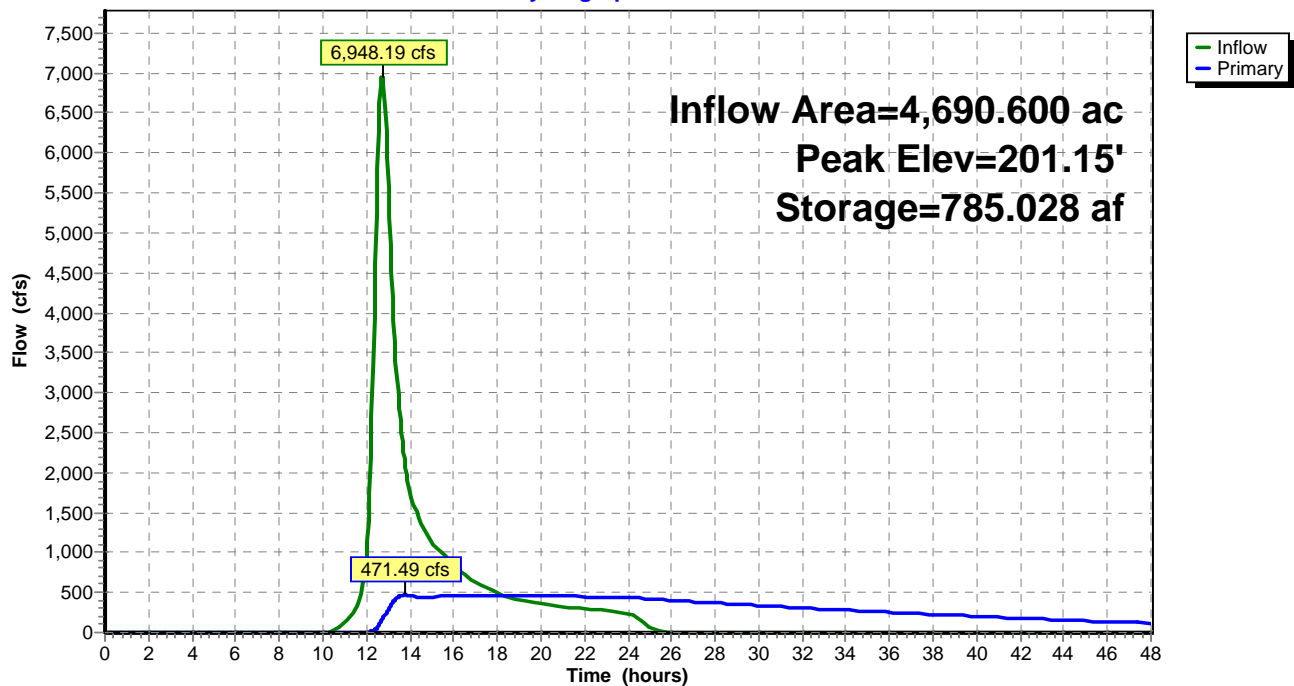
Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=471.68 cfs @ 13.77 hrs HW=200.61' TW=199.65' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 471.68 cfs @ 4.18 fps)

Pond RD: Red Dam**Hydrograph**

W350 Existing Calibrated Model_REV2*Type III 24-hr CURRENT 100yr Rainfall=9.01"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 43

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=6.82"
Tc=50.0 min CN=82 Runoff=34.19 cfs 5.686 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=4.11"
Tc=50.0 min CN=60 Runoff=9,761.26 cfs 1,605.988 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=197.46' Inflow=968.53 cfs 1,296.538 af
Primary=617.78 cfs 1,229.479 af Secondary=350.74 cfs 67.060 af Outflow=968.53 cfs 1,296.538 af

Pond ED: Eagle Dam - Existing

Peak Elev=203.50' Storage=81.784 af Inflow=1,454.82 cfs 1,313.462 af
Outflow=968.53 cfs 1,296.538 af

Pond RD: Red Dam

Peak Elev=203.90' Storage=1,044.017 af Inflow=9,761.26 cfs 1,605.988 af
Outflow=1,451.41 cfs 1,307.776 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 1,611.675 af Average Runoff Depth = 4.11"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

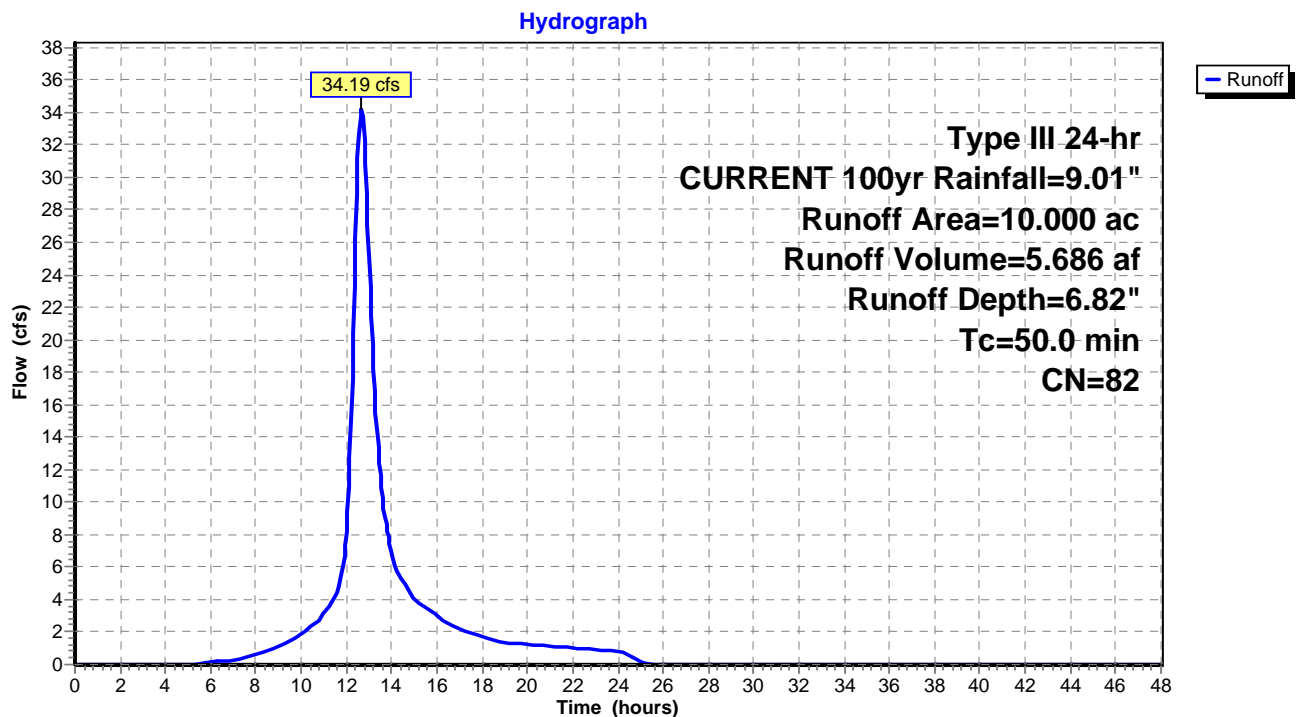
Runoff = 34.19 cfs @ 12.66 hrs, Volume= 5.686 af, Depth= 6.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 100yr Rainfall=9.01"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 9,761.26 cfs @ 12.71 hrs, Volume= 1,605.988 af, Depth= 4.11"

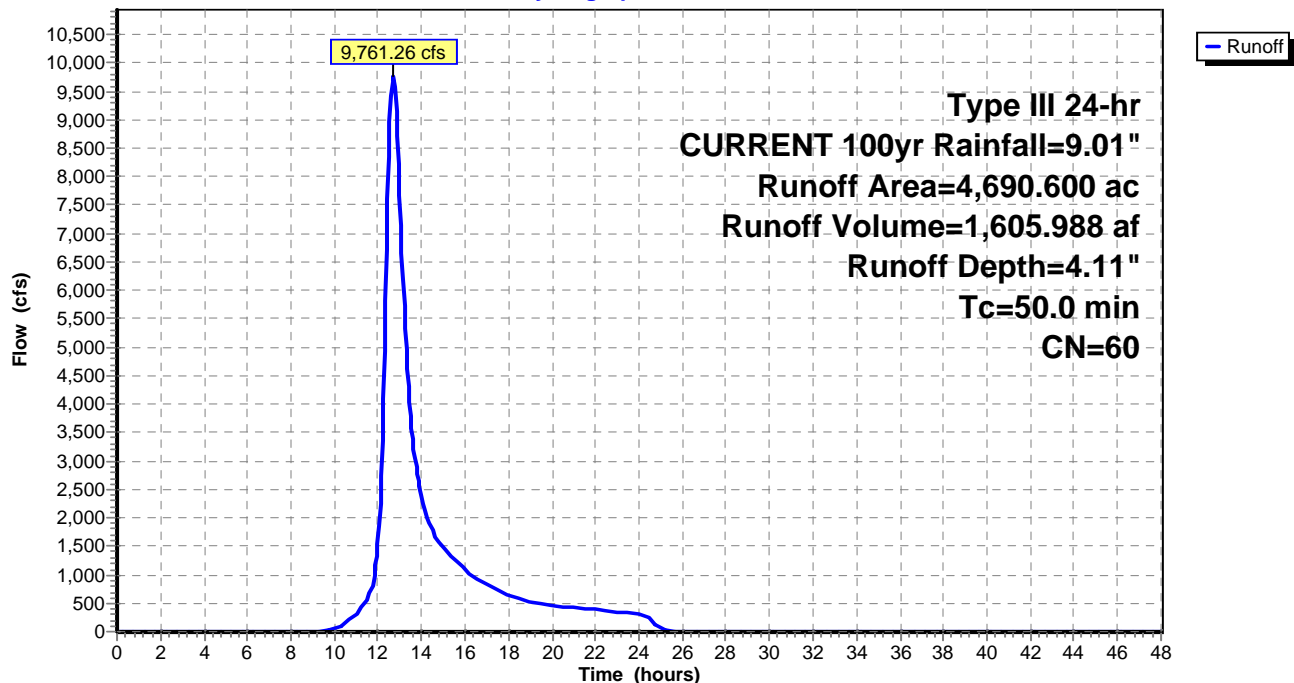
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 100yr Rainfall=9.01"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

Hydrograph



Summary for Pond 1P: Existing Route 140 Culvert Opening

[58] Hint: Peaked 0.93' above defined flood level

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 3.31" for CURRENT 100yr event
 Inflow = 968.53 cfs @ 16.40 hrs, Volume= 1,296.538 af
 Outflow = 968.53 cfs @ 16.40 hrs, Volume= 1,296.538 af, Atten= 0%, Lag= 0.0 min
 Primary = 617.78 cfs @ 16.40 hrs, Volume= 1,229.479 af
 Secondary = 350.74 cfs @ 16.40 hrs, Volume= 67.060 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 197.46' @ 16.40 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

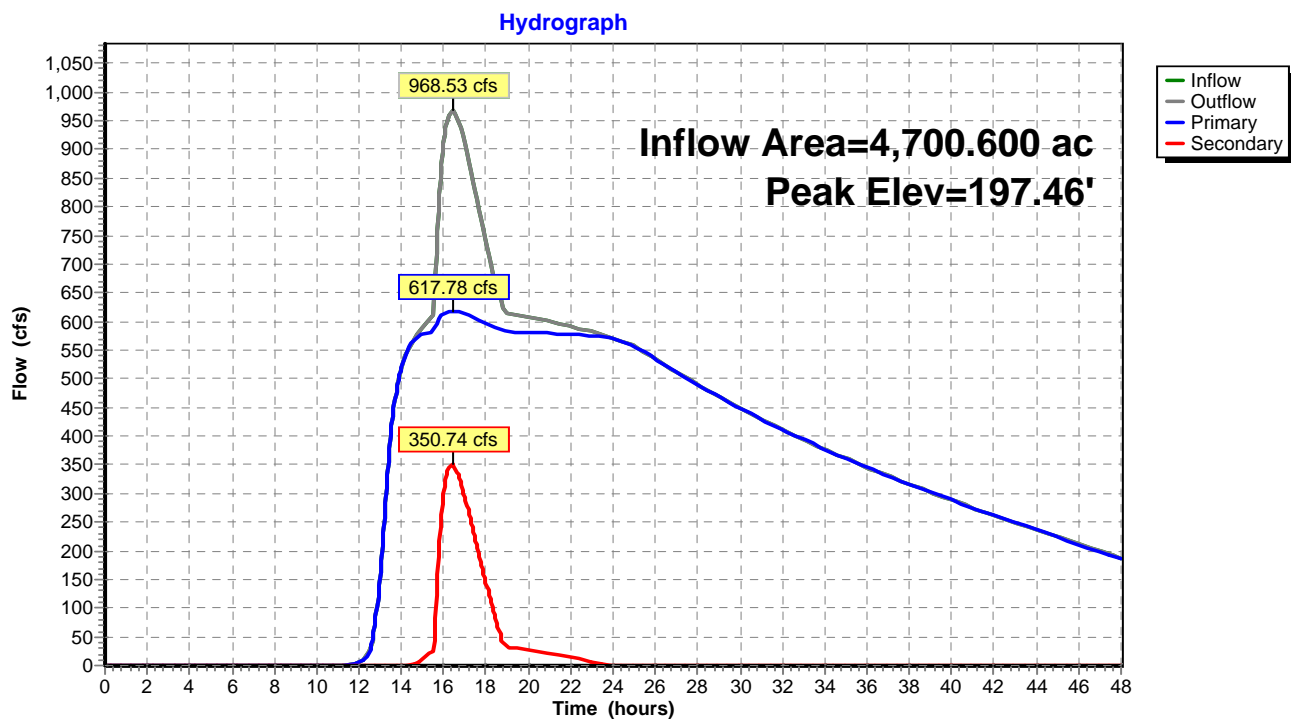
Primary OutFlow Max=617.78 cfs @ 16.40 hrs HW=197.46' (Free Discharge)

↑ **2=Culvert** (Passes 617.78 cfs of 790.33 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 617.78 cfs @ 9.65 fps)

Secondary OutFlow Max=350.69 cfs @ 16.40 hrs HW=197.46' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Weir Controls 350.69 cfs @ 3.15 fps)

Pond 1P: Existing Route 140 Culvert Opening

Summary for Pond ED: Eagle Dam - Existing Spillway = 196.50

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 3.35" for CURRENT 100yr event
 Inflow = 1,454.82 cfs @ 15.60 hrs, Volume= 1,313.462 af
 Outflow = 968.53 cfs @ 16.40 hrs, Volume= 1,296.538 af, Atten= 33%, Lag= 47.7 min
 Primary = 968.53 cfs @ 16.40 hrs, Volume= 1,296.538 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 196.50' Surf.Area= 6.380 ac Storage= 22.321 af

Peak Elev= 203.50' @ 16.40 hrs Surf.Area= 10.000 ac Storage= 81.784 af (59.463 af above start)

Plug-Flow detention time= 88.0 min calculated for 1,272.891 af (97% of inflow)

Center-of-Mass det. time= 35.7 min (1,614.5 - 1,578.9)

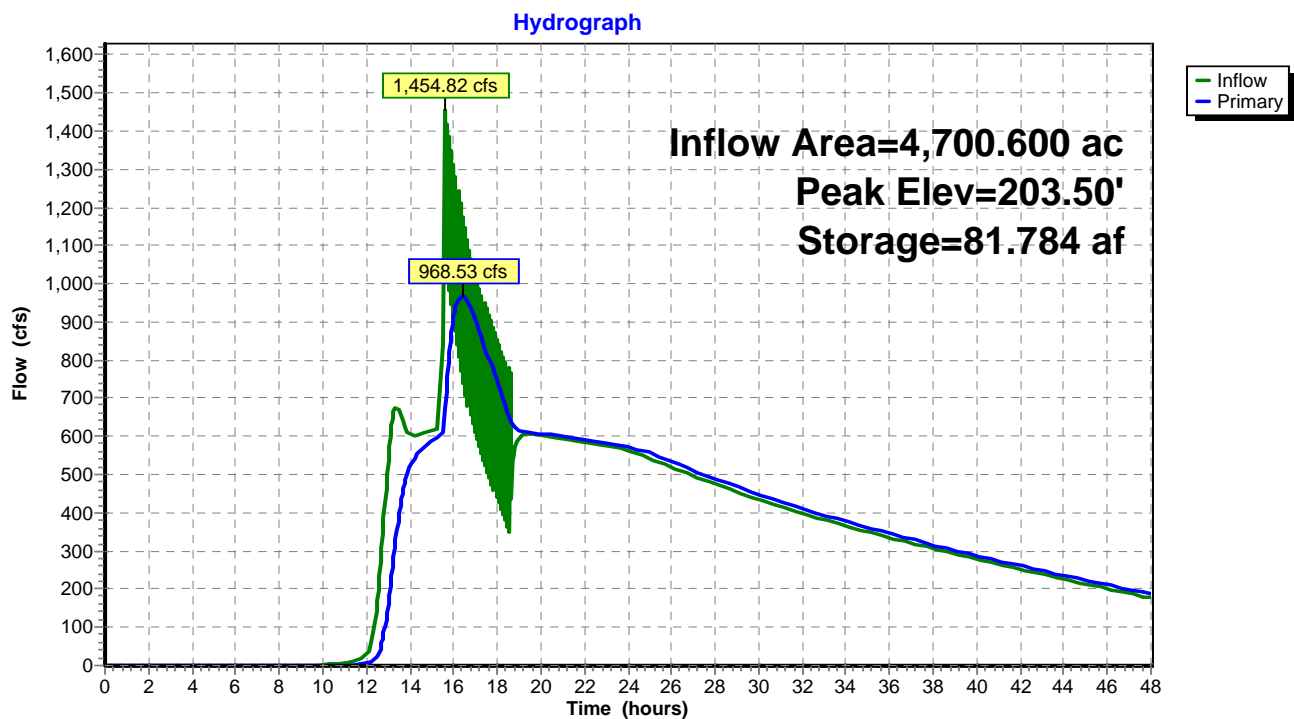
Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	196.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=968.46 cfs @ 16.40 hrs HW=203.50' TW=197.46' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 968.46 cfs @ 8.64 fps)

Pond ED: Eagle Dam - Existing Spillway = 196.50

Summary for Pond RD: Red Dam

[93] Warning: Storage range exceeded by 1.97'

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=31)

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 4.11" for CURRENT 100yr event
 Inflow = 9,761.26 cfs @ 12.71 hrs, Volume= 1,605.988 af
 Outflow = 1,451.41 cfs @ 15.60 hrs, Volume= 1,307.776 af, Atten= 85%, Lag= 173.7 min
 Primary = 1,451.41 cfs @ 15.60 hrs, Volume= 1,307.776 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 203.90' @ 16.30 hrs Surf.Area= 0.000 ac Storage= 1,044.017 af

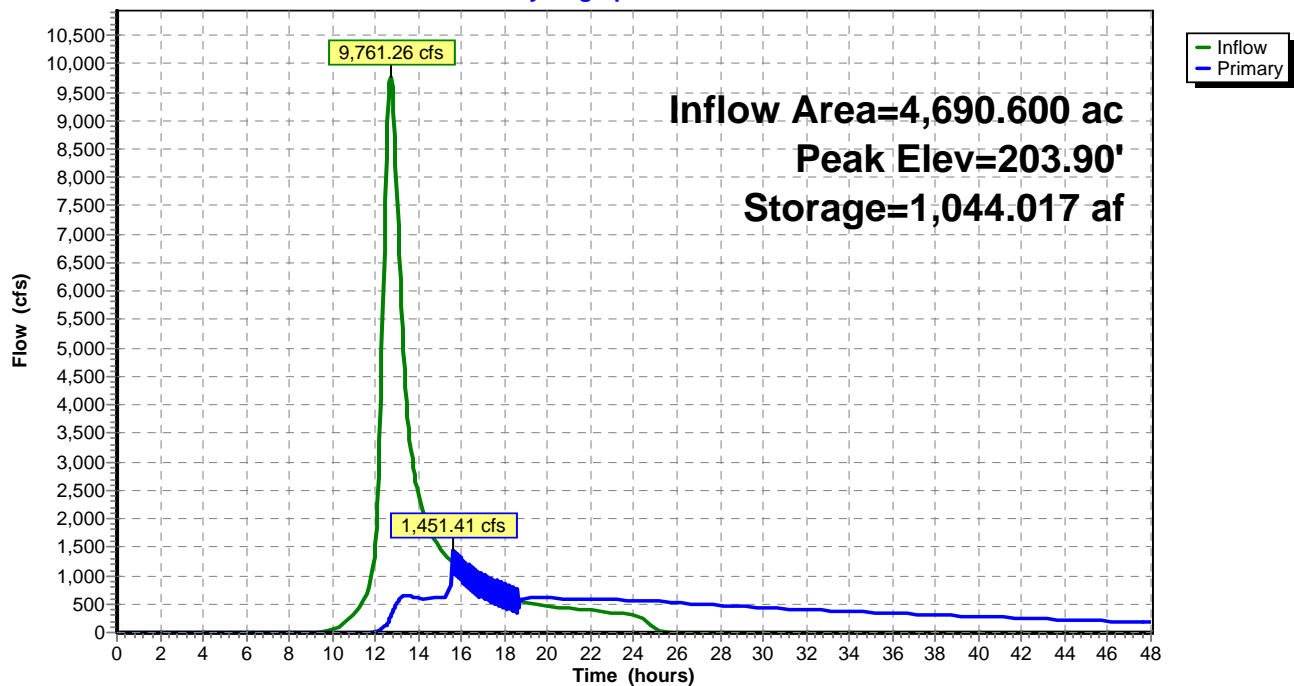
Plug-Flow detention time= 776.1 min calculated for 1,306.415 af (81% of inflow)
 Center-of-Mass det. time= 701.3 min (1,582.1 - 880.8)

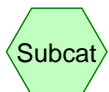
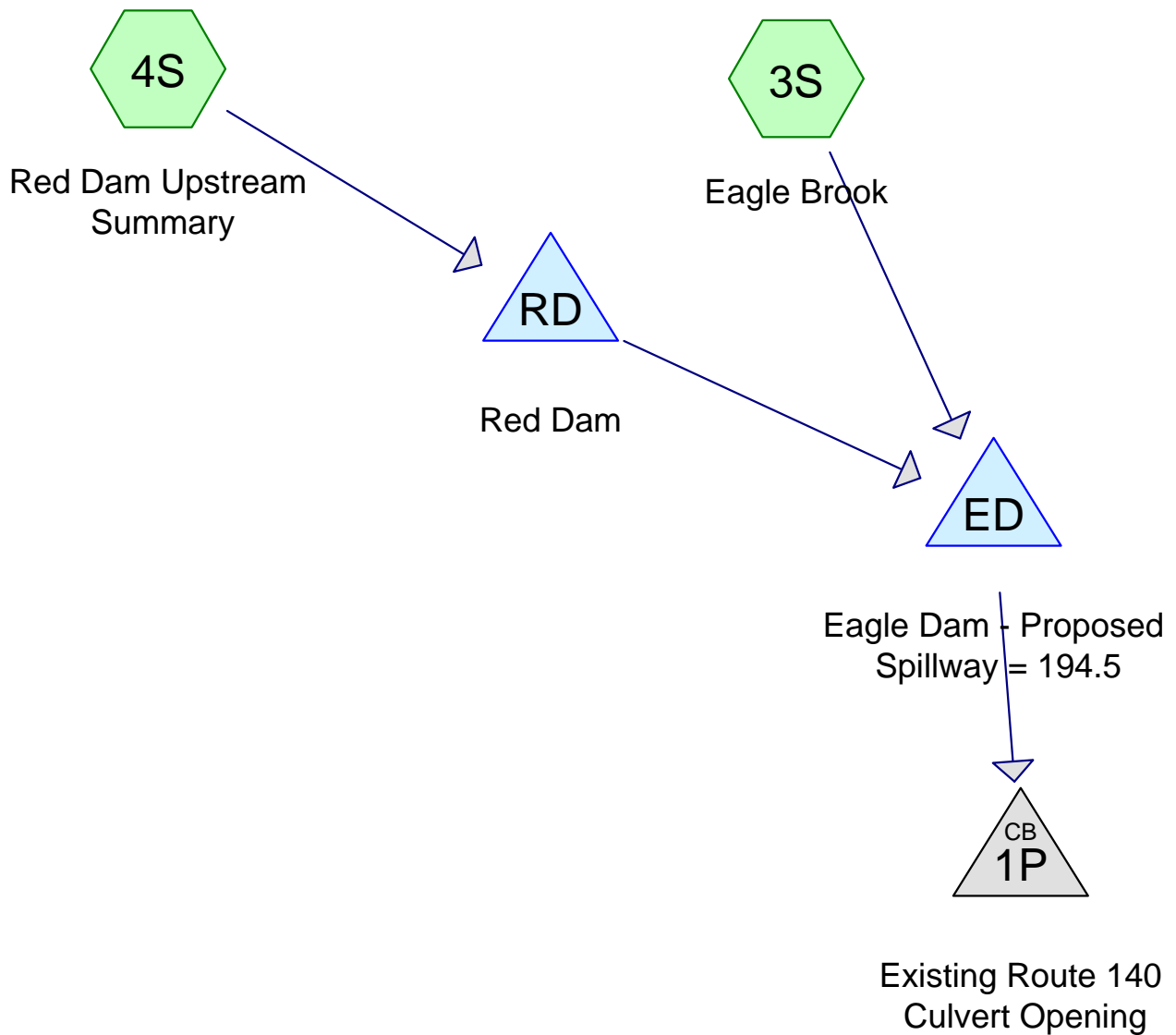
Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=1,451.40 cfs @ 15.60 hrs HW=203.17' TW=201.99' (Dynamic Tailwater)
 ↑1=Sharp-Crested Vee/Trap Weir (Weir Controls 1,451.40 cfs @ 5.44 fps)

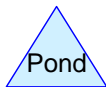
Pond RD: Red Dam**Hydrograph**



Subcat



Reach



Pond



Link

Routing Diagram for W350 Lowered Eagle Dam Proposed Model_REV2

Prepared by ESS Group, Inc., Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

W350 Lowered Eagle Dam Proposed Model_REV2*Type III 24-hr 25yr Rainfall=5.50"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 2

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=3.53"
Tc=50.0 min CN=82 Runoff=18.03 cfs 2.942 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=1.60"
Tc=50.0 min CN=60 Runoff=3,540.99 cfs 626.416 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=192.54' Inflow=286.42 cfs 485.413 af
Primary=286.42 cfs 485.413 af Secondary=0.00 cfs 0.000 af Outflow=286.42 cfs 485.413 af

Pond ED: Eagle Dam - Proposed

Peak Elev=197.60' Storage=29.806 af Inflow=287.78 cfs 491.304 af
Outflow=286.42 cfs 485.413 af

Pond RD: Red Dam

Peak Elev=200.02' Storage=413.954 af Inflow=3,540.99 cfs 626.416 af
Outflow=286.84 cfs 488.362 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 629.357 af Average Runoff Depth = 1.61"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

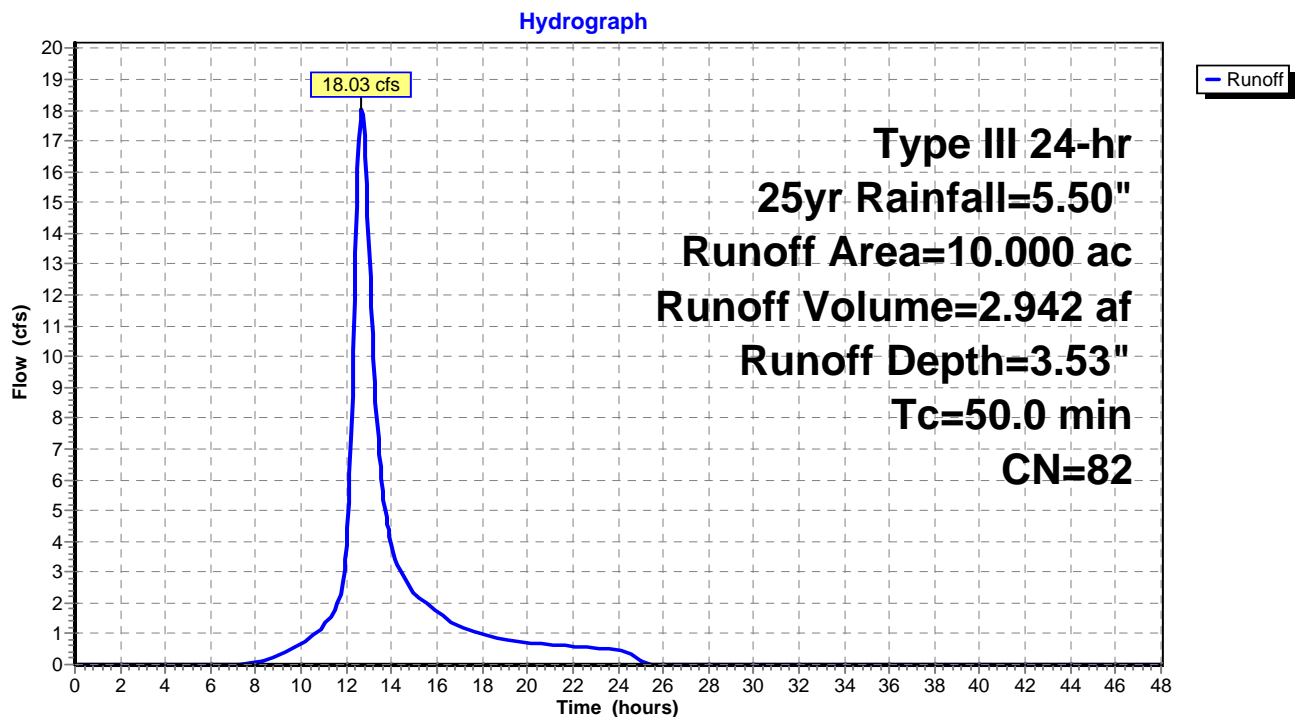
Runoff = 18.03 cfs @ 12.68 hrs, Volume= 2.942 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=5.50"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

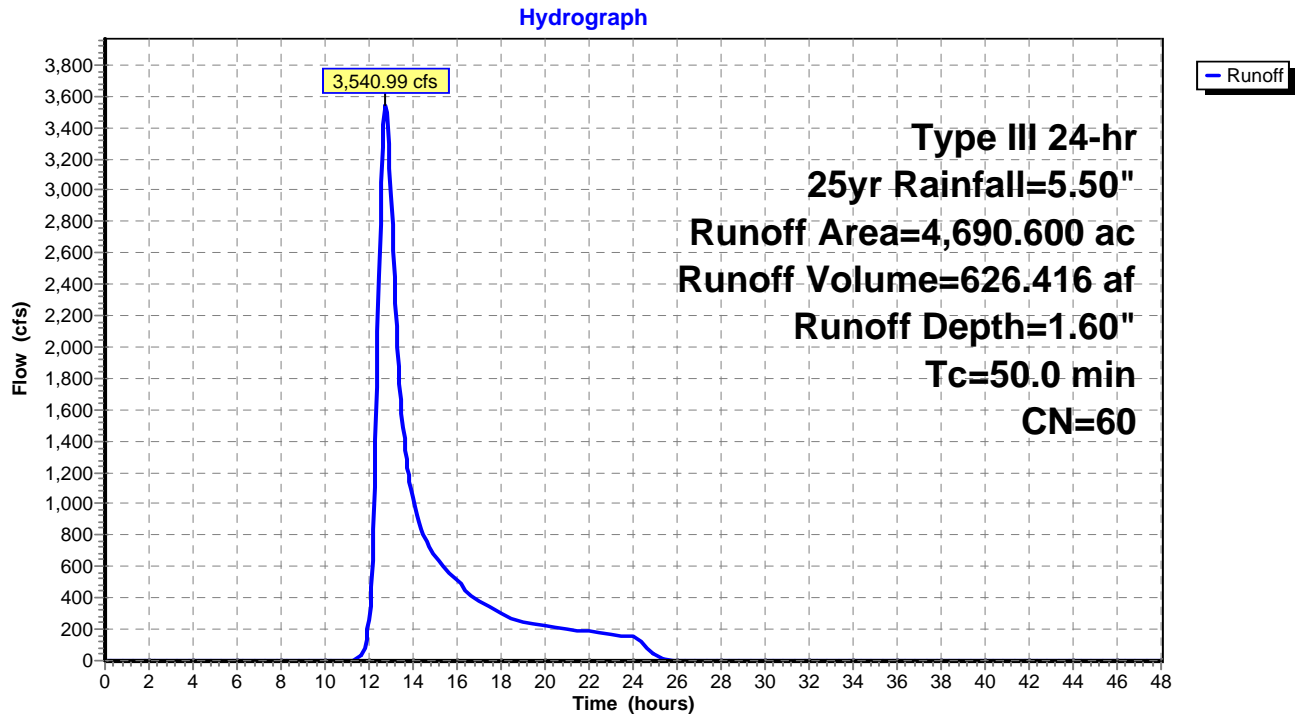
Runoff = 3,540.99 cfs @ 12.75 hrs, Volume= 626.416 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=5.50"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.24" for 25yr event
 Inflow = 286.42 cfs @ 18.91 hrs, Volume= 485.413 af
 Outflow = 286.42 cfs @ 18.91 hrs, Volume= 485.413 af, Atten= 0%, Lag= 0.0 min
 Primary = 286.42 cfs @ 18.91 hrs, Volume= 485.413 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 192.54' @ 18.91 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=286.42 cfs @ 18.91 hrs HW=192.54' (Free Discharge)

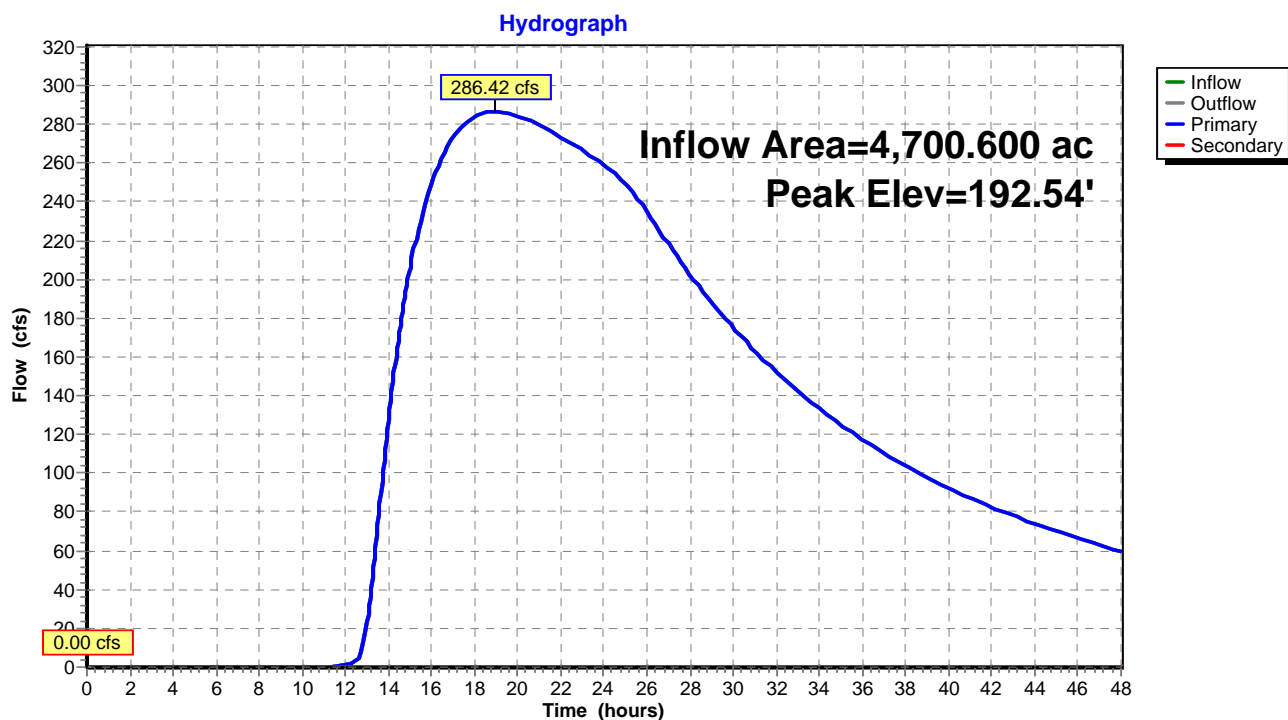
↑ **2=Culvert** (Passes 286.42 cfs of 328.55 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 286.42 cfs @ 4.83 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 194.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.25" for 25yr event
 Inflow = 287.78 cfs @ 18.18 hrs, Volume= 491.304 af
 Outflow = 286.42 cfs @ 18.91 hrs, Volume= 485.413 af, Atten= 0%, Lag= 43.6 min
 Primary = 286.42 cfs @ 18.91 hrs, Volume= 485.413 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Starting Elev= 194.50' Surf.Area= 4.951 ac Storage= 10.929 af
 Peak Elev= 197.60' @ 18.91 hrs Surf.Area= 7.200 ac Storage= 29.806 af (18.878 af above start)

Plug-Flow detention time= 98.6 min calculated for 473.990 af (96% of inflow)
 Center-of-Mass det. time= 37.4 min (1,599.4 - 1,562.1)

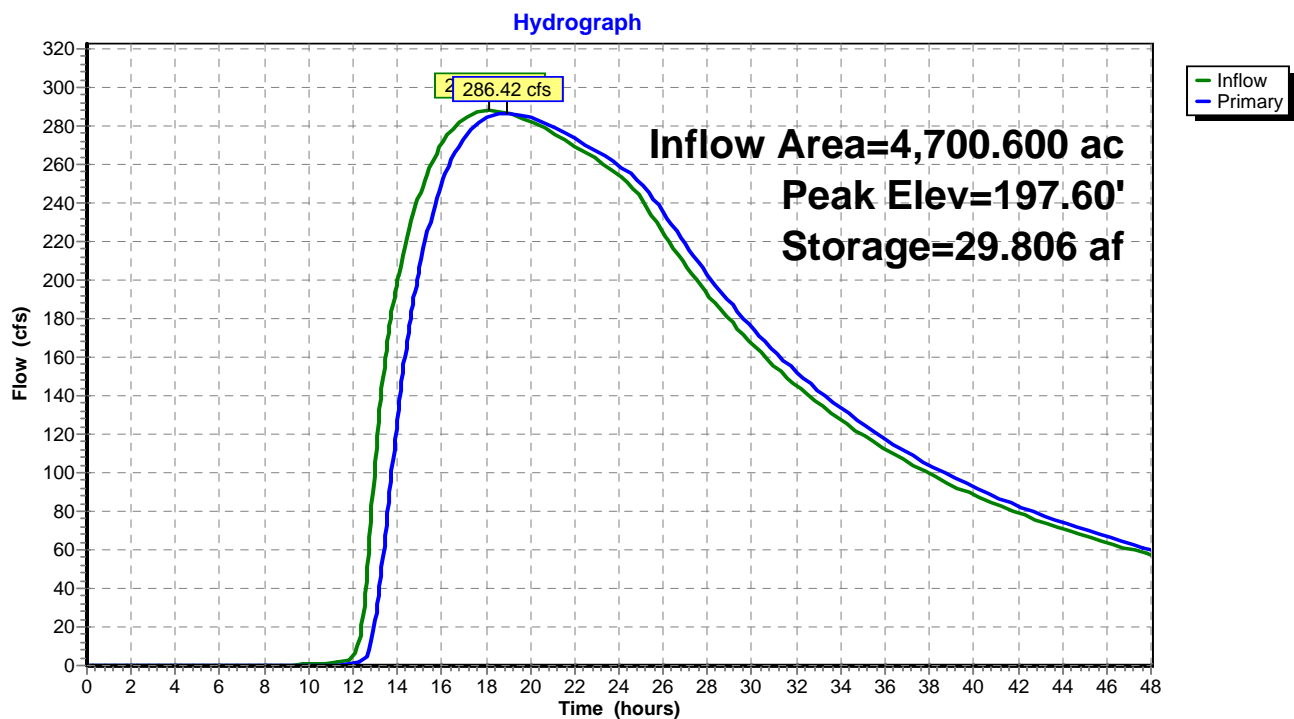
Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	194.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=286.42 cfs @ 18.91 hrs HW=197.60' TW=192.54' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 286.42 cfs @ 5.77 fps)

Pond ED: Eagle Dam - Proposed Spillway = 194.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 1.60" for 25yr event
 Inflow = 3,540.99 cfs @ 12.75 hrs, Volume= 626.416 af
 Outflow = 286.84 cfs @ 18.22 hrs, Volume= 488.362 af, Atten= 92%, Lag= 328.3 min
 Primary = 286.84 cfs @ 18.22 hrs, Volume= 488.362 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.02' @ 18.22 hrs Surf.Area= 0.000 ac Storage= 413.954 af

Plug-Flow detention time= 744.9 min calculated for 488.362 af (78% of inflow)
 Center-of-Mass det. time= 656.9 min (1,566.3 - 909.4)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

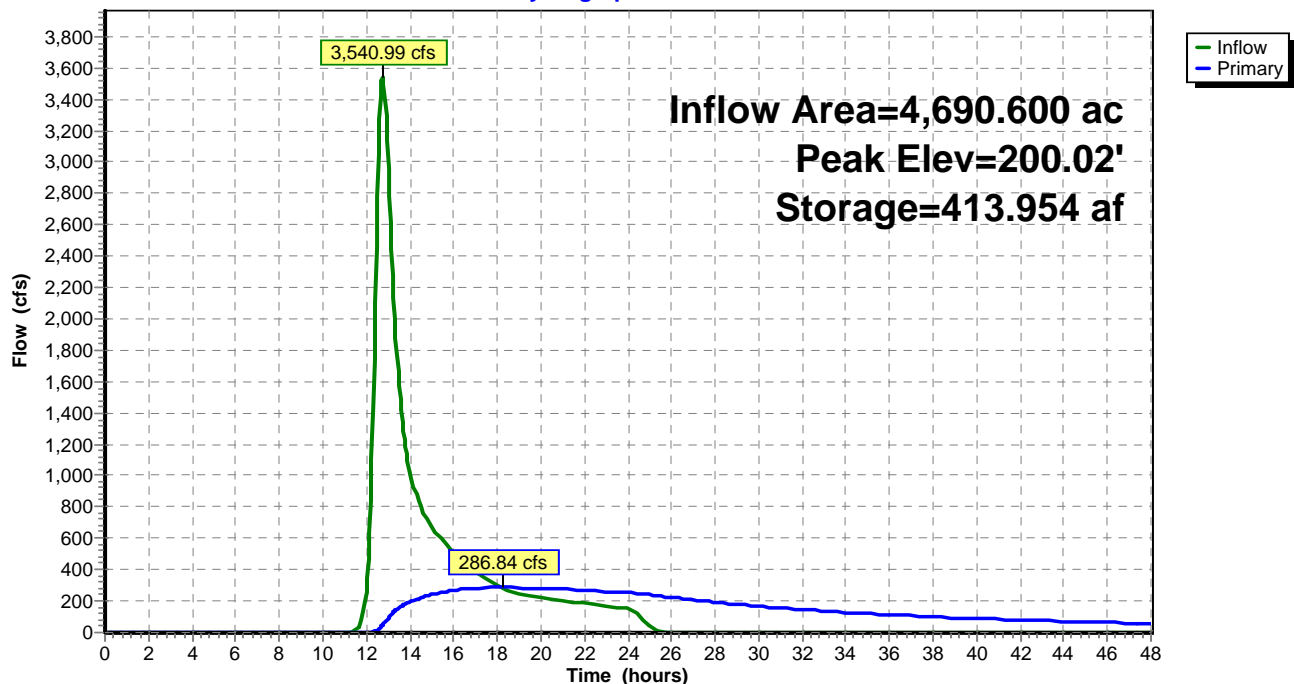
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=286.83 cfs @ 18.22 hrs HW=200.02' TW=197.59' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 286.83 cfs @ 3.72 fps)

Pond RD: Red Dam

Hydrograph



W350 Lowered Eagle Dam Proposed Model_REV2*Type III 24-hr 50yr Rainfall=6.10"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 10

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.08"
Tc=50.0 min CN=82 Runoff=20.77 cfs 3.399 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=1.99"
Tc=50.0 min CN=60 Runoff=4,500.53 cfs 776.790 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=193.51' Inflow=383.97 cfs 621.110 af
Primary=383.97 cfs 621.110 af Secondary=0.00 cfs 0.000 af Outflow=383.97 cfs 621.110 af

Pond ED: Eagle Dam - Proposed

Peak Elev=198.27' Storage=34.801 af Inflow=385.88 cfs 627.666 af
Outflow=383.97 cfs 621.110 af

Pond RD: Red Dam

Peak Elev=200.29' Storage=504.845 af Inflow=4,500.53 cfs 776.790 af
Outflow=384.68 cfs 624.266 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 780.190 af Average Runoff Depth = 1.99"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

Runoff = 20.77 cfs @ 12.67 hrs, Volume= 3.399 af, Depth= 4.08"

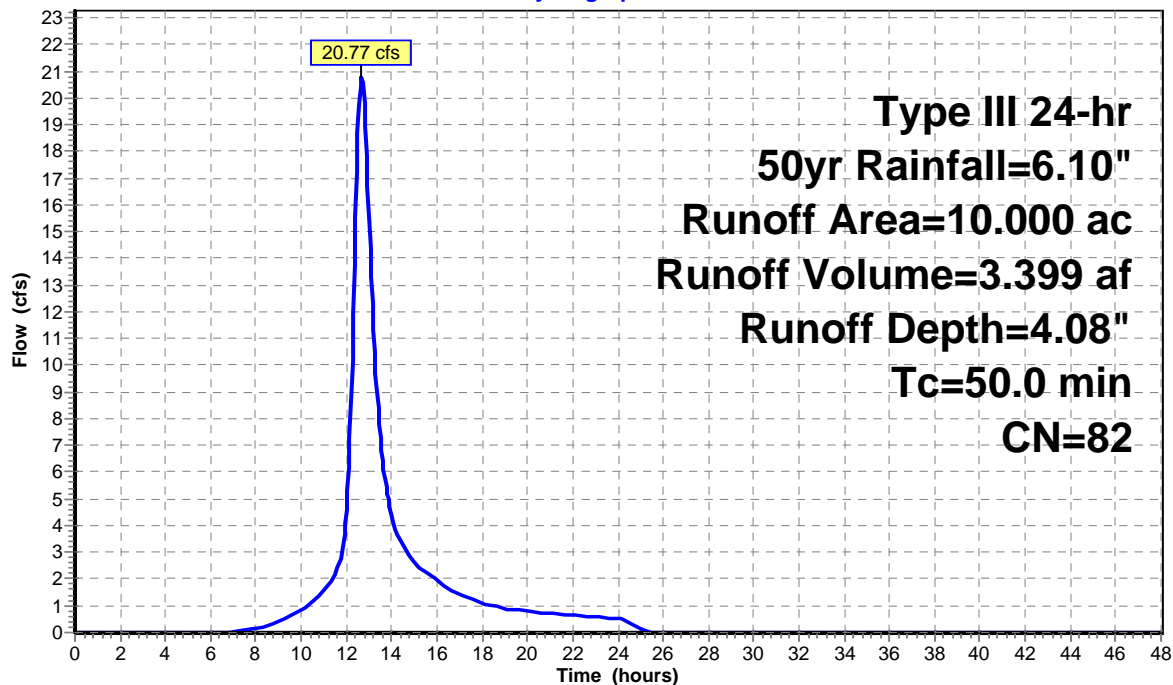
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 50yr Rainfall=6.10"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



Summary for Subcatchment 4S: Red Dam Upstream Summary

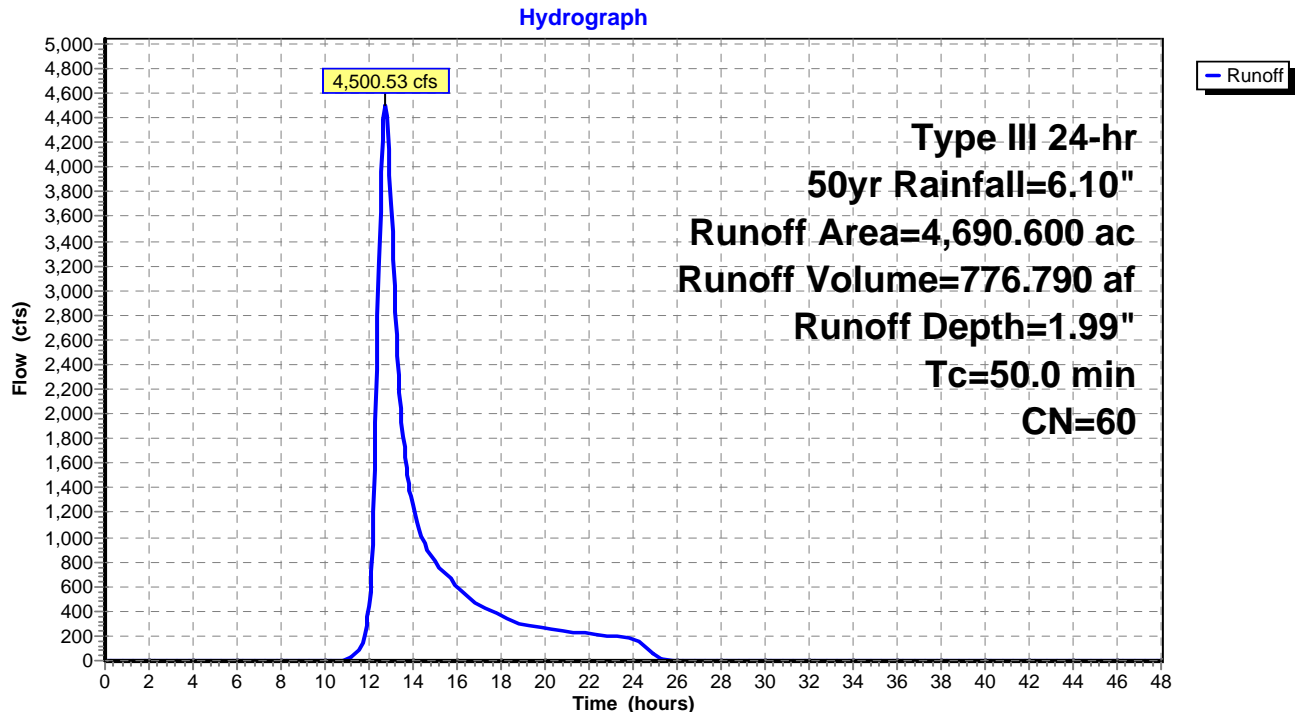
Runoff = 4,500.53 cfs @ 12.74 hrs, Volume= 776.790 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 50yr Rainfall=6.10"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.59" for 50yr event
 Inflow = 383.97 cfs @ 18.37 hrs, Volume= 621.110 af
 Outflow = 383.97 cfs @ 18.37 hrs, Volume= 621.110 af, Atten= 0%, Lag= 0.0 min
 Primary = 383.97 cfs @ 18.37 hrs, Volume= 621.110 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 193.51' @ 18.37 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=383.96 cfs @ 18.37 hrs HW=193.51' (Free Discharge)

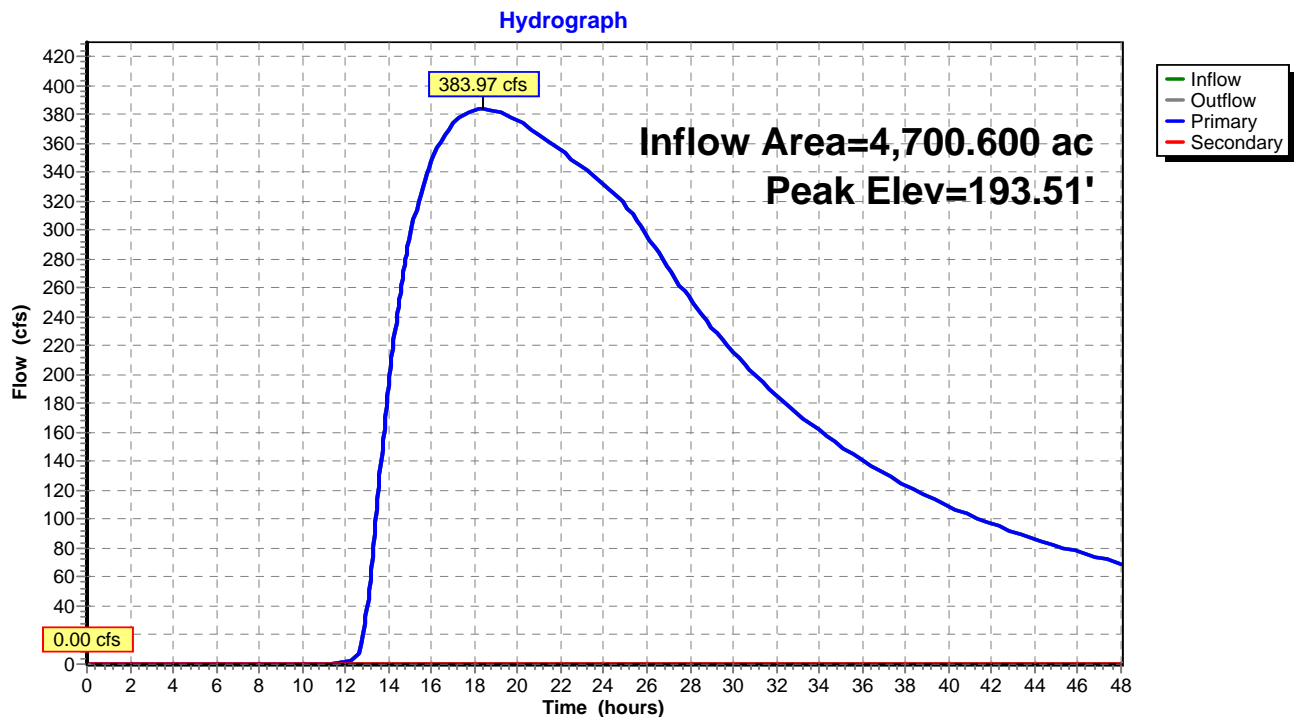
↑ **2=Culvert** (Passes 383.96 cfs of 452.91 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 383.96 cfs @ 6.00 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 194.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.60" for 50yr event
 Inflow = 385.88 cfs @ 17.67 hrs, Volume= 627.666 af
 Outflow = 383.97 cfs @ 18.37 hrs, Volume= 621.110 af, Atten= 0%, Lag= 41.9 min
 Primary = 383.97 cfs @ 18.37 hrs, Volume= 621.110 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Starting Elev= 194.50' Surf.Area= 4.951 ac Storage= 10.929 af
 Peak Elev= 198.27' @ 18.37 hrs Surf.Area= 7.722 ac Storage= 34.801 af (23.872 af above start)

Plug-Flow detention time= 85.9 min calculated for 609.547 af (97% of inflow)
 Center-of-Mass det. time= 36.1 min (1,569.3 - 1,533.2)

Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

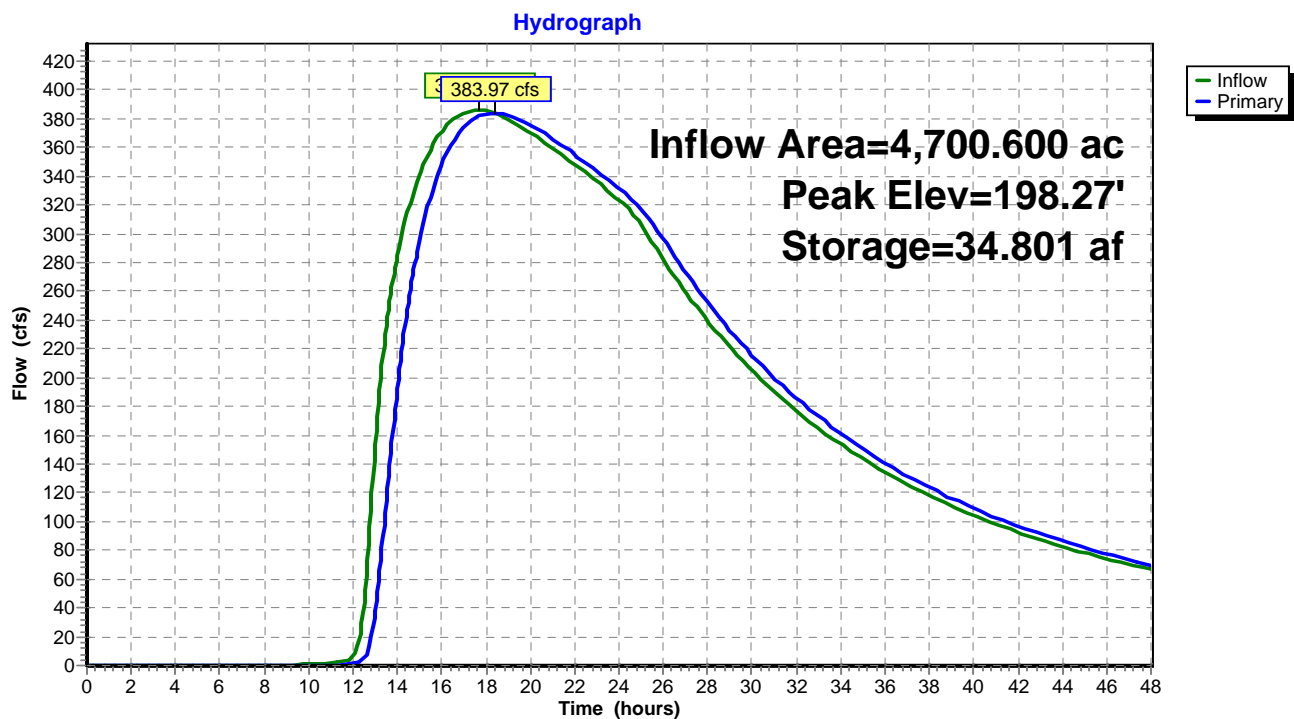
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	194.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=383.96 cfs @ 18.37 hrs HW=198.27' TW=193.51' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 383.96 cfs @ 6.36 fps)

Pond ED: Eagle Dam - Proposed Spillway = 194.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 1.99" for 50yr event
 Inflow = 4,500.53 cfs @ 12.74 hrs, Volume= 776.790 af
 Outflow = 384.68 cfs @ 17.71 hrs, Volume= 624.266 af, Atten= 91%, Lag= 298.2 min
 Primary = 384.68 cfs @ 17.71 hrs, Volume= 624.266 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.29' @ 17.71 hrs Surf.Area= 0.000 ac Storage= 504.845 af

Plug-Flow detention time= 715.2 min calculated for 624.266 af (80% of inflow)
 Center-of-Mass det. time= 634.3 min (1,536.9 - 902.6)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

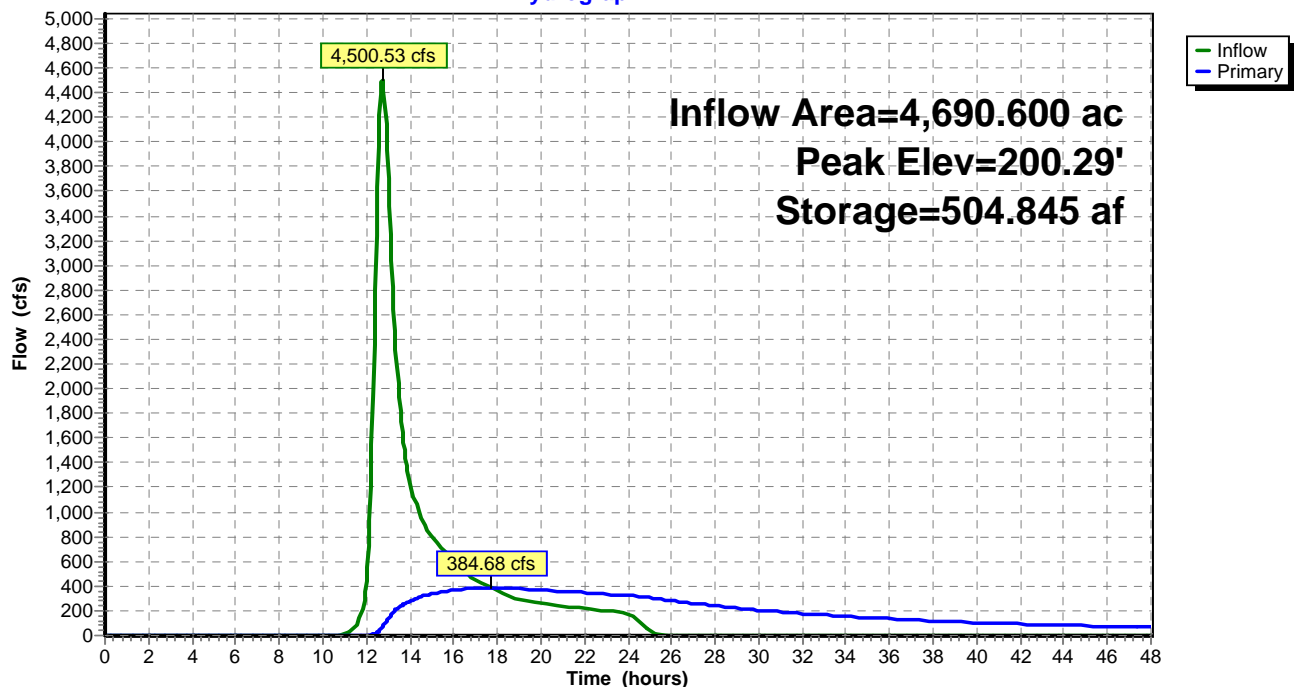
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=384.68 cfs @ 17.71 hrs HW=200.29' TW=198.26' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 384.68 cfs @ 4.10 fps)

Pond RD: Red Dam

Hydrograph



W350 Lowered Eagle Dam Proposed Model_REV2

Type III 24-hr 100yr Rainfall=6.80"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 18

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.73"
Tc=50.0 min CN=82 Runoff=23.99 cfs 3.941 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.46"
Tc=50.0 min CN=60 Runoff=5,685.64 cfs 962.747 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=195.42' Inflow=511.55 cfs 791.795 af
Primary=511.55 cfs 791.795 af Secondary=0.00 cfs 0.000 af Outflow=511.55 cfs 791.795 af

Pond ED: Eagle Dam - Proposed

Peak Elev=199.09' Storage=41.372 af Inflow=515.15 cfs 799.033 af
Outflow=511.55 cfs 791.795 af

Pond RD: Red Dam

Peak Elev=200.63' Storage=615.922 af Inflow=5,685.64 cfs 962.747 af
Outflow=513.57 cfs 795.092 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 966.688 af Average Runoff Depth = 2.47"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

Runoff = 23.99 cfs @ 12.67 hrs, Volume= 3.941 af, Depth= 4.73"

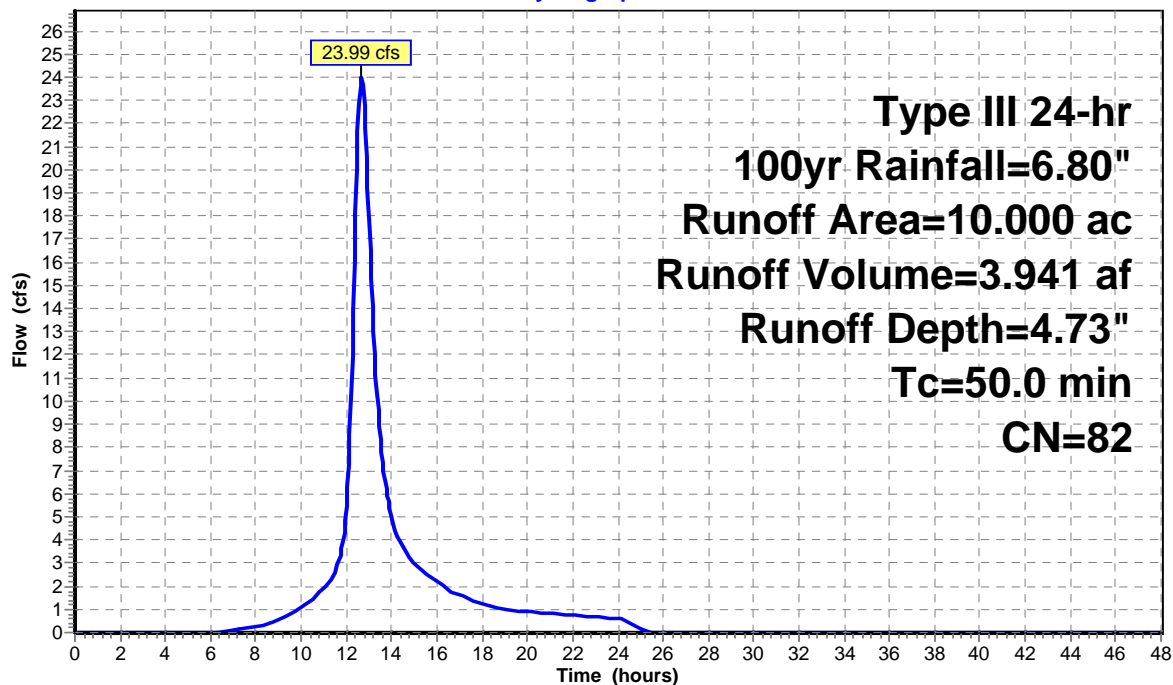
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=6.80"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 5,685.64 cfs @ 12.73 hrs, Volume= 962.747 af, Depth= 2.46"

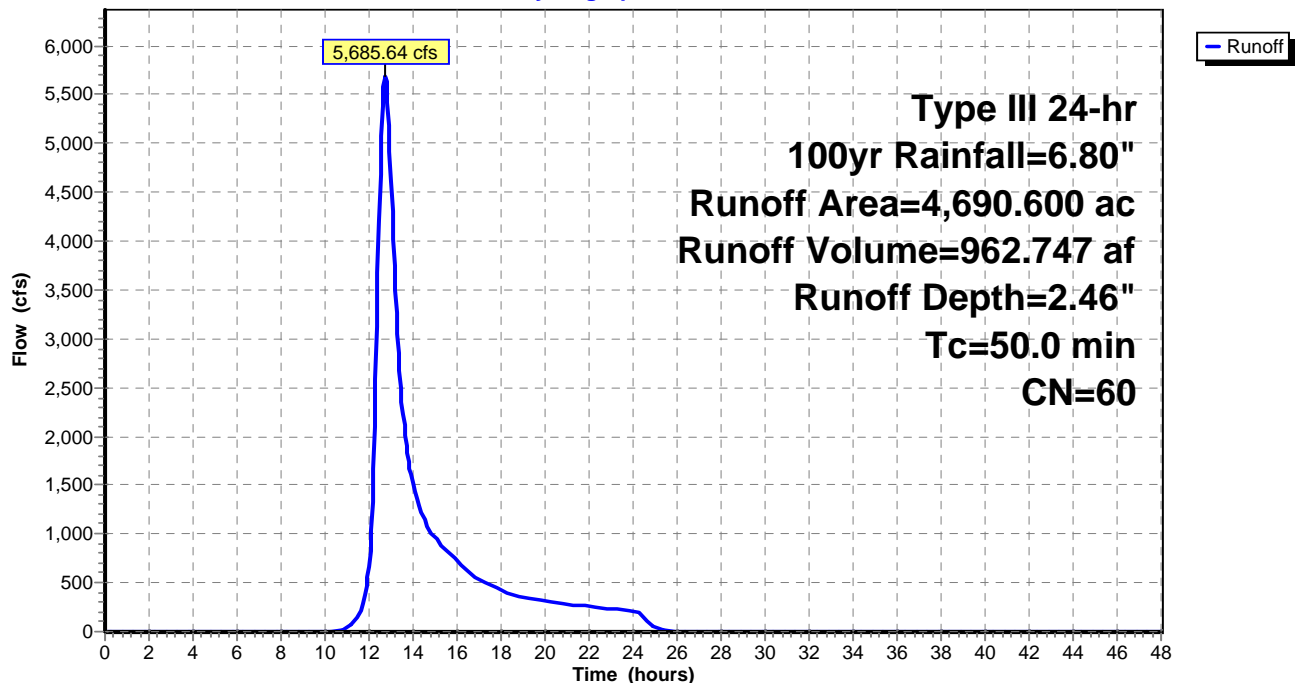
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100yr Rainfall=6.80"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

Hydrograph



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.02" for 100yr event
 Inflow = 511.55 cfs @ 17.90 hrs, Volume= 791.795 af
 Outflow = 511.55 cfs @ 17.90 hrs, Volume= 791.795 af, Atten= 0%, Lag= 0.0 min
 Primary = 511.55 cfs @ 17.90 hrs, Volume= 791.795 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 195.42' @ 17.90 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=511.55 cfs @ 17.90 hrs HW=195.42' (Free Discharge)

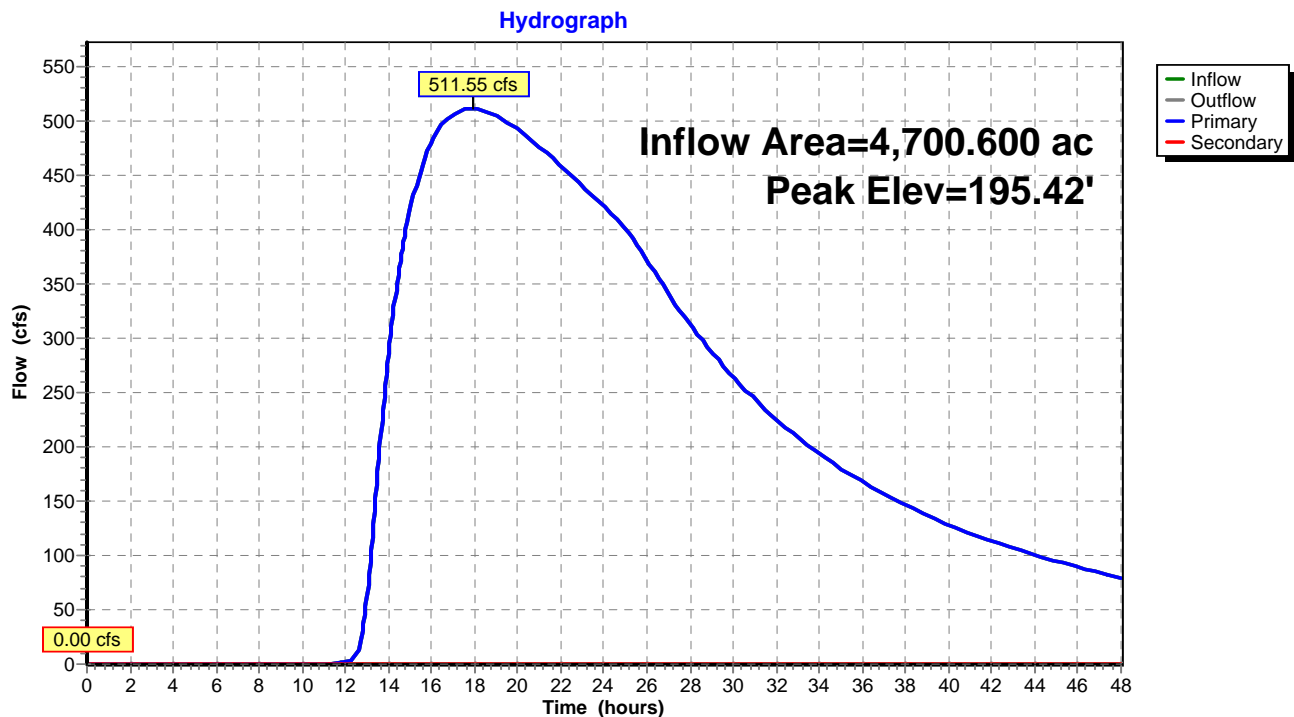
↑ **2=Culvert** (Passes 511.55 cfs of 654.43 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 511.55 cfs @ 7.99 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 194.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.04" for 100yr event
 Inflow = 515.15 cfs @ 17.02 hrs, Volume= 799.033 af
 Outflow = 511.55 cfs @ 17.90 hrs, Volume= 791.795 af, Atten= 1%, Lag= 52.5 min
 Primary = 511.55 cfs @ 17.90 hrs, Volume= 791.795 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Starting Elev= 194.50' Surf.Area= 4.951 ac Storage= 10.929 af
 Peak Elev= 199.09' @ 17.90 hrs Surf.Area= 8.383 ac Storage= 41.372 af (30.443 af above start)

Plug-Flow detention time= 75.9 min calculated for 780.866 af (98% of inflow)
 Center-of-Mass det. time= 35.2 min (1,539.4 - 1,504.2)

Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

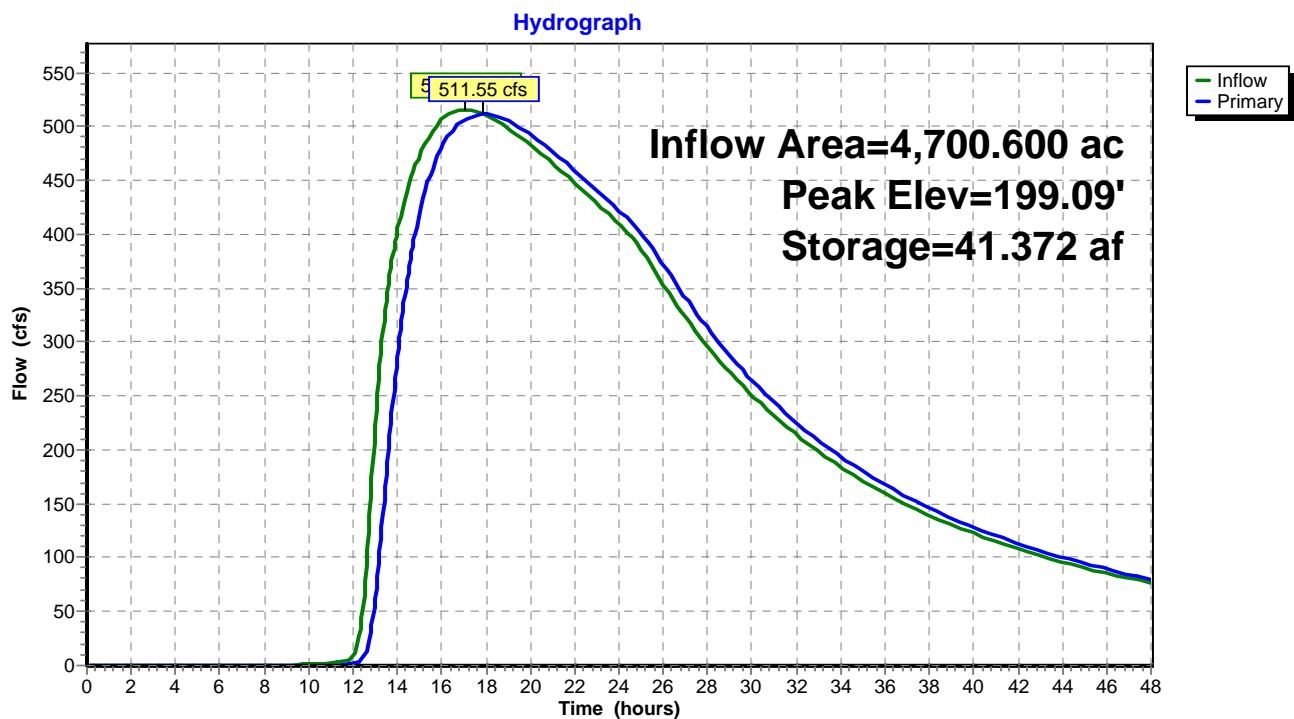
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	194.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=511.55 cfs @ 17.90 hrs HW=199.09' TW=195.42' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 511.55 cfs @ 6.97 fps)

Pond ED: Eagle Dam - Proposed Spillway = 194.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.46" for 100yr event
 Inflow = 5,685.64 cfs @ 12.73 hrs, Volume= 962.747 af
 Outflow = 513.57 cfs @ 17.06 hrs, Volume= 795.092 af, Atten= 91%, Lag= 259.8 min
 Primary = 513.57 cfs @ 17.06 hrs, Volume= 795.092 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.63' @ 17.18 hrs Surf.Area= 0.000 ac Storage= 615.922 af

Plug-Flow detention time= 684.3 min calculated for 794.265 af (82% of inflow)
 Center-of-Mass det. time= 611.5 min (1,507.5 - 896.0)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

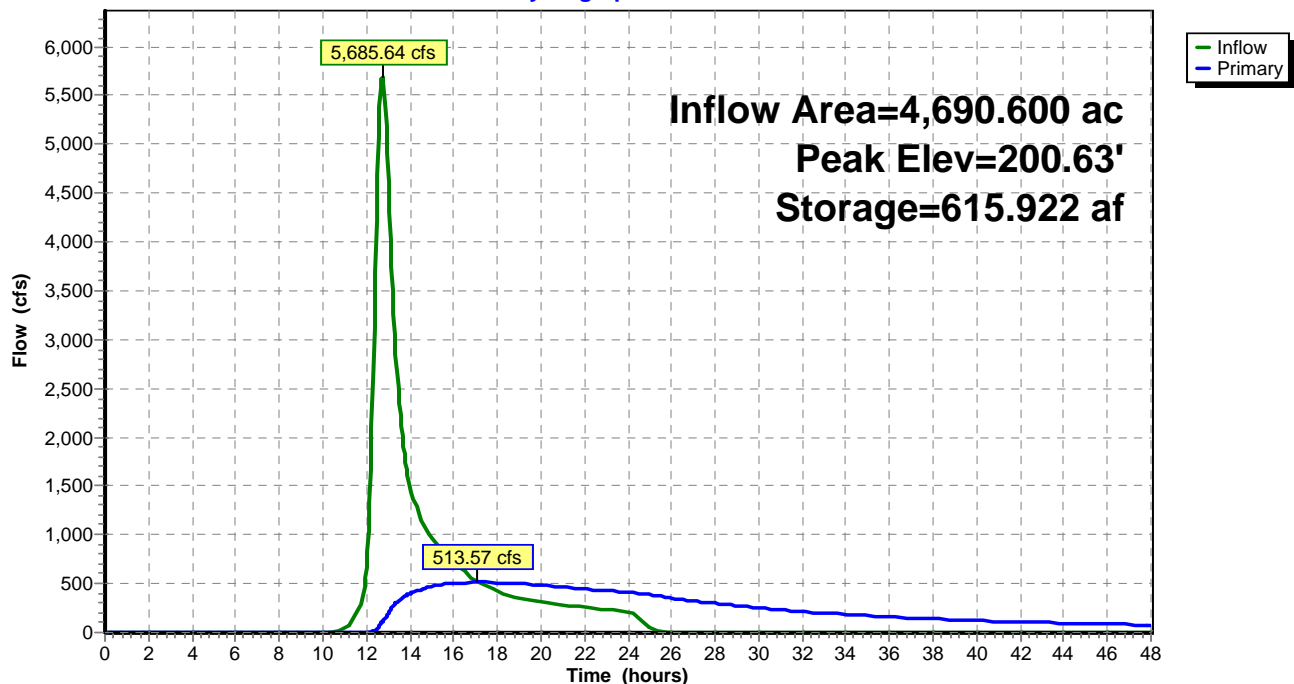
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=513.55 cfs @ 17.06 hrs HW=200.63' TW=199.06' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 513.55 cfs @ 4.50 fps)

Pond RD: Red Dam

Hydrograph



W350 Lowered Eagle Dam Proposed Model_ Type III 24-hr CURRENT 25yr Rainfall=6.27"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 26

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.24"
Tc=50.0 min CN=82 Runoff=21.55 cfs 3.530 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.10"
Tc=50.0 min CN=60 Runoff=4,782.35 cfs 820.979 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=193.90' Inflow=414.00 cfs 661.427 af
Primary=414.00 cfs 661.427 af Secondary=0.00 cfs 0.000 af Outflow=414.00 cfs 661.427 af

Pond ED: Eagle Dam - Proposed Peak Elev=198.47' Storage=36.316 af Inflow=416.13 cfs 668.156 af
Outflow=414.00 cfs 661.427 af

Pond RD: Red Dam Peak Elev=200.38' Storage=531.329 af Inflow=4,782.35 cfs 820.979 af
Outflow=414.85 cfs 664.626 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 824.509 af Average Runoff Depth = 2.10"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

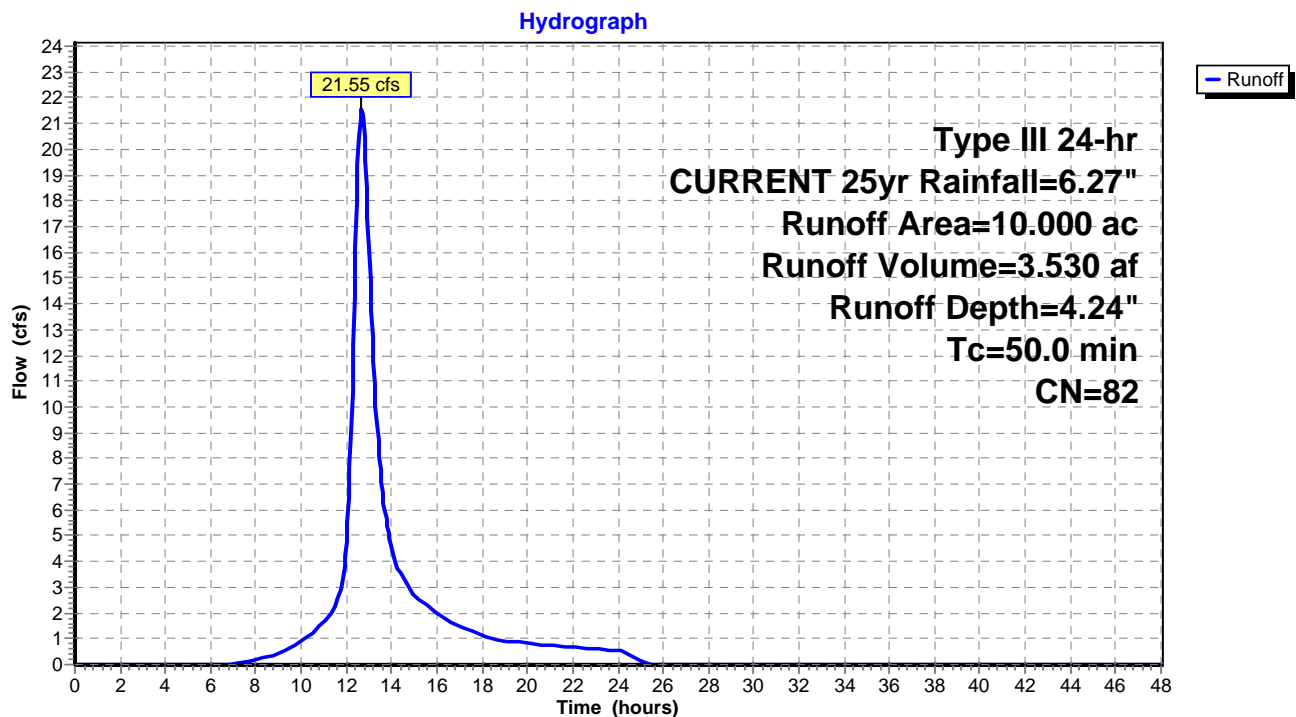
Runoff = 21.55 cfs @ 12.67 hrs, Volume= 3.530 af, Depth= 4.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr CURRENT 25yr Rainfall=6.27"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

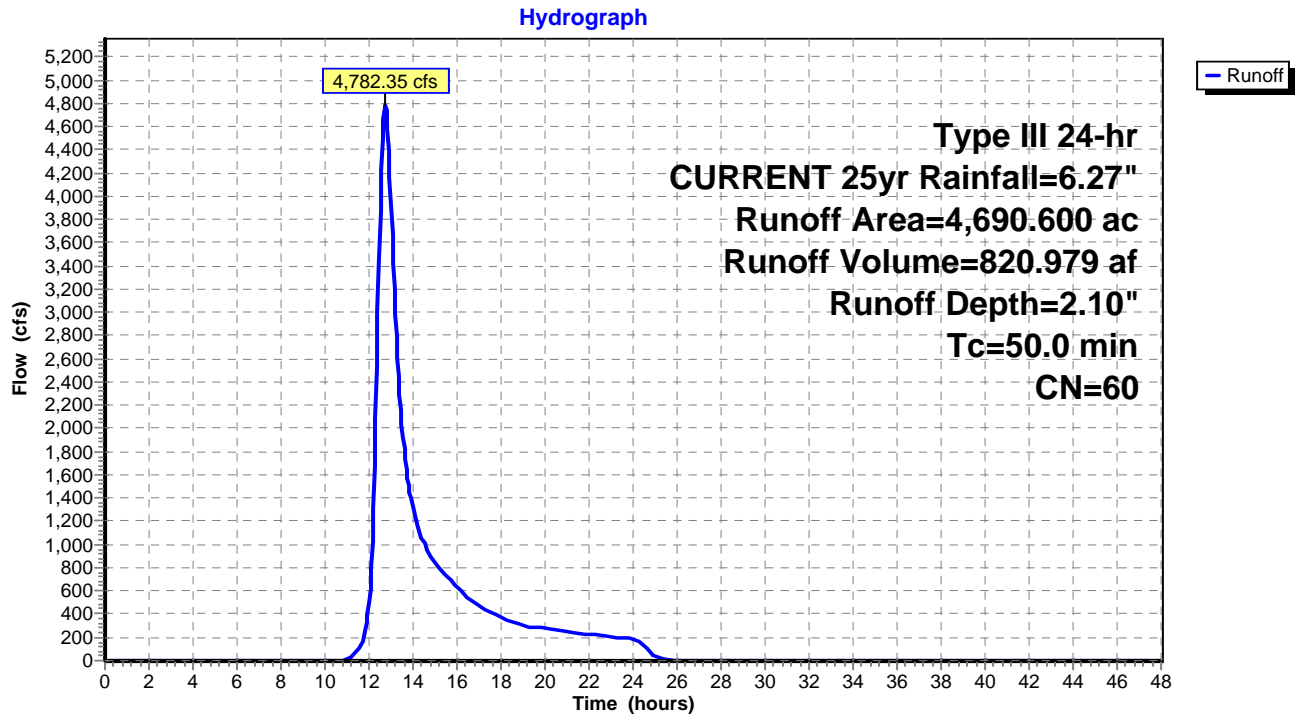
Runoff = 4,782.35 cfs @ 12.73 hrs, Volume= 820.979 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr CURRENT 25yr Rainfall=6.27"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.69" for CURRENT 25yr event
 Inflow = 414.00 cfs @ 18.24 hrs, Volume= 661.427 af
 Outflow = 414.00 cfs @ 18.24 hrs, Volume= 661.427 af, Atten= 0%, Lag= 0.0 min
 Primary = 414.00 cfs @ 18.24 hrs, Volume= 661.427 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 193.90' @ 18.24 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=414.00 cfs @ 18.24 hrs HW=193.90' (Free Discharge)

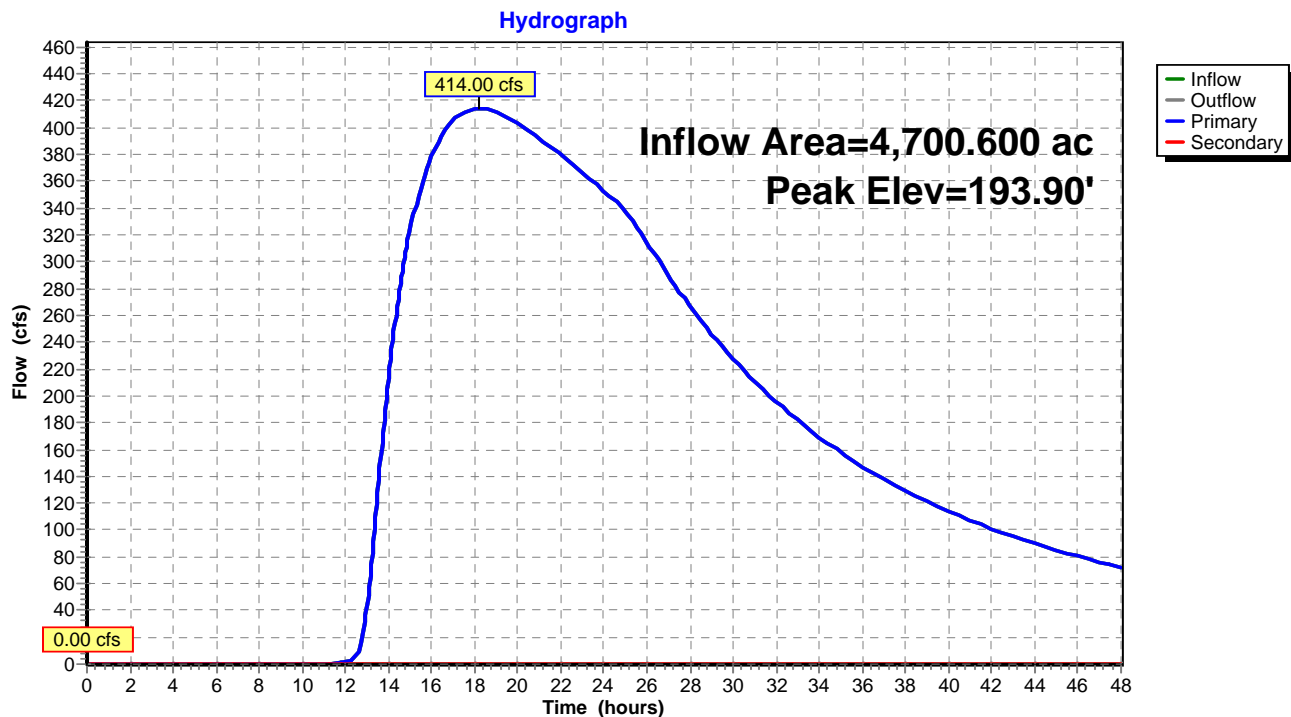
↑ **2=Culvert** (Passes 414.00 cfs of 506.26 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 414.00 cfs @ 6.47 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 194.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.71" for CURRENT 25yr event
 Inflow = 416.13 cfs @ 17.53 hrs, Volume= 668.156 af
 Outflow = 414.00 cfs @ 18.24 hrs, Volume= 661.427 af, Atten= 1%, Lag= 42.5 min
 Primary = 414.00 cfs @ 18.24 hrs, Volume= 661.427 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 194.50' Surf.Area= 4.951 ac Storage= 10.929 af

Peak Elev= 198.47' @ 18.24 hrs Surf.Area= 7.877 ac Storage= 36.316 af (25.387 af above start)

Plug-Flow detention time= 83.2 min calculated for 650.498 af (97% of inflow)

Center-of-Mass det. time= 35.8 min (1,561.5 - 1,525.7)

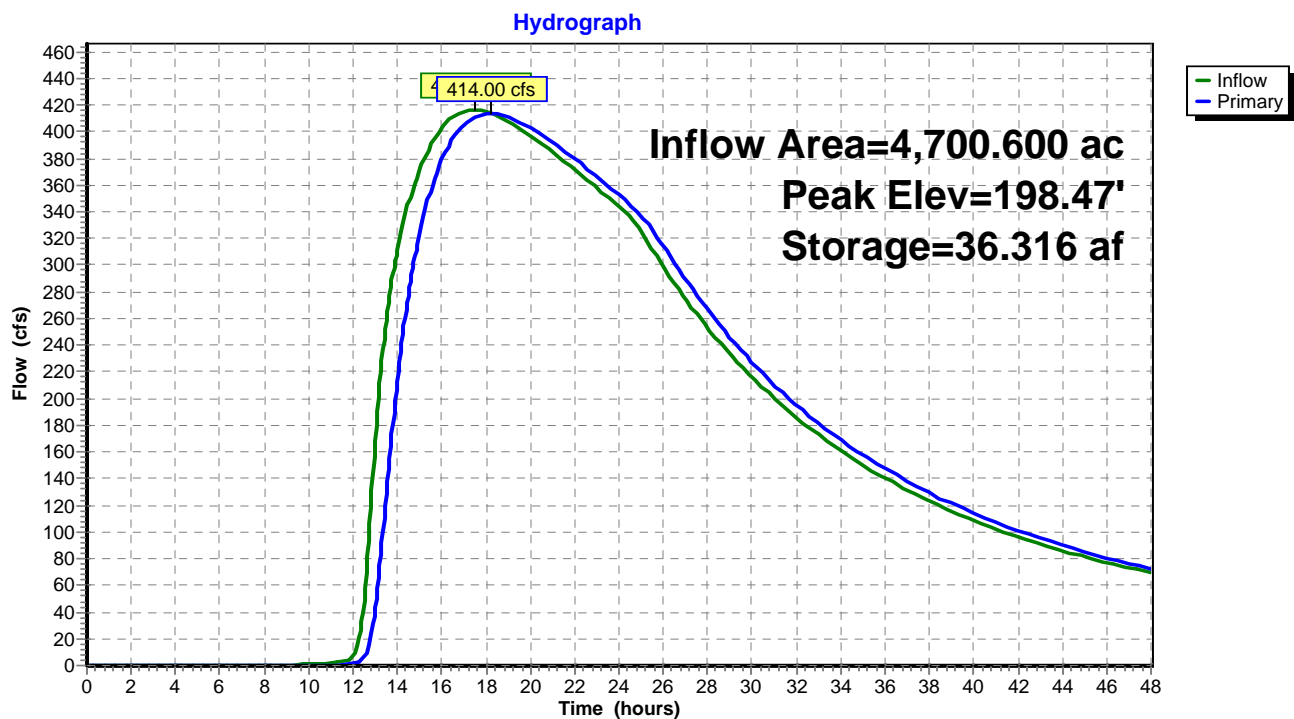
Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	194.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=414.00 cfs @ 18.24 hrs HW=198.47' TW=193.90' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 414.00 cfs @ 6.52 fps)

Pond ED: Eagle Dam - Proposed Spillway = 194.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.10" for CURRENT 25yr event
Inflow = 4,782.35 cfs @ 12.73 hrs, Volume= 820.979 af
Outflow = 414.85 cfs @ 17.57 hrs, Volume= 664.626 af, Atten= 91%, Lag= 290.0 min
Primary = 414.85 cfs @ 17.57 hrs, Volume= 664.626 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 200.38' @ 17.57 hrs Surf.Area= 0.000 ac Storage= 531.329 af

Plug-Flow detention time= 707.4 min calculated for 664.626 af (81% of inflow)
Center-of-Mass det. time= 628.4 min (1,529.2 - 900.9)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

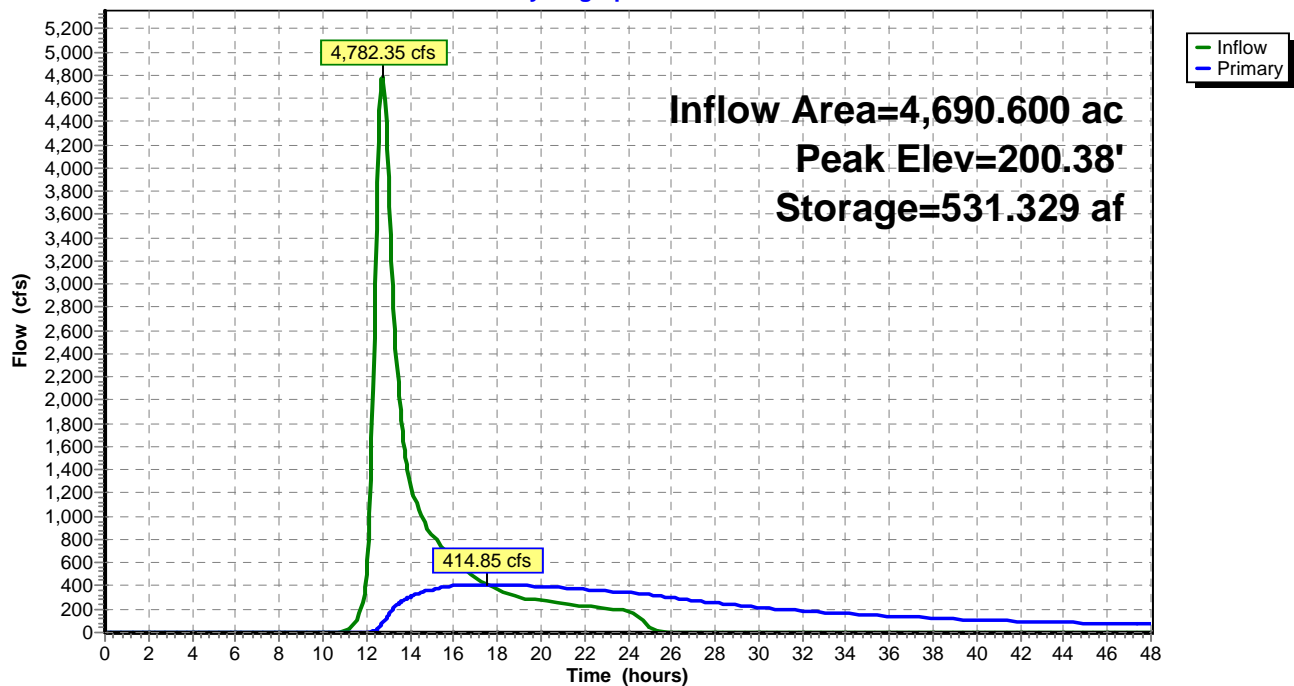
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=414.83 cfs @ 17.57 hrs HW=200.38' TW=198.45' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 414.83 cfs @ 4.20 fps)

Pond RD: Red Dam

Hydrograph



W350 Lowered Eagle Dam Proposed Model_ Type III 24-hr CURRENT 50yr Rainfall=7.51"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 34

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=5.40"
Tc=50.0 min CN=82 Runoff=27.27 cfs 4.497 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.97"
Tc=50.0 min CN=60 Runoff=6,948.19 cfs 1,161.122 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=196.75' Inflow=624.56 cfs 974.194 af
Primary=583.36 cfs 960.747 af Secondary=41.20 cfs 13.449 af Outflow=624.56 cfs 974.194 af

Pond ED: Eagle Dam - Proposed Peak Elev=199.88' Storage=48.154 af Inflow=628.21 cfs 982.152 af
Outflow=624.56 cfs 974.194 af

Pond RD: Red Dam Peak Elev=201.01' Storage=737.984 af Inflow=6,948.19 cfs 1,161.122 af
Outflow=626.13 cfs 977.655 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 1,165.618 af Average Runoff Depth = 2.98"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

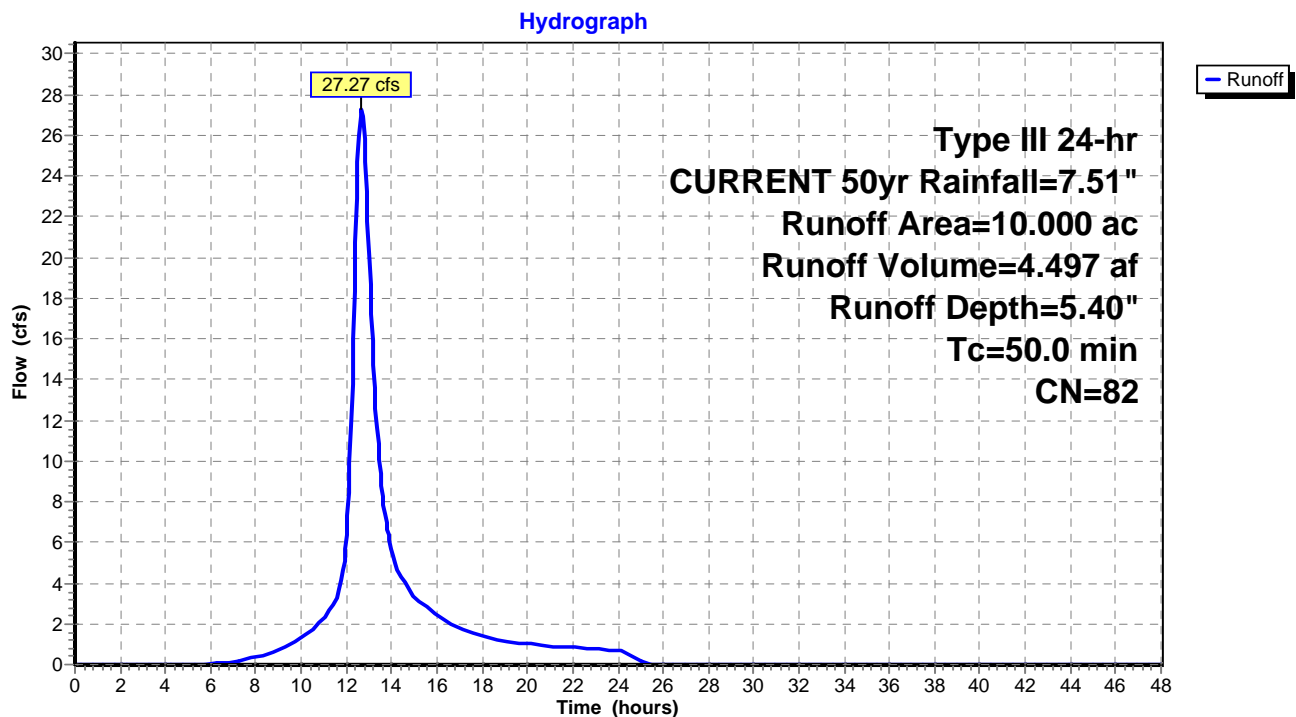
Runoff = 27.27 cfs @ 12.67 hrs, Volume= 4.497 af, Depth= 5.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 50yr Rainfall=7.51"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

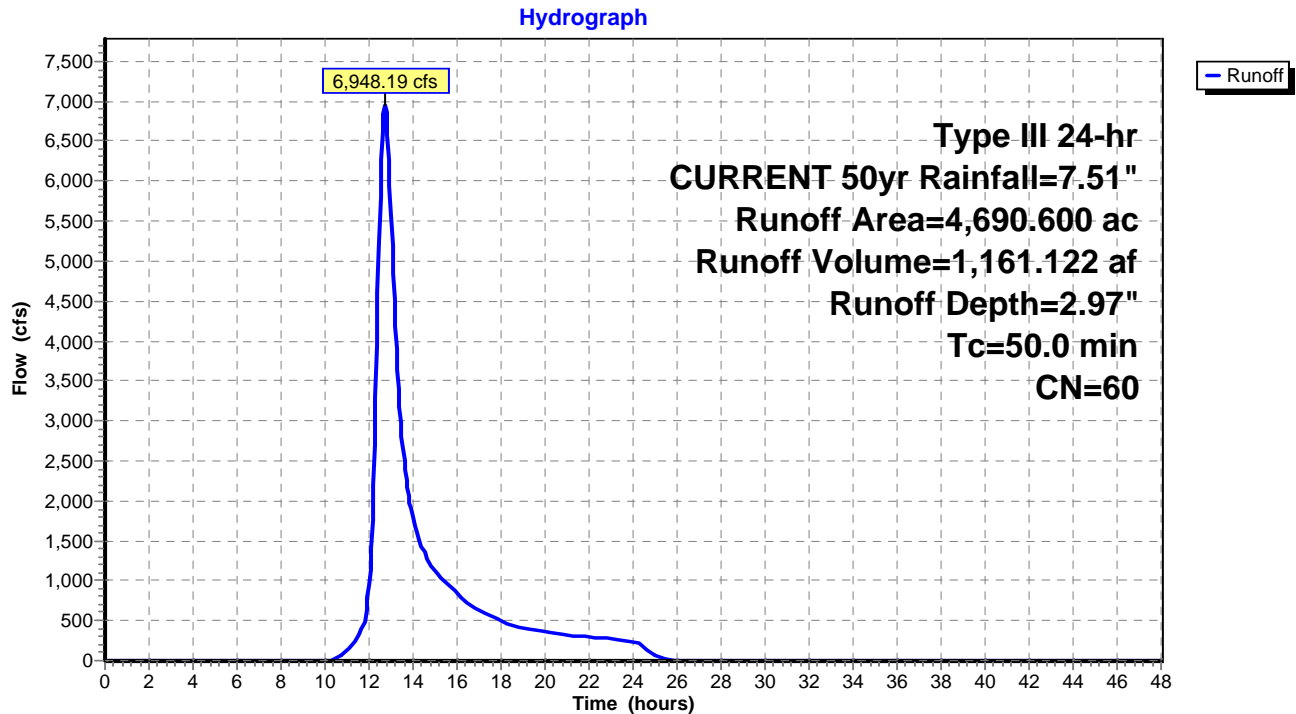
Runoff = 6,948.19 cfs @ 12.72 hrs, Volume= 1,161.122 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 50yr Rainfall=7.51"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

[58] Hint: Peaked 0.22' above defined flood level

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.49" for CURRENT 50yr event
Inflow = 624.56 cfs @ 17.41 hrs, Volume= 974.194 af
Outflow = 624.56 cfs @ 17.41 hrs, Volume= 974.194 af, Atten= 0%, Lag= 0.0 min
Primary = 583.36 cfs @ 17.41 hrs, Volume= 960.747 af
Secondary = 41.20 cfs @ 17.41 hrs, Volume= 13.449 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

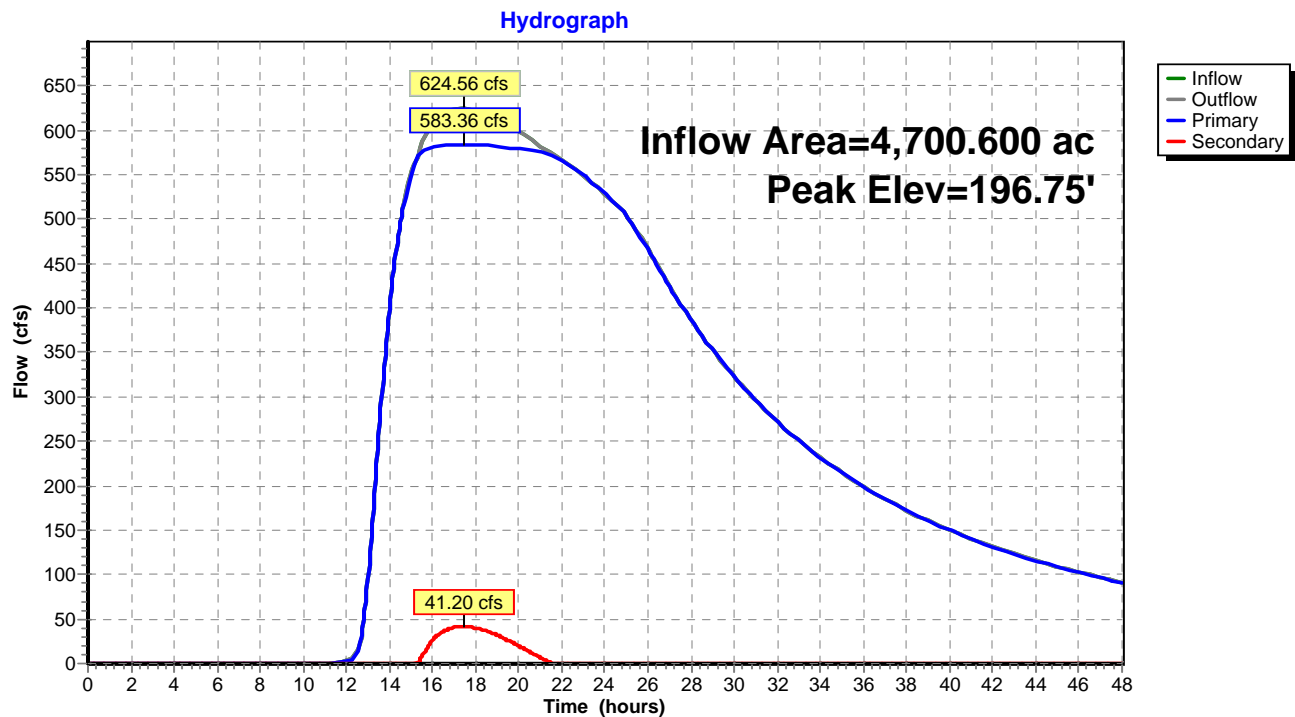
Peak Elev= 196.75' @ 17.41 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=583.36 cfs @ 17.41 hrs HW=196.75' (Free Discharge)↑ **2=Culvert** (Passes 583.36 cfs of 746.30 cfs potential flow)↑ **1=Route 140 Culvert Opening** (Orifice Controls 583.36 cfs @ 9.12 fps)**Secondary OutFlow** Max=41.20 cfs @ 17.41 hrs HW=196.75' (Free Discharge)↑ **3=Sharp-Crested Rectangular Weir** (Weir Controls 41.20 cfs @ 1.54 fps)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 194.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.51" for CURRENT 50yr event
 Inflow = 628.21 cfs @ 16.45 hrs, Volume= 982.152 af
 Outflow = 624.56 cfs @ 17.41 hrs, Volume= 974.194 af, Atten= 1%, Lag= 57.2 min
 Primary = 624.56 cfs @ 17.41 hrs, Volume= 974.194 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 194.50' Surf.Area= 4.951 ac Storage= 10.929 af

Peak Elev= 199.88' @ 17.41 hrs Surf.Area= 8.661 ac Storage= 48.154 af (37.226 af above start)

Plug-Flow detention time= 69.5 min calculated for 963.265 af (98% of inflow)

Center-of-Mass det. time= 35.1 min (1,524.1 - 1,489.0)

Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

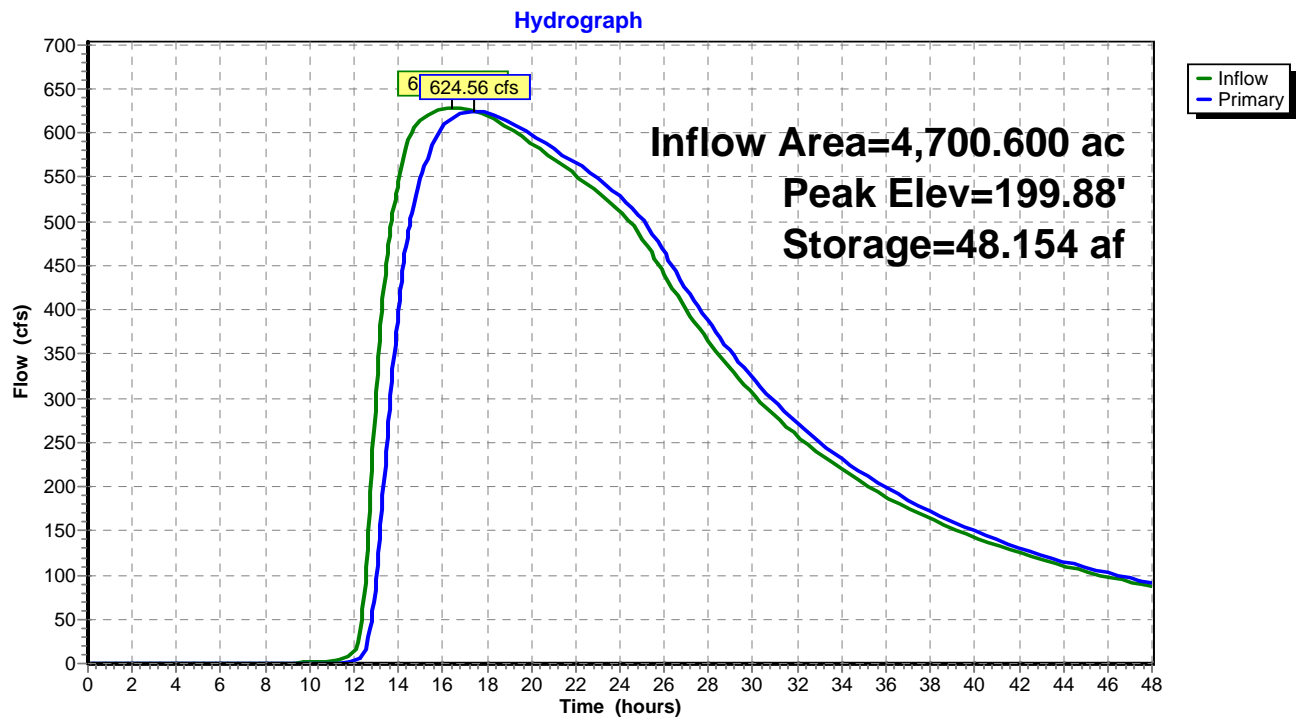
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	194.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=624.56 cfs @ 17.41 hrs HW=199.88' TW=196.75' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 624.56 cfs @ 7.25 fps)

Pond ED: Eagle Dam - Proposed Spillway = 194.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.97" for CURRENT 50yr event
Inflow = 6,948.19 cfs @ 12.72 hrs, Volume= 1,161.122 af
Outflow = 626.13 cfs @ 16.52 hrs, Volume= 977.655 af, Atten= 91%, Lag= 228.0 min
Primary = 626.13 cfs @ 16.52 hrs, Volume= 977.655 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 201.01' @ 16.98 hrs Surf.Area= 0.000 ac Storage= 737.984 af

Plug-Flow detention time= 669.3 min calculated for 976.638 af (84% of inflow)
Center-of-Mass det. time= 601.6 min (1,492.0 - 890.4)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

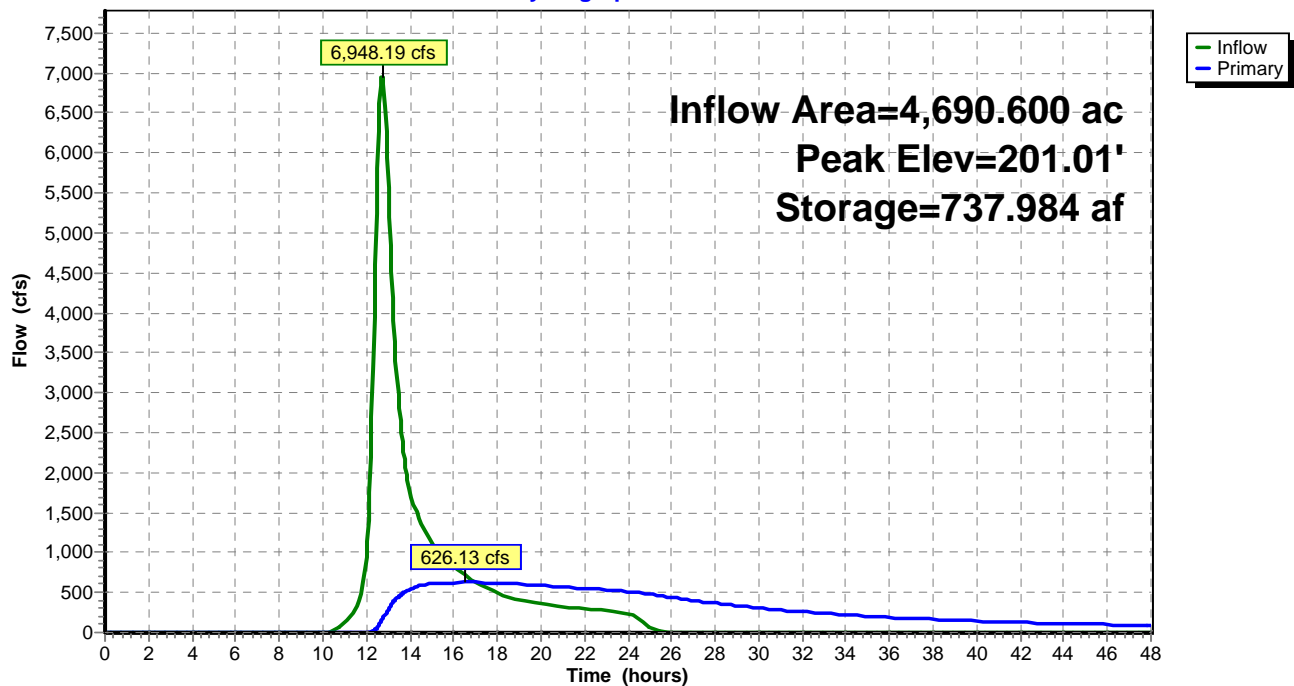
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=626.14 cfs @ 16.52 hrs HW=201.00' TW=199.85' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 626.14 cfs @ 4.59 fps)

Pond RD: Red Dam

Hydrograph



W350 Lowered Eagle Dam Proposed Model *Type III 24-hr CURRENT 100yr Rainfall=9.01"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 43

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=6.82"
Tc=50.0 min CN=82 Runoff=34.19 cfs 5.686 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=4.11"
Tc=50.0 min CN=60 Runoff=9,761.26 cfs 1,605.988 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=197.25' Inflow=847.94 cfs 1,380.498 af
Primary=607.87 cfs 1,196.297 af Secondary=240.07 cfs 184.226 af Outflow=847.94 cfs 1,380.498 af

Pond ED: Eagle Dam - Proposed Peak Elev=201.10' Storage=58.861 af Inflow=850.89 cfs 1,390.229 af
Outflow=847.94 cfs 1,380.498 af

Pond RD: Red Dam Peak Elev=201.88' Storage=1,026.544 af Inflow=9,761.26 cfs 1,605.988 af
Outflow=848.26 cfs 1,384.543 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 1,611.675 af Average Runoff Depth = 4.11"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

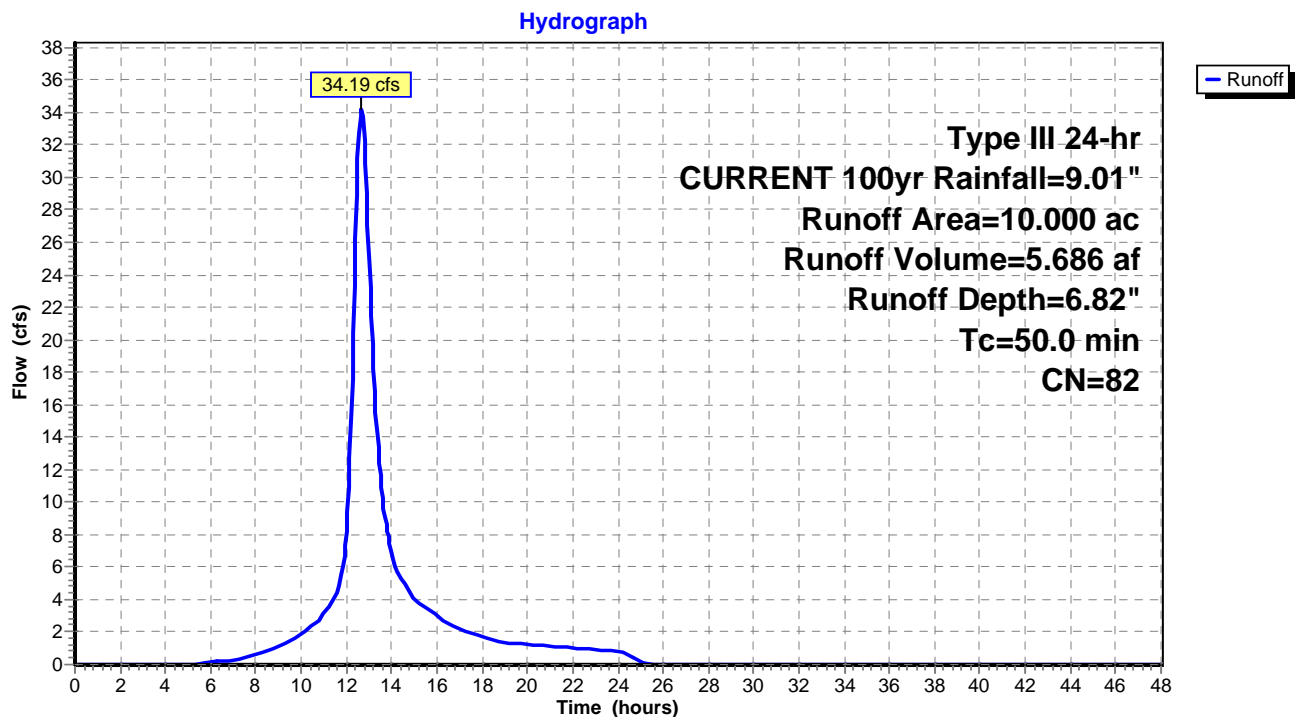
Runoff = 34.19 cfs @ 12.66 hrs, Volume= 5.686 af, Depth= 6.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr CURRENT 100yr Rainfall=9.01"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 9,761.26 cfs @ 12.71 hrs, Volume= 1,605.988 af, Depth= 4.11"

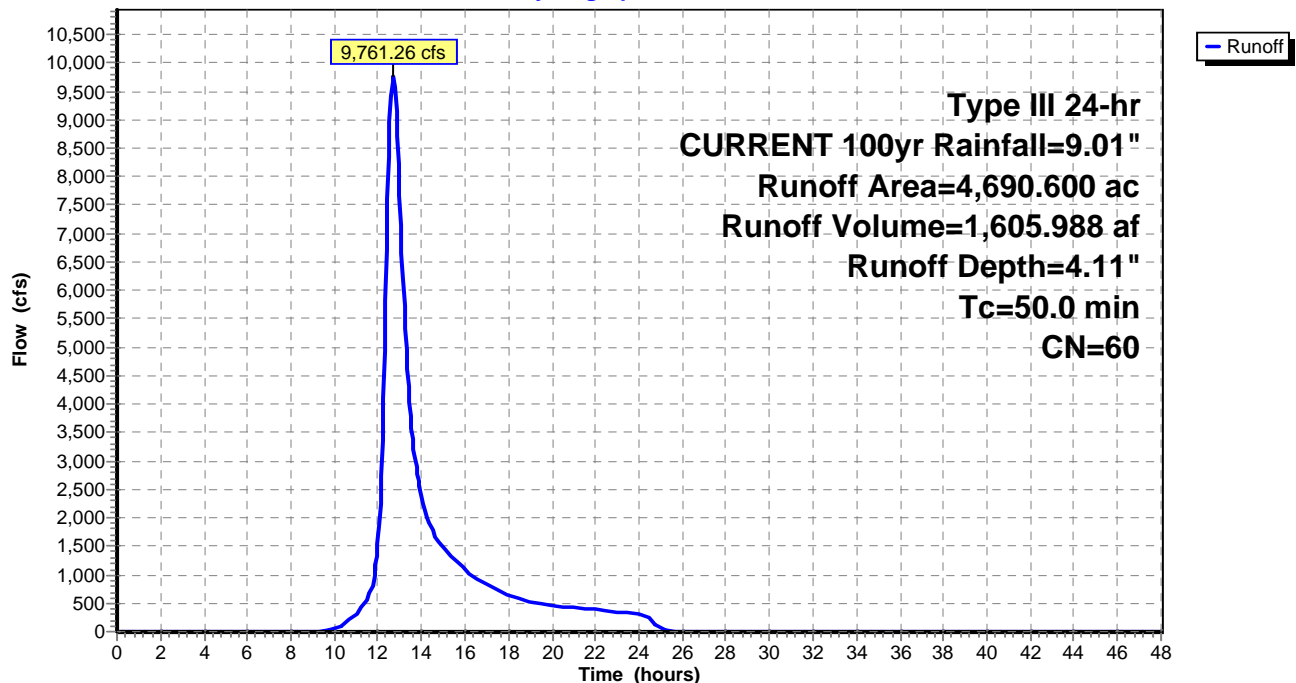
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr CURRENT 100yr Rainfall=9.01"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

Hydrograph



Summary for Pond 1P: Existing Route 140 Culvert Opening

[58] Hint: Peaked 0.72' above defined flood level

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 3.52" for CURRENT 100yr event
 Inflow = 847.94 cfs @ 17.04 hrs, Volume= 1,380.498 af
 Outflow = 847.94 cfs @ 17.04 hrs, Volume= 1,380.498 af, Atten= 0%, Lag= 0.0 min
 Primary = 607.87 cfs @ 17.04 hrs, Volume= 1,196.297 af
 Secondary = 240.07 cfs @ 17.04 hrs, Volume= 184.226 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 197.25' @ 17.04 hrs
 Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=607.87 cfs @ 17.04 hrs HW=197.25' (Free Discharge)

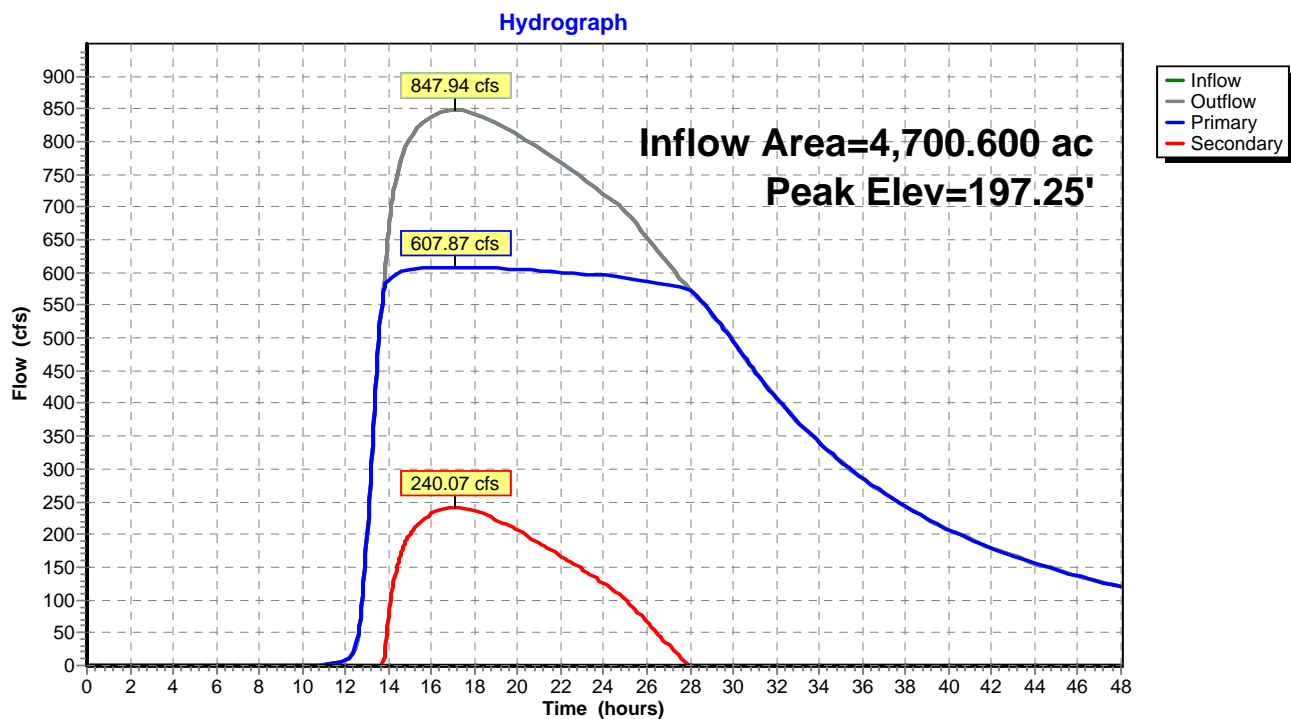
↑ **2=Culvert** (Passes 607.87 cfs of 777.66 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 607.87 cfs @ 9.50 fps)

Secondary OutFlow Max=240.06 cfs @ 17.04 hrs HW=197.25' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Weir Controls 240.06 cfs @ 2.78 fps)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 194.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 3.55" for CURRENT 100yr event
 Inflow = 850.89 cfs @ 16.36 hrs, Volume= 1,390.229 af
 Outflow = 847.94 cfs @ 17.04 hrs, Volume= 1,380.498 af, Atten= 0%, Lag= 40.8 min
 Primary = 847.94 cfs @ 17.04 hrs, Volume= 1,380.498 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Starting Elev= 194.50' Surf.Area= 4.951 ac Storage= 10.929 af

Peak Elev= 201.10' @ 17.04 hrs Surf.Area= 8.966 ac Storage= 58.861 af (47.932 af above start)

Plug-Flow detention time= 60.6 min calculated for 1,369.570 af (99% of inflow)

Center-of-Mass det. time= 34.2 min (1,521.8 - 1,487.6)

Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

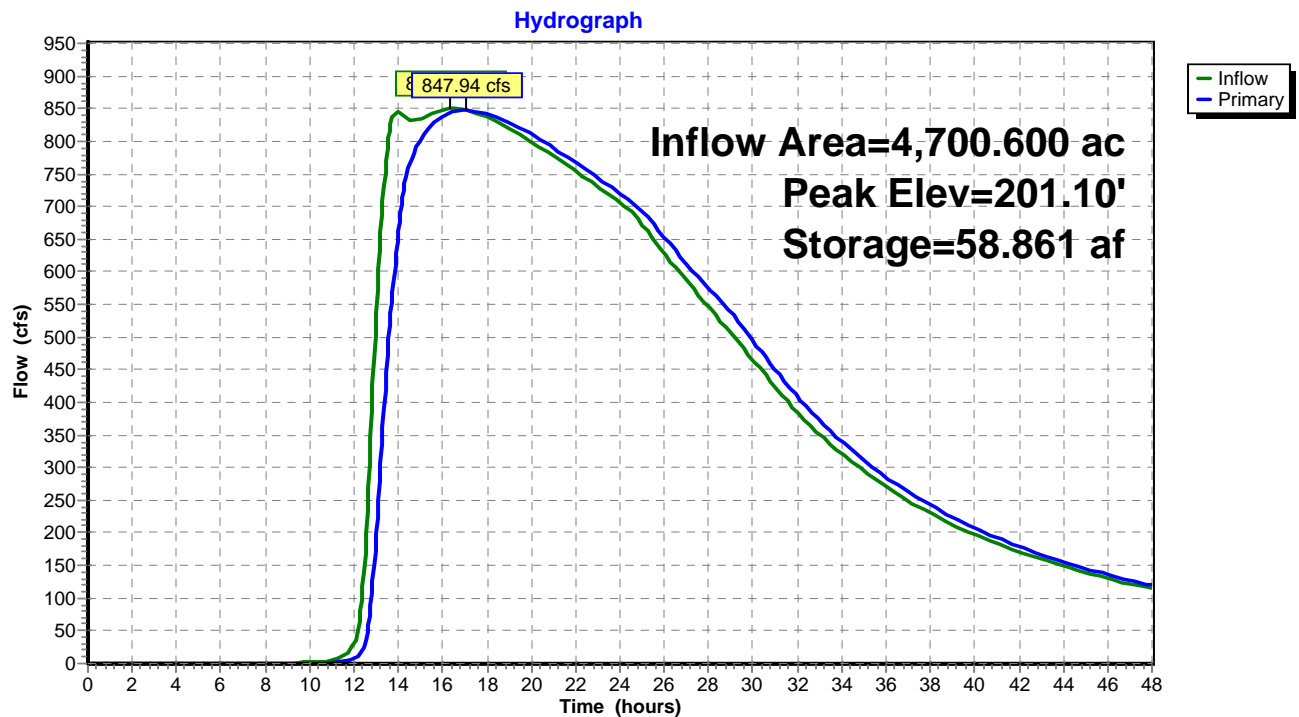
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	194.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=847.94 cfs @ 17.04 hrs HW=201.10' TW=197.25' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 847.94 cfs @ 8.03 fps)

Pond ED: Eagle Dam - Proposed Spillway = 194.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 4.11" for CURRENT 100yr event
 Inflow = 9,761.26 cfs @ 12.71 hrs, Volume= 1,605.988 af
 Outflow = 848.26 cfs @ 16.41 hrs, Volume= 1,384.543 af, Atten= 91%, Lag= 222.2 min
 Primary = 848.26 cfs @ 16.41 hrs, Volume= 1,384.543 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 201.88' @ 16.82 hrs Surf.Area= 0.000 ac Storage= 1,026.544 af

Plug-Flow detention time= 670.4 min calculated for 1,383.102 af (86% of inflow)
 Center-of-Mass det. time= 609.5 min (1,490.3 - 880.8)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

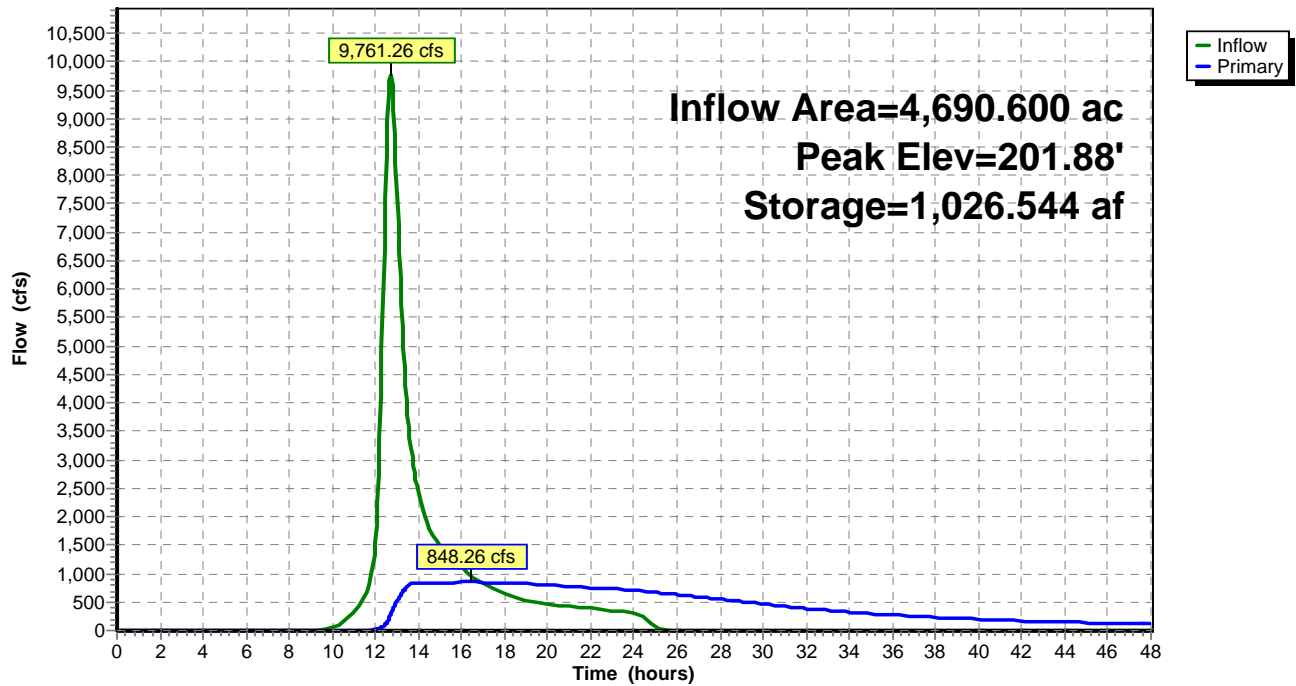
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

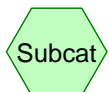
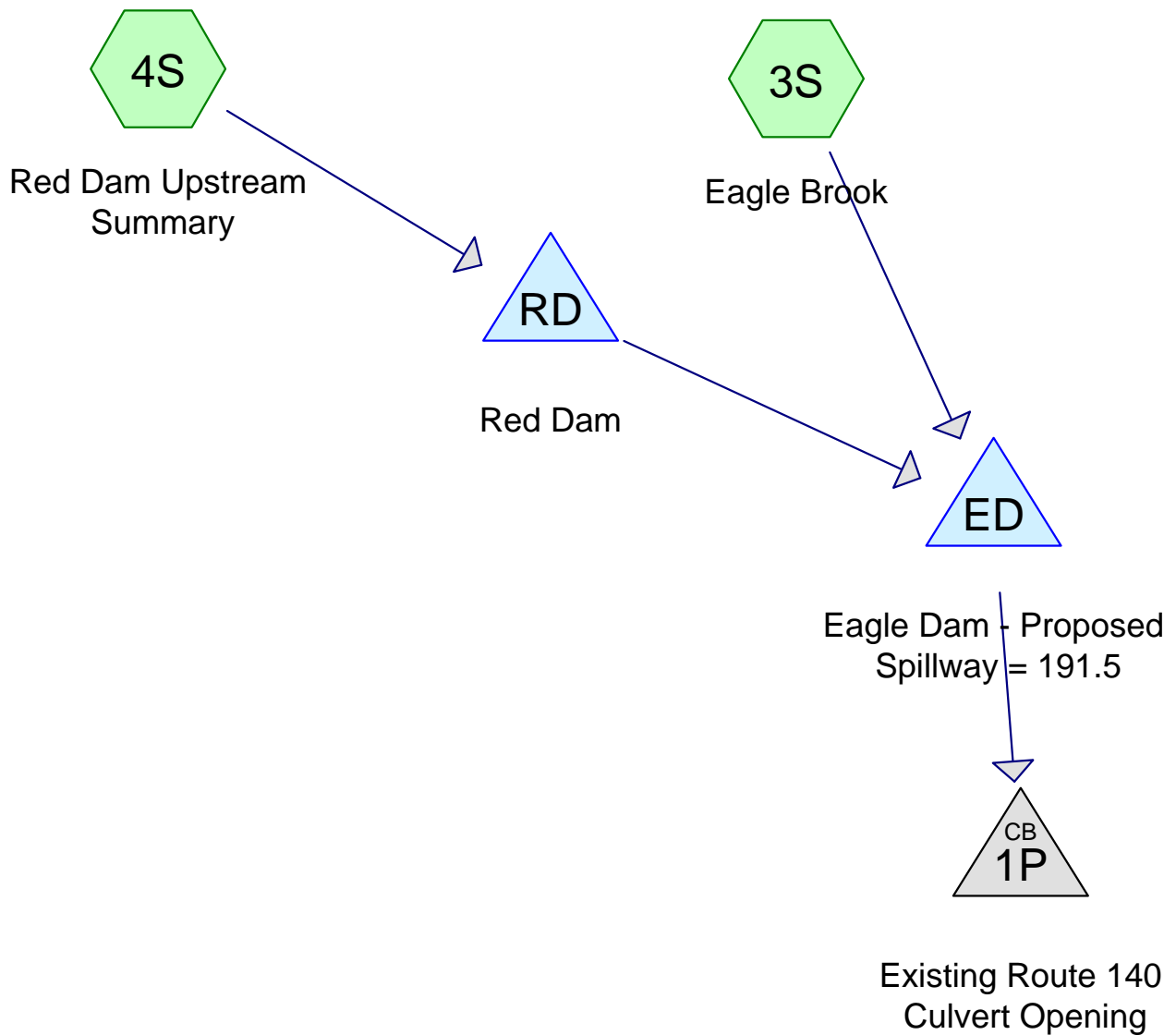
Primary OutFlow Max=848.34 cfs @ 16.41 hrs HW=201.87' TW=201.08' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 848.34 cfs @ 4.50 fps)

Pond RD: Red Dam

Hydrograph

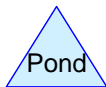




Subcat



Reach



Pond



Link

Routing Diagram for W350 Removed Eagle Dam Proposed Model_REV2

Prepared by ESS Group, Inc., Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

W350 Removed Eagle Dam Proposed Model_REV2

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 2

Project Notes

Rainfall events imported from "W350 Lowered Eagle Dam Proposed Model_REV2.hcp"

W350 Removed Eagle Dam Proposed Model_REV2*Type III 24-hr 25yr Rainfall=5.50"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 3

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=3.53"
Tc=50.0 min CN=82 Runoff=18.03 cfs 2.942 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=1.60"
Tc=50.0 min CN=60 Runoff=3,540.99 cfs 626.416 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=192.54' Inflow=286.98 cfs 488.346 af
Primary=286.98 cfs 488.346 af Secondary=0.00 cfs 0.000 af Outflow=286.98 cfs 488.346 af

Pond ED: Eagle Dam - Proposed

Peak Elev=194.66' Storage=11.726 af Inflow=287.78 cfs 491.304 af
Outflow=286.98 cfs 488.346 af

Pond RD: Red Dam

Peak Elev=200.02' Storage=413.954 af Inflow=3,540.99 cfs 626.416 af
Outflow=286.84 cfs 488.362 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 629.357 af Average Runoff Depth = 1.61"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

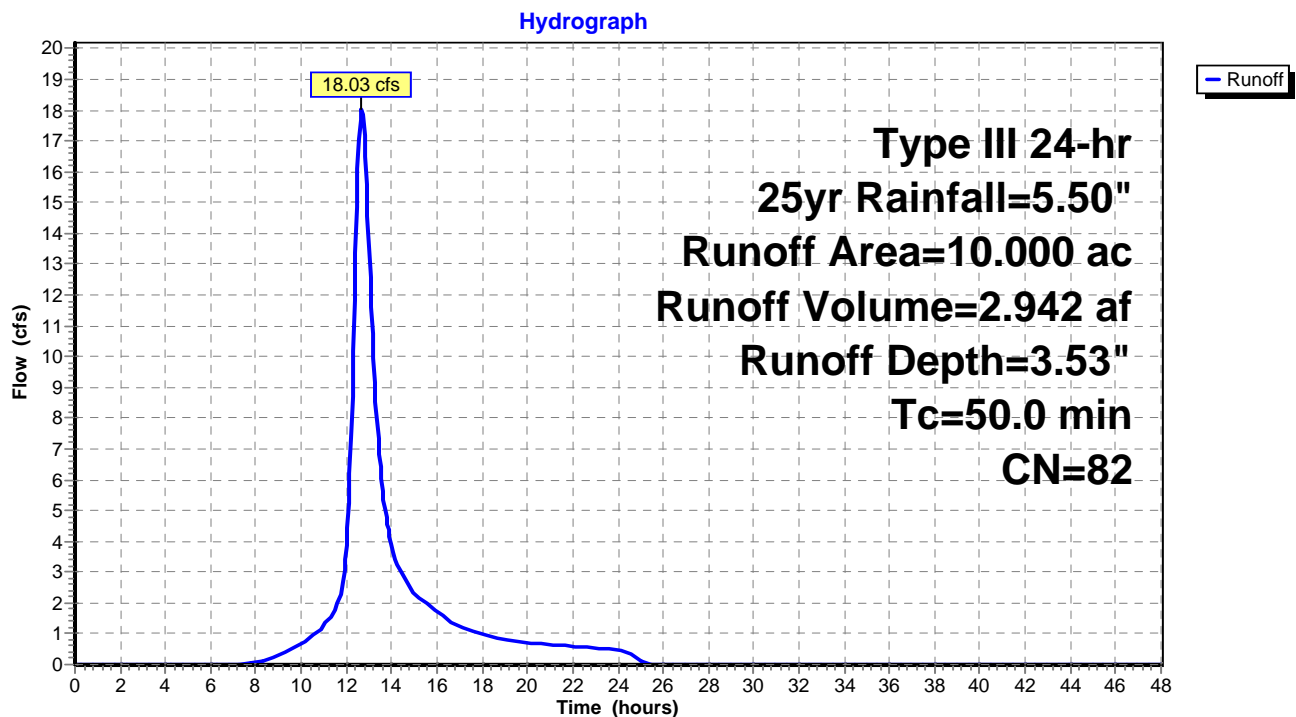
Runoff = 18.03 cfs @ 12.68 hrs, Volume= 2.942 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=5.50"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

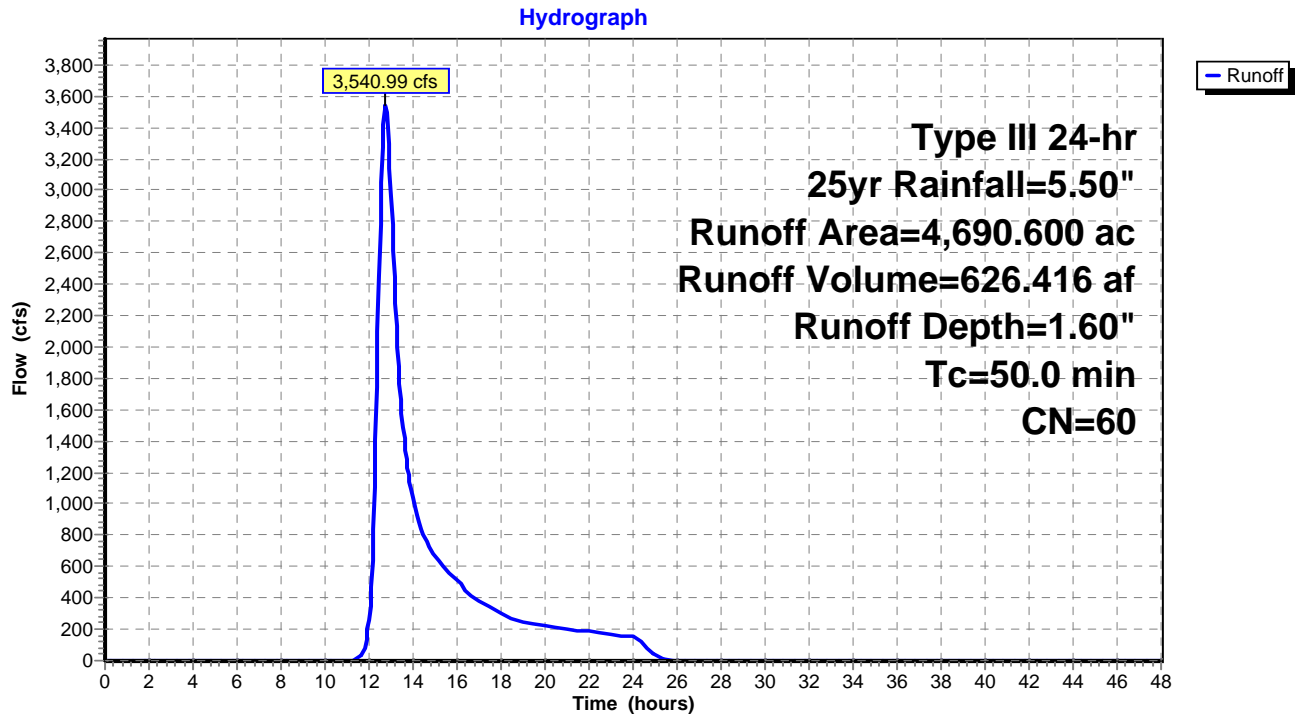
Runoff = 3,540.99 cfs @ 12.75 hrs, Volume= 626.416 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 25yr Rainfall=5.50"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.25" for 25yr event
 Inflow = 286.98 cfs @ 18.72 hrs, Volume= 488.346 af
 Outflow = 286.98 cfs @ 18.72 hrs, Volume= 488.346 af, Atten= 0%, Lag= 0.0 min
 Primary = 286.98 cfs @ 18.72 hrs, Volume= 488.346 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 192.54' @ 18.72 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=286.98 cfs @ 18.72 hrs HW=192.54' (Free Discharge)

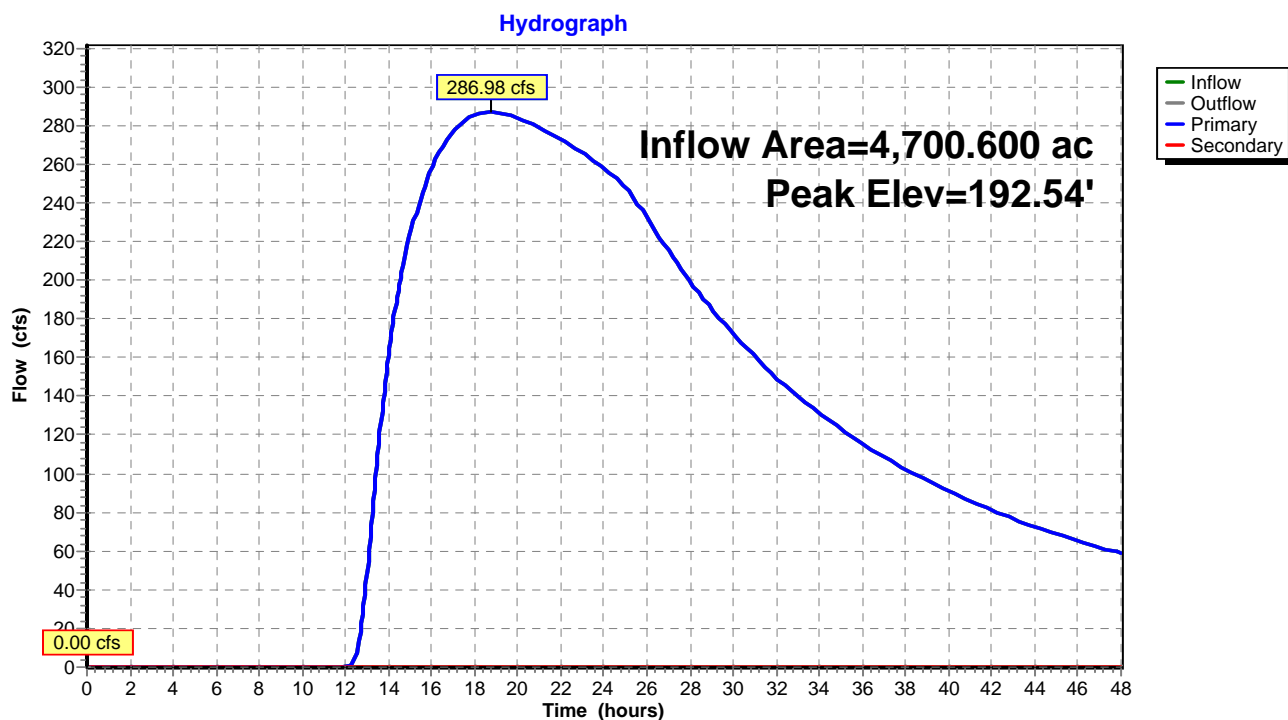
↑ **2=Culvert** (Passes 286.98 cfs of 329.14 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 286.98 cfs @ 4.83 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 191.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.25" for 25yr event
 Inflow = 287.78 cfs @ 18.18 hrs, Volume= 491.304 af
 Outflow = 286.98 cfs @ 18.72 hrs, Volume= 488.346 af, Atten= 0%, Lag= 32.5 min
 Primary = 286.98 cfs @ 18.72 hrs, Volume= 488.346 af

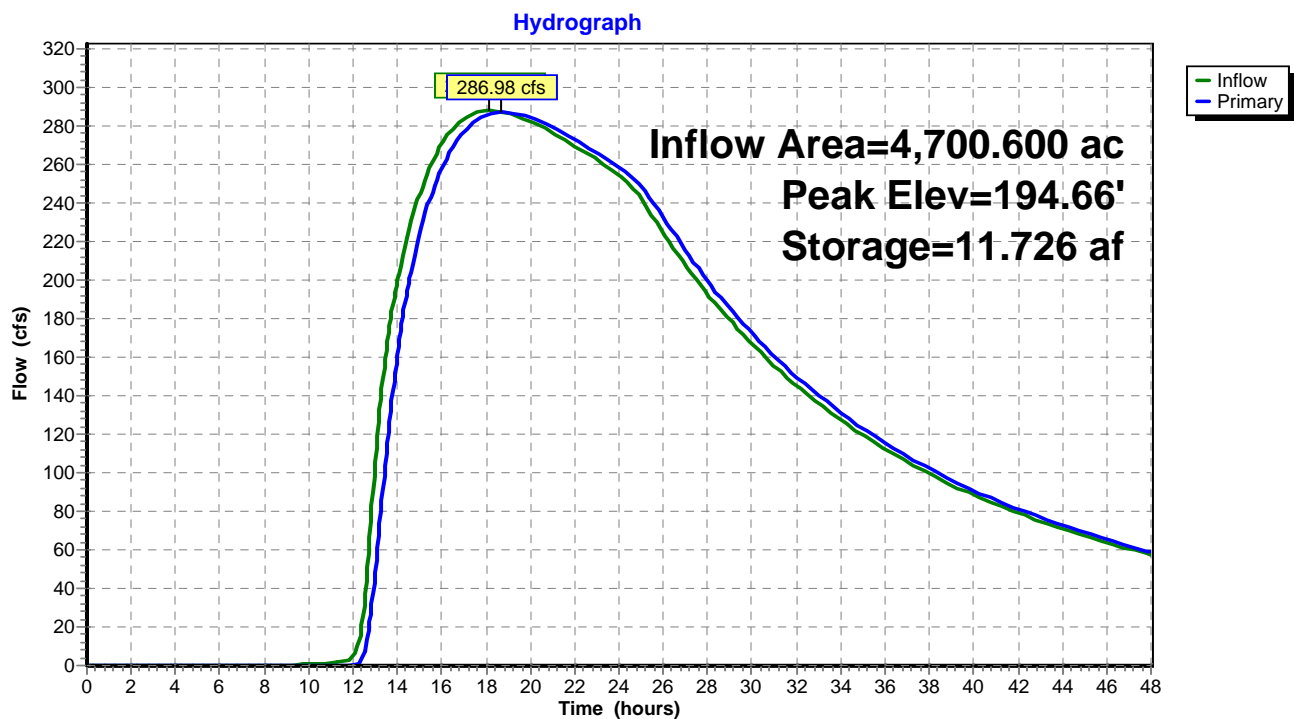
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 194.66' @ 18.72 hrs Surf.Area= 5.089 ac Storage= 11.726 af

Plug-Flow detention time= 30.8 min calculated for 488.346 af (99% of inflow)
 Center-of-Mass det. time= 23.0 min (1,585.0 - 1,562.1)

Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	191.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=286.98 cfs @ 18.72 hrs HW=194.66' TW=192.54' (Dynamic Tailwater)
 ↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 286.98 cfs @ 5.68 fps)

Pond ED: Eagle Dam - Proposed Spillway = 191.5

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 1.60" for 25yr event
 Inflow = 3,540.99 cfs @ 12.75 hrs, Volume= 626.416 af
 Outflow = 286.84 cfs @ 18.22 hrs, Volume= 488.362 af, Atten= 92%, Lag= 328.3 min
 Primary = 286.84 cfs @ 18.22 hrs, Volume= 488.362 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.02' @ 18.22 hrs Surf.Area= 0.000 ac Storage= 413.954 af

Plug-Flow detention time= 744.9 min calculated for 488.362 af (78% of inflow)
 Center-of-Mass det. time= 656.9 min (1,566.3 - 909.4)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

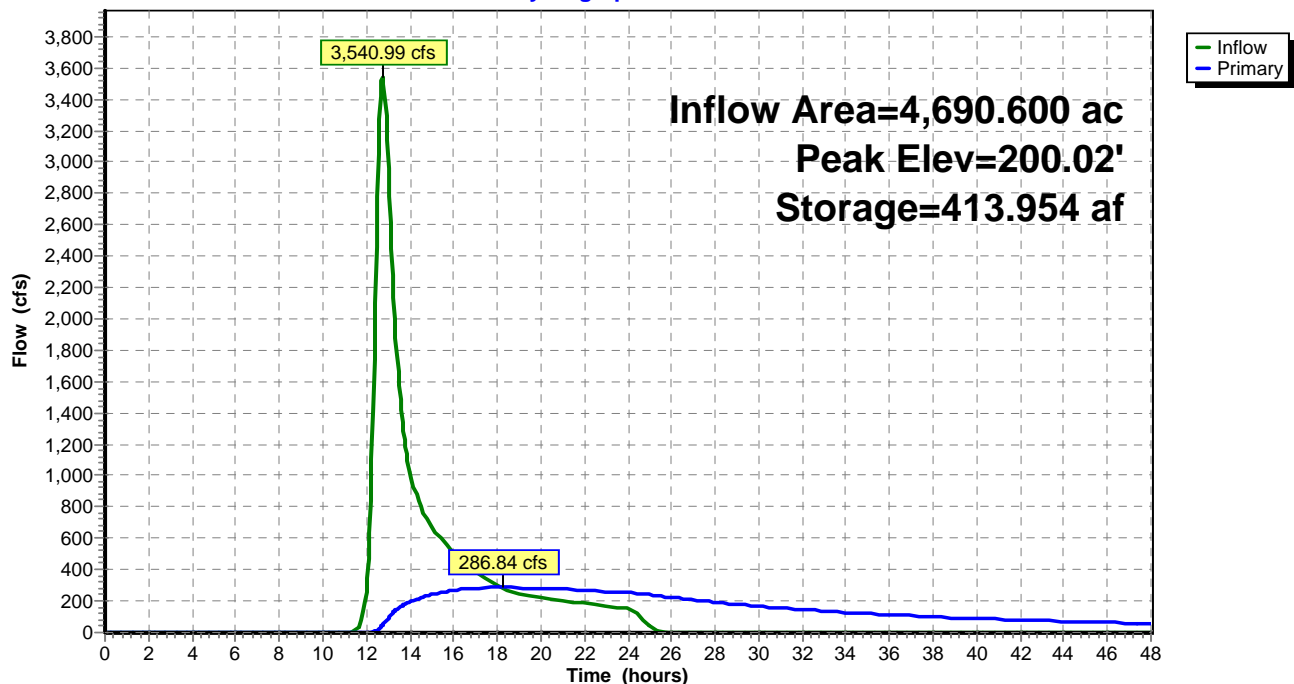
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=286.83 cfs @ 18.22 hrs HW=200.02' TW=194.65' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 286.83 cfs @ 3.72 fps)

Pond RD: Red Dam

Hydrograph



W350 Removed Eagle Dam Proposed Model_REV2*Type III 24-hr 50yr Rainfall=6.10"*

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 11

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook

Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.08"

Tc=50.0 min CN=82 Runoff=20.77 cfs 3.399 af

Subcatchment 4S: Red Dam Upstream

Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=1.99"

Tc=50.0 min CN=60 Runoff=4,500.53 cfs 776.790 af

Pond 1P: Existing Route 140 Culvert Opening

Peak Elev=193.51' Inflow=384.16 cfs 624.338 af

Primary=384.16 cfs 624.338 af Secondary=0.00 cfs 0.000 af Outflow=384.16 cfs 624.338 af

Pond ED: Eagle Dam - Proposed

Peak Elev=195.47' Storage=16.141 af Inflow=385.88 cfs 627.666 af

Outflow=384.16 cfs 624.338 af

Pond RD: Red Dam

Peak Elev=200.29' Storage=504.845 af Inflow=4,500.53 cfs 776.790 af

Outflow=384.68 cfs 624.266 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 780.190 af Average Runoff Depth = 1.99"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

Runoff = 20.77 cfs @ 12.67 hrs, Volume= 3.399 af, Depth= 4.08"

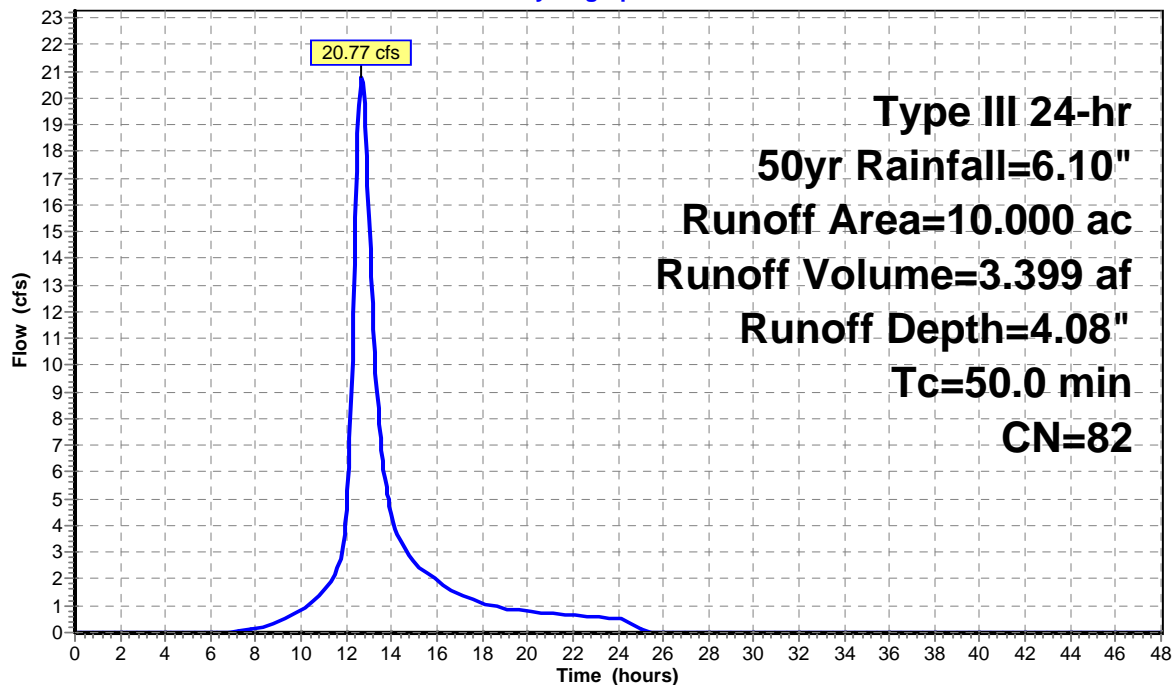
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 50yr Rainfall=6.10"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



Summary for Subcatchment 4S: Red Dam Upstream Summary

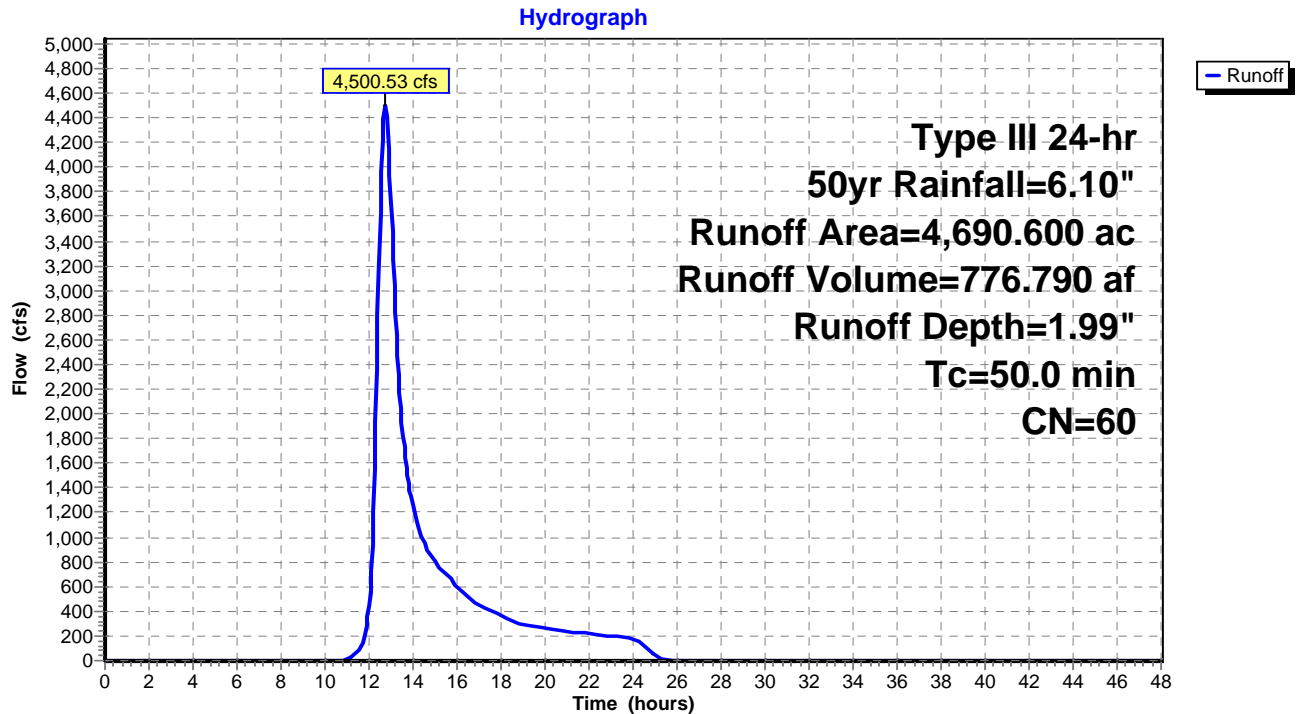
Runoff = 4,500.53 cfs @ 12.74 hrs, Volume= 776.790 af, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 50yr Rainfall=6.10"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.59" for 50yr event
 Inflow = 384.16 cfs @ 18.35 hrs, Volume= 624.338 af
 Outflow = 384.16 cfs @ 18.35 hrs, Volume= 624.338 af, Atten= 0%, Lag= 0.0 min
 Primary = 384.16 cfs @ 18.35 hrs, Volume= 624.338 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 193.51' @ 18.35 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=384.16 cfs @ 18.35 hrs HW=193.51' (Free Discharge)

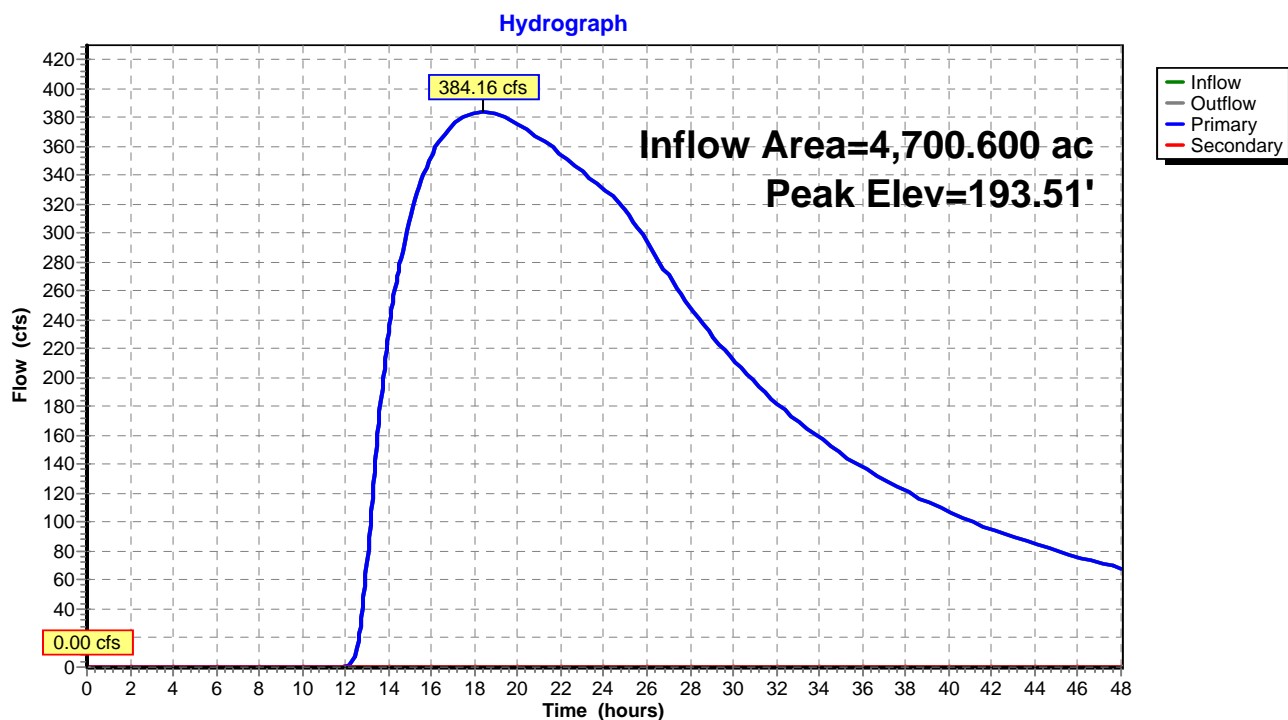
↑ **2=Culvert** (Passes 384.16 cfs of 453.24 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 384.16 cfs @ 6.00 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 191.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.60" for 50yr event
 Inflow = 385.88 cfs @ 17.67 hrs, Volume= 627.666 af
 Outflow = 384.16 cfs @ 18.35 hrs, Volume= 624.338 af, Atten= 0%, Lag= 40.6 min
 Primary = 384.16 cfs @ 18.35 hrs, Volume= 624.338 af

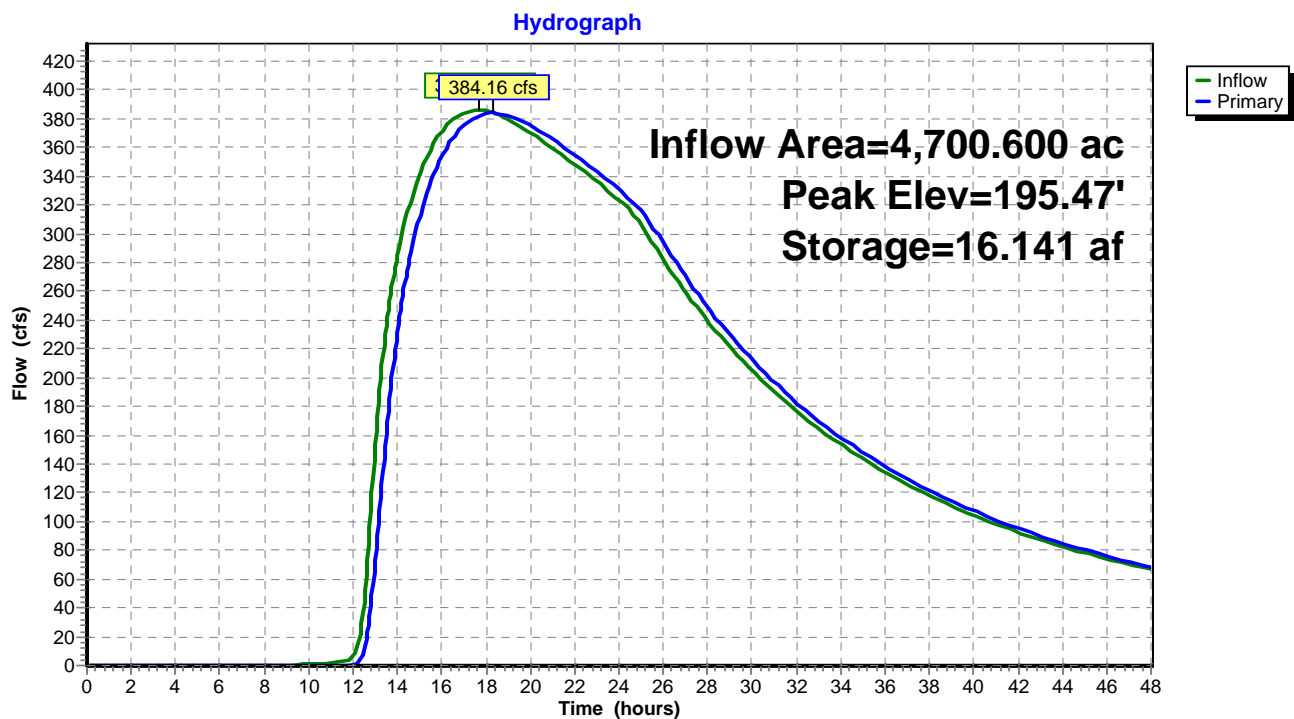
Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 195.47' @ 18.33 hrs Surf.Area= 5.688 ac Storage= 16.141 af

Plug-Flow detention time= 30.6 min calculated for 624.338 af (99% of inflow)
 Center-of-Mass det. time= 23.5 min (1,556.7 - 1,533.2)

Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	191.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=384.16 cfs @ 18.35 hrs HW=195.47' TW=193.51' (Dynamic Tailwater)
 ↑1=Sharp-Crested Vee/Trap Weir (Weir Controls 384.16 cfs @ 6.04 fps)

Pond ED: Eagle Dam - Proposed Spillway = 191.5

Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 1.99" for 50yr event
 Inflow = 4,500.53 cfs @ 12.74 hrs, Volume= 776.790 af
 Outflow = 384.68 cfs @ 17.71 hrs, Volume= 624.266 af, Atten= 91%, Lag= 298.2 min
 Primary = 384.68 cfs @ 17.71 hrs, Volume= 624.266 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.29' @ 17.71 hrs Surf.Area= 0.000 ac Storage= 504.845 af

Plug-Flow detention time= 715.2 min calculated for 624.266 af (80% of inflow)
 Center-of-Mass det. time= 634.3 min (1,536.9 - 902.6)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

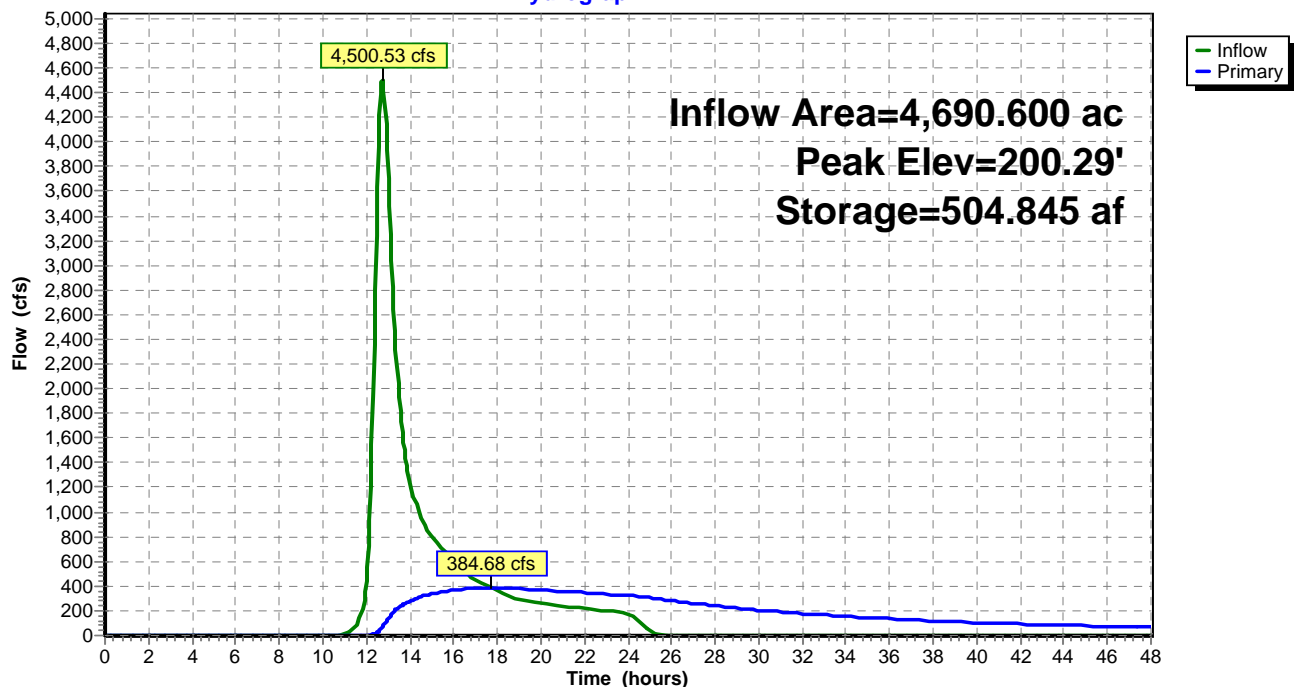
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=384.68 cfs @ 17.71 hrs HW=200.29' TW=195.46' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 384.68 cfs @ 4.10 fps)

Pond RD: Red Dam

Hydrograph



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.73"
Tc=50.0 min CN=82 Runoff=23.99 cfs 3.941 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.46"
Tc=50.0 min CN=60 Runoff=5,685.64 cfs 962.747 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=195.53' Inflow=518.18 cfs 795.393 af
Primary=518.18 cfs 795.393 af Secondary=140.87 cfs 157.909 af Outflow=518.18 cfs 795.393 af

Pond ED: Eagle Dam - Proposed Peak Elev=197.77' Storage=31.043 af Inflow=517.47 cfs 799.113 af
Outflow=518.18 cfs 795.393 af

Pond RD: Red Dam Peak Elev=200.63' Storage=615.775 af Inflow=5,685.64 cfs 962.747 af
Outflow=515.92 cfs 795.172 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 966.688 af Average Runoff Depth = 2.47"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

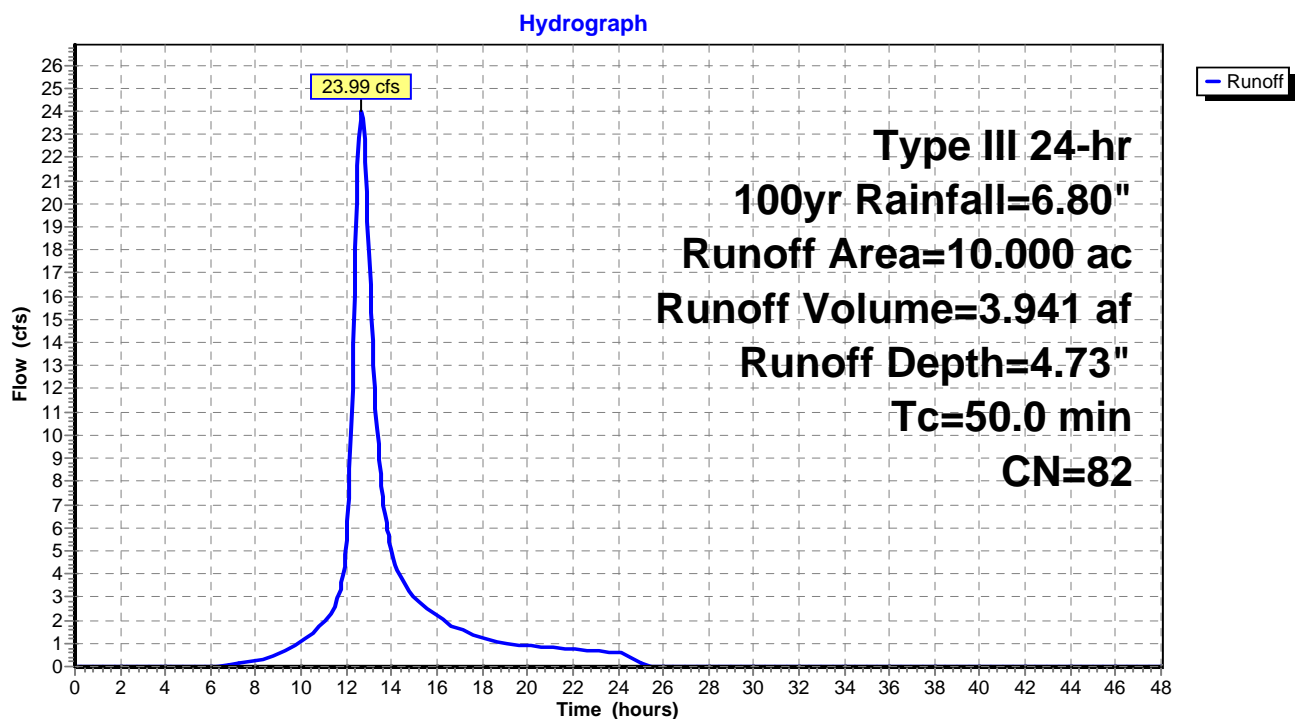
Runoff = 23.99 cfs @ 12.67 hrs, Volume= 3.941 af, Depth= 4.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100yr Rainfall=6.80"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

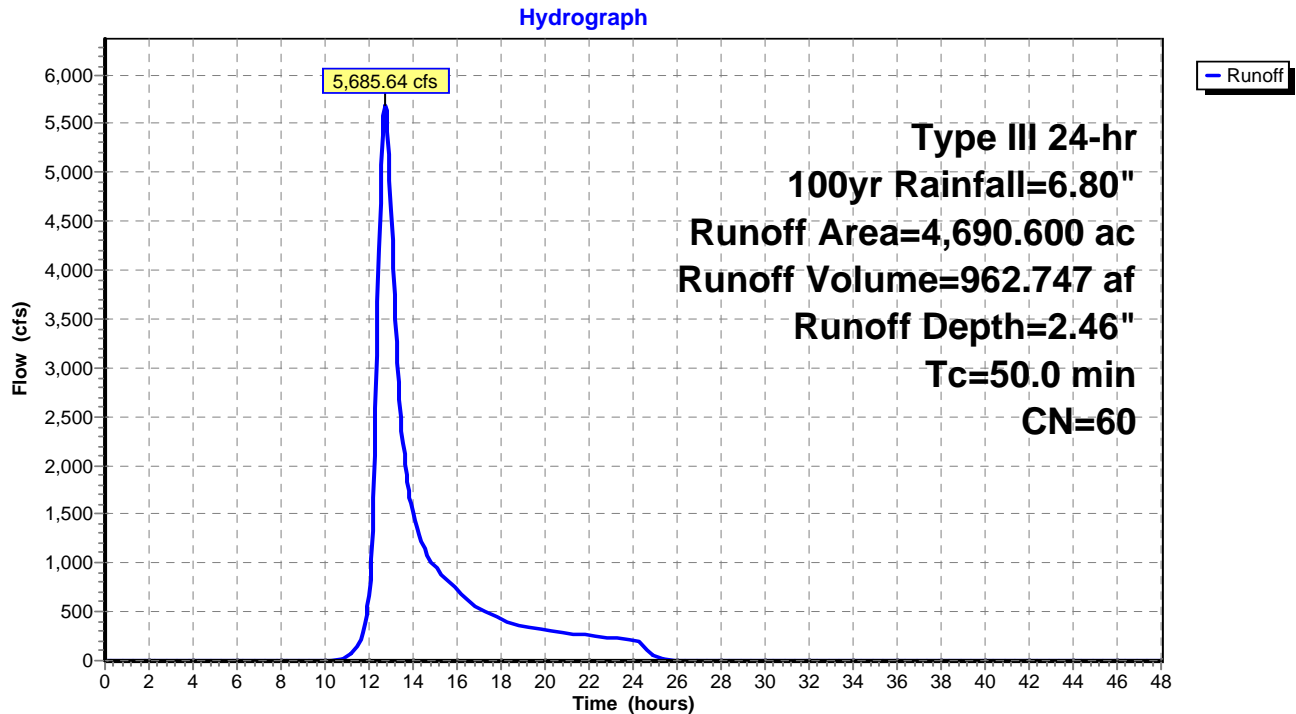
Runoff = 5,685.64 cfs @ 12.73 hrs, Volume= 962.747 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100yr Rainfall=6.80"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.03" for 100yr event
 Inflow = 518.18 cfs @ 17.07 hrs, Volume= 795.393 af
 Outflow = 518.18 cfs @ 17.07 hrs, Volume= 795.393 af, Atten= 0%, Lag= 0.0 min
 Primary = 518.18 cfs @ 17.07 hrs, Volume= 795.393 af
 Secondary = 140.87 cfs @ 16.22 hrs, Volume= 157.909 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 195.53' @ 17.07 hrs
 Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/ Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=518.17 cfs @ 17.07 hrs HW=195.53' (Free Discharge)

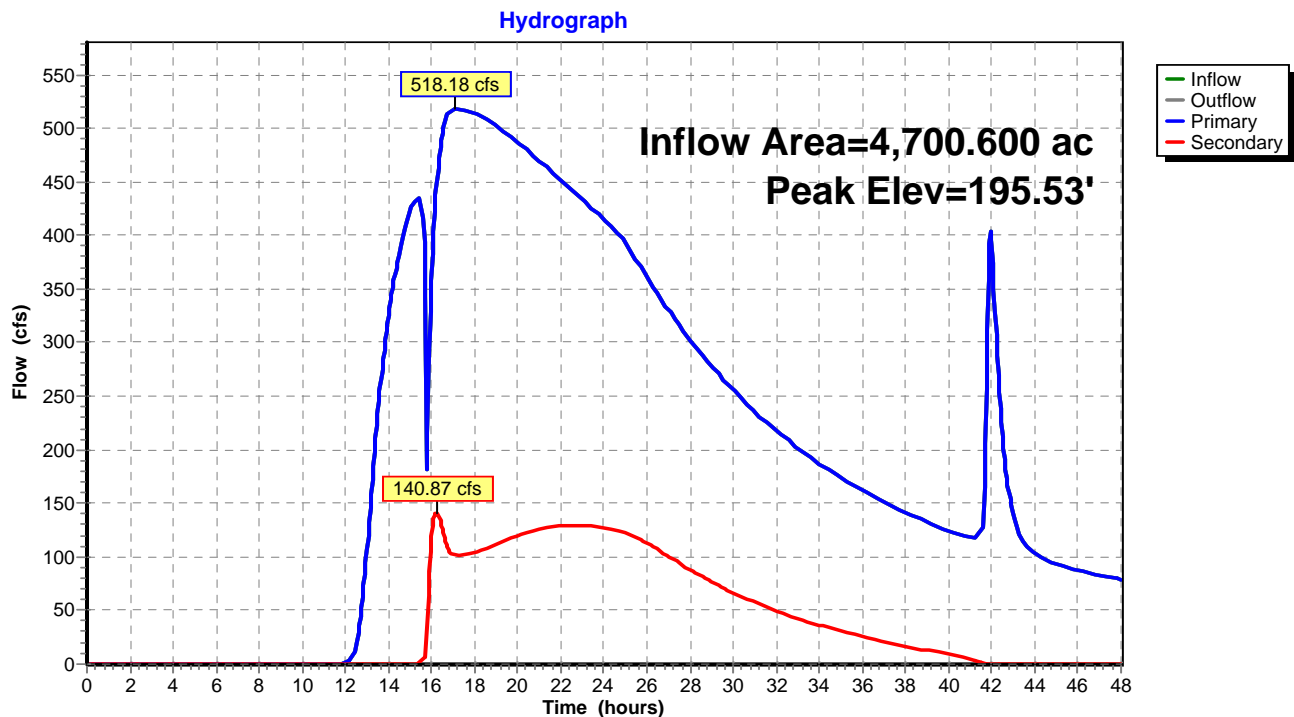
↑ **2=Culvert** (Passes 518.17 cfs of 662.90 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 518.17 cfs @ 8.10 fps)

Secondary OutFlow Max=0.00 cfs @ 16.22 hrs HW=194.32' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 191.5

[90] Warning: Qout>Qin may require smaller dt or Finer Routing

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.04" for 100yr event
 Inflow = 517.47 cfs @ 17.13 hrs, Volume= 799.113 af
 Outflow = 518.18 cfs @ 17.07 hrs, Volume= 795.393 af, Atten= 0%, Lag= 0.0 min
 Primary = 518.18 cfs @ 17.07 hrs, Volume= 795.393 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 197.77' @ 16.89 hrs Surf.Area= 7.331 ac Storage= 31.043 af

Plug-Flow detention time= 58.4 min calculated for 795.393 af (100% of inflow)
 Center-of-Mass det. time= 52.1 min (1,555.8 - 1,503.7)

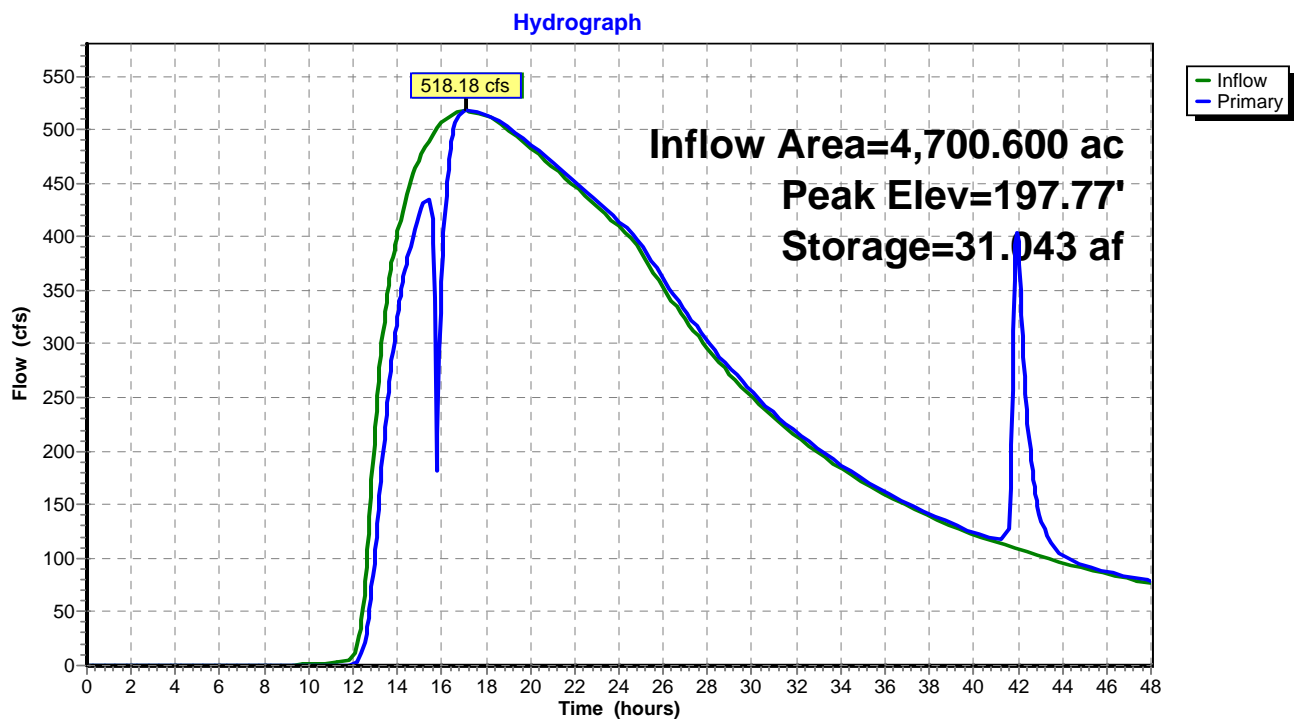
Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	191.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=705.05 cfs @ 17.07 hrs HW=197.77' TW=195.53' (Dynamic Tailwater)
 ↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 705.05 cfs @ 7.03 fps)

Pond ED: Eagle Dam - Proposed Spillway = 191.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.46" for 100yr event
 Inflow = 5,685.64 cfs @ 12.73 hrs, Volume= 962.747 af
 Outflow = 515.92 cfs @ 17.16 hrs, Volume= 795.172 af, Atten= 91%, Lag= 266.1 min
 Primary = 515.92 cfs @ 17.16 hrs, Volume= 795.172 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 200.63' @ 17.16 hrs Surf.Area= 0.000 ac Storage= 615.775 af

Plug-Flow detention time= 685.0 min calculated for 795.172 af (83% of inflow)
 Center-of-Mass det. time= 611.0 min (1,507.0 - 896.0)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

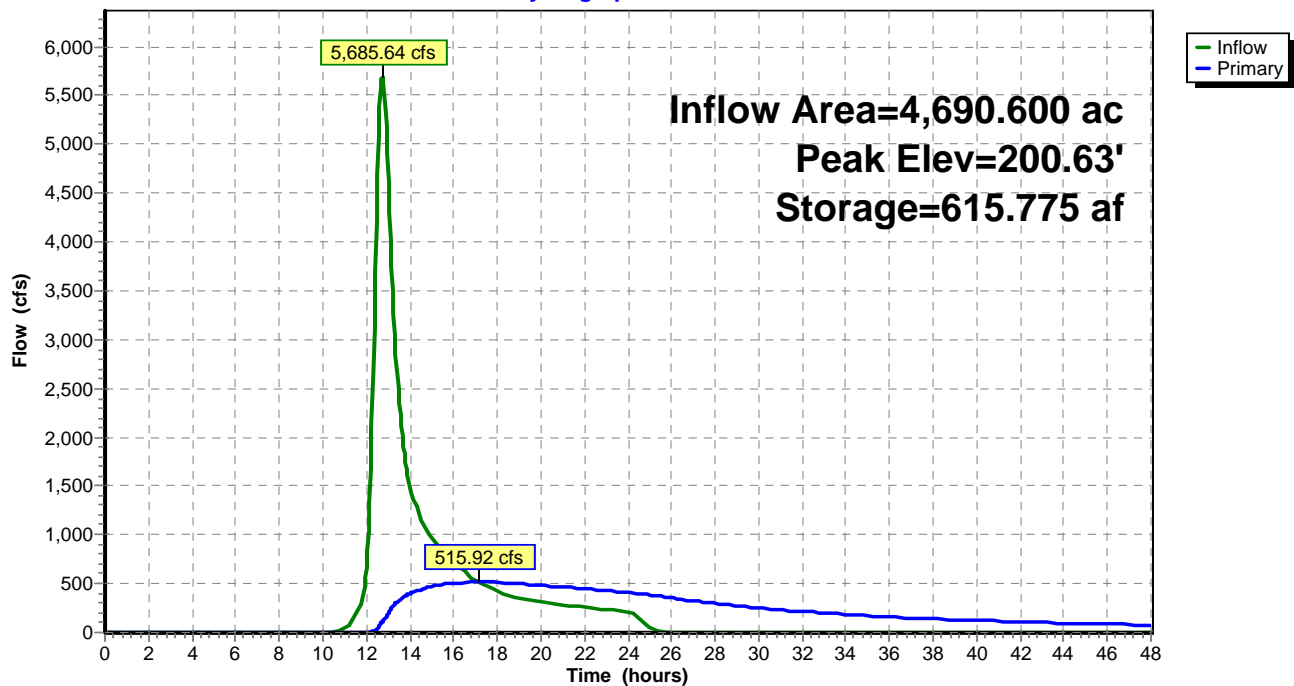
Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=515.91 cfs @ 17.16 hrs HW=200.63' TW=197.77' (Dynamic Tailwater)
 ↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 515.91 cfs @ 4.52 fps)

Pond RD: Red Dam

Hydrograph



W350 Removed Eagle Dam Proposed Model_Type III 24-hr CURRENT 25yr Rainfall=6.27"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 27

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=4.24"
Tc=50.0 min CN=82 Runoff=21.55 cfs 3.530 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.10"
Tc=50.0 min CN=60 Runoff=4,782.35 cfs 820.979 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=193.90' Inflow=413.92 cfs 664.729 af
Primary=413.92 cfs 664.729 af Secondary=0.00 cfs 0.000 af Outflow=413.92 cfs 664.729 af

Pond ED: Eagle Dam - Proposed Peak Elev=195.75' Storage=17.762 af Inflow=416.13 cfs 668.156 af
Outflow=413.92 cfs 664.729 af

Pond RD: Red Dam Peak Elev=200.38' Storage=531.329 af Inflow=4,782.35 cfs 820.979 af
Outflow=414.85 cfs 664.626 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 824.509 af Average Runoff Depth = 2.10"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

Runoff = 21.55 cfs @ 12.67 hrs, Volume= 3.530 af, Depth= 4.24"

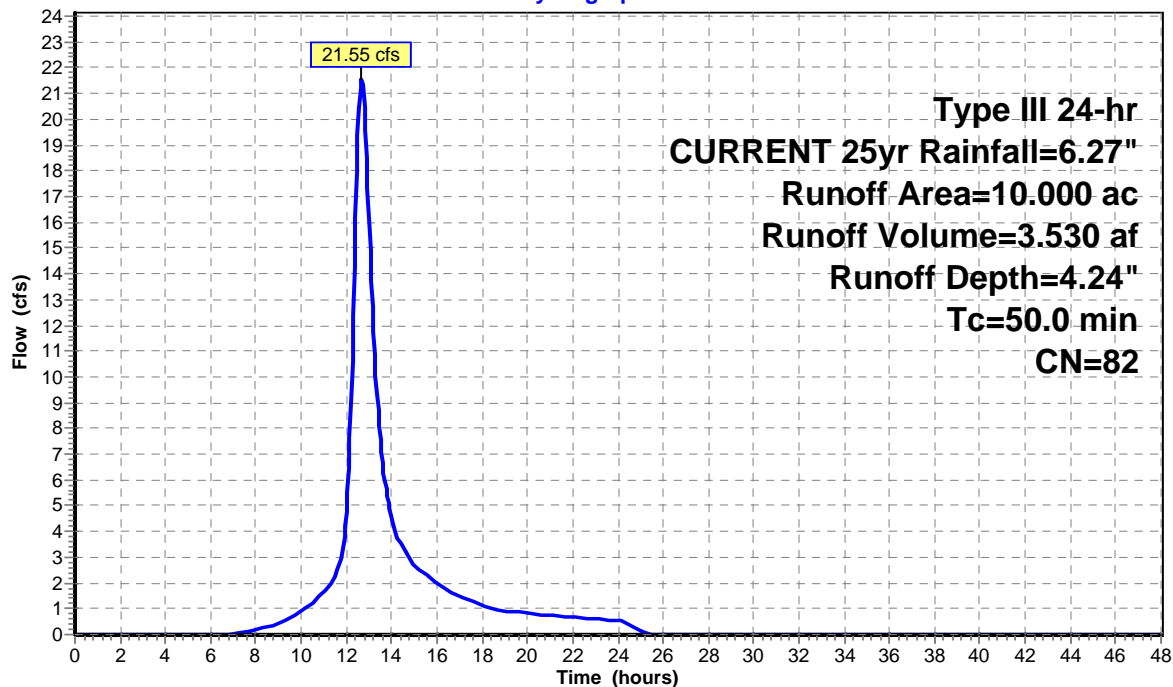
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 25yr Rainfall=6.27"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook

Hydrograph



Summary for Subcatchment 4S: Red Dam Upstream Summary

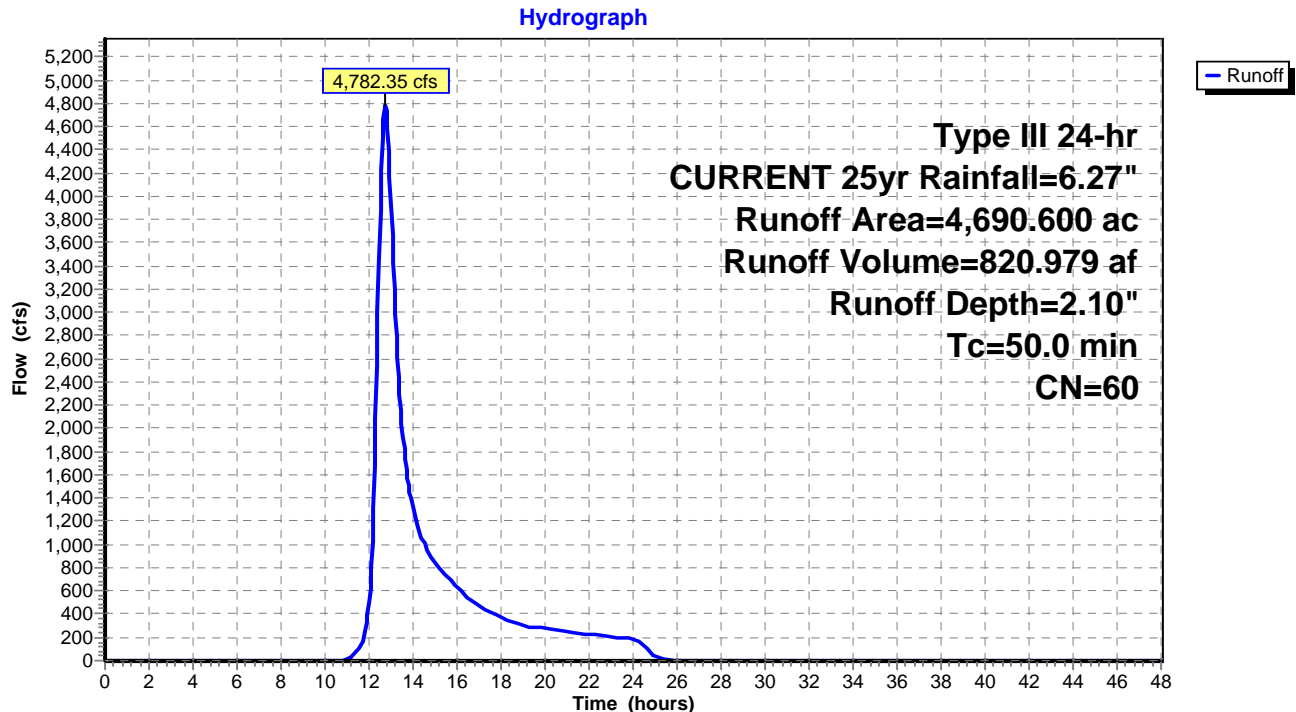
Runoff = 4,782.35 cfs @ 12.73 hrs, Volume= 820.979 af, Depth= 2.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 25yr Rainfall=6.27"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.70" for CURRENT 25yr event
 Inflow = 413.92 cfs @ 18.30 hrs, Volume= 664.729 af
 Outflow = 413.92 cfs @ 18.30 hrs, Volume= 664.729 af, Atten= 0%, Lag= 0.0 min
 Primary = 413.92 cfs @ 18.30 hrs, Volume= 664.729 af
 Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 193.90' @ 18.30 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=413.92 cfs @ 18.30 hrs HW=193.90' (Free Discharge)

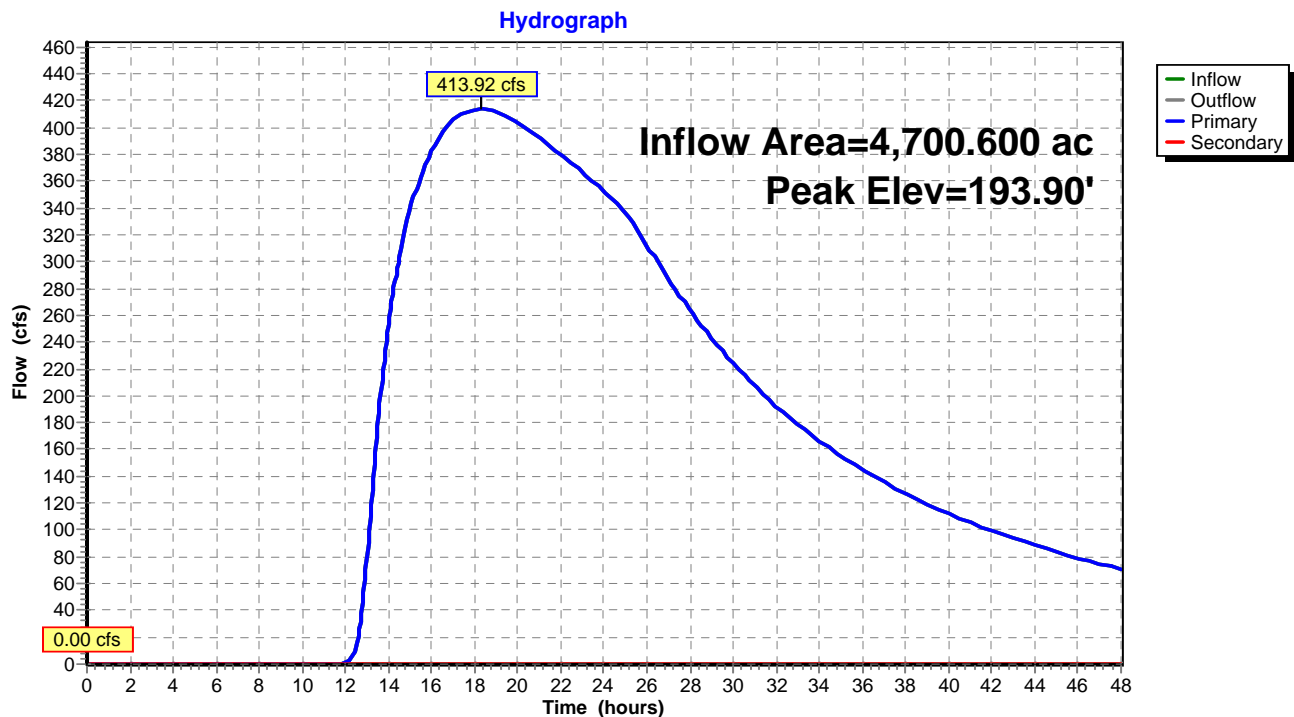
↑ **2=Culvert** (Passes 413.92 cfs of 506.10 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 413.92 cfs @ 6.47 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=188.83' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 191.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 1.71" for CURRENT 25yr event
 Inflow = 416.13 cfs @ 17.53 hrs, Volume= 668.156 af
 Outflow = 413.92 cfs @ 18.30 hrs, Volume= 664.729 af, Atten= 1%, Lag= 46.0 min
 Primary = 413.92 cfs @ 18.30 hrs, Volume= 664.729 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 195.75' @ 18.25 hrs Surf.Area= 5.867 ac Storage= 17.762 af

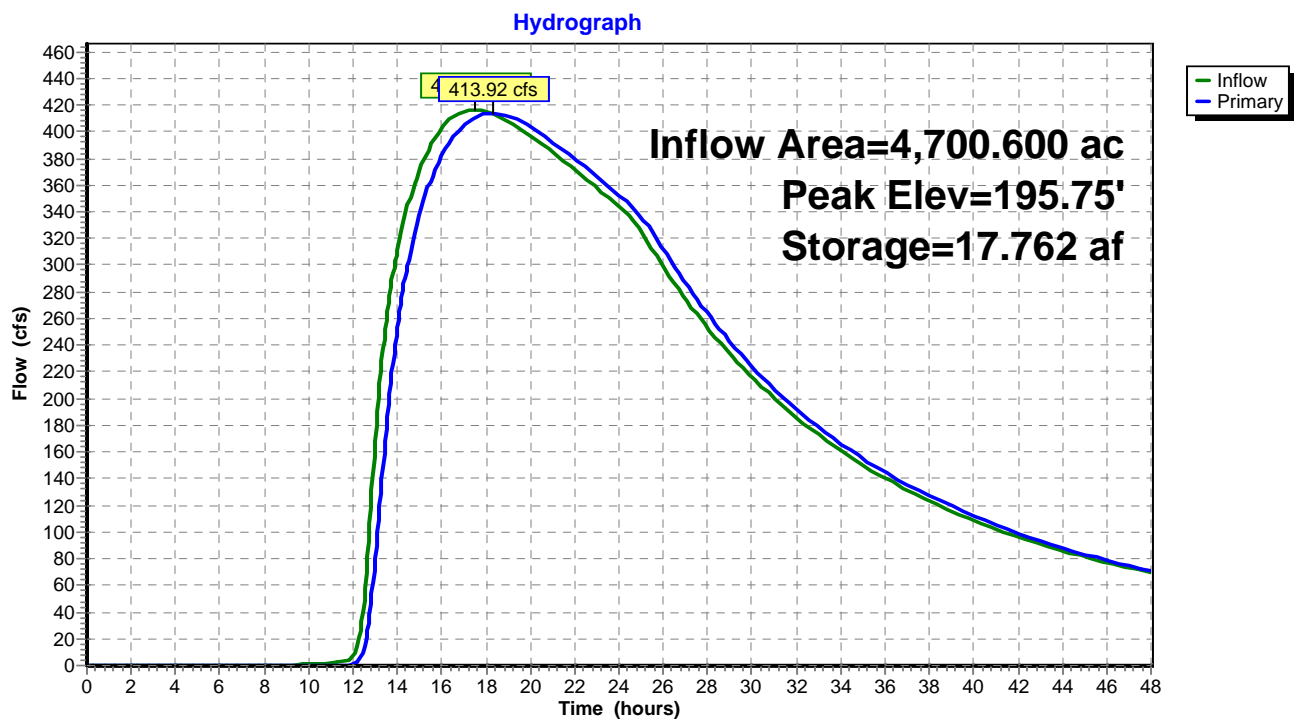
Plug-Flow detention time= 30.7 min calculated for 664.729 af (99% of inflow)
 Center-of-Mass det. time= 23.9 min (1,549.5 - 1,525.7)

Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	191.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=413.93 cfs @ 18.30 hrs HW=195.75' TW=193.90' (Dynamic Tailwater)
 ↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 413.93 cfs @ 6.08 fps)

Pond ED: Eagle Dam - Proposed Spillway = 191.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.10" for CURRENT 25yr event
Inflow = 4,782.35 cfs @ 12.73 hrs, Volume= 820.979 af
Outflow = 414.85 cfs @ 17.57 hrs, Volume= 664.626 af, Atten= 91%, Lag= 290.0 min
Primary = 414.85 cfs @ 17.57 hrs, Volume= 664.626 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 200.38' @ 17.57 hrs Surf.Area= 0.000 ac Storage= 531.329 af

Plug-Flow detention time= 707.4 min calculated for 664.626 af (81% of inflow)
Center-of-Mass det. time= 628.4 min (1,529.2 - 900.9)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

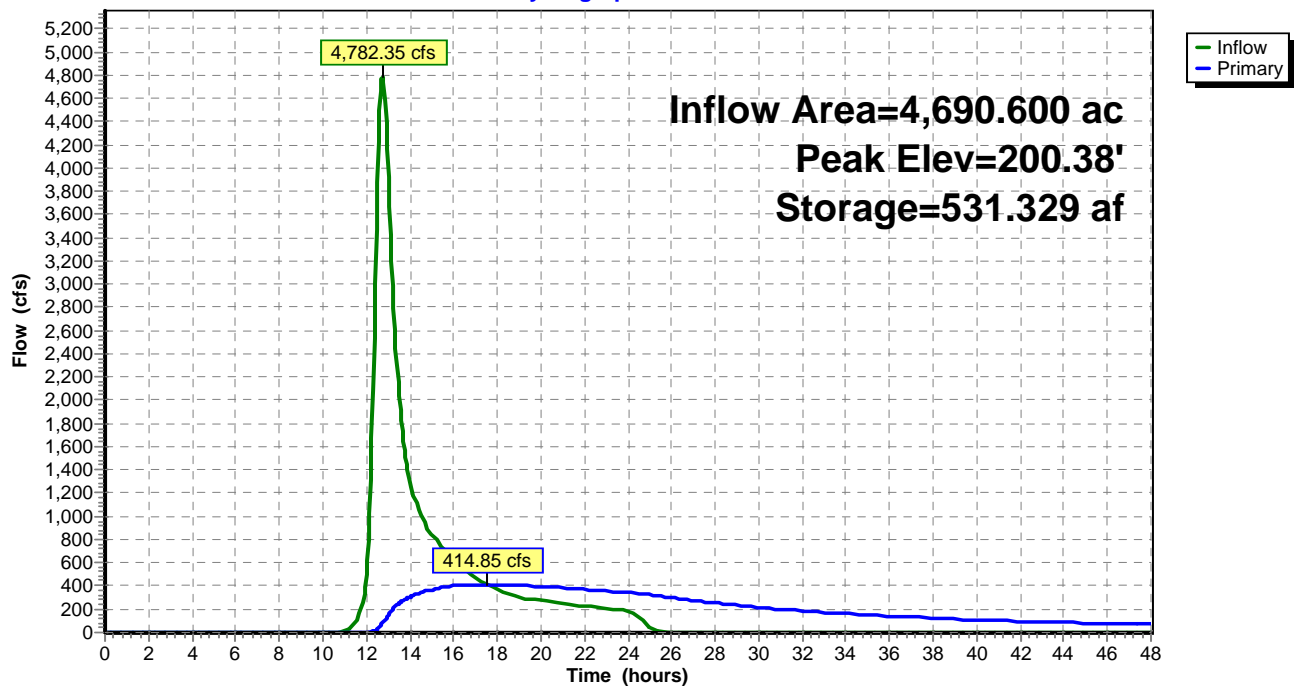
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=414.83 cfs @ 17.57 hrs HW=200.38' TW=195.73' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 414.83 cfs @ 4.20 fps)

Pond RD: Red Dam

Hydrograph



W350 Removed Eagle Dam Proposed Model_Type III 24-hr CURRENT 50yr Rainfall=7.51"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 35

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=5.40"
Tc=50.0 min CN=82 Runoff=27.27 cfs 4.497 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=2.97"
Tc=50.0 min CN=60 Runoff=6,948.19 cfs 1,161.122 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=197.00' Inflow=720.21 cfs 980.461 af
Primary=595.46 cfs 946.689 af Secondary=152.97 cfs 38.878 af Outflow=720.21 cfs 980.461 af

Pond ED: Eagle Dam - Proposed Peak Elev=198.25' Storage=34.619 af Inflow=669.59 cfs 984.546 af
Outflow=720.21 cfs 980.461 af

Pond RD: Red Dam Peak Elev=200.99' Storage=732.825 af Inflow=6,948.19 cfs 1,161.122 af
Outflow=667.65 cfs 980.050 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 1,165.618 af Average Runoff Depth = 2.98"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

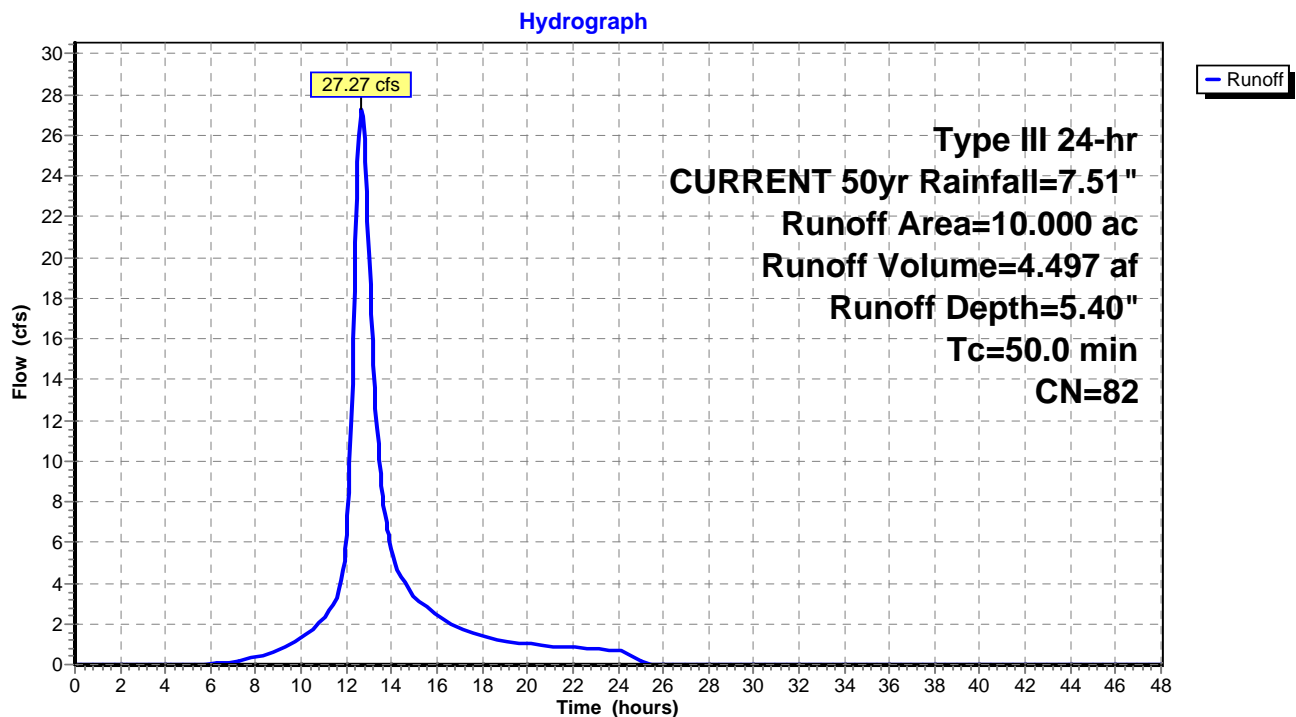
Runoff = 27.27 cfs @ 12.67 hrs, Volume= 4.497 af, Depth= 5.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 50yr Rainfall=7.51"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

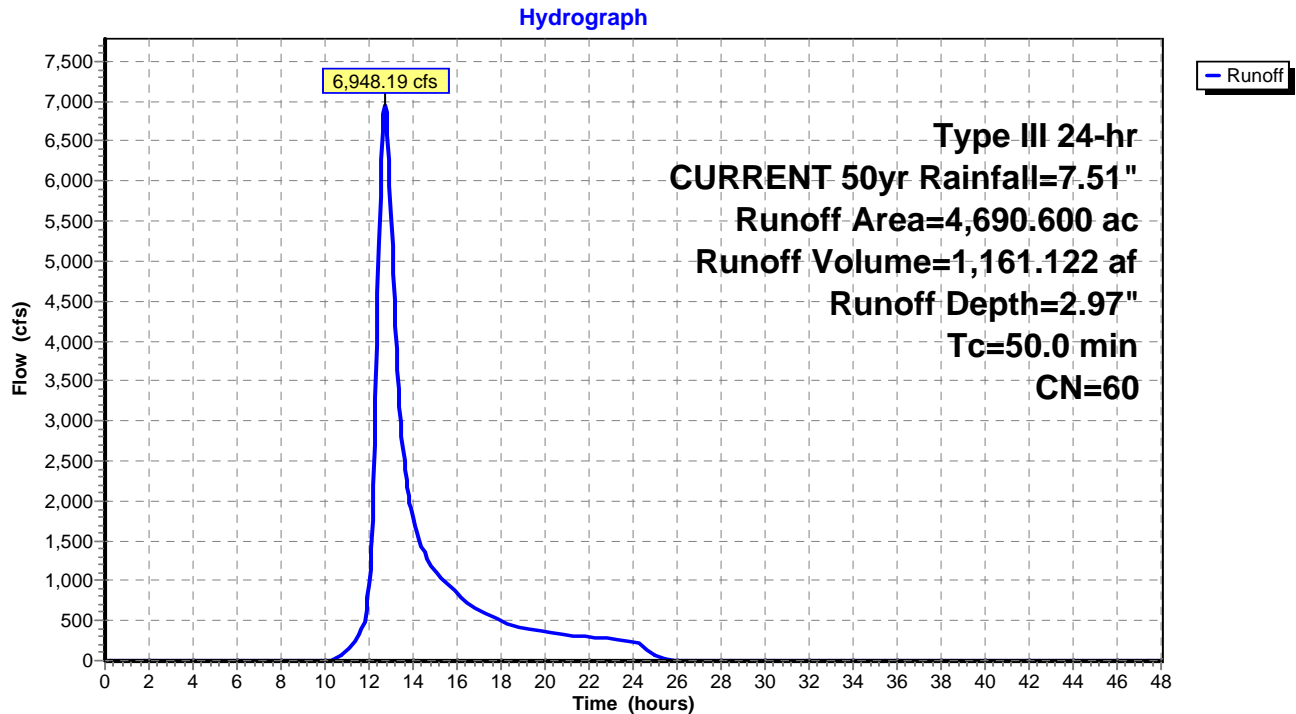
Runoff = 6,948.19 cfs @ 12.72 hrs, Volume= 1,161.122 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr CURRENT 50yr Rainfall=7.51"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary



Summary for Pond 1P: Existing Route 140 Culvert Opening

[58] Hint: Peaked 0.47' above defined flood level

[80] Warning: Exceeded Pond ED by 0.12' @ 22.80 hrs (199.06 cfs 7.435 af)

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.50" for CURRENT 50yr event
Inflow = 720.21 cfs @ 22.02 hrs, Volume= 980.461 af
Outflow = 720.21 cfs @ 22.02 hrs, Volume= 980.461 af, Atten= 0%, Lag= 0.0 min
Primary = 595.46 cfs @ 22.02 hrs, Volume= 946.689 af
Secondary = 152.97 cfs @ 14.68 hrs, Volume= 38.878 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2

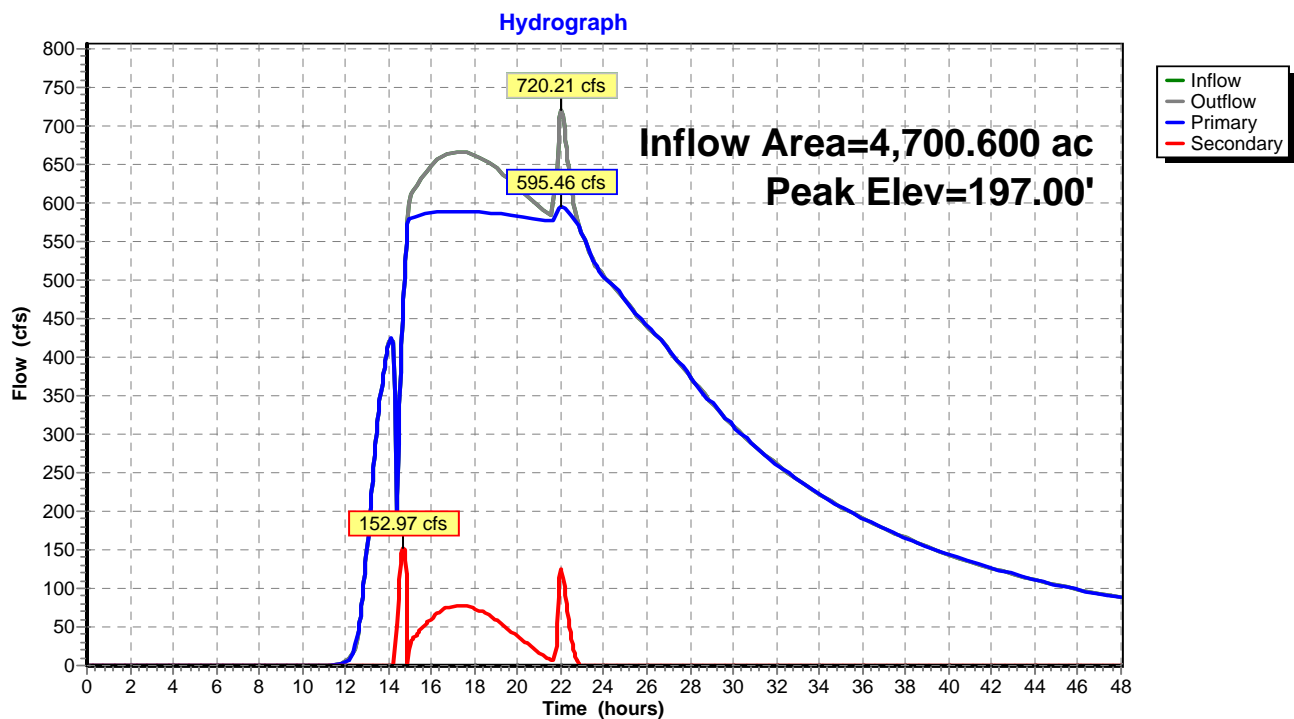
Peak Elev= 197.00' @ 22.02 hrs

Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=595.29 cfs @ 22.02 hrs HW=196.99' (Free Discharge)↑ **2=Culvert** (Passes 595.29 cfs of 761.57 cfs potential flow)↑ **1=Route 140 Culvert Opening** (Orifice Controls 595.29 cfs @ 9.30 fps)**Secondary OutFlow** Max=0.00 cfs @ 14.68 hrs HW=194.66' (Free Discharge)↑ **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 191.5

[90] Warning: Qout>Qin may require smaller dt or Finer Routing

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 2.51" for CURRENT 50yr event
 Inflow = 669.59 cfs @ 16.70 hrs, Volume= 984.546 af
 Outflow = 720.21 cfs @ 22.02 hrs, Volume= 980.461 af, Atten= 0%, Lag= 318.9 min
 Primary = 720.21 cfs @ 22.02 hrs, Volume= 980.461 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 198.25' @ 17.24 hrs Surf.Area= 7.703 ac Storage= 34.619 af

Plug-Flow detention time= 33.6 min calculated for 979.441 af (99% of inflow)
 Center-of-Mass det. time= 27.9 min (1,505.4 - 1,477.5)

Volume	Invert	Avail.Storage	Storage Description
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)

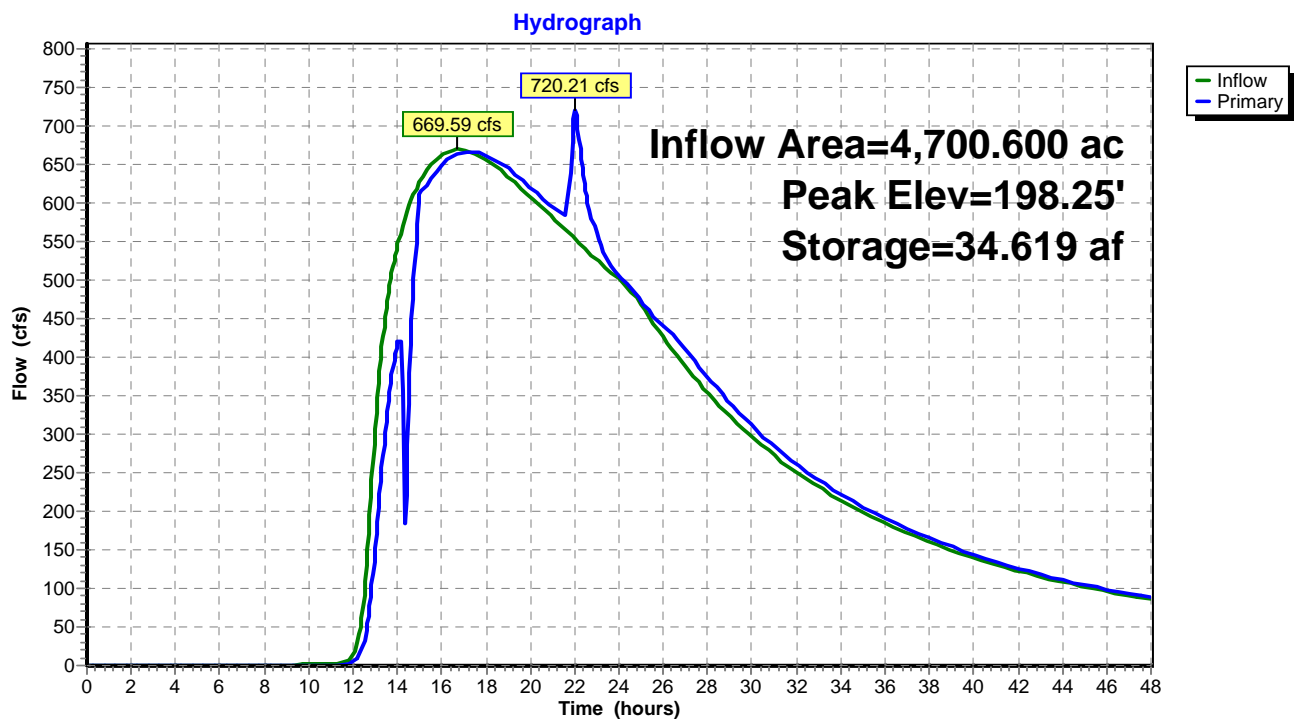
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	191.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=372.30 cfs @ 22.02 hrs HW=197.40' TW=196.99' (Dynamic Tailwater)

↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 372.30 cfs @ 3.95 fps)

Pond ED: Eagle Dam - Proposed Spillway = 191.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 2.97" for CURRENT 50yr event
Inflow = 6,948.19 cfs @ 12.72 hrs, Volume= 1,161.122 af
Outflow = 667.65 cfs @ 16.73 hrs, Volume= 980.050 af, Atten= 90%, Lag= 240.6 min
Primary = 667.65 cfs @ 16.73 hrs, Volume= 980.050 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 200.99' @ 16.73 hrs Surf.Area= 0.000 ac Storage= 732.825 af

Plug-Flow detention time= 657.1 min calculated for 979.030 af (84% of inflow)
Center-of-Mass det. time= 590.1 min (1,480.4 - 890.4)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

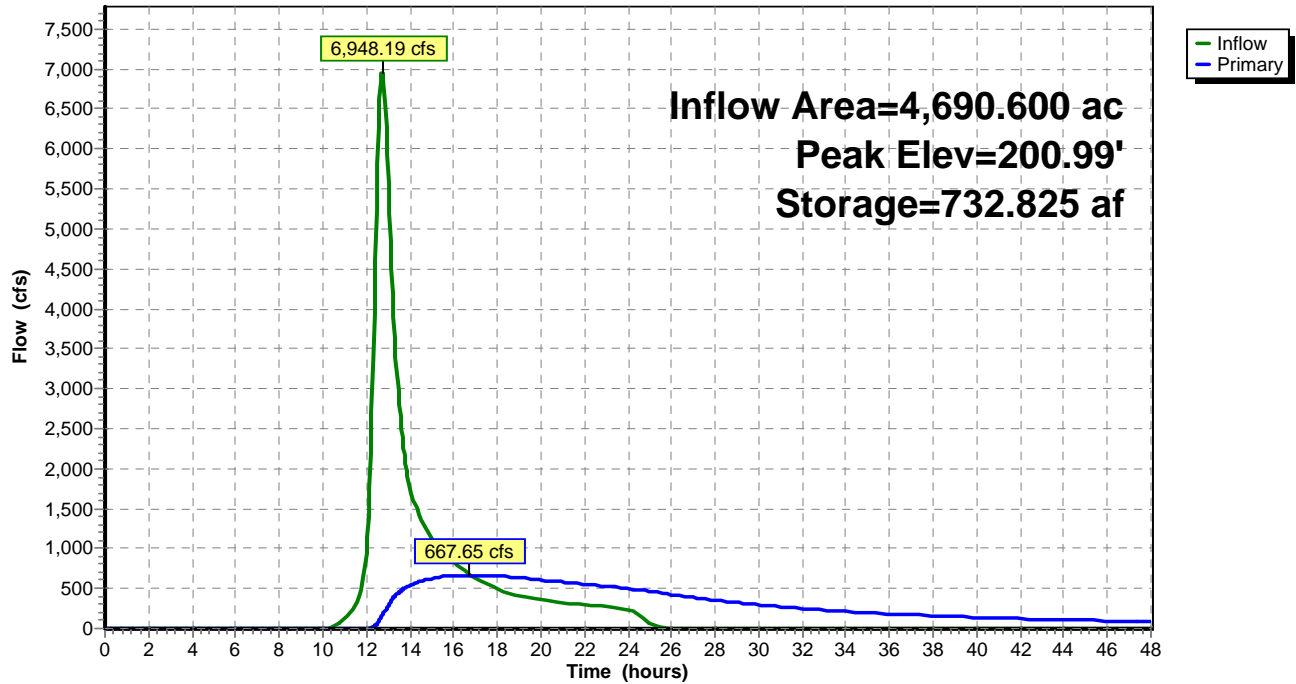
Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=667.64 cfs @ 16.73 hrs HW=200.99' TW=198.23' (Dynamic Tailwater)

↑**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 667.64 cfs @ 4.92 fps)

Pond RD: Red Dam

Hydrograph



W350 Removed Eagle Dam Proposed Model Type III 24-hr CURRENT 100yr Rainfall=9.01"

Prepared by ESS Group, Inc.

Printed 4/6/2020

HydroCAD® 10.00-25 s/n 01446 © 2019 HydroCAD Software Solutions LLC

Page 44

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 3S: Eagle Brook Runoff Area=10.000 ac 60.00% Impervious Runoff Depth=6.82"
Tc=50.0 min CN=82 Runoff=34.19 cfs 5.686 af

Subcatchment 4S: Red Dam Upstream Runoff Area=4,690.600 ac 0.00% Impervious Runoff Depth=4.11"
Tc=50.0 min CN=60 Runoff=9,761.26 cfs 1,605.988 af

Pond 1P: Existing Route 140 Culvert Opening Peak Elev=197.53' Inflow=1,011.93 cfs 1,401.017 af
Primary=621.07 cfs 1,136.713 af Secondary=390.86 cfs 266.829 af Outflow=1,011.93 cfs 1,401.017 af

Pond ED: Eagle Dam - Proposed Peak Elev=199.86' Storage=47.963 af Inflow=1,016.03 cfs 1,405.809 af
Outflow=1,011.93 cfs 1,401.017 af

Pond RD: Red Dam Peak Elev=201.78' Storage=994.155 af Inflow=9,761.26 cfs 1,605.988 af
Outflow=1,013.13 cfs 1,400.122 af

Total Runoff Area = 4,700.600 ac Runoff Volume = 1,611.675 af Average Runoff Depth = 4.11"
99.87% Pervious = 4,694.600 ac 0.13% Impervious = 6.000 ac

Summary for Subcatchment 3S: Eagle Brook

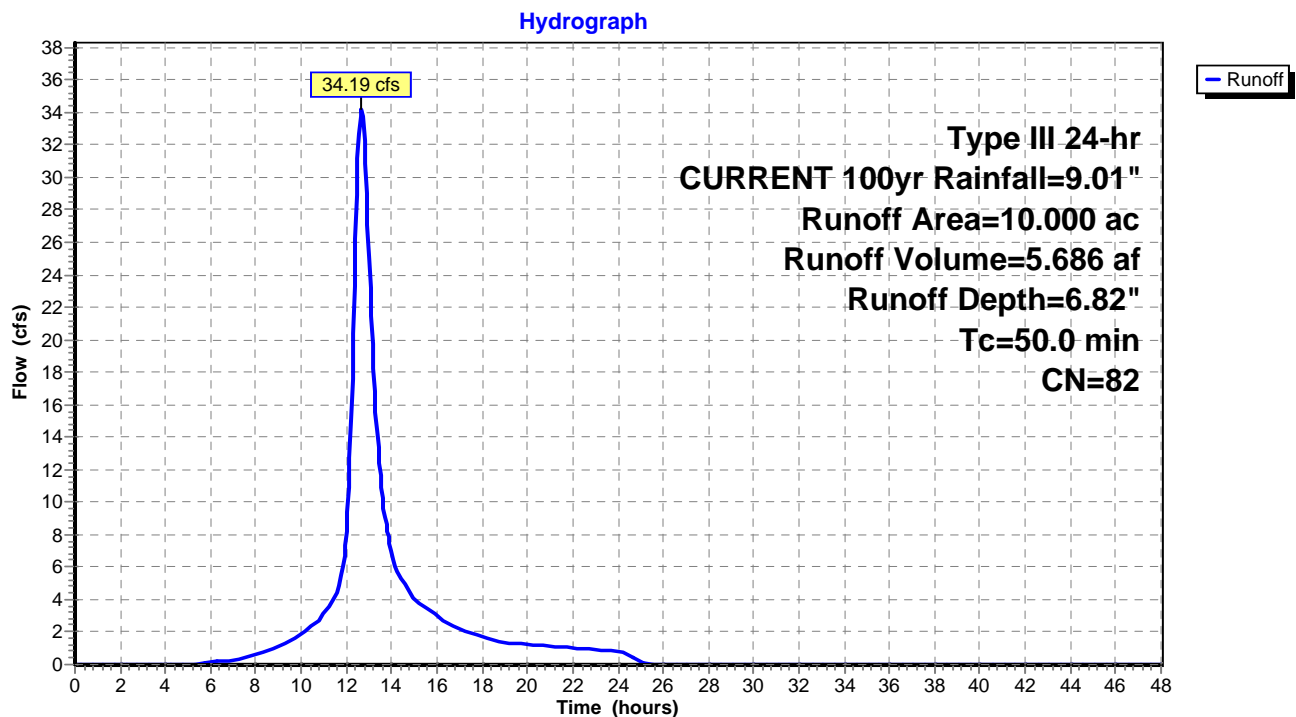
Runoff = 34.19 cfs @ 12.66 hrs, Volume= 5.686 af, Depth= 6.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr CURRENT 100yr Rainfall=9.01"

Area (ac)	CN	Description
* 5.000	65	1 acre lots, 20% imp, HSG A
* 5.000	98	Water Surface
10.000	82	Weighted Average
4.000		40.00% Pervious Area
6.000		60.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 3S: Eagle Brook



Summary for Subcatchment 4S: Red Dam Upstream Summary

Runoff = 9,761.26 cfs @ 12.71 hrs, Volume= 1,605.988 af, Depth= 4.11"

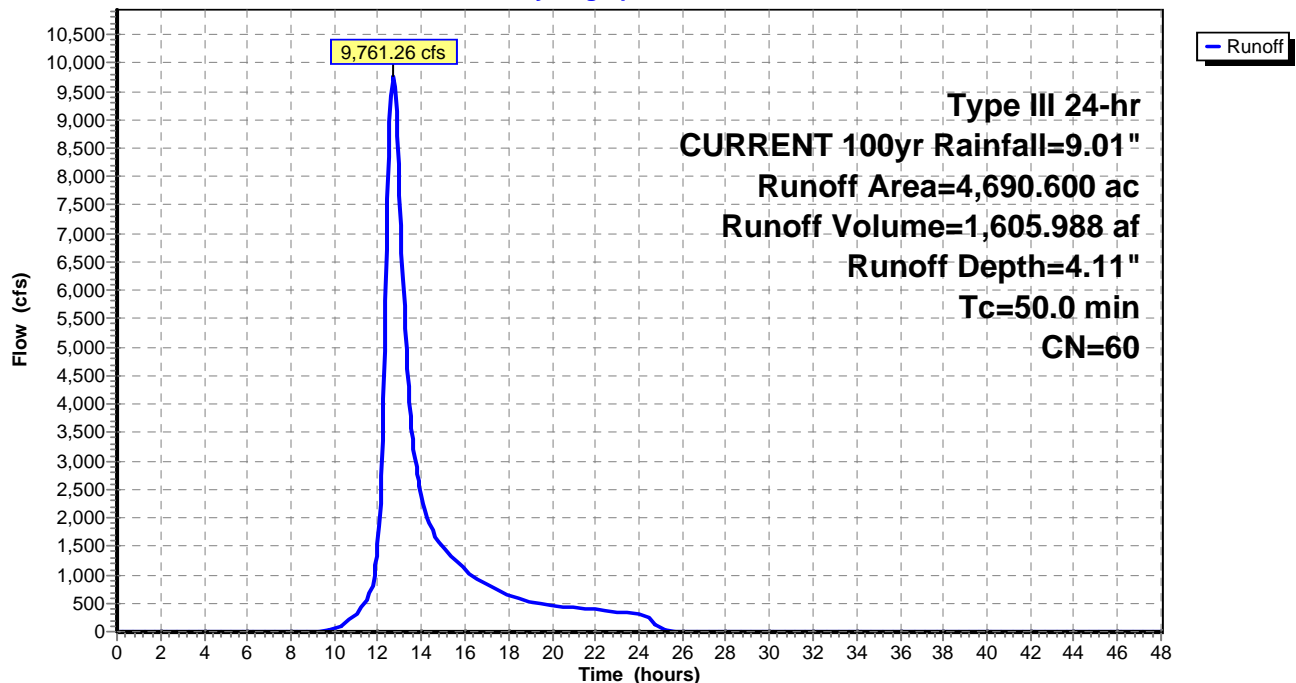
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
 Type III 24-hr CURRENT 100yr Rainfall=9.01"

Area (ac)	CN	Description
* 1,253.000	60	Subwatershed 1
* 209.000	61	Subwatershed 2
* 606.800	61	Subwatershed 3
* 645.000	66	Subwatershed 4
* 251.000	69	Subwatershed 5
* 896.800	52	Subwatershed 6
* 829.000	59	Subwatershed 7
4,690.600	60	Weighted Average
4,690.600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
50.0					Direct Entry,

Subcatchment 4S: Red Dam Upstream Summary

Hydrograph



Summary for Pond 1P: Existing Route 140 Culvert Opening

[58] Hint: Peaked 1.00' above defined flood level

[80] Warning: Exceeded Pond ED by 0.12' @ 27.55 hrs (199.88 cfs 4.653 af)

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 3.58" for CURRENT 100yr event
 Inflow = 1,011.93 cfs @ 16.61 hrs, Volume= 1,401.017 af
 Outflow = 1,011.93 cfs @ 16.61 hrs, Volume= 1,401.017 af, Atten= 0%, Lag= 0.0 min
 Primary = 621.07 cfs @ 16.61 hrs, Volume= 1,136.713 af
 Secondary = 390.86 cfs @ 16.61 hrs, Volume= 266.829 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 197.53' @ 16.61 hrs
 Flood Elev= 196.53'

Device	Routing	Invert	Outlet Devices
#1	Device 2	188.83'	96.0" W x 48.0" H Vert. Route 140 Culvert Opening X 2.00 C= 0.469
#2	Primary	188.83'	96.0" W x 48.0" H Box Culvert X 2.00 L= 100.0' Box, headwall w/3 square edges, Ke= 0.500 Inlet / Outlet Invert= 188.83' / 188.33' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 32.00 sf
#3	Secondary	196.53'	120.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=621.07 cfs @ 16.61 hrs HW=197.53' (Free Discharge)

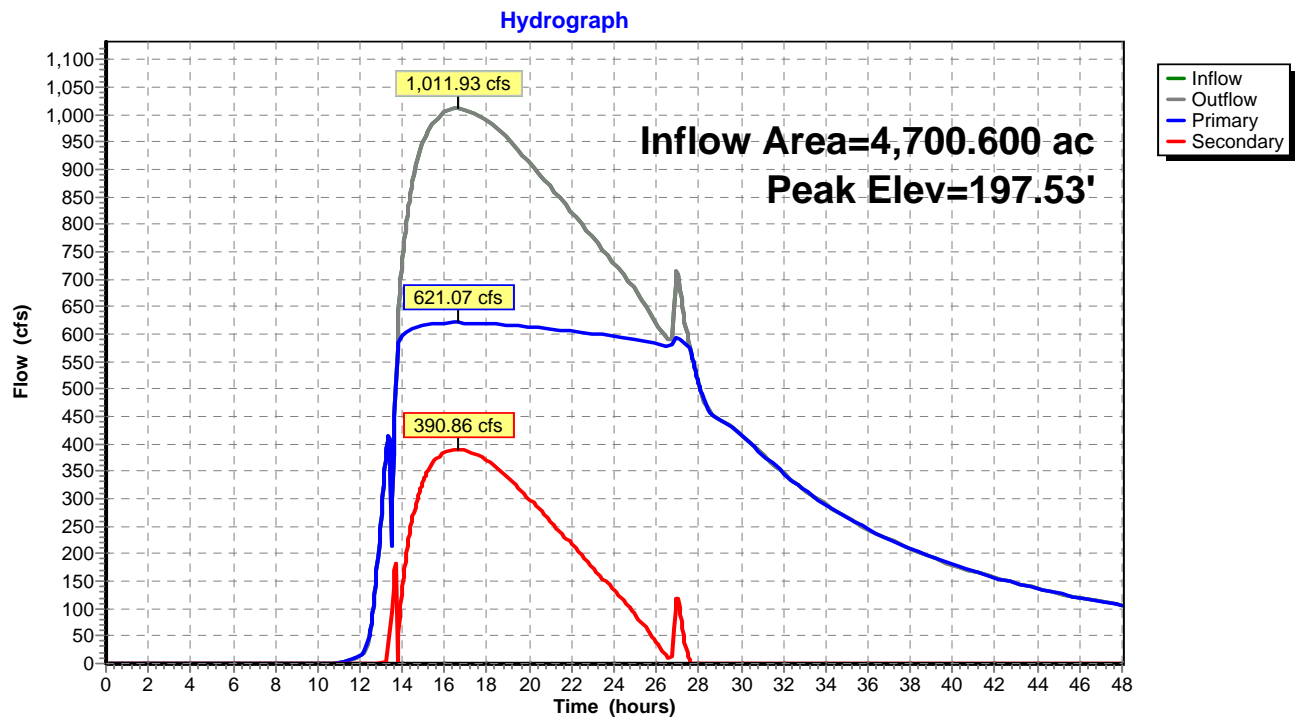
↑ **2=Culvert** (Passes 621.07 cfs of 794.54 cfs potential flow)

↑ **1=Route 140 Culvert Opening** (Orifice Controls 621.07 cfs @ 9.70 fps)

Secondary OutFlow Max=390.86 cfs @ 16.61 hrs HW=197.53' (Free Discharge)

↑ **3=Sharp-Crested Rectangular Weir** (Weir Controls 390.86 cfs @ 3.27 fps)

Pond 1P: Existing Route 140 Culvert Opening



Summary for Pond ED: Eagle Dam - Proposed Spillway = 191.5

Inflow Area = 4,700.600 ac, 0.13% Impervious, Inflow Depth > 3.59" for CURRENT 100yr event
 Inflow = 1,016.03 cfs @ 16.09 hrs, Volume= 1,405.809 af
 Outflow = 1,011.93 cfs @ 16.61 hrs, Volume= 1,401.017 af, Atten= 0%, Lag= 31.3 min
 Primary = 1,011.93 cfs @ 16.61 hrs, Volume= 1,401.017 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 199.86' @ 16.61 hrs Surf.Area= 8.656 ac Storage= 47.963 af

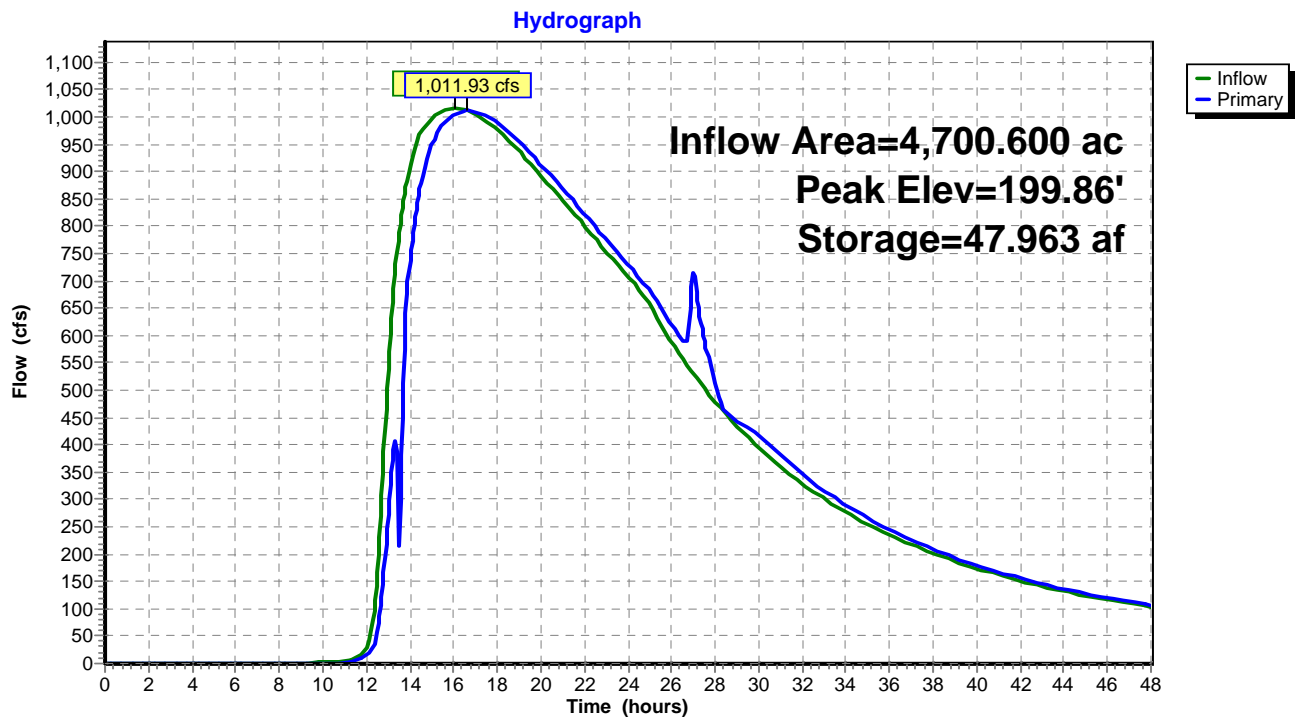
Plug-Flow detention time= 33.9 min calculated for 1,399.560 af (100% of inflow)
 Center-of-Mass det. time= 29.1 min (1,464.7 - 1,435.6)

Volume	Invert	Avail.Storage	Storage Description	
#1	191.00'	139.053 af	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
191.00	0.468	0.000	0.000	0.468
192.00	2.457	1.332	1.332	2.457
193.00	3.764	3.087	4.420	3.764
194.00	4.528	4.140	8.560	4.529
195.00	5.393	4.954	13.514	5.395
196.00	6.025	5.706	19.220	6.028
199.23	8.500	23.344	42.564	8.508
201.23	9.000	17.498	60.061	9.018
203.23	10.000	18.991	79.053	10.023
209.23	10.000	60.000	139.053	10.345

Device	Routing	Invert	Outlet Devices
#1	Primary	191.50'	16.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=1,011.93 cfs @ 16.61 hrs HW=199.86' TW=197.53' (Dynamic Tailwater)
 ↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 1,011.93 cfs @ 7.57 fps)

Pond ED: Eagle Dam - Proposed Spillway = 191.5



Summary for Pond RD: Red Dam

Inflow Area = 4,690.600 ac, 0.00% Impervious, Inflow Depth = 4.11" for CURRENT 100yr event
 Inflow = 9,761.26 cfs @ 12.71 hrs, Volume= 1,605.988 af
 Outflow = 1,013.13 cfs @ 16.12 hrs, Volume= 1,400.122 af, Atten= 90%, Lag= 204.8 min
 Primary = 1,013.13 cfs @ 16.12 hrs, Volume= 1,400.122 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 201.78' @ 16.25 hrs Surf.Area= 0.000 ac Storage= 994.155 af

Plug-Flow detention time= 614.9 min calculated for 1,398.665 af (87% of inflow)
 Center-of-Mass det. time= 557.2 min (1,438.0 - 880.8)

Volume	Invert	Avail.Storage	Storage Description
#1	198.73'	1,044.017 af	Custom Stage Data Listed below

Elevation (feet)	Cum.Store (acre-feet)
198.73	0.000
199.23	157.096
200.23	483.557
201.23	811.513
201.93	1,044.017

Device	Routing	Invert	Outlet Devices
#1	Primary	198.73'	60.0' long Sharp-Crested Vee/Trap Weir Cv= 2.62 (C= 3.28)

Primary OutFlow Max=1,013.12 cfs @ 16.12 hrs HW=201.78' TW=199.84' (Dynamic Tailwater)
 ↑ **1=Sharp-Crested Vee/Trap Weir** (Weir Controls 1,013.12 cfs @ 5.54 fps)

Pond RD: Red Dam

Hydrograph

