# -- *Waite Pond Dam* --
# PHASE II
# INVESTIGATIONS REPORT

| | |
|---|---|
| Dam Name: | Waite Pond Dam |
| State Dam ID#: | 3-14-151-21 |
| NID#: | MA00987 |
| Owner: | Town of Leicester |
| Owner Type: | Municipal |
| Town: | Leicester |
| Consultant: | Fuss & O'Neill, Inc. |
| Date of Completion: | August 4, 2014 |

FUSS & O'NEILL

# Table of Contents

## Waite Pond Dam Phase II Investigations Report
## Town of Leicester

# Table of Contents

## Waite Pond Dam Phase II Investigations Report
## Town of Leicester



### Figures



### Appendices

# 1 Description of Project

## 1.1 Introduction

Fuss & O'Neill, Inc. has been retained by the Town of Leicester to perform a Phase II Inspection and Investigation of the dam at Waite Pond in Leicester, Massachusetts in accordance With a Dam Safety Order issued by the Massachusetts Department of Conservation and recreation Office of Dam Safety (ODS) dated February 22, 2008. In0 addition to performance of the Phase II Dam Inspection and Investigation, the order required the Town to perform Follow up inspections to be completed at 6-month intervals until adequate repairs are made to the dam.

Typically, the Phase II Investigation presents alternatives for disposition of the dam. These alternatives can include various types of repair, replacement, removal, and partial removal, among others. However, in the case of Waite Pond Dam, the pond is used by residences for recreational purposes. Therefore, it was decided by the Town to proceed with the understanding that the dam would be repaired, maintaining the current pond level and spillway geometry.

## 1.2 Purpose of this Report

The purpose of this investigation is to assess the current condition of the dam, the options available for its repair or removal, a preliminary/conceptual design of proposed repairs, an opinion of the costs for those repairs, the approach to bringing it into compliance, and the permitting that is likely to be necessary. The findings will be used by the Town of Leicester to meet the conditions for submission of a Phase II Inspection and Investigation report set forth by the Office of Dam Safety in the previously mentioned dam safety order.

## 1.3 Dam Data

| | |
|---|---|
| Dam Name: | Waite Pond Dam |
| AKA Name: | Not applicable |
| Nat. ID Number: | MA00987 |
| State ID Number: | 3-14-151-21 |
| Town | Leicester |
| Dam Owner/Caretaker: | Town of Leicester<br>3 Washburn Square, Leicester, MA 01524<br>Contact: Kevin Mizikar |
| Hazard Potential: | Significant |
| Size Classification: | Intermediate |
| Location of Dam (town): | Leicester |
| Coordinate location (lat, long): | 42.24900, -71.88708 |
| Street Address/Nearest Intersection: | Sacks Drive & Chapel Street |
| Purpose of the Dam: | Current: Recreation and Conservation<br>Historical: Early industrial hydropower |
| Constructed: | Unknown |

| | |
|---|---|
| Length: | 134 feet |
| Structural Height: | 11 feet |
| Hydraulic Height: | 8 feet |
| Type of Dam: | Earth embankment supported by stone masonry & concrete walls |
| Low-Level Outlet: | Hand-operated 24 inch diameter outlet |

## 1.4 Description of Dam

Waite Pond Dam consists of an earth core supported by upstream and downstream masonry and concrete walls. The structural height is 11 feet, and the hydraulic height at normal pool is 8 feet. The spillway is located in the approximate center of the dam. The right embankment has an average elevation of 823.5 feet (NAVD 88); the left embankment is slightly lower, with an average elevation of 823.0 feet.

The spillway is a 42-foot wide earth/stone lined broad crested weir supported by a concrete capped stone masonry retaining wall at the downstream face of the dam. The left and right training walls are constructed of concrete. Timber weir boards, supported by steel dowels anchored into the concrete cap, are installed to a height of 2± feet above the spillway crest. The elevation of the spillway crest is 819.24 feet, which provides a maximum flow depth of 3.8 feet measured from the left abutment. With the weir boards installed, the maximum flow depth is reduced to 1.9 feet. A grouted stone splash pad/stilling basin is located downstream of the spillway.

There is a 24-inch diameter CMP low-level outlet with a slide gate located in a circular, roofless masonry structure that is located in the upstream end of the spillway channel. The outlet pipe discharges approximately 10 feet downstream of the spillway, at the base of the stilling basin.

The upstream face of the dam is supported by concrete retaining walls. The downstream right face of the dam consists of a vertical dry-laid masonry wall. The downstream left embankment consists of a relatively flat earthen area used for parking, supported along the stream by a vertical masonry wall that has partially collapsed. The left dam crest is isolated from the parking area by a timber post and rail fence. An existing conditions plan is provided as *Figure 4*.

## 1.5 Summary of Deficiencies

Recent visual inspections of Waite Pond Dam include a Phase I inspection performed by Fuss & O'Neill on August 8, 2012, a follow-up inspection performed by Fuss & O'Neill on January 23, 2013, and a follow-up inspection performed by Fuss & O'Neill on July 31, 2014. A copy of the most recent inspection report is provided in *Appendix A*. Previous inspections were performed in 1986, 1998, 2009, 2010, and 2011.

During the Phase I inspection and the follow-up inspections, the dam was found to be in P**oor** condition. The primary deficiencies identified during these inspections include:

- **Upstream Face:** Severe erosion, cracking, and undermining of both of the concrete retaining walls were observed. The left retaining wall is leaning towards the impoundment.
- **Embankment Crest:** The crest of the dam consists of vegetated earth. Depressions were observed on the right and left crests. Dense small woody vegetation and tree root encroachment were also observed on the left crest.
- **Downstream Face:** The right downstream face consists of vertical dry-laid stone masonry wall. The wall appears to be slightly leaning out of plumb and some stones are missing. The left downstream area consists of a gravel parking area supported by a vertical masonry wall parallel to the brook channel; a portion of this wall has collapsed.
- **Primary Spillway:** The concrete training walls on both sides of the spillway are cracked and eroded. The stilling basin consists of stone rubble covered with concrete that spills overflow to the channel below. The concrete is breaking into fragments.
- **Low Level Outlet:** The 24-inch CMP low level outlet is rusted and appears to be approximately ½ full of sediment; however, water was observed to be discharging from the pipe during the July 31, 2014 inspection. It is not known if this is due to leakage past the gate, or the gate having been recently opened. Sediment was not observed in the water discharging from the outlet pipe. The position/height of the gate operator stem observed during the inspection appeared to have changed relative to the previous inspection (based on photographs). It was also noted that a series of stones had been placed in the spillway channel between the left training wall and the door in the gate house, presumably for access to the gate operator.
- **Gate House:** The gate operator is located in a circular structure in the upstream end of the spillway channel. The structure has no roof, the walls are leaning out of plumb, and the concrete foundation is severely deteriorated. There is currently no access to the structure except by wading or boat.
- **Vegetation:** Large trees are present within 20 feet of the downstream toe of the right embankment at both abutments.

# 2 Site Resources Areas

Resource areas were delineated in the field on September 17, 2013. A copy of the *Site Investigation & Inland Resource Area Delineation Report* is provided in *Appendix E*. The delineated wetland boundaries are shown on the existing conditions survey plan (*Figure 4*). Regulated resource areas associated with this location include the following:

- Bank
- Land Under Water Bodies & Waterways
- Riverfront Area
- Buffer Zone
- Bordering Vegetated Wetland

# 3 Hydrologic & Hydraulic Assessments

## 3.1 Drainage Basin Description

Waite Pond is fed primarily by Kettle Brook and an unnamed stream from the west. The drainage area is approximately 4.92 square miles and extends into the Town of Paxton. The majority of land use consists of undeveloped wooded areas, but includes pastures and residential developments throughout the basin. The drainage area, shown in *Figure 3*, was delineated using USGS topographic mapping. It is long and narrow, with a total length of 6.1 miles and an average width of 0.95 miles.

The surface area of Waite Pond is approximately 53.9 acres at the normal water surface elevation. The dominant hydrologic feature of the drainage basin is flood storage provided Waite Pond and upstream impoundments, which include Kettle Brook Reservoir No. 1, No. 2, No. 3, and No. 4.

## 3.2 Model Description

A hydrologic and hydraulic model was prepared using the HydroCAD software to assess the peak flood discharges and spillway capacity at Waite Pond Dam. HydroCAD incorporates the TR-55 rainfall/runoff routing method, which was used for this project. Flood attenuation in Waite Pond and Kettle Brook Reservoir No. 1, No. 2, No. 3, and No. 4 was modeled in the analyses using level-pool routing. The 4.9 square mile drainage basin was divided into ten sub-basins. Two sub-basins were assigned to each impoundment; one for direct precipitation onto the water surface of the impoundments and the one for overland runoff.

The hydrologic properties of the drainage basin were determined from available topographic, land use, soils, and hydrography data. A composite curve number for each of five sub-basins representing overland runoff to the impoundments were determined from land use and hydrologic soils group and range from 64 to 70. A curve number of 98 was assigned to represent inflow volume to the impoundments via direct precipitation.

Storm hyetographs were based on the Soil Conservation Service Type III storm events, with storm depths determined from TP-40. The model elements and hydraulic and hydrologic parameters used in the HydroCad (TR-20) model are provided in *Appendix B*.

## 3.3 Spillway Design Flood Capacity Assessment

The significant hazard class and intermediate size of Waite Pond Dam dictate that the spillway must safely pass the 100-year storm (the Spillway Design Flood, or SDF) per 302 CMR 10.00. Adequate freeboard is generally preferred between the peak water surface elevation and the top of the dam such that waves do not cause overtopping. For a relatively small impoundment such as Waite Pond, adequate freeboard is generally considered to be one foot.

From the National Weather Bureau Technical Paper 40 (TP-40) (Hershfield 1961), the 100-year storm consists of 6.5 inches of precipitation in 24 hours. This rainfall was routed through the pond

as described in *Section 3.2* to assess the spillway capacity. Separate analyses were performed for the existing dam with the weir boards removed and with them installed.

The results of the analysis indicate that with the weir boards removed the spillway has adequate capacity to safely convey the SDF. The maximum water surface elevation for the 100-year flood is shown to be 822.0 feet, which is 1.0 foot below the left embankment crest and 1.5 feet below the right embankment crest. With the weir boards installed, however, the results of the analysis indicate a maximum WSE of 823.1 feet, which will overtop the left embankment by 0.1± feet. This is a minor depth of overtopping, and small variations in the design of the structure could be effective in allowing the dam to safely pass the SDF.

By raising the crest of the left embankment 0.5 feet to EL 823.5 feet (equal to the right embankment crest), 0.4 feet of freeboard will be provided with the weir boards installed and 1.5 feet of freeboard will be provided with them removed. It is assumed that the weir boards will be removed prior to the start of runoff when heavy precipitation is predicted; therefore, 1.5 feet of freeboard is the design capacity and 0.4 feet is for conservatism in the worst case scenario. This is discussed in greater detail under the assessment of alternatives in *Section 5.0*.

## 3.4 Hazard Class Assessment

Chapel Street, a secondary road, runs parallel to the southeastern shore of Waite Pond and forms the left abutment of the dam. Kettle Brook is conveyed beneath Chapel, via a box culvert, approximately 150 feet downstream of the dam and continues flowing in the southeast direction for another 1,500 feet until it passes under a second bridge crossing on Chapel Street and enters City Pond. It appears that a failure of the dam at maximum pool may cause damage to the downstream bridge/culvert crossings. A failure of the dam could also result in damage to Chapel Street at the left abutment of the structure.

Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Waite Pond Dam is classified as a **Significant** hazard potential dam.

# 4 Geotechnical Assessment

## 4.1 General

No seepage has been observed at Waite Pond Dam, but visual inspection reveals the vertical masonry and concrete walls have moved and are therefore not stable, indicating remedial measures are necessary. A soil boring program was implemented to provide the necessary data for design of repairs to the dam.

## 4.2 Subsurface Explorations

Fuss & O'Neill retained the services of Martin Geo-Environmental drilling contractors of Belchertown, Massachusetts to drill test borings at the site. The borings were drilled on January 13, 2014 using a truck mounted drill rig, using standard hollow stem auger techniques. Two borings were drilled; borehole B-2 on the left dam crest and B-1 in front of the crest by the side of the adjacent road. A bedrock core was performed in boring B-1 to confirm the depth to bedrock and to assess the quality of the rock. The rock core was advanced 5 feet into bedrock. Refer to *Appendix A* for a boring location plan.

The borings were advanced using hollow stem augers. Soil samples were obtained at 5-foot intervals using a standard split spoon sampler driven 24 inches with a 140-pound weight falling 30 inches. The number of blows required to drive the sampler from 6 to 18 inches was recorded as the Standard Penetration Resistance (N-value), which is a standard test used to estimate the in situ soil density. Samples obtained from each soil boring were logged by a Fuss &O'Neill engineer. Refer to the *Appendix B* for the boring logs.

The bedrock cores advanced in boring B-1 used an NQ core barrel with water-cooled diamond bit. The resulting core (2.16-inch diameter) was measured to determine the Rock Quality Designation (RQD), a measure of the relative amount of fracturing and general quality of the rock. The locations are indicated on *Figure 4*, labeled borings B-1 and B-2.

## 4.3 Subsurface Conditions

Subsurface conditions in the dam crest generally consist of 5 feet of dense gravelly sand overlying a 7-foot thick layer of medium dense to dense natural sand. Auger refusal was encountered at a depth of 12 feet in boring B-1 and rock fragments and split spoon refusal were encountered at a depth of 12 feet in boring B-2. Augering continued in the rock for an additional foot in boring B-2 before the augers encountered refusal. Rock coring was performed in boring B-1 and a rock sample was collected between 12 feet and 17 feet deep. The rock consisted of granite with a recovery of 100 percent and a measured RQD of 83 percent, which indicates the rock is of high quality with little fracturing. Groundwater was encountered at a depth of 9 feet below the ground surface in boring B-1 and 6 feet below ground surface in boring B-2.

## 4.4 Stability Analysis

Visual observation indicates the dam embankment walls are failing likely do to a combination of soil pressures and frost heave. We were unable to determine the depth of the wall footings, if any exist, so a conventional sliding/overturning wall analysis was not possible. However, the stability is obviously compromised and needs to be corrected. We performed embankment stability analysis for the apparent most critical section of wall, which is the downstream right embankment wall immediately adjacent to the spillway. Embankment stability analysis was performed using Galena Version 4.0 software and Spencer's methodology with circular failure surfaces. The resulting slope stability analysis indicated the existing factor of safety against failure is just above 1.0, assuming the existing masonry wall does not extend vertically very deeply into the downstream embankment. The new spillway will need to incorporate downstream training walls to allow fill to be placed against the downstream face of the dam to increase stability. When preliminary design is performed, both retaining wall and dam stability analyses will be included to assure the proposed design is stable.

The subgrade soil is suitably coarse and dense to support a new or reconstructed dam and spillway without any special soil improvement considerations.

## 4.5 Seepage Analysis

Since the dam embankment and walls will be reconstructed, no seepage analysis was performed of the existing conditions. As mentioned above, boring data was obtained for use in design of future embankment slopes and/or walls. Seepage analysis will be performed for proposed conditions when preliminary repair design is performed.

## 4.6 Conclusions

Stability of the dam is inadequate in its present condition. Even though the dam has not suffered catastrophic failure, it does not meet dam safety requirements for stability. The repair construction will require removal of most of the dam embankment to correct the deficiencies identified visually. Therefore, the dam will be effectively rebuilt and the issue of the current instability is not a factor.

# 5 Evaluation of Repair Alternatives

Alternatives were evaluated for the repair of Waite Pond Dam to address the existing structural deficiencies, ensure that the dam can safely pass the SDF, and otherwise bring the dam into compliance with Office of Dam Safety design regulations and dam safety design practice. We determined that repairs can be made the dam to meet these requirements while maintaining the existing configuration of the structure, with minimal modification.

The recommended repairs, associated permitting requirements, and estimated costs are discussed in *Section 5.1* and *Section 8.0*. The opinion of cost is of order of magnitude accuracy based on the information available for the writing of this report. Order of Magnitude accuracy cost estimates are generally accurate within a range of -30% to +50%.

Dam removal is often also considered as an option, as its advantages and disadvantages are important to consider. This is not deemed a viable alternative, however, because the impoundment is actively used for recreation and is surrounded by privately owned residential properties.

## 5.1 Required Repairs

The flowing deficiencies need to be addressed in the repair design:

- Depressions observed on the right and left embankment crests.
- The stone masonry wall on the downstream face of the right abutment leaning out of plumb and missing stones.
- The upstream concrete retaining walls are severely deteriorated; the left retaining wall is leaning toward the impoundment.
- The stone masonry retaining wall along the left bank of the downstream channel has collapsed. This wall partially supports the downstream face of the left embankment and the left spillway training wall. Additional deterioration could destabilize those portions of the dam.
- The training walls at the spillway are severely deteriorated. Portions of the grouted stone splash pad/stilling basin are breaking into fragments.
- The gatehouse and the discharge conduit on the low-level outlet are deteriorated. The 24-inch CMP is rusted and appears to be approximately ½ full of sediment. The gatehouse has no roof, the walls are leaning out of plumb, and the concrete foundation is severely deteriorated.
- Trees and woody vegetation are present within 20 feet of the downstream toe of the right embankment at both abutments.

To correct these deficiencies, Fuss & O'Neill recommends the following repairs:

- Replace the existing stone masonry retaining wall at the downstream face of the right embankment with a concrete gravity wall. A concrete buttress is proposed for added stability of the retaining wall. As shown in *Figure 5*, the buttress would be located adjacent to

the spillway and integral with the energy dissipation basin (discussed below). The use of a sloped earth embankment instead of a retaining wall was also considered as a means of reducing construction cost. That approach, however, would require a retaining wall to be constructed along the right bank of the downstream channel.

- Earth slopes, graded into the impoundment, are recommended at the upstream face of the left and right embankments. This approach will be less expensive than reconstruction of the existing concrete retaining walls.
- Replace the existing stone masonry wall at the downstream face of the spillway and the left and right concrete training walls with concrete gravity walls. The training walls extend into the impoundment to accommodate the proposed earth slopes at the upstream face. The elevation of the spillway crest, as proposed, matches the existing condition. Structural supports for weir boards can be cast into and/or attached to the retaining wall at the downstream face of the spillway.
- A plunge pool type energy dissipation basin is proposed downstream of the spillway. This will serve to dissipate the energy from flow over the spillway crest and from the low-level outlet.
- Remove the existing gatehouse and low-level CMP outlet pipe. A new low-level outlet is proposed to be installed through the left embankment and will discharge into the proposed energy dissipation basin. A valve chamber, consisting of a 6-foot diameter manhole, is proposed to be located in the embankment.
- Raise left embankment crest to EL 823.5 feet. Level the right embankment crest and remove vegetation.
- Remove trees greater than 6 inches in diameter within 20 feet of the dam.

The attached plan of the dam (*Figure 5*) and immediate surrounding area indicates the locations of the repairs.

# 6 Construction Methods

This section presents general guidelines for materials and methods of major components of the project that may occur under the proposed repairs described in this report.

## 6.1 Reconstruction of Downstream Stone Masonry Wall

The downstream masonry wall would be reconstructed by a mason, who would most likely disassemble the wall, regrade and recompact the foundation, cut away a small portion of the dam embankment behind it, and rebuild it completely. The space between the replaced stones and the embankment soils would be filled with freely draining sand to ensure that and groundwater pressure is relieved. The reconstructed wall would remain unmortared to allow for free drainage.

A graded filter drain would be necessary to prevent the sand and embankment materials from migrating through the wall. These drains consist of layers of uniformly-graded soils that gradually increase in grain size to prevent embankment soils from being carried by groundwater through voids

between stones in the larger adjacent layer. Alternatively, a properly-selected filter fabric could be used for this purpose.

## 6.2 Embankment Buttressing

Rather than being reconstructed, the downstream stone masonry wall could be buttressed with dumped stone to resist the forces of frost heaving, water, and erosion that may have caused the existing damage to the wall, and prevent the wall from toppling under applied loading conditions. It is important to note, however, that this approach would require a retaining wall to be constructed along the right bank of downstream channel. Without the retaining wall, the volume of buttress stone that could be placed would be limited by the angle of repose of the material.

The area would be filled with a well-graded fill material that includes larger gravel and cobble-sized particles, such as a crusher-run stone, to a level approximately 1 foot below finished grade. Riprap slope protection with an average stone diameter of four to five inches, with little fine material, would be installed on top. The riprap slope protection will provide adequate resistance to erosion without grass cover. Additionally, if undesired vegetation growth begins, it could be easily hand pulled or cut with a string trimmer.

## 6.3 Cast-in-Place Concrete

Cast-in-place concrete walls are proposed to be used for the retaining walls at the downstream face of the dam and along the left bank of the downstream channel, the right and left spillway training walls, the bottom slab and walls of the energy dissipation basin, and the buttress at the downstream face. Construction requires demolition of the existing walls, excavation of the material supported by them, and preparation of a base for the footings. The cast-in-place concrete would be formed in place to the required dimensions and poured on site.

## 6.4 Low Level Outlet Pipe

The low-level outlet pipe is proposed to be ductile iron and lined with cement to resist internal corrosion. The pipe would connect to the valve thimble at the proposed outlet structure, and then be installed in sections into the impoundment to the desired length. In the impoundment sediment would be excavated to the desired installation depth, and then replaced after the pipe is positioned.

A trash rack would be constructed for the end using a flange attached to the end of the pipe with threaded rod bolted to it and projecting out beyond the pipe's end. A blank flange would be bolted to the threaded rod on the opposite end.

High density polyethylene (HDPE) pipe could also be used for this application. The Federal Emergency Management Agency (FEMA) provides guidance for the use of plastic pipe in dams in

the following document: *Technical Manual: Plastic Pipe Used in Embankment Dams*, dated November 2007.

## 6.5 Tree Removal

Removing trees from a dam embankment must be undertaken carefully to ensure proper strength following completion, and would ideally be performed with the impoundment drawn down since excavating the embankment reduces its factor of safety against instability. Trees should be removed by cutting, followed by grinding of the stumps and removal by excavation of any roots greater in diameter than ½ inch. Any unsuitable material should then be removed from the resulting void, including organic soil, and replaced with suitable, impervious fill that is compacted in place.

# 7 Anticipated Permits Required for Construction

The permits presented in this section are anticipated to be necessary for implementation of the repairs discussed above.

## 7.1 Local Permits

### 7.1.1 Leicester Conservation Commission

An Order of Conditions will be necessary from the Town of Leicester Conservation Commission.

## 7.2 State Permits

### 7.2.1 MGL Chapter 253 - Dam Safety Permit

This permit is required for the construction, repair, material alterations, breach, or removal of a dam, and would be required for this project.

### 7.2.2 Clean Water Act Section 401 Water Quality Certification

This permit is required for projects that involve more than 100 cubic yards of dredging and management and disposal of dredged materials, for disturbance of more than 5,000 square feet of BVW or LUW, and for state review of an activity that requires a permit from the Army Corps of Engineers related to wetlands and waterways. Other thresholds exist which may require a permit application when exceeded. We do not believe this project will require a Section 401 permit since less than 100 cubic yards of material will be dredged and less than 5,000 square feet of wetlands will be disturbed.

### 7.2.3 Massachusetts Environmental Policy Act Environmental Notification Form

This review process must be undertaken for projects that involve alteration of more than 5,000 square feet of bordering or isolated vegetated wetlands. We do not anticipate that this permit will be necessary for this project.

### 7.2.4 MESA Notification

A notification of the project will need to be sent to MESA. A review of the most current mapping of the Natural Heritage Endangered Species Program (NHESP) Estimated Habitats of Rare Wildlife and Priority Habitats of Rare Species indicates no such habitats are listed in the Waite Pond area. This mapping is expected to be updated soon, but presently it appears no requirements will be necessary that would affect the permitting or construction of the dam repairs. This mapping should be checked again prior to preparing permit applications.

### 7.2.5 Mass. Historical Commission

A Section 106 notification form with appropriate attachments will need to be sent to the Massachusetts Historical Commission (MHC) describing the project.

## 7.3 Federal Permits

### 7.3.1 Clean Water Act Section 404

Compliance with this permitting program administered by the Army Corps of Engineers is required for excavation and dredging in wetlands and waterways. The category of permit will depend on quantity of disturbance. Several of the alternatives proposed as part of this project might qualify for Category 1 of coverage under the Programmatic General Permit (PGP), which is non-reporting, whereas the removal alternatives may require an individual permit. This permitting program is closely associated with the 401 Water Quality Certification program.

As part of the Clean Water Act Section 404 requirements, Native American Tribal Authorities representative of this area will be notified of the project for their review and comment.

# 8 Opinion of Total Project Costs

Fuss & O'Neill prepared an Order of Magnitude Opinion of Construction cost based on the level of effort for a Phase II Investigation, which does not involve preparing detailed permit or construction drawings and specifications. Where possible, unit costs were obtained from recent experience with similar projects, as well as use of cost estimating guides such as RS Means Heavy Construction guide. These costs will be able to be more accurately estimated when more accurate quantities and material types required for preparation of preliminary design plans and technical specifications are determined. We have also provided estimates of the costs for engineering services based upon our extensive experience with design and permitting of water resources projects in Massachusetts. The opinion of construction cost and engineering costs will total to provide the opinion of total project costs. This however does not include any costs that may be incurred for acquisition of property rights if required or the costs for other professional services such as legal fees or Town staff time.

Order of Magnitude opinions of cost are typically accurate to within -30% to +50%. The attached Opinion of Cost spreadsheet indicates a cost of $808,000, which includes engineering and permitting costs, plus a 20% contingency. Using the stated range for Order of Magnitude estimates, the expected total cost could range from as little as $565,000 to as much as $1,212,000. It should be noted that Fuss & O'Neill are not professional cost estimators, and costs can vary considerably due to conditions over which Fuss & O'Neill has no control, such as the economic climate at the time of bidding. The costs included here should only be used for planning purposes, and not for bidding purposes. The basis for this cost estimate is included in the attached Cost Estimation Spreadsheet located in *Appendix D*.

# 9 References

## 9.1 Documents and Reports


Fay, William K. (November 1986). *Dam Inspection, Safety & Repair Report.* Prepared for the Worcester Spinning & Finishing Company.

Fuss & O'Neill (June 2009). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (February 2010). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (June 2010). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (January 2011). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (July 2011). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (January 2012). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (August 2012). *Phase I Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (January 2013). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Fuss & O'Neill (July 2014). *Poor Condition Follow-up Inspection Report.* Prepared for the Town of Leicester.

Haley & Aldrich (March 2008). *Phase I Inspection Report.* Prepared for the Massachusetts Department of Environmental Management.

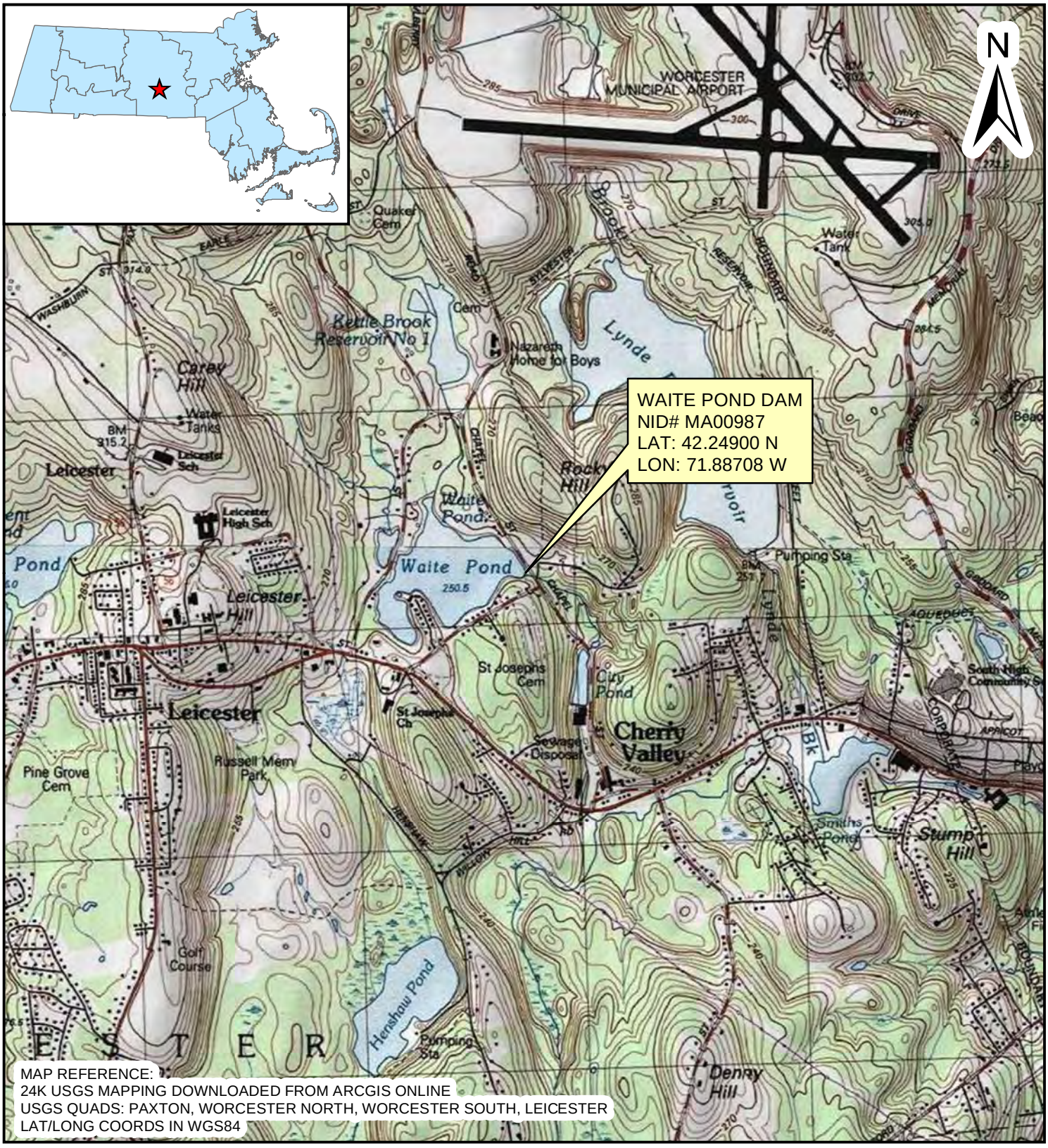
Hershfield, David M. (May 1961) *Rainfall Frequency Atlas of the United States.* National Weather Bureau Technical Paper 40. Prepared for Engineering Division, Soil Conservation Service.

NRCS (June 1986). *Urban Hydrology for Small Watersheds.* Natural Resources Conservation Service Technical Release 55.

## 9.2 Regulations

MA Department of Conservation and Recreation Dam Safety Regulations, 302 CMR 10.00.

# Figures




AUGUST 2012

**FIGURE 1**

2,000 1,000 0 2,000 Feet

TOWN OF LEICESTER

# LOCUS MAP

WAITE POND DAM (MA00987)

LEICESTER, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 2,000 FEET
VERT:
DATUM
HORZ:
VERT: NGVD29 (3-METER CONTOURS)

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AUGUST 2012

**FIGURE 2**

200 100 0 200 Feet

TOWN OF LEICESTER

# AERIAL PHOTOGRAPH

WAITE POND DAM (MA00987)

LEICESTER, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 200 FEET
VERT:
DATUM
HORZ:
VERT:

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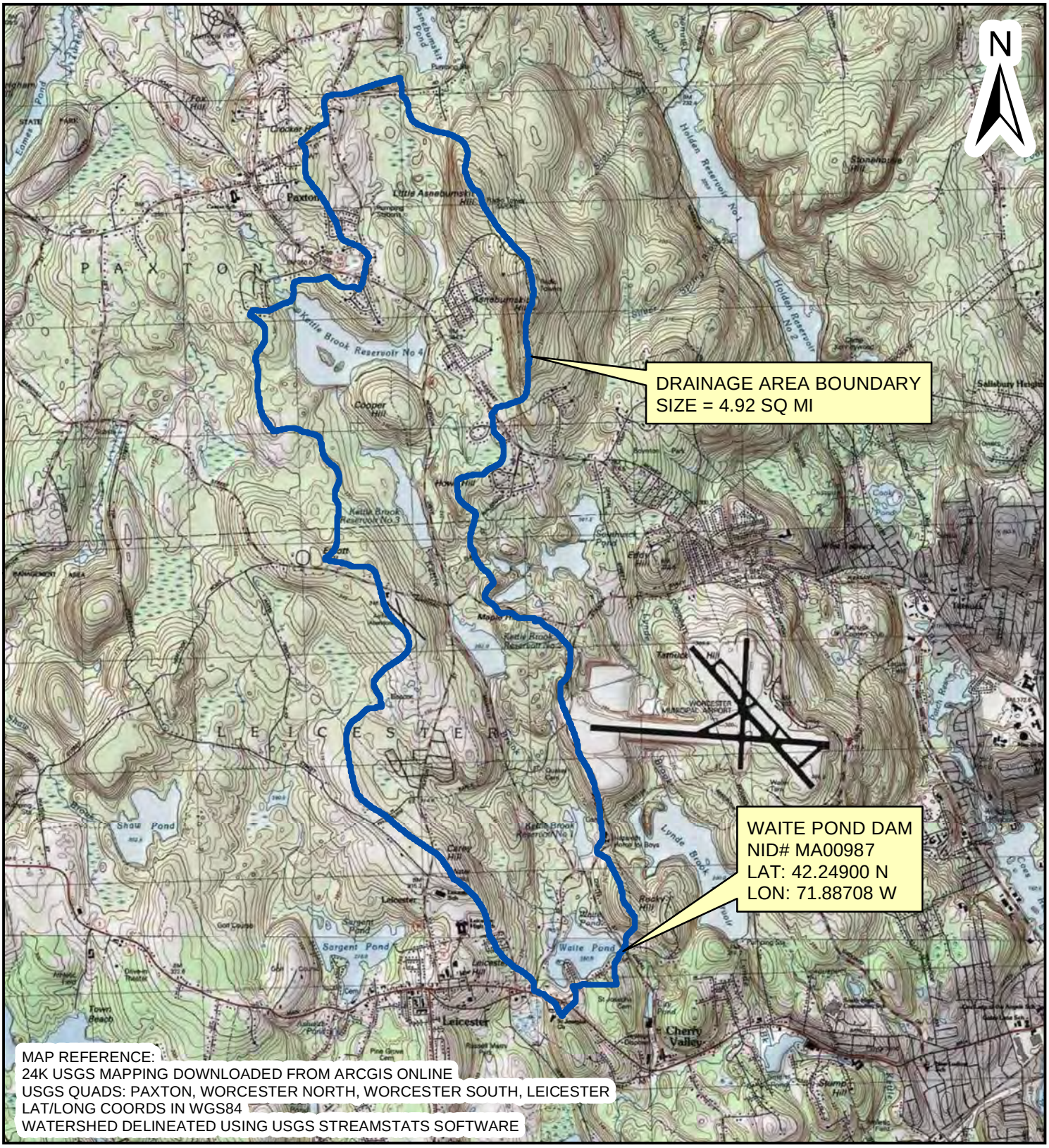



AUGUST 2012

**FIGURE 3**

4,000 2,000 0 4,000 Feet

TOWN OF LEICESTER

# DRAINAGE AREA

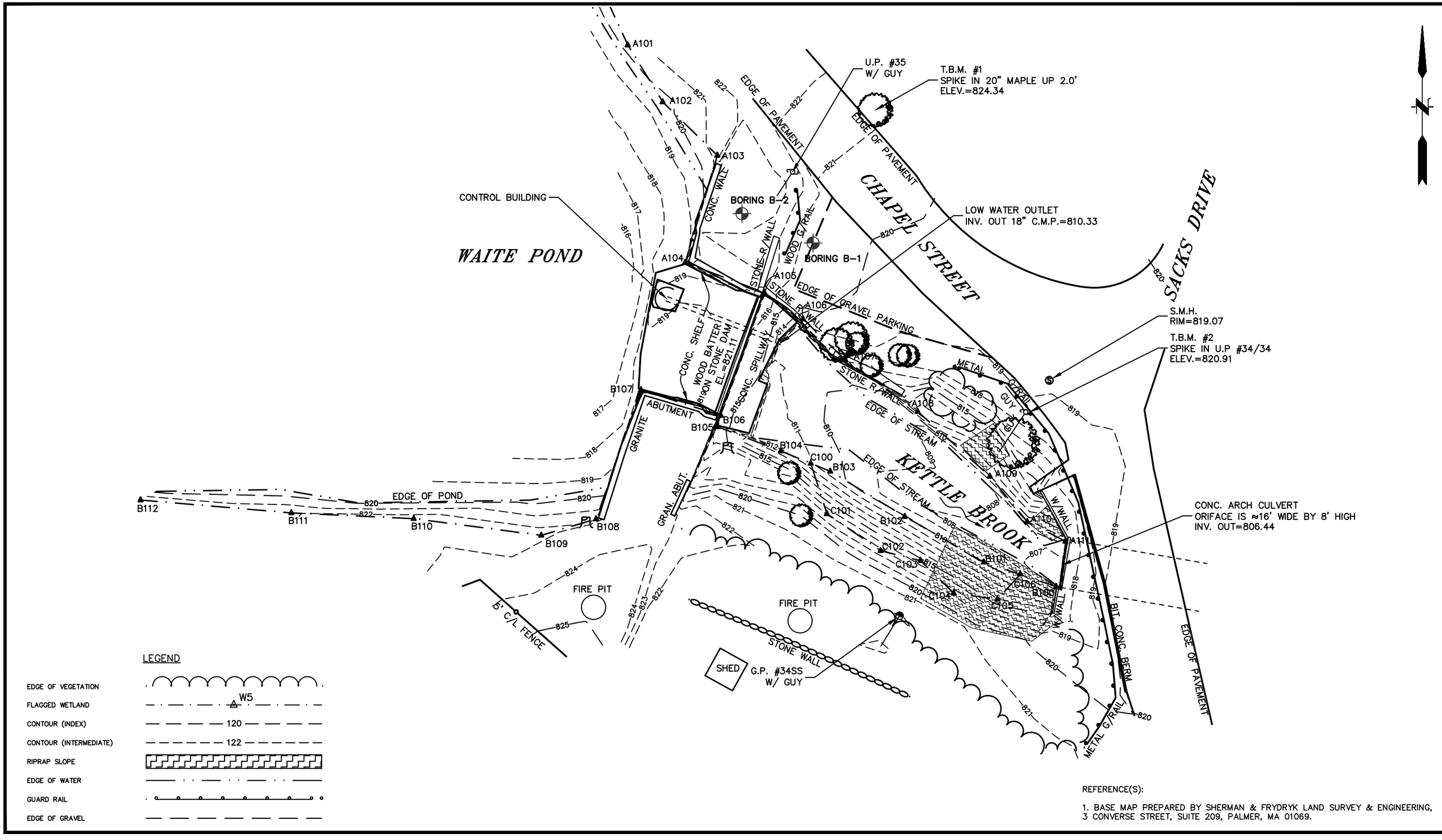
WAITE POND DAM (MA00987)

LEICESTER, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 4,000 FEET
VERT:
DATUM
HORZ:
VERT: NGVD29 (3-METER CONTOURS)

FUSS & O'NEILL

K:\GIS\P2008\1286\A50\MA00987_WaitePondDam\MXD\Fig3_DrainageArea.mxd




LEGEND

- EDGE OF VEGETATION
- FLAGGED WETLAND — W5
- CONTOUR (INDEX) — 120
- CONTOUR (INTERMEDIATE) — 122
- RIPRAP SLOPE
- EDGE OF WATER
- GUARD RAIL
- EDGE OF GRAVEL

REFERENCE(S):

1. BASE MAP PREPARED BY SHERMAN & FRYDRYK LAND SURVEY & ENGINEERING, 3 CONVERSE STREET, SUITE 209, PALMER, MA 01069.

| No. | DATE | DESCRIPTION | DESIGNER | REVIEWER |
|---|---|---|---|---|

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.:
VERT.: NAVD 1988
0 15 30
GRAPHIC SCALE

FUSS & O'NEILL
146 HARTFORD ROAD
MANCHESTER, CONNECTICUT 06040
860.646.2469
www.fando.com

TOWN OF LEICESTER

EXISTING CONDITIONS PLAN

WAITE POND DAM

LEICESTER MASSACHUSETTS

PROJ. No.: 20081286.A60
DATE: SEPTEMBER 2014

FIG 4

File Path: J:\DWG\P2008\1286\A60\Civil\Plan\081286A60_STP01.dwg Layout: EXISTING Plotted: Wed, January 21, 2015 - 1:58 PM User: kmikolinski
MS VIEW: LAYER STATE: EXISTING Plotter: DWG TO PDF.PC3 CTB File: FO MONO.STB

RAISE EMBANKMENT
CREST TO 823.5'

GRADE UPSTREAM EMBANKMENT
SLOPE AT 2H:1V (TYP OF 2)

INSTALL VALVE CHAMBER
(6' DIA. MANHOLE)

INSTALL 24" D.I. OUTLET PIPE
DOWNSTREAM INV = 810.3
SLOPE = 0.02 FT/FT

CONTROL BUILDING

LOCATION OF PIPE INLET TO BE DETERMINED
BASED ON POND BATHYMETRY

TRASH RACK
(NOT SHOWN)

WAITE POND

REMOVE EXISTING SPILLWAY
TRAINING WALLS (TYP OF 2)

REMOVE GATE HOUSE. BACKFILL EXISTING
LOW LEVEL OUTLET PIPE WITH
GROUT & ABANDON IN-PLACE

BACKFILL BEHIND SPILLWAY WALL.
MATCH EXISTING GRADES.

CONSTRUCT CONCRETE GRAVITY TRAINING
WALLS - CREST EL VARIES (TYP OF 2)

LEVEL EMBANKMENT
CREST AT 823.5'

823.5'

820.5'

ENERGY DISSIPATION BASIN

817.65'

CONSTRUCT CONCRETE GRAVITY
RETAINING WALL - CREST EL VARIES

814.3'

815.5'

LOW-FLOW NOTCH
INV = 810.3'

823.5'

814.3'

CONSTRUCT CONCRETE GRAVITY
SPILLWAY WALL - CREST = 819.24'

CONSTRUCT BUTTRESS WALL

CONSTRUCT CONCRETE GRAVITY
RETAINING WALL - CREST = 823.5'

LOW WATER OUTLET
INV. OUT 18" C.M.P.=810.33

CHAPEL STREET

KETTLE BROOK

EDGE OF PAVEMENT

CONC. WALL

WOOD GUARD RAIL

STONE R/WALL

ABUTMENT

GRANITE

STUMP

18" ASH

30" OAK

10" MAP. (STUMP)

METAL GUARD RAIL

GUY WIRE

W/WALL

LEGEND

- EDGE OF VEGETATION
- FLAGGED WETLAND (W5)
- CONTOUR (INDEX) (120)
- CONTOUR (INTERMEDIATE) (122)
- RIPRAP SLOPE
- EDGE OF WATER
- GUARD RAIL
- EDGE OF GRAVEL

REFERENCE(S):

1. BASE MAP PREPARED BY SHERMAN & FRYDRYK LAND SURVEY & ENGINEERING, 3 CONVERSE STREET, SUITE 209, PALMER, MA 01069.

| No. | DATE | DESCRIPTION | DESIGNER | REVIEWER |
|---|---|---|---|---|

SCALE:
HORZ.: 1" = 20'
VERT.:
DATUM:
HORZ.:
VERT.: NAVD 1988
0 10 20
GRAPHIC SCALE

FUSS & O'NEILL
146 HARTFORD ROAD
MANCHESTER, CONNECTICUT 06040
860.646.2469
www.fando.com

TOWN OF LEICESTER

CONCEPTUAL DAM REPAIRS

WAITE POND DAM

LEICESTER MASSACHUSETTS

PROJ. No.: 20081286.A60
DATE: SEPTEMBER 2014

FIG 5

File Path: J:\DWG\P\20081286\A60\Civil\Plan\081286A60_STP01.dwg Layout: PROPOSED Plotted: Fri, January 23, 2015 - 11:37 AM User: ksullenger
Plotter: DWG TO PDF.PC3 CTB File: FO MONO.STB
LAYER STATE: PROPOSED
MS VIEW:

# Appendix A

## Visual Inspection Update

FUSS & O'NEILL

January 22, 2015

Commonwealth of Massachusetts
Department of Conservation and Recreation
Office of Dam Safety-Inspections Unit
180 Beaman Street
West Boylston, MA 01583

RE: Follow-up Inspection
Waite Pond Dam MA00987
Leicester, MA

To: Office of Dam Safety:

Fuss & O'Neill, Inc. has completed the Follow-up Inspection for Waite Pond Dam as required by the Dam Safety Regulations and the Dam Safety Order. The inspection was performed on August 4, 2014. Our Follow-up assessment of the dam indicates the overall condition of the dam to be in Poor Condition.

The Follow-up Inspection Form describing the current condition and deficiencies of the dam is attached. Please contact us, if you have any questions regarding this report.

Sincerely,

Christopher J. Cullen, P.E.
Project Manager

Attachment: Follow-up Inspection Form
Site Sketch
Photographs
Locus Map

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800.286.2469
f 413.846.0497

www.fando.com

Connecticut
Massachusetts
Rhode Island
South Carolina

# Commonwealth of Massachusetts
# Department of Conservation and Recreation
# Office of Dam Safety Poor Condition Dam
# Follow-up Inspection Form

**Dam Name: Waite Pond Dam**
**Dam Owner: Town of Leicester**
**Nat. ID Number: MA00987**
**Hazard Potential: Significant**
**Location of Dam (town): Leicester**
**Coordinate location lat, long): 42d 14.9' N, 71d 53.3W**
**Date of Inspection: August 4, 2014**
**Weather: Clear, sunny, 75 degrees F**

## I. Previous Inspection date/Overall Condition:

- The dam was previously found to be in Poor Condition at the time of the previous Phase I Inspection performed on January 16, 2013.

## II. Previous Inspection Deficiencies

- The deficiencies identified in that report included the following:

a. Deteriorating and undermined concrete training walls and embankment walls.
b. Upstream left embankment wall leaning toward impoundment.
c. Downstream right masonry embankment wall overhanging out of plumb and missing stones.
d. Downstream left masonry channel wall collapsing
e. Tree root penetration into embankment.
f. Subsidence/depressions in right crest of dam.
g. Low level outlet structure leaning out of plumb, concrete deteriorated, foundation undermined, no roof.
h. Low level outlet pipe operator operability unknown.
i. Low level outlet pipe 50 percent full of sediment.

- **Overall Condition of Dam at the Time of the Current Follow-up Inspection:**
  The current condition of the dam is Poor. In addition to the previous inspection deficiencies listed above, dense tall vegetation is present on the right embankment crest and along the toe of the downstream retaining wall.

- **Comparison of Current Conditions to Conditions Listed in Previous Phase I Inspection Report:**
  The dam appears to be the same as previously inspected in January 2013. It should be noted, however, that the condition of the downstream retaining wall and crest at the right embankment was obscured by dense vegetation.

- **Dam Safety Orders:**
  Certificate of Non-Compliance and Dam Safety Order dated February 22, 2008 issued by the Massachusetts DCR Office of Dam Safety.

- **Maintenance:**
  There is currently no routinely scheduled maintenance for the dam. However, a lake association is in the process of being organized that has begun to take on the operation and maintenance of the dam.

- **Recommendations:**
  Fuss & O'Neill recognizes that a lake association is being formed to take on the maintenance and repair of the dam. A Phase II investigation in accordance with the recent Dam Safety Order is in progress.

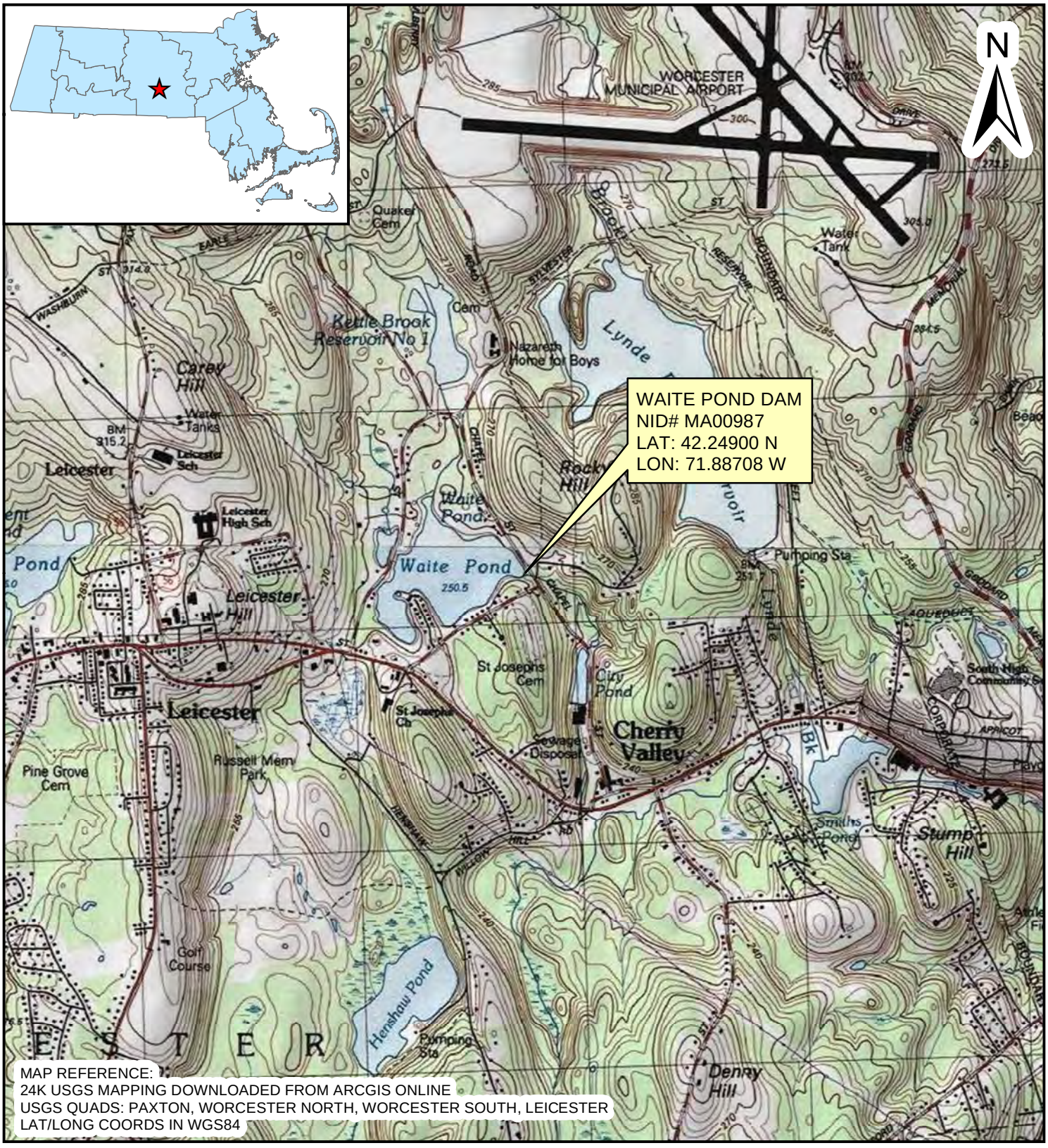
- **Other Comments or Observations:**
  The operability of the low-level outlet gate is unknown. During this follow up inspection water was observed discharging from the 24" outlet pipe into the downstream channel. Furthermore, the position/height of the gate operator stem observed during this inspection appears to have changed relative to the previous inspection (based on photographs). It was also noted that a series of stones had been placed in the spillway channel between the left training wall and the door in the gate house, presumably for access to the gate operator.

- **Updated Site Sketch with Photo Locations:**
  An updated site sketch with photo locations is attached.

- **Updated Photos:**
  Updated photographs of the dam are attached.

- **Copy of Locus Map from Phase I Report:**
  A copy of the previous Locus Map is attached

- **Other Applicable Attachment:** None




AUGUST 2012

**FIGURE 1**

2,000 1,000 0 2,000 Feet

TOWN OF LEICESTER

# LOCUS MAP

WAITE POND DAM (MA00987)

LEICESTER, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 2,000 FEET
VERT:
DATUM
HORZ:
VERT: NGVD29 (3-METER CONTOURS)

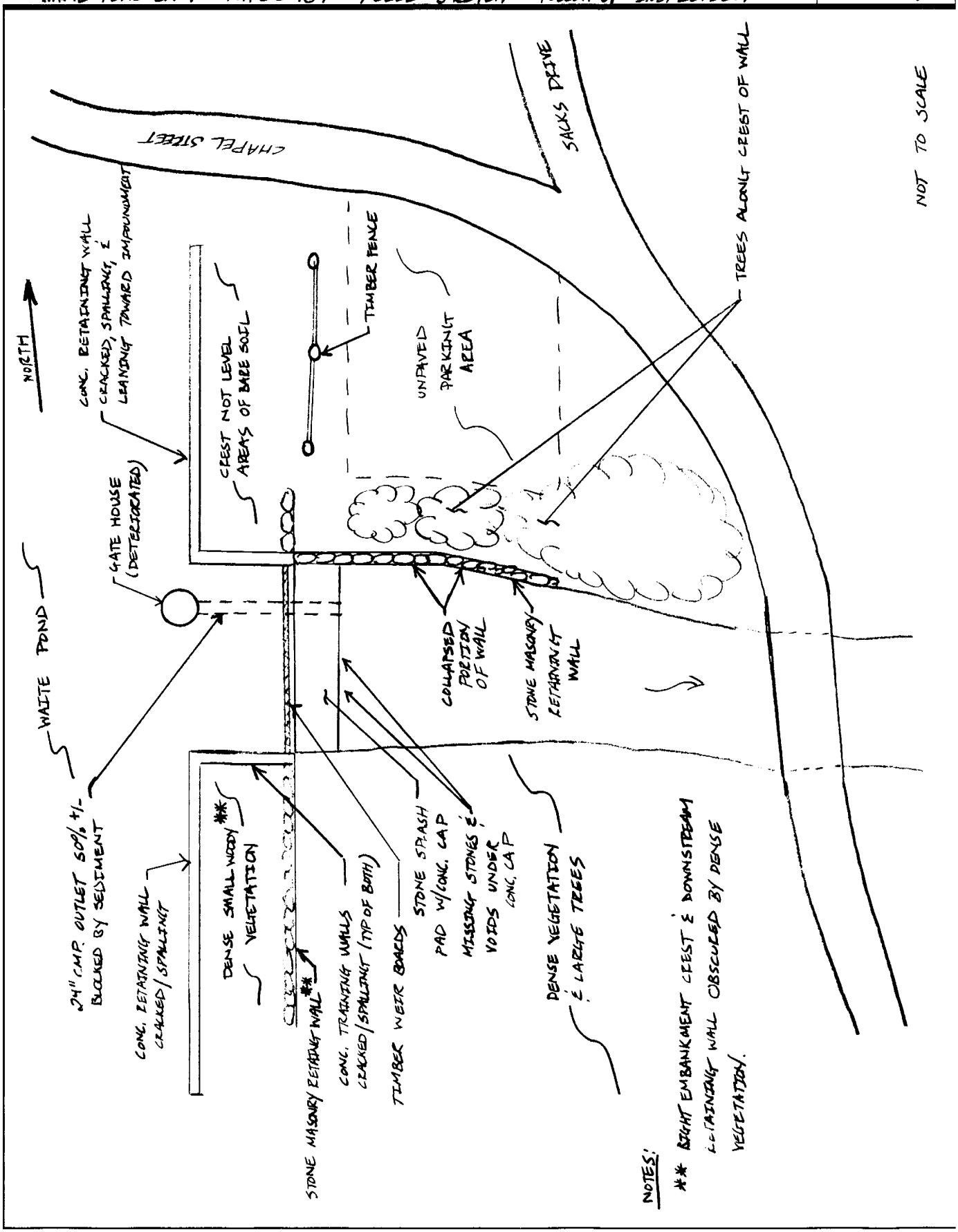
FUSS & O'NEILL

K:\GIS\P2008\1286\A50\MA00987_WaitePondDam\MXD\Fig1_Locus.mxd

| FUSS & O'NEILL | Prepared By | Date | Checked By | Date | Project No |
|---|---|---|---|---|---|
| | KCM | 8/4/14 | | | 20081286.A00 |

WAITE POND DAM - MA00987 - FIELD SKETCH - FOLLOW UP INSPECTION

Sheet No 1 of 1

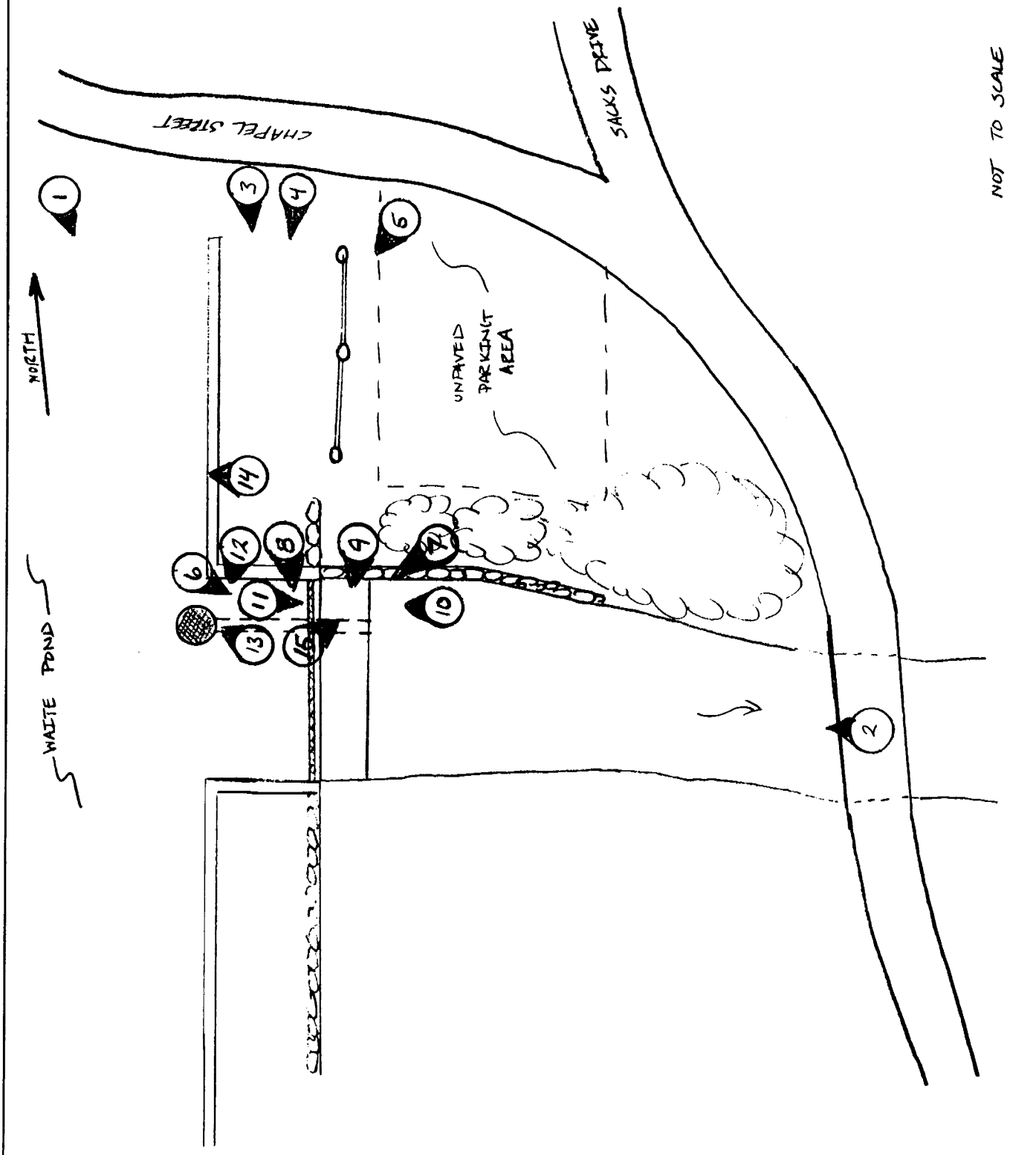


FUSS & O'NEILL

| Prepared By | Date | Checked By | Date | Project No |
|---|---|---|---|---|
| KCM | 8/4/14 | | | J00812816.A00 |

WAITE POND DAM - MA00987 - PHOTO LOCATION MAP

Sheet No 1 of 1



# PHOTOGRAPHS


Photo 1: Overview of dam from upstream


Photo 2: Overview of dam from downstream

Photo 3: Overview of upstream face from left abutment

Photo 4: Overview of dam crest from left abutment


Photo 5: Overview of downstream face from left abutment


Photo 6: Overview of spillway from upstream

Photo 7: Overview of spillway from downstream (tailrace or channel area)

Photo 8: Overview of right training wall


Photo 9: Overview of weir


Photo 10: Overview of stilling basin & low-level outlet discharge location

Photo 11: Overview of downstream channel

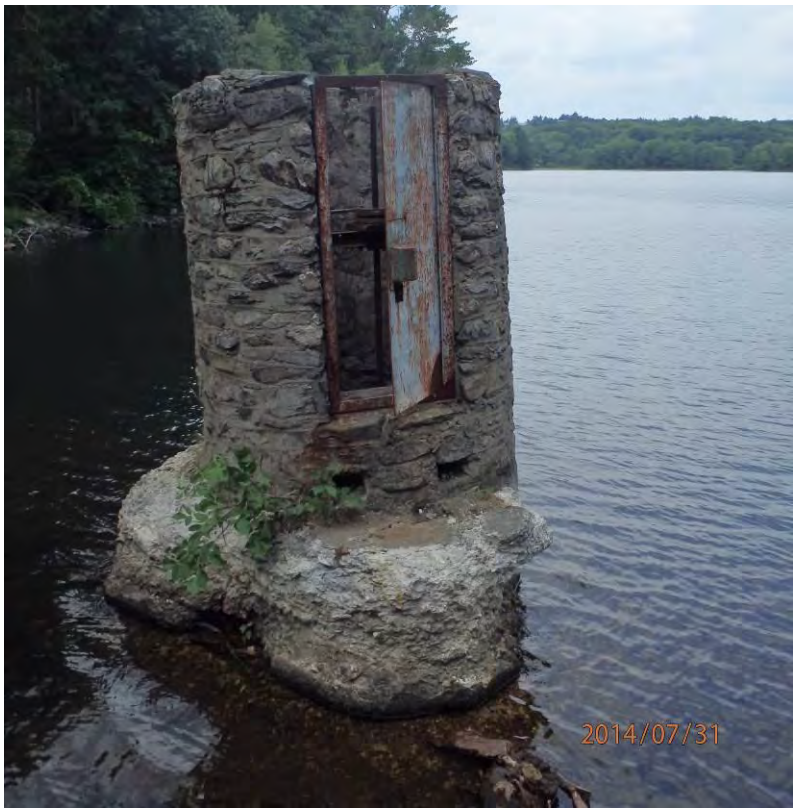


Photo 12: Overview of gatehouse exterior

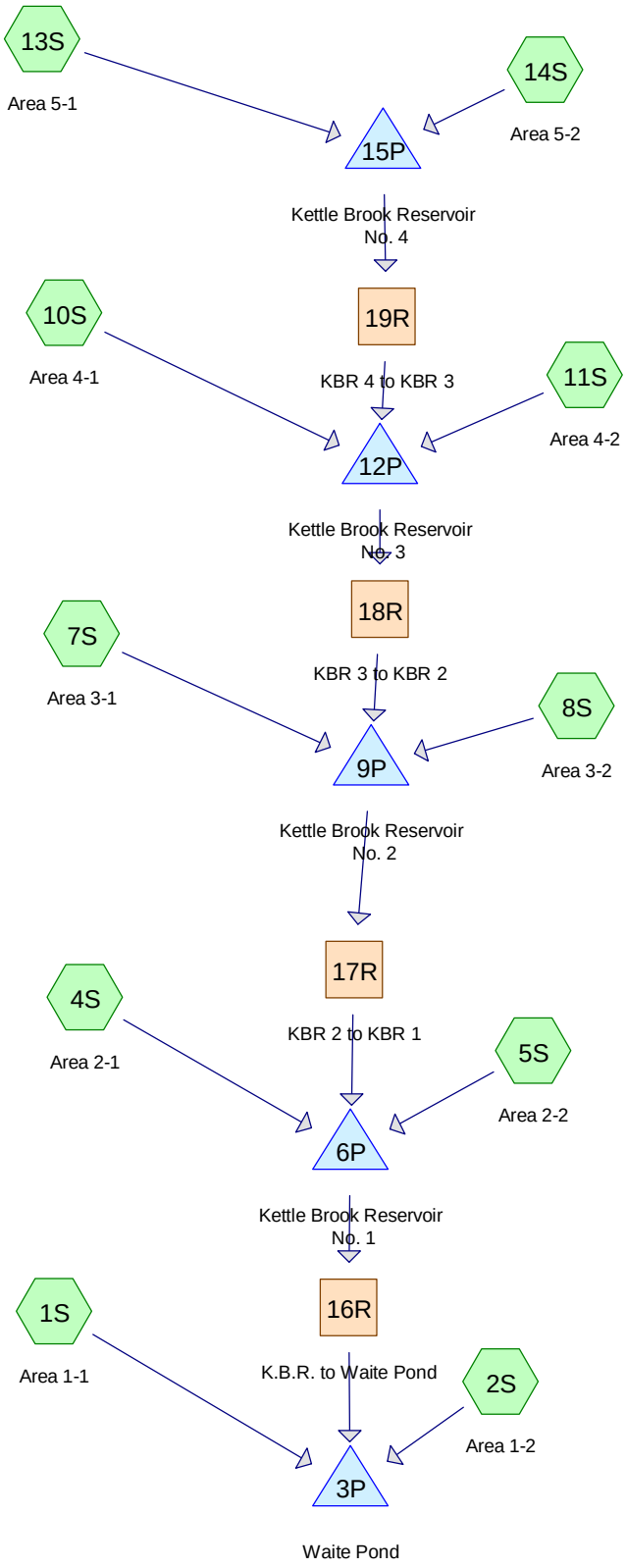

Photo 13: Overview of Operators


Photo 14: Overview of Reservoir


Photo 15: Areas of specific deficiencies-failing downstream channel wall

# Appendix B

## H&H Model Report




Scenario: Weir Boards Installed in Spillway

Subcat Reach Pond Link

**Routing Diagram for Waite Pond Dam-Proposed-Weir Boards Installed**
Prepared by Fuss & O'Neill, Printed 1/21/2015

## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 59.231 | 68 | 1 acre lots, 20% imp, HSG B (1S, 13S) |
| 325.752 | 79 | 1 acre lots, 20% imp, HSG C (1S, 4S, 7S, 10S, 13S) |
| 39.442 | 61 | Pasture/grassland/range, Good, HSG B (1S, 4S, 7S) |
| 143.407 | 74 | Pasture/grassland/range, Good, HSG C (1S, 4S, 7S, 10S, 13S) |
| 0.937 | 80 | Pasture/grassland/range, Good, HSG D (4S) |
| 53.901 | 98 | Water Surface, 0% imp, HSG C (2S) |
| 209.378 | 98 | Water Surface, HSG C (4S, 5S, 8S, 11S, 14S) |
| 521.770 | 55 | Woods, Good, HSG B (1S, 4S, 7S, 10S, 13S) |
| 1,619.398 | 70 | Woods, Good, HSG C (1S, 4S, 7S, 10S, 13S) |
| 154.550 | 77 | Woods, Good, HSG D (1S, 4S, 7S, 10S, 13S) |
| **3,127.766** | **71** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.000 | HSG A | |
| 620.443 | HSG B | 1S, 4S, 7S, 10S, 13S |
| 2,351.836 | HSG C | 1S, 2S, 4S, 5S, 7S, 8S, 10S, 11S, 13S, 14S |
| 155.487 | HSG D | 1S, 4S, 7S, 10S, 13S |
| 0.000 | Other | |
| **3,127.766** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 59.231 | 325.752 | 0.000 | 0.000 | 384.983 | 1 acre lots, 20% imp | 1S, 4S, 7S, 10S, 13S |
| 0.000 | 39.442 | 143.407 | 0.937 | 0.000 | 183.786 | Pasture/grassland/range, Good | 1S, 4S, 7S, 10S, 13S |
| 0.000 | 0.000 | 209.378 | 0.000 | 0.000 | 209.378 | Water Surface | 4S, 5S, 8S, 11S, 14S |
| 0.000 | 0.000 | 53.901 | 0.000 | 0.000 | 53.901 | Water Surface, 0% imp | 2S |
| 0.000 | 521.770 | 1,619.398 | 154.550 | 0.000 | 2,295.718 | Woods, Good | 1S, 4S, 7S, 10S, 13S |
| **0.000** | **620.443** | **2,351.836** | **155.487** | **0.000** | **3,127.766** | **TOTAL AREA** | |

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Area 1-1** Runoff Area=411.454 ac 5.72% Impervious Runoff Depth>3.06"
Flow Length=4,785' Slope=0.0525 '/' Tc=66.5 min CN=69 Runoff=551.38 cfs 104.898 af

**Subcatchment 2S: Area 1-2** Runoff Area=53.901 ac 0.00% Impervious Runoff Depth>6.26"
Flow Length=2,500' Tc=3.3 min CN=98 Runoff=378.29 cfs 28.113 af

**Subcatchment 4S: Area 2-1** Runoff Area=667.890 ac 0.63% Impervious Runoff Depth>2.84"
Flow Length=6,024' Slope=0.0383 '/' Tc=98.7 min CN=67 Runoff=637.60 cfs 158.068 af

**Subcatchment 5S: Area 2-2** Runoff Area=11.658 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=1,540' Tc=2.0 min CN=98 Runoff=85.72 cfs 6.082 af

**Subcatchment 7S: Area 3-1** Runoff Area=286.135 ac 0.35% Impervious Runoff Depth>2.57"
Flow Length=4,084' Slope=0.0394 '/' Tc=77.1 min CN=64 Runoff=288.43 cfs 61.364 af

**Subcatchment 8S: Area 3-2** Runoff Area=31.267 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=2,160' Tc=2.8 min CN=98 Runoff=223.51 cfs 16.309 af

**Subcatchment 10S: Area 4-1** Runoff Area=459.666 ac 0.86% Impervious Runoff Depth>3.06"
Flow Length=3,334' Slope=0.0280 '/' Tc=68.2 min CN=69 Runoff=606.08 cfs 117.138 af

**Subcatchment 11S: Area 4-2** Runoff Area=39.207 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=3,700' Tc=4.9 min CN=98 Runoff=259.79 cfs 20.445 af

**Subcatchment 13S: Area 5-1** Runoff Area=1,042.248 ac 4.53% Impervious Runoff Depth>3.01"
Flow Length=8,740' Slope=0.0118 '/' Tc=221.2 min CN=70 Runoff=629.06 cfs 261.248 af

**Subcatchment 14S: Area 5-2** Runoff Area=124.340 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=4,326' Tc=5.7 min CN=98 Runoff=801.12 cfs 64.830 af

**Reach 16R: K.B.R. to Waite Pond** Avg. Flow Depth=3.53' Max Vel=3.44 fps Inflow=614.30 cfs 367.453 af
n=0.070 L=1,620.0' S=0.0100 '/' Capacity=3,087.40 cfs Outflow=612.16 cfs 360.683 af

**Reach 17R: KBR 2 to KBR 1** Avg. Flow Depth=2.07' Max Vel=5.45 fps Inflow=276.29 cfs 232.803 af
n=0.050 L=5,320.0' S=0.0240 '/' Capacity=11,169.75 cfs Outflow=275.93 cfs 221.898 af

**Reach 18R: KBR 3 to KBR 2** Avg. Flow Depth=2.43' Max Vel=4.22 fps Inflow=227.49 cfs 202.299 af
n=0.050 L=2,060.0' S=0.0113 '/' Capacity=5,794.51 cfs Outflow=227.48 cfs 197.546 af

**Reach 19R: KBR 4 to KBR 3** Inflow=189.32 cfs 134.029 af
Outflow=189.32 cfs 134.029 af

**Pond 3P: Waite Pond** Peak Elev=823.11' Storage=214.749 af Inflow=811.80 cfs 493.694 af
Outflow=438.70 cfs 296.465 af

**Pond 6P: Kettle Brook Reservoir No. 1** Peak Elev=852.95' Storage=34.232 af Inflow=721.36 cfs 386.048 af
Outflow=614.30 cfs 367.453 af

**Pond 9P: Kettle Brook Reservoir No. 2** Peak Elev=996.46' Storage=47.203 af Inflow=397.49 cfs 275.218 af
Outflow=276.29 cfs 232.803 af

**Pond 12P: Kettle Brook Reservoir No. 3** Peak Elev=1,041.75' Storage=73.767 af Inflow=648.86 cfs 271.612 af
Outflow=227.49 cfs 202.299 af

**Pond 15P: Kettle Brook Reservoir No. 4** Peak Elev=1,088.80' Storage=213.882 af Inflow=830.65 cfs 326.079 af
Outflow=189.32 cfs 134.029 af

**Total Runoff Area = 3,127.766 ac Runoff Volume = 838.494 af Average Runoff Depth = 3.22"**
**90.84% Pervious = 2,841.391 ac 9.16% Impervious = 286.375 ac**

## Summary for Subcatchment 1S: Area 1-1

Overland runoff to Waite Pond.

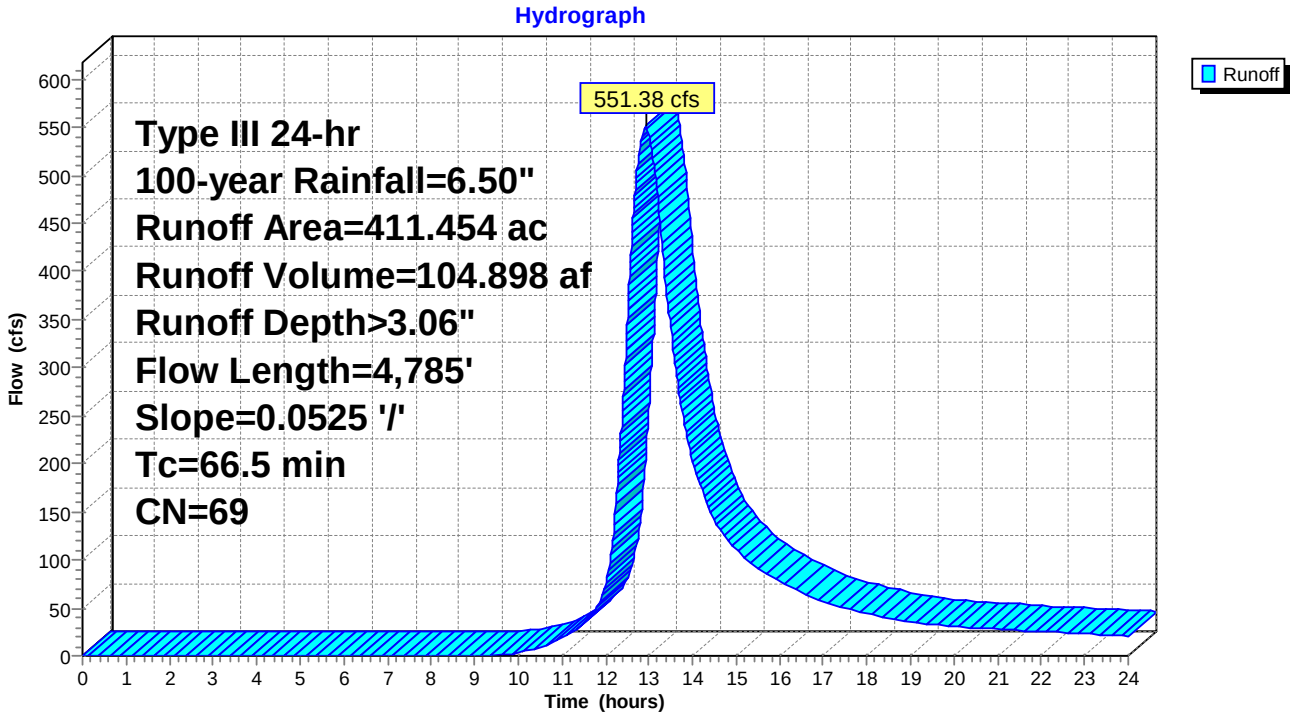
Runoff = 551.38 cfs @ 12.93 hrs, Volume= 104.898 af, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 49.447 | 68 | 1 acre lots, 20% imp, HSG B |
| 13.446 | 61 | Pasture/grassland/range, Good, HSG B |
| 70.642 | 55 | Woods, Good, HSG B |
| 68.149 | 79 | 1 acre lots, 20% imp, HSG C |
| 4.689 | 74 | Pasture/grassland/range, Good, HSG C |
| 170.963 | 70 | Woods, Good, HSG C |
| 34.118 | 77 | Woods, Good, HSG D |
| 411.454 | 69 | Weighted Average |
| 387.935 | | 94.28% Pervious Area |
| 23.519 | | 5.72% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 66.5 | 4,785 | 0.0525 | 1.20 | | **Lag/CN Method,** |

### Subcatchment 1S: Area 1-1



## Summary for Subcatchment 2S: Area 1-2

Direct precipitation to Waite Pond.

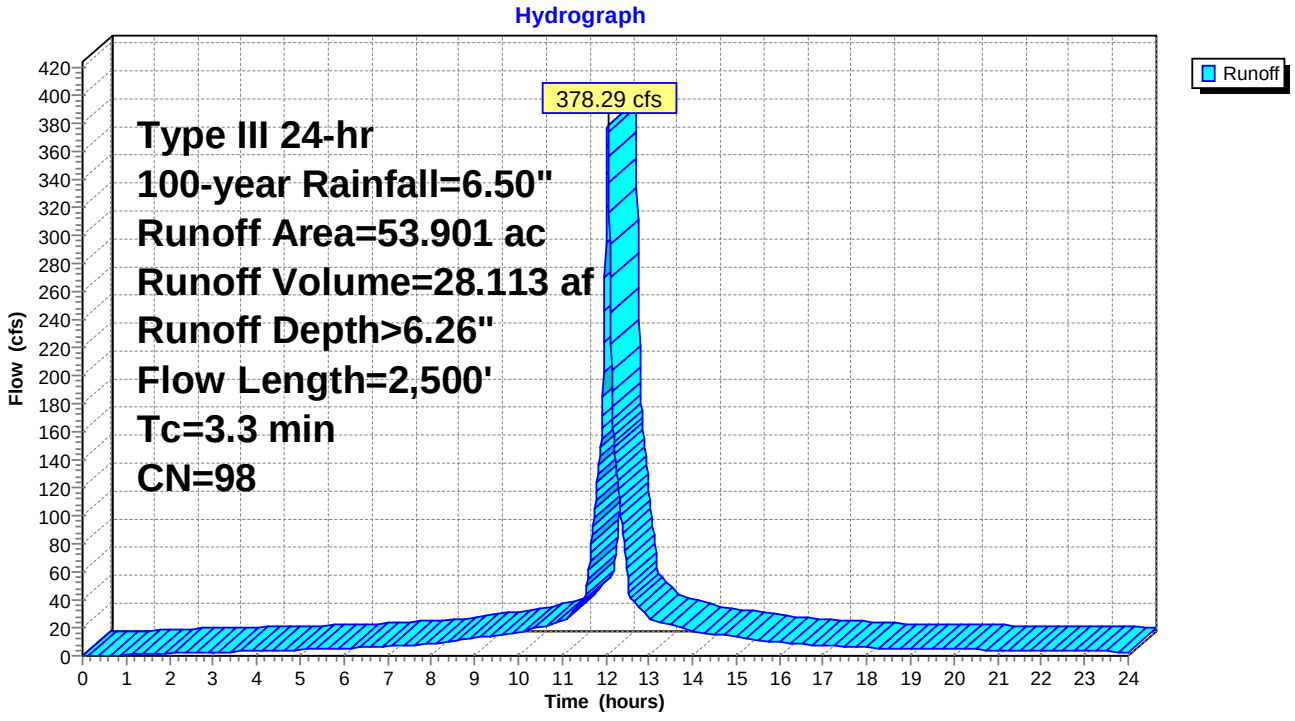
Runoff = 378.29 cfs @ 12.05 hrs, Volume= 28.113 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 53.901 | 98 | Water Surface, 0% imp, HSG C |
| 53.901 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.3 | 2,500 | | 12.69 | | **Lake or Reservoir, Estimated travel time through Waite Pond.** Mean Depth= 5.00' |

### Subcatchment 2S: Area 1-2



## Summary for Subcatchment 4S: Area 2-1

Overland runoff to Kettle Brook Reservoir No. 1.

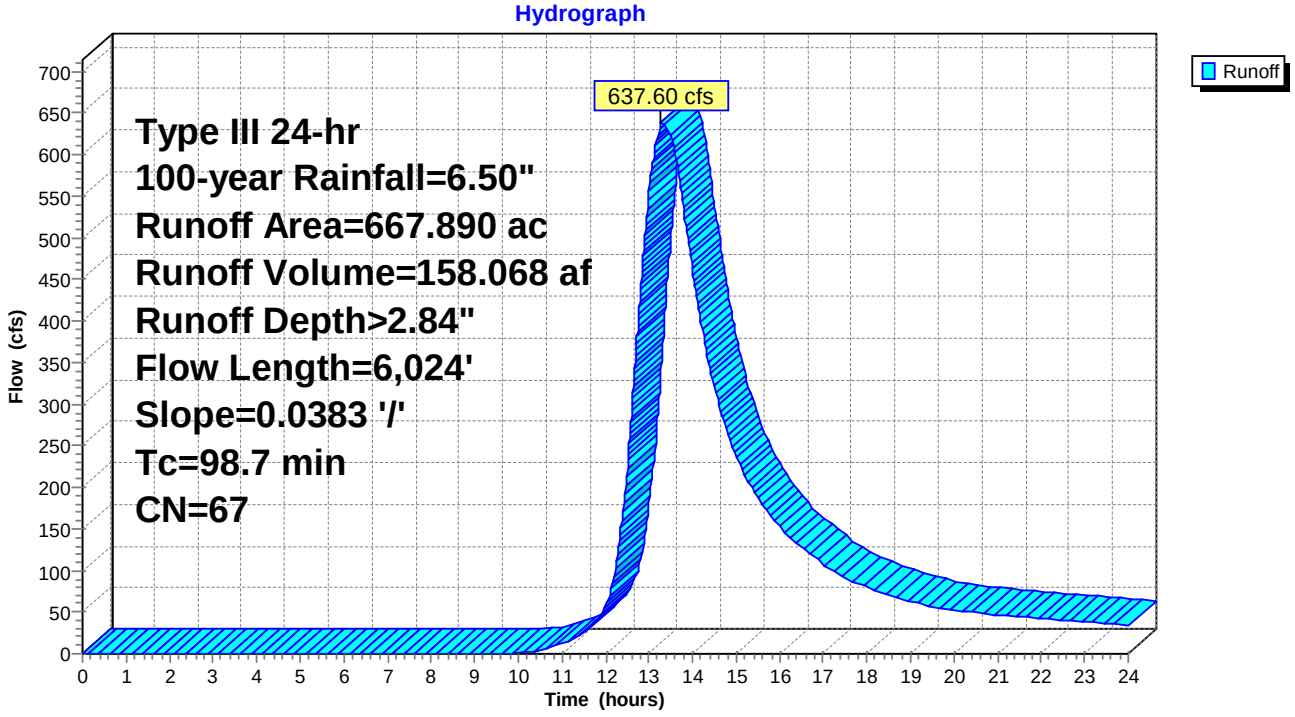
Runoff = 637.60 cfs @ 13.28 hrs, Volume= 158.068 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 6.557 | 79 | 1 acre lots, 20% imp, HSG C |
| 23.867 | 61 | Pasture/grassland/range, Good, HSG B |
| 95.923 | 74 | Pasture/grassland/range, Good, HSG C |
| 0.937 | 80 | Pasture/grassland/range, Good, HSG D |
| 152.437 | 55 | Woods, Good, HSG B |
| 348.095 | 70 | Woods, Good, HSG C |
| 37.168 | 77 | Woods, Good, HSG D |
| 2.906 | 98 | Water Surface, HSG C |
| 667.890 | 67 | Weighted Average |
| 663.673 | | 99.37% Pervious Area |
| 4.217 | | 0.63% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 98.7 | 6,024 | 0.0383 | 1.02 | | **Lag/CN Method,** |

### Subcatchment 4S: Area 2-1



## Summary for Subcatchment 5S: Area 2-2

Direct precipitation to Kettle Brook Reservoir No. 1.

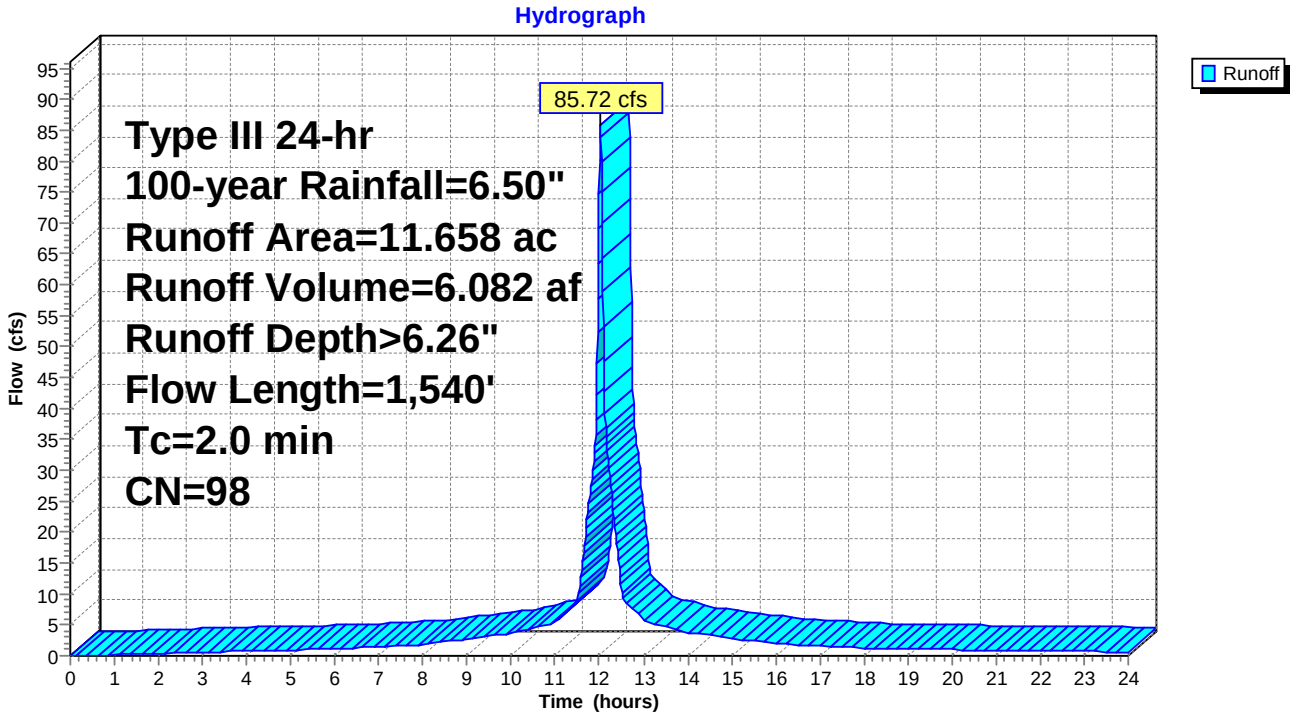
Runoff = 85.72 cfs @ 12.03 hrs, Volume= 6.082 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 11.658 | 98 | Water Surface, HSG C |
| 11.658 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.0 | 1,540 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 5S: Area 2-2



## Summary for Subcatchment 7S: Area 3-1

Overland runoff to Kettle Brook Reservoir No. 2.

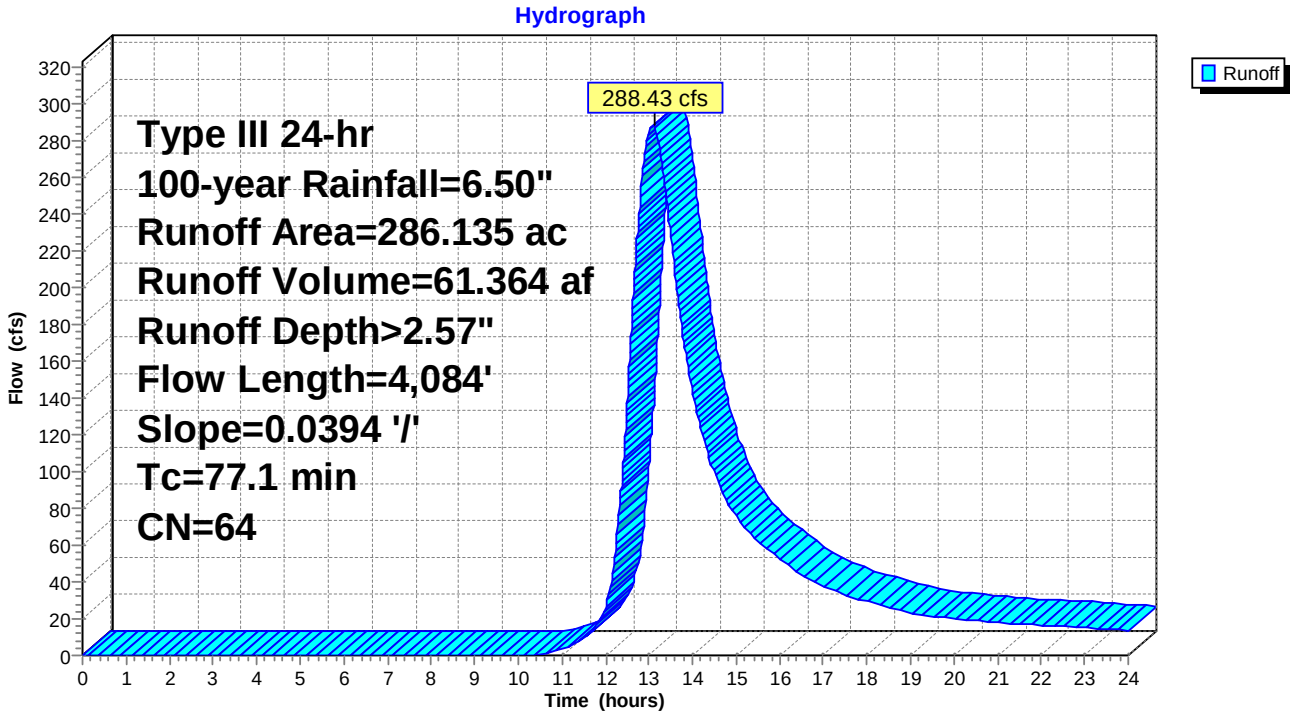
Runoff = 288.43 cfs @ 13.10 hrs, Volume= 61.364 af, Depth> 2.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 5.050 | 79 | 1 acre lots, 20% imp, HSG C |
| 2.129 | 61 | Pasture/grassland/range, Good, HSG B |
| 14.941 | 74 | Pasture/grassland/range, Good, HSG C |
| 115.991 | 55 | Woods, Good, HSG B |
| 139.035 | 70 | Woods, Good, HSG C |
| 8.989 | 77 | Woods, Good, HSG D |
| 286.135 | 64 | Weighted Average |
| 285.125 | | 99.65% Pervious Area |
| 1.010 | | 0.35% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 77.1 | 4,084 | 0.0394 | 0.88 | | **Lag/CN Method,** |

### Subcatchment 7S: Area 3-1



## Summary for Subcatchment 8S: Area 3-2

Direct precipitation to Kettle Brook Reservoir No. 2.

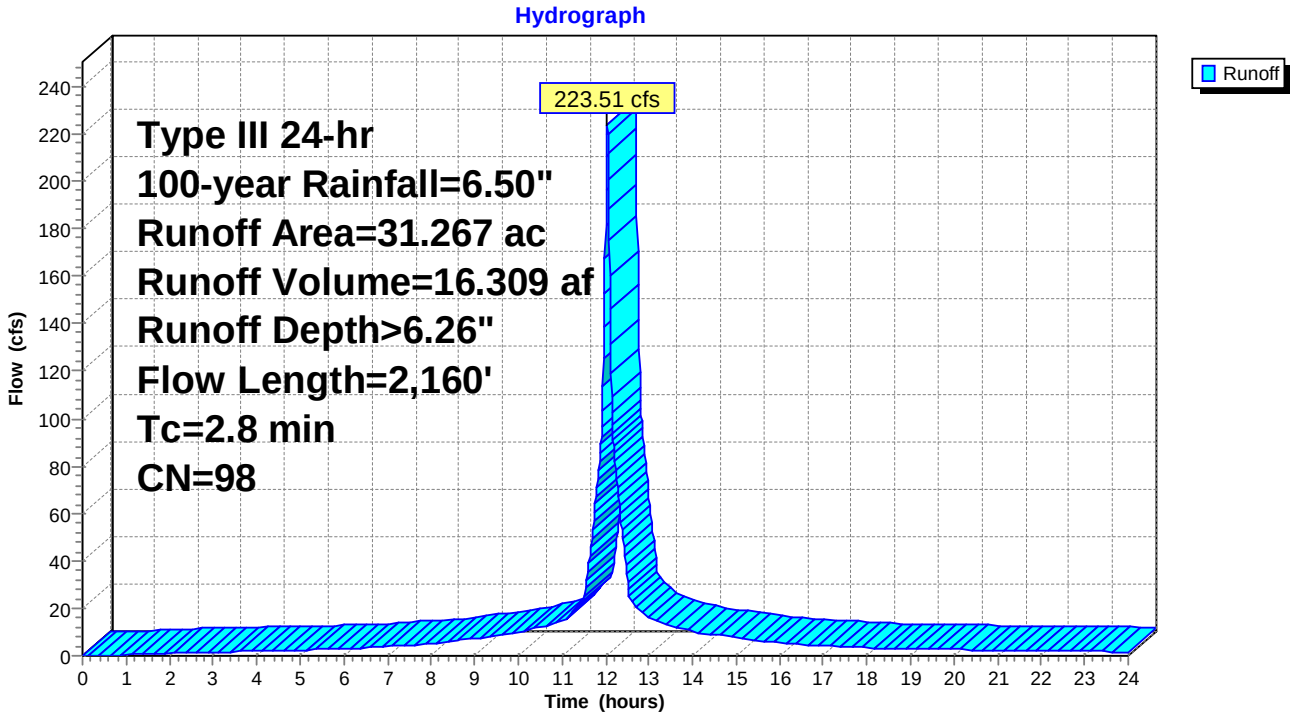
Runoff = 223.51 cfs @ 12.04 hrs, Volume= 16.309 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 31.267 | 98 | Water Surface, HSG C |
| 31.267 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.8 | 2,160 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 8S: Area 3-2



## Summary for Subcatchment 10S: Area 4-1

Overland runoff to Kettle Brook Reservoir No. 3.

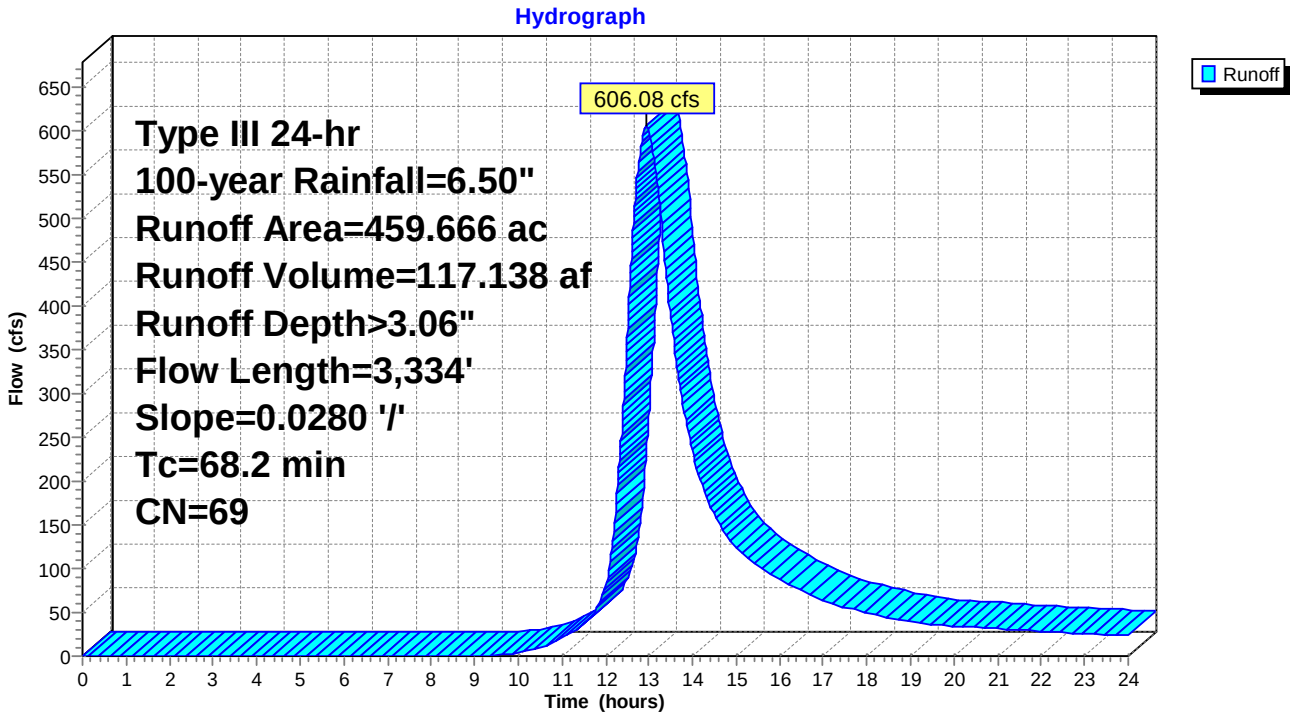
Runoff = 606.08 cfs @ 12.96 hrs, Volume= 117.138 af, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 19.759 | 79 | 1 acre lots, 20% imp, HSG C |
| 7.916 | 74 | Pasture/grassland/range, Good, HSG C |
| 48.751 | 55 | Woods, Good, HSG B |
| 367.701 | 70 | Woods, Good, HSG C |
| 15.539 | 77 | Woods, Good, HSG D |
| 459.666 | 69 | Weighted Average |
| 455.714 | | 99.14% Pervious Area |
| 3.952 | | 0.86% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 68.2 | 3,334 | 0.0280 | 0.81 | | **Lag/CN Method,** |

### Subcatchment 10S: Area 4-1



## Summary for Subcatchment 11S: Area 4-2

Direct precipitation to Kettle Brook Reservoir No. 3.

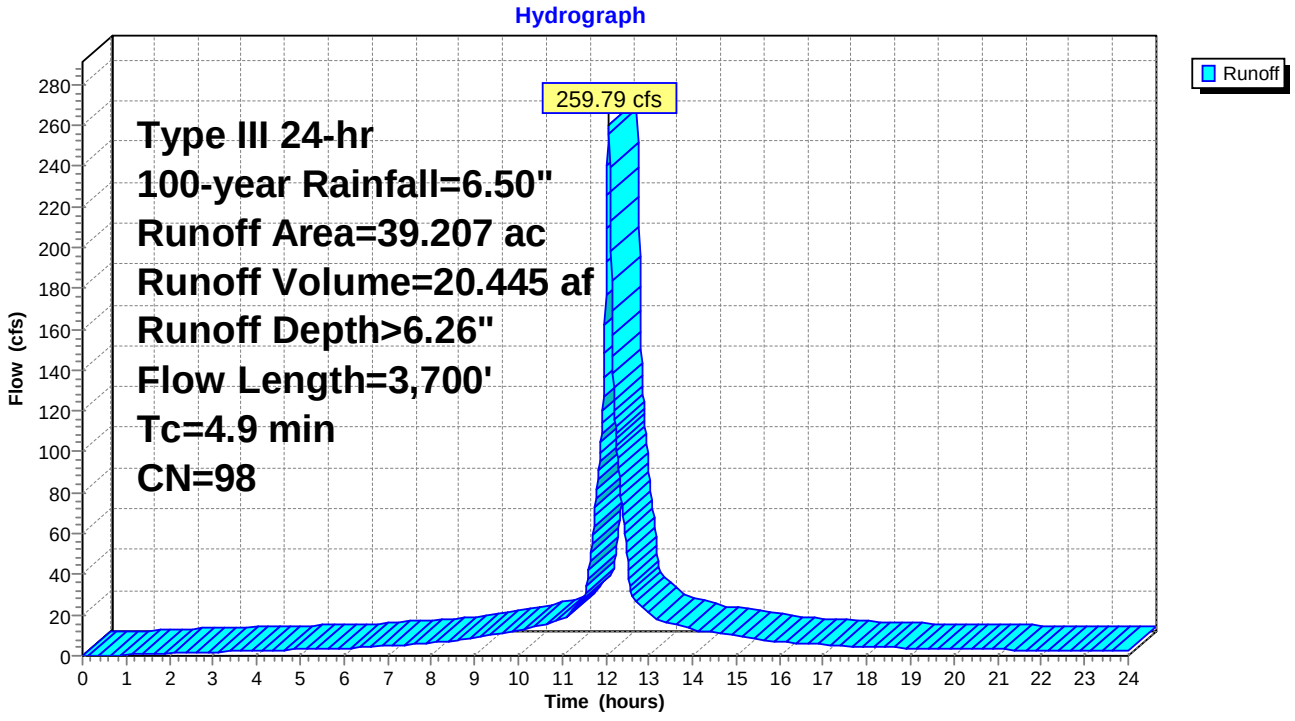
Runoff = 259.79 cfs @ 12.07 hrs, Volume= 20.445 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 39.207 | 98 | Water Surface, HSG C |
| 39.207 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.9 | 3,700 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 11S: Area 4-2



## Summary for Subcatchment 13S: Area 5-1

Overland runoff to Kettle Brook Reservoir No. 4.

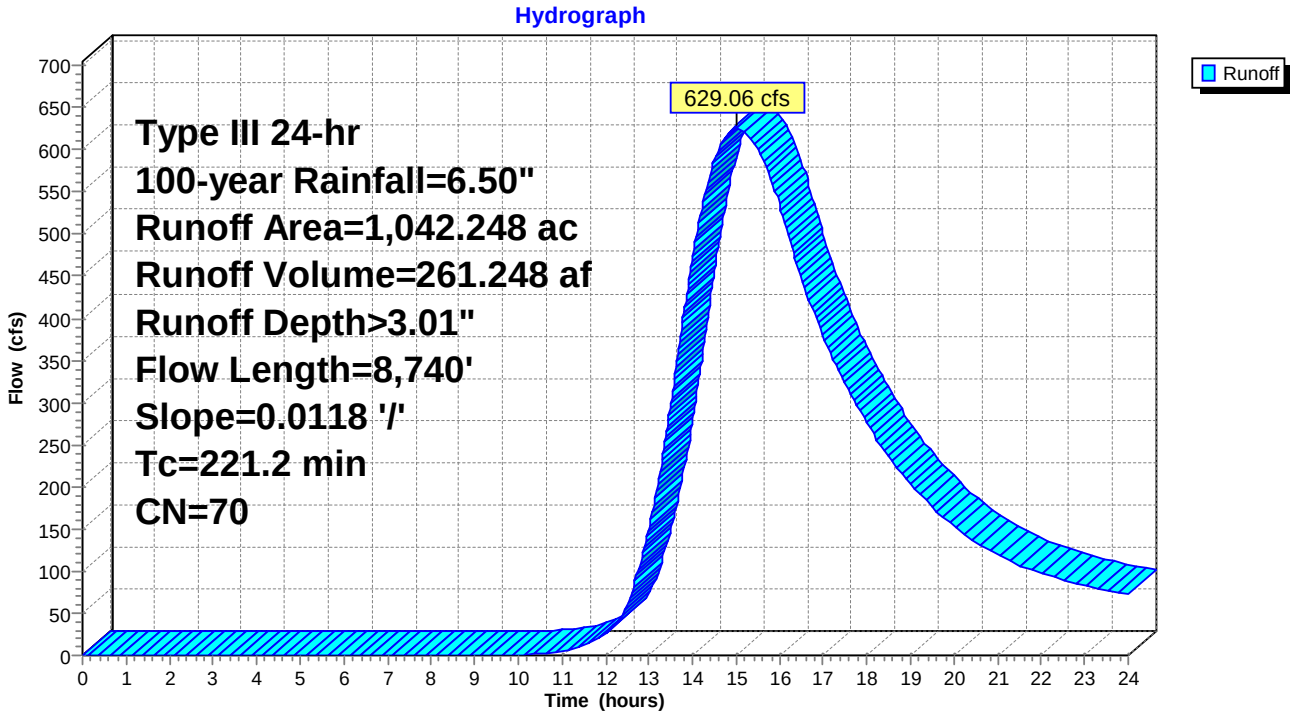
Runoff = 629.06 cfs @ 14.99 hrs, Volume= 261.248 af, Depth> 3.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 9.784 | 68 | 1 acre lots, 20% imp, HSG B |
| 226.237 | 79 | 1 acre lots, 20% imp, HSG C |
| 19.938 | 74 | Pasture/grassland/range, Good, HSG C |
| 133.949 | 55 | Woods, Good, HSG B |
| 593.604 | 70 | Woods, Good, HSG C |
| 58.736 | 77 | Woods, Good, HSG D |
| 1,042.248 | 70 | Weighted Average |
| 995.044 | | 95.47% Pervious Area |
| 47.204 | | 4.53% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 221.2 | 8,740 | 0.0118 | 0.66 | | **Lag/CN Method,** |

### Subcatchment 13S: Area 5-1



## Summary for Subcatchment 14S: Area 5-2

Direct precipitation to Kettle Brook Reservoir No. 4.

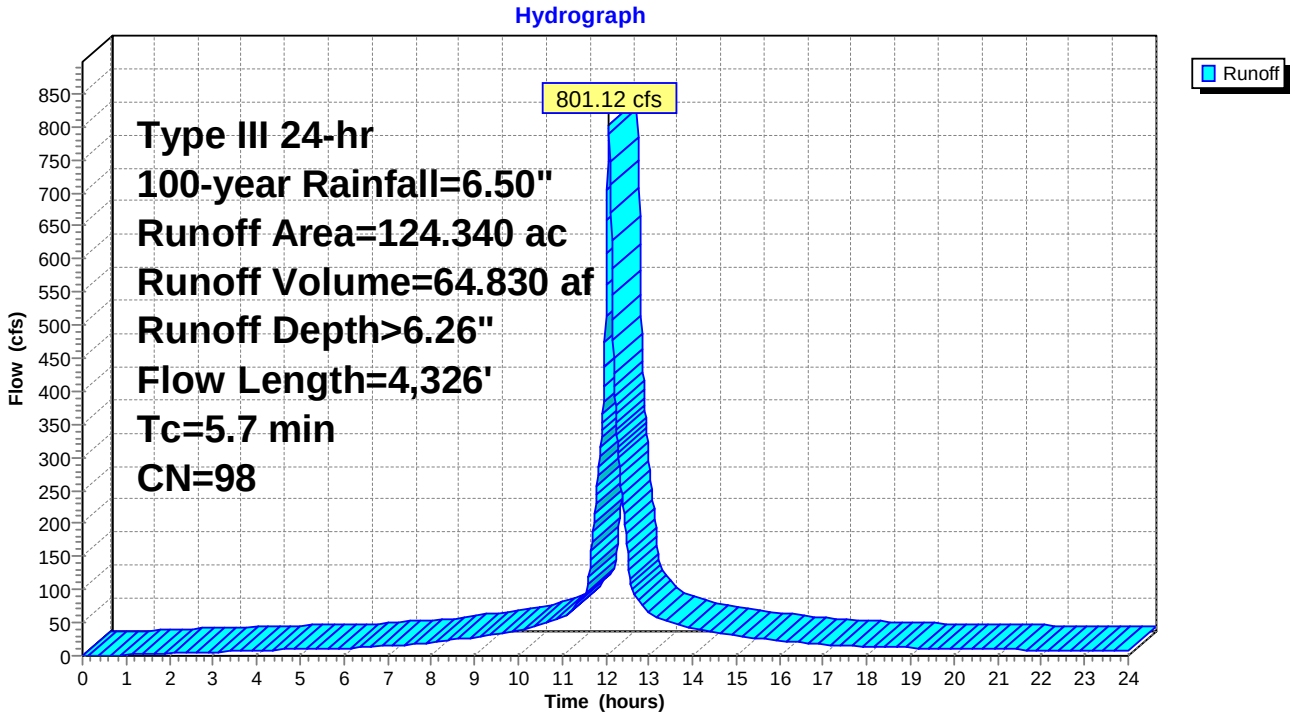
Runoff = 801.12 cfs @ 12.08 hrs, Volume= 64.830 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 124.340 | 98 | Water Surface, HSG C |
| 124.340 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 5.7 | 4,326 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 14S: Area 5-2



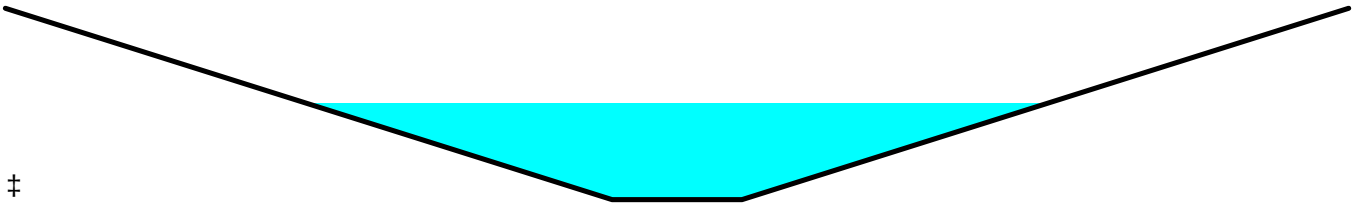
## Summary for Reach 16R: K.B.R. to Waite Pond

Inflow Area = 2,662.411 ac, 9.87% Impervious, Inflow Depth > 1.66" for 100-year event
Inflow = 614.30 cfs @ 14.06 hrs, Volume= 367.453 af
Outflow = 612.16 cfs @ 14.30 hrs, Volume= 360.683 af, Atten= 0%, Lag= 14.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.44 fps, Min. Travel Time= 7.8 min
Avg. Velocity = 1.81 fps, Avg. Travel Time= 14.9 min

Peak Storage= 287,899 cf @ 14.17 hrs
Average Depth at Peak Storage= 3.53'
Bank-Full Depth= 7.00' Flow Area= 595.0 sf, Capacity= 3,087.40 cfs

15.00' x 7.00' deep channel, n= 0.070 Sluggish weedy reaches w/pools
Side Slope Z-value= 10.0 '/' Top Width= 155.00'
Length= 1,620.0' Slope= 0.0100 '/'
Inlet Invert= 838.00', Outlet Invert= 821.80'



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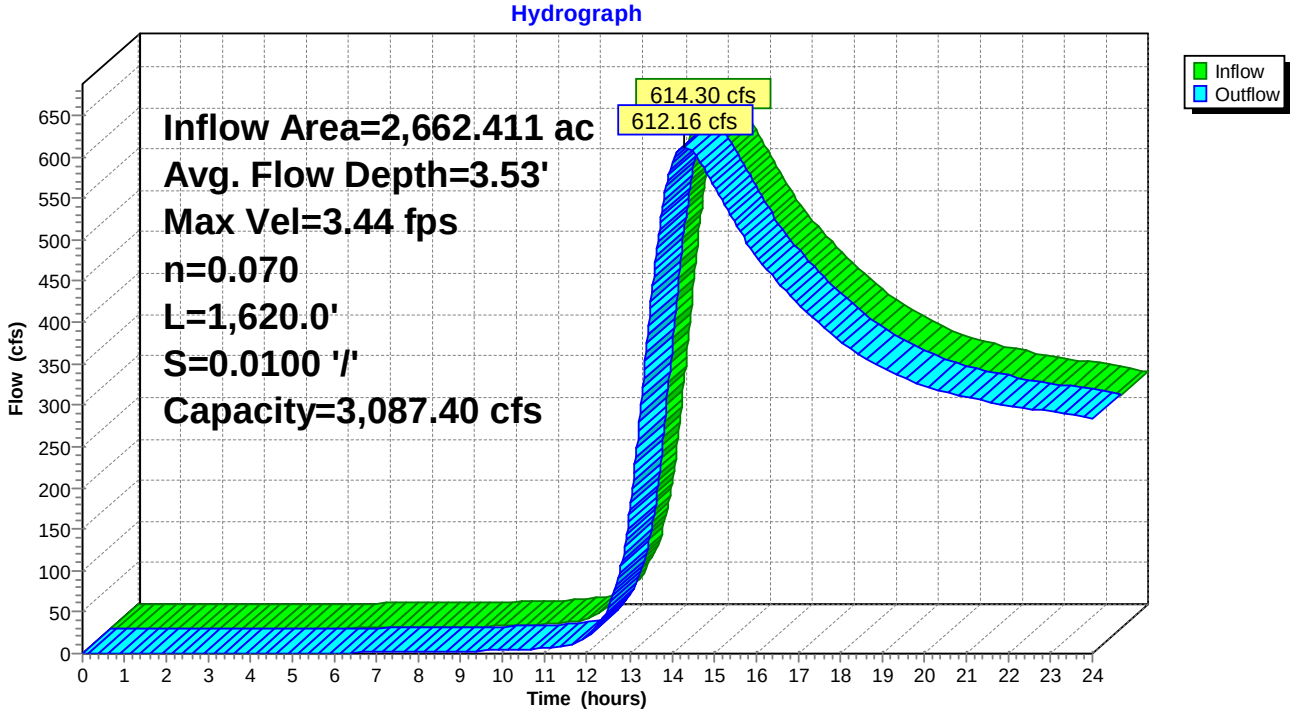
## Reach 16R: K.B.R. to Waite Pond



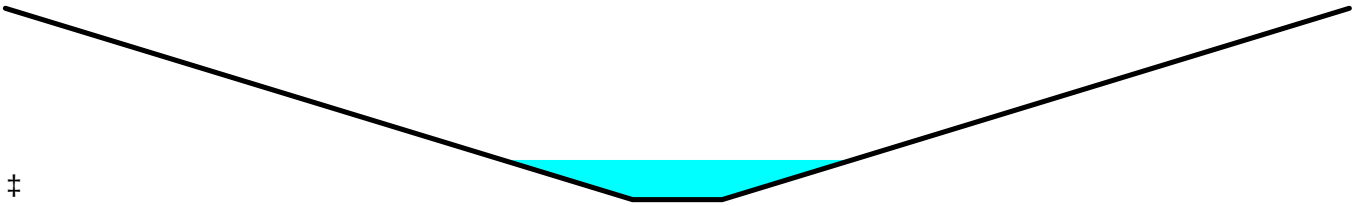
## Summary for Reach 17R: KBR 2 to KBR 1

Inflow Area = 1,982.863 ac, 12.46% Impervious, Inflow Depth > 1.41" for 100-year event
Inflow = 276.29 cfs @ 15.85 hrs, Volume= 232.803 af
Outflow = 275.93 cfs @ 16.35 hrs, Volume= 221.898 af, Atten= 0%, Lag= 30.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.45 fps, Min. Travel Time= 16.3 min
Avg. Velocity = 3.22 fps, Avg. Travel Time= 27.6 min

Peak Storage= 269,143 cf @ 16.08 hrs
Average Depth at Peak Storage= 2.07'
Bank-Full Depth= 10.00' Flow Area= 800.0 sf, Capacity= 11,169.75 cfs

10.00' x 10.00' deep channel, n= 0.050
Side Slope Z-value= 7.0 '/' Top Width= 150.00'
Length= 5,320.0' Slope= 0.0240 '/'
Inlet Invert= 979.00', Outlet Invert= 851.40'



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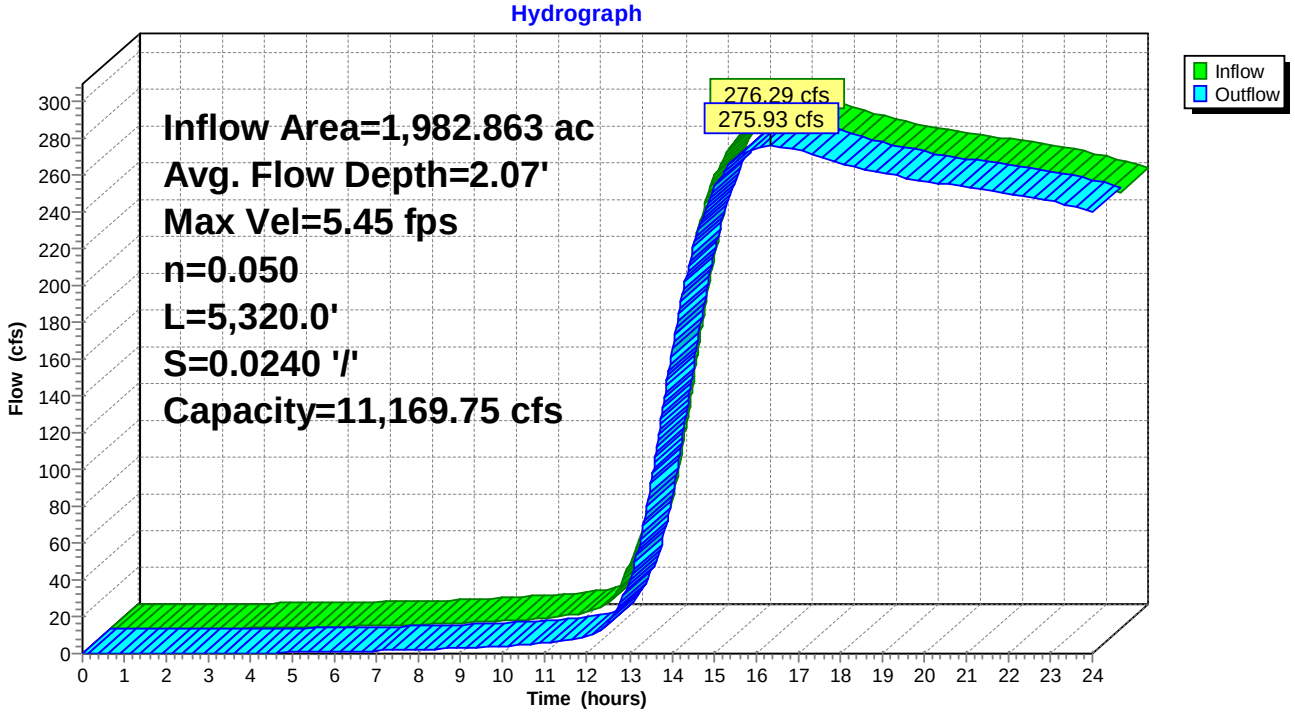
## Reach 17R: KBR 2 to KBR 1



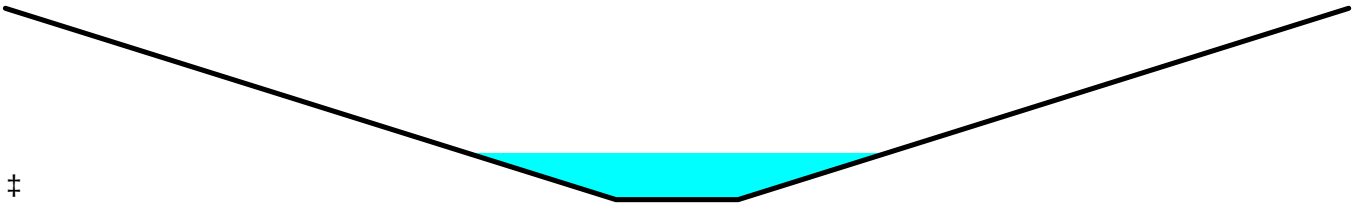
## Summary for Reach 18R: KBR 3 to KBR 2

Inflow Area = 1,665.461 ac, 12.89% Impervious, Inflow Depth > 1.46" for 100-year event
Inflow = 227.49 cfs @ 19.87 hrs, Volume= 202.299 af
Outflow = 227.48 cfs @ 20.11 hrs, Volume= 197.546 af, Atten= 0%, Lag= 14.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.22 fps, Min. Travel Time= 8.1 min
Avg. Velocity = 2.50 fps, Avg. Travel Time= 13.7 min

Peak Storage= 110,991 cf @ 19.97 hrs
Average Depth at Peak Storage= 2.43'
Bank-Full Depth= 10.00' Flow Area= 600.0 sf, Capacity= 5,794.51 cfs

10.00' x 10.00' deep channel, n= 0.050
Side Slope Z-value= 5.0 '/' Top Width= 110.00'
Length= 2,060.0' Slope= 0.0113 '/'
Inlet Invert= 1,014.00', Outlet Invert= 990.80'



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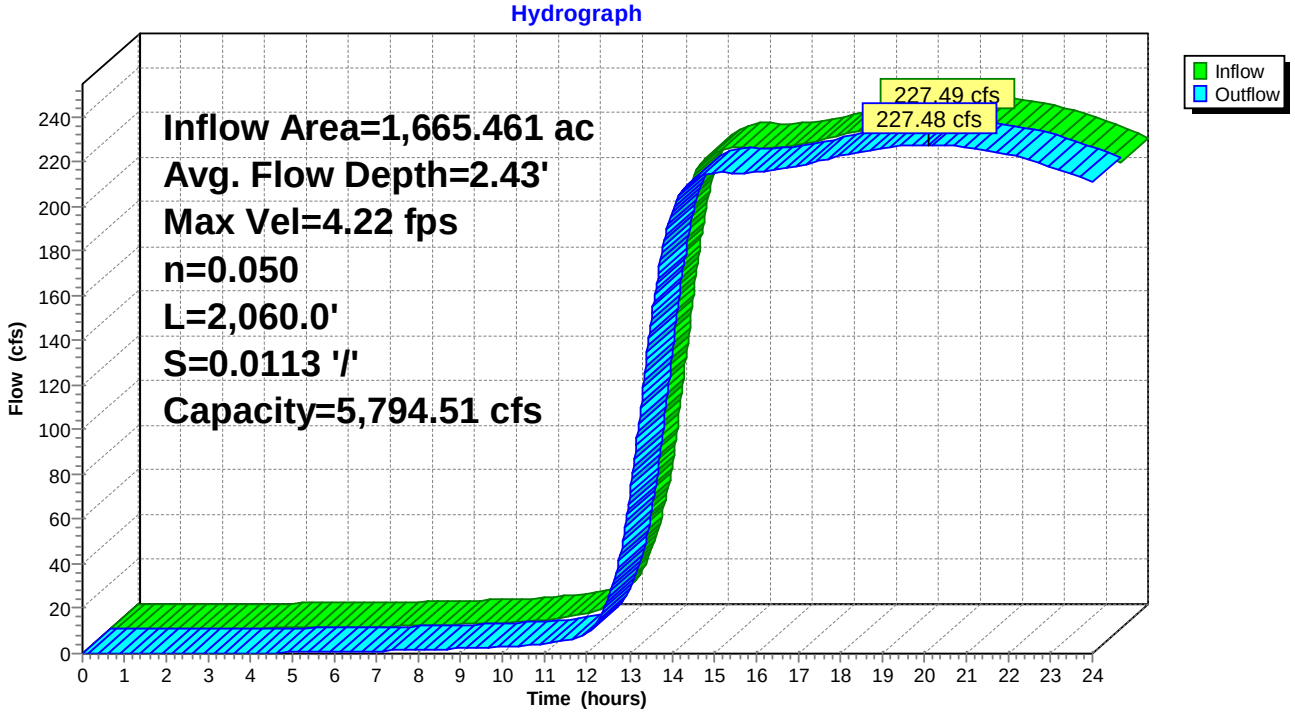
## Reach 18R: KBR 3 to KBR 2



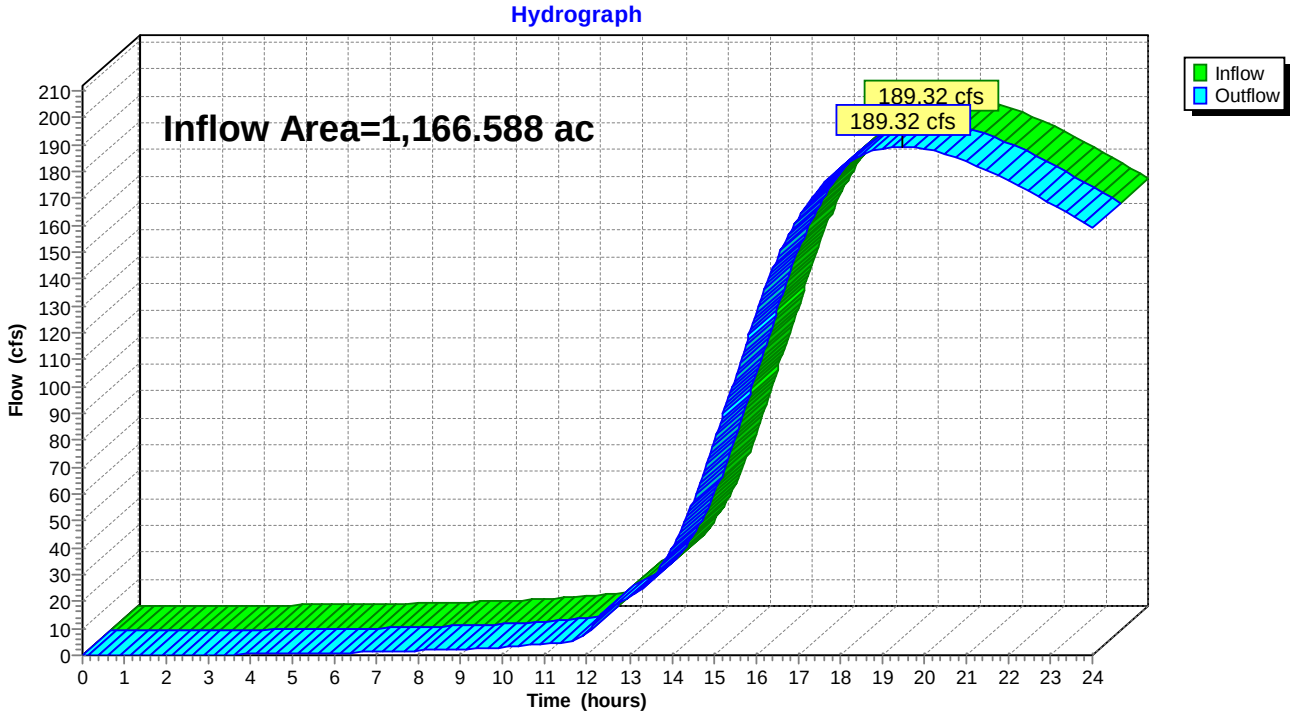
## Summary for Reach 19R: KBR 4 to KBR 3

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,166.588 ac, 14.70% Impervious, Inflow Depth > 1.38" for 100-year event
Inflow = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af
Outflow = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

### Reach 19R: KBR 4 to KBR 3



## Summary for Pond 3P: Waite Pond

[61] Hint: Exceeded Reach 16R outlet invert by 1.31' @ 17.79 hrs

Inflow Area = 3,127.766 ac, 9.16% Impervious, Inflow Depth > 1.89" for 100-year event
Inflow = 811.80 cfs @ 13.95 hrs, Volume= 493.694 af
Outflow = 438.70 cfs @ 17.79 hrs, Volume= 296.465 af, Atten= 46%, Lag= 230.4 min
Primary = 438.70 cfs @ 17.79 hrs, Volume= 296.465 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 823.11' @ 17.79 hrs Surf.Area= 56.860 ac Storage= 214.749 af

Plug-Flow detention time= 296.5 min calculated for 296.465 af (60% of inflow)
Center-of-Mass det. time= 149.6 min ( 1,156.7 - 1,007.1 )

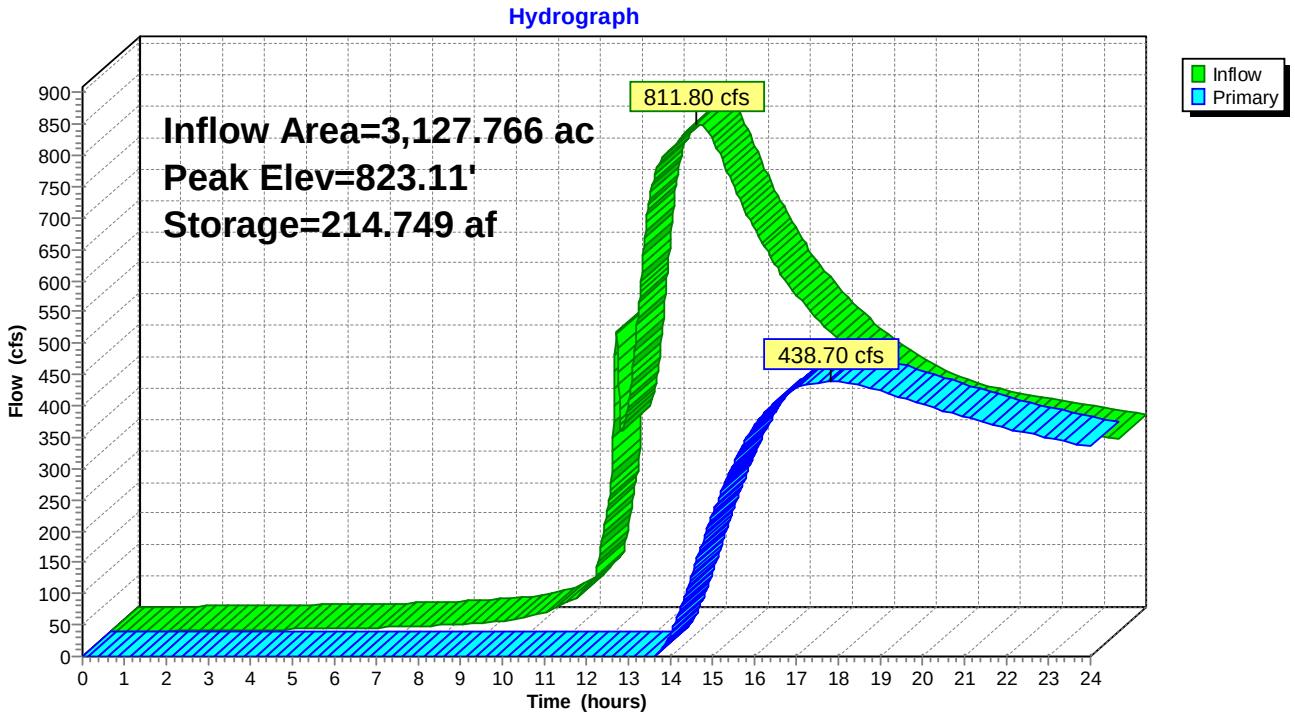
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 819.23' | 2,648.447 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 819.23 | 53.901 | 0.000 | 0.000 | 53.901 |
| 826.80 | 59.750 | 429.979 | 429.979 | 59.830 |
| 836.60 | 115.614 | 844.361 | 1,274.340 | 115.715 |
| 846.40 | 166.350 | 1,374.107 | 2,648.447 | 166.489 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 821.11' | **42.0' long Primary Spillway w/ Weir Boards** 0 End Contraction(s)<br>1.9' Crest Height |
| #2 | Primary | 823.50' | **44.0' long x 25.0' breadth Right Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #3 | Primary | 823.50' | **36.0' long x 25.0' breadth Left Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=437.83 cfs @ 17.79 hrs HW=823.11' (Free Discharge)
- **1=Primary Spillway w/ Weir Boards** (Weir Controls 437.83 cfs @ 5.22 fps)
- **2=Right Embankment Crest** ( Controls 0.00 cfs)
- **3=Left Embankment Crest** ( Controls 0.00 cfs)

## Pond 3P: Waite Pond



## Summary for Pond 6P: Kettle Brook Reservoir No. 1

[61] Hint: Exceeded Reach 17R outlet invert by 1.55' @ 14.06 hrs

Inflow Area = 2,662.411 ac, 9.87% Impervious, Inflow Depth > 1.74" for 100-year event
Inflow = 721.36 cfs @ 13.49 hrs, Volume= 386.048 af
Outflow = 614.30 cfs @ 14.06 hrs, Volume= 367.453 af, Atten= 15%, Lag= 34.5 min
Primary = 614.30 cfs @ 14.06 hrs, Volume= 367.453 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 852.95' @ 14.06 hrs Surf.Area= 17.746 ac Storage= 34.232 af

Plug-Flow detention time= 44.0 min calculated for 367.453 af (95% of inflow)
Center-of-Mass det. time= 24.5 min ( 1,054.2 - 1,029.7 )

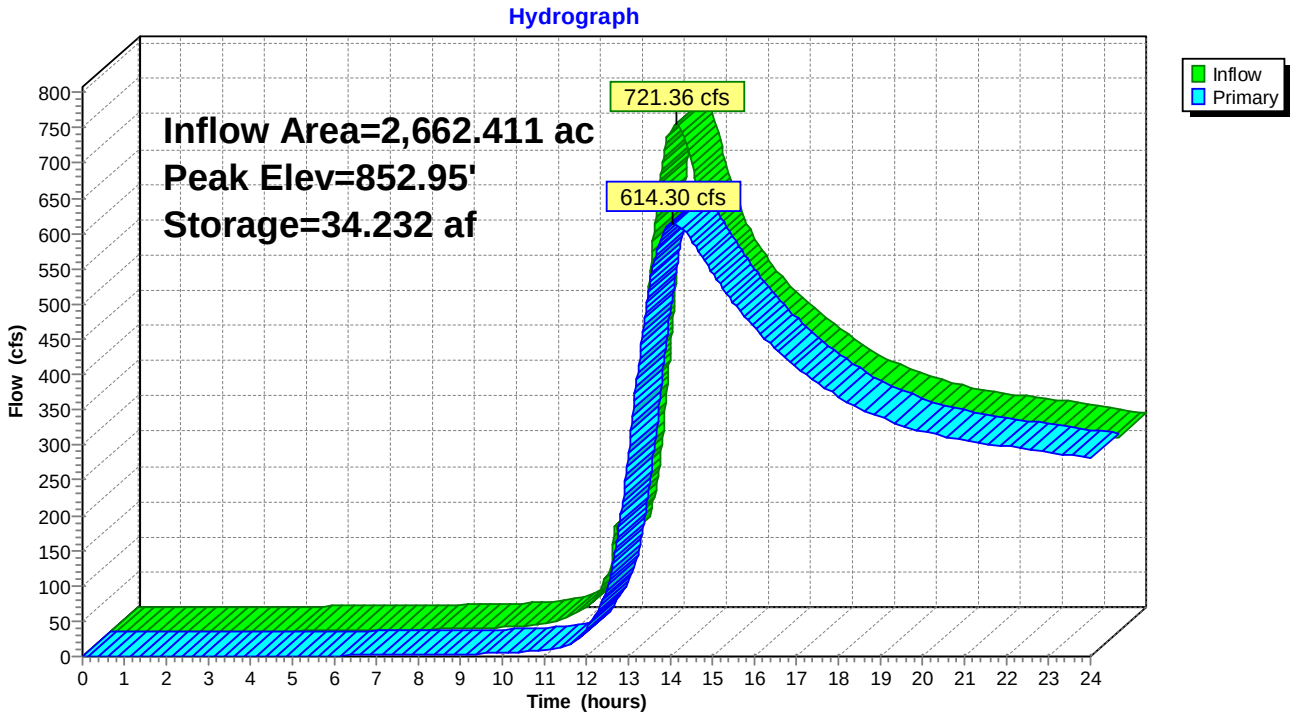
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 850.60' | 476.839 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 850.60 | 11.658 | 0.000 | 0.000 | 11.658 |
| 856.30 | 28.670 | 111.359 | 111.359 | 28.675 |
| 866.10 | 46.643 | 365.480 | 476.839 | 46.677 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 850.60' | **45.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 |
| #2 | Primary | 855.00' | **580.0' long x 25.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=614.18 cfs @ 14.06 hrs HW=852.95' (Free Discharge)
└**1=Primary Spillway** (Weir Controls 614.18 cfs @ 5.82 fps)
└**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 6P: Kettle Brook Reservoir No. 1



## Summary for Pond 9P: Kettle Brook Reservoir No. 2

[62] Hint: Exceeded Reach 18R OUTLET depth by 4.20' @ 1.03 hrs

Inflow Area = 1,982.863 ac, 12.46% Impervious, Inflow Depth > 1.67" for 100-year event
Inflow = 397.49 cfs @ 13.28 hrs, Volume= 275.218 af
Outflow = 276.29 cfs @ 15.85 hrs, Volume= 232.803 af, Atten= 30%, Lag= 154.0 min
Primary = 276.29 cfs @ 15.85 hrs, Volume= 232.803 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 996.46' @ 15.85 hrs Surf.Area= 33.243 ac Storage= 47.203 af

Plug-Flow detention time= 118.9 min calculated for 232.706 af (85% of inflow)
Center-of-Mass det. time= 58.9 min ( 1,103.6 - 1,044.7 )

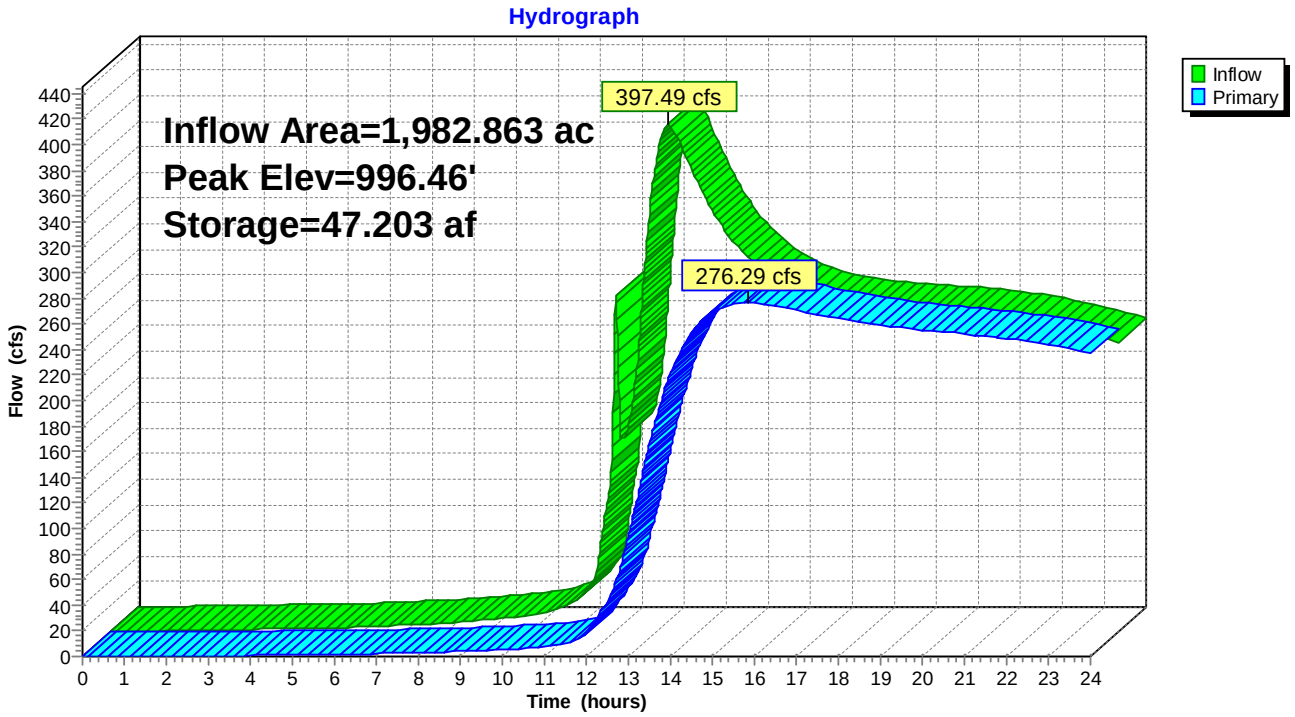
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 995.00' | 1,660.546 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 995.00 | 31.267 | 0.000 | 0.000 | 31.267 |
| 1,003.90 | 44.217 | 334.244 | 334.244 | 44.250 |
| 1,013.80 | 68.192 | 552.157 | 886.401 | 68.258 |
| 1,023.60 | 90.314 | 774.146 | 1,660.546 | 90.429 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 995.00' | **41.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 |
| #2 | Primary | 1,000.00' | **600.0' long x 15.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=275.89 cfs @ 15.85 hrs HW=996.46' (Free Discharge)
└**1=Primary Spillway** (Weir Controls 275.89 cfs @ 4.60 fps)
└**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 9P: Kettle Brook Reservoir No. 2



## Summary for Pond 12P: Kettle Brook Reservoir No. 3

Inflow Area = 1,665.461 ac, 12.89% Impervious, Inflow Depth > 1.96" for 100-year event
Inflow = 648.86 cfs @ 12.96 hrs, Volume= 271.612 af
Outflow = 227.49 cfs @ 19.87 hrs, Volume= 202.299 af, Atten= 65%, Lag= 414.8 min
Primary = 227.49 cfs @ 19.87 hrs, Volume= 202.299 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 1,041.75' @ 19.87 hrs Surf.Area= 45.036 ac Storage= 73.767 af

Plug-Flow detention time= 203.0 min calculated for 202.299 af (74% of inflow)
Center-of-Mass det. time= 97.8 min ( 1,105.3 - 1,007.6 )

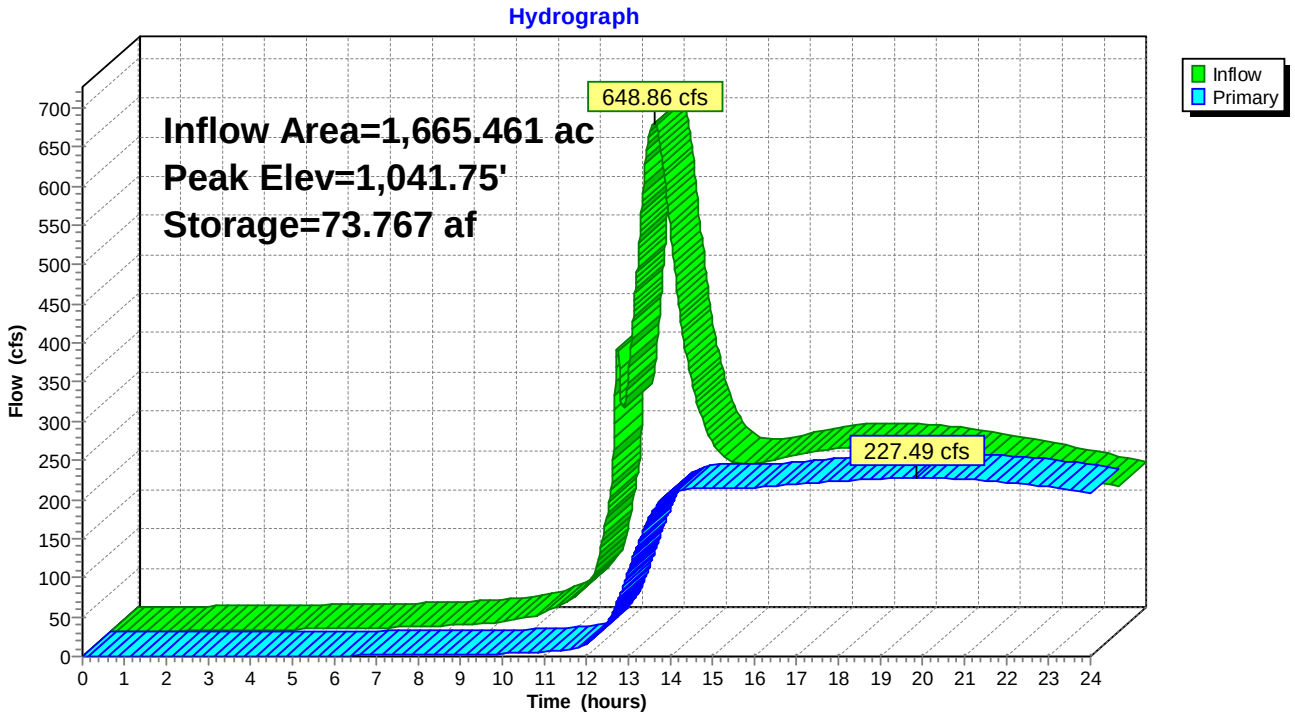
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,040.00' | 2,031.123 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 1,040.00 | 39.207 | 0.000 | 0.000 | 39.207 |
| 1,043.30 | 50.517 | 147.651 | 147.651 | 50.523 |
| 1,053.10 | 97.200 | 711.448 | 859.099 | 97.228 |
| 1,063.00 | 140.922 | 1,172.024 | 2,031.123 | 140.988 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,040.00' | **34.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 |
| #2 | Primary | 1,044.60' | **329.0' long x 15.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=227.40 cfs @ 19.87 hrs HW=1,041.75' (Free Discharge)
└**1=Primary Spillway** (Weir Controls 227.40 cfs @ 3.82 fps)
└**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 12P: Kettle Brook Reservoir No. 3



## Summary for Pond 15P: Kettle Brook Reservoir No. 4

Inflow Area = 1,166.588 ac, 14.70% Impervious, Inflow Depth > 3.35" for 100-year event
Inflow = 830.65 cfs @ 12.08 hrs, Volume= 326.079 af
Outflow = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af, Atten= 77%, Lag= 443.2 min
Primary = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 1,088.80' @ 19.47 hrs Surf.Area= 128.987 ac Storage= 213.882 af

Plug-Flow detention time= 380.8 min calculated for 133.973 af (41% of inflow)
Center-of-Mass det. time= 207.0 min ( 1,155.3 - 948.3 )

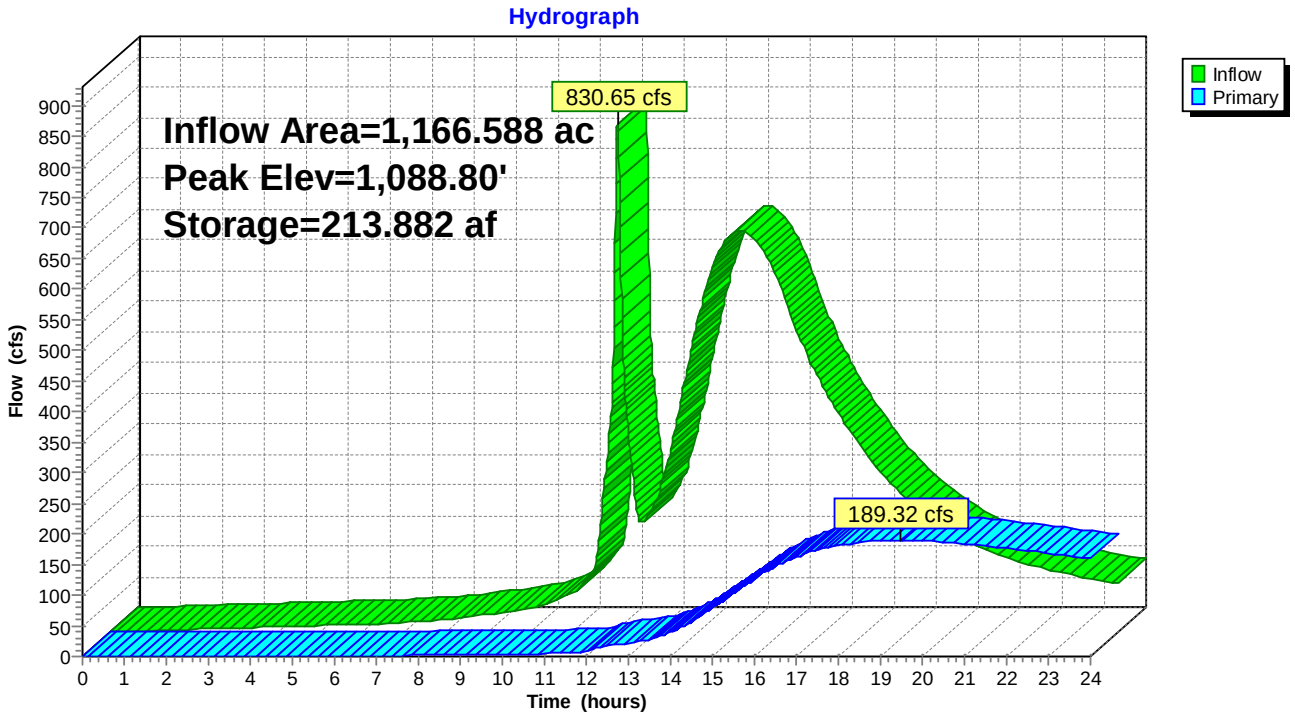
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,087.11' | 4,375.774 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

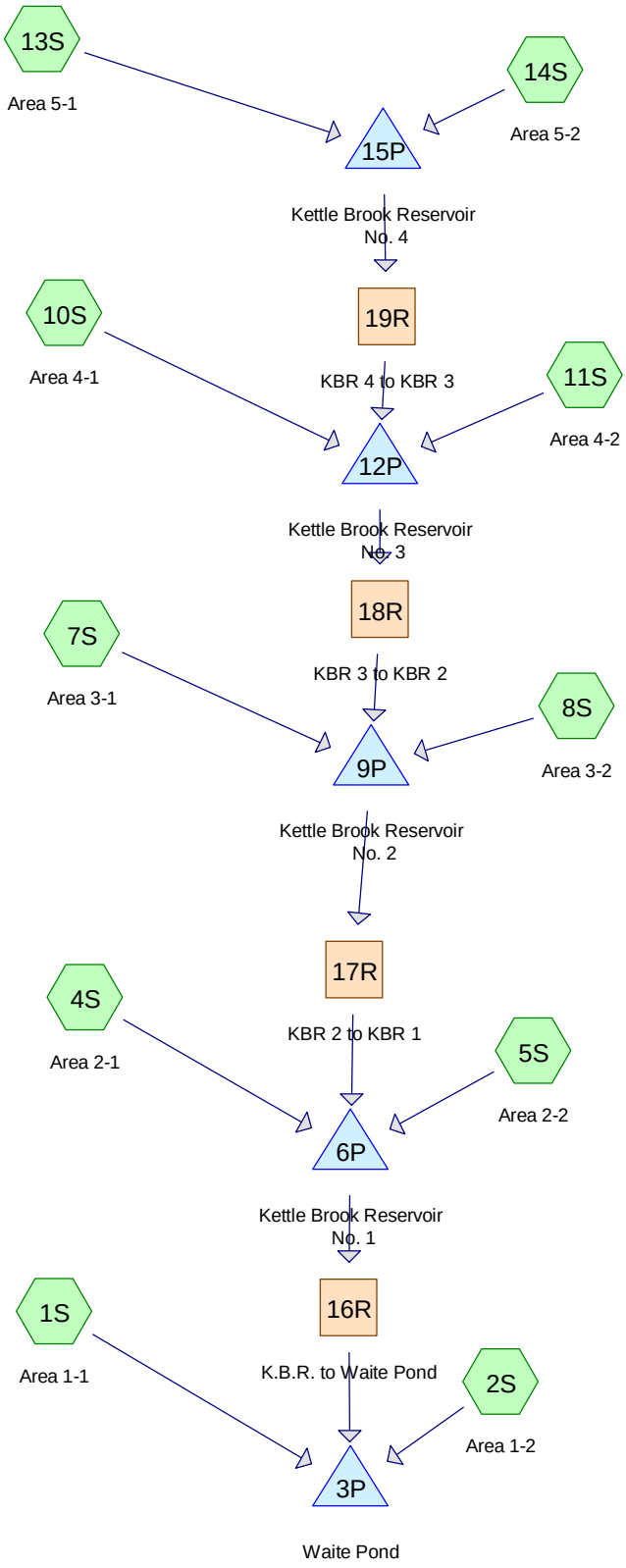
| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 1,087.11 | 124.340 | 0.000 | 0.000 | 124.340 |
| 1,092.50 | 139.470 | 710.578 | 710.578 | 139.506 |
| 1,102.30 | 181.000 | 1,565.889 | 2,276.467 | 181.090 |
| 1,112.20 | 244.700 | 2,099.307 | 4,375.774 | 244.837 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,087.11' | **30.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 |
| #2 | Primary | 1,091.12' | **1,100.0' long x 15.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=189.96 cfs @ 19.47 hrs HW=1,088.80' (Free Discharge)
**1=Primary Spillway** (Weir Controls 189.96 cfs @ 3.75 fps)
**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 15P: Kettle Brook Reservoir No. 4






Scenario: Weir Boards Removed from Spillway

Subcat Reach Pond Link

**Routing Diagram for Waite Pond Dam-Proposed-No Weir Boards**
Prepared by Fuss & O'Neill, Printed 1/21/2015

## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 59.231 | 68 | 1 acre lots, 20% imp, HSG B (1S, 13S) |
| 325.752 | 79 | 1 acre lots, 20% imp, HSG C (1S, 4S, 7S, 10S, 13S) |
| 39.442 | 61 | Pasture/grassland/range, Good, HSG B (1S, 4S, 7S) |
| 143.407 | 74 | Pasture/grassland/range, Good, HSG C (1S, 4S, 7S, 10S, 13S) |
| 0.937 | 80 | Pasture/grassland/range, Good, HSG D (4S) |
| 53.901 | 98 | Water Surface, 0% imp, HSG C (2S) |
| 209.378 | 98 | Water Surface, HSG C (4S, 5S, 8S, 11S, 14S) |
| 521.770 | 55 | Woods, Good, HSG B (1S, 4S, 7S, 10S, 13S) |
| 1,619.398 | 70 | Woods, Good, HSG C (1S, 4S, 7S, 10S, 13S) |
| 154.550 | 77 | Woods, Good, HSG D (1S, 4S, 7S, 10S, 13S) |
| **3,127.766** | **71** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.000 | HSG A | |
| 620.443 | HSG B | 1S, 4S, 7S, 10S, 13S |
| 2,351.836 | HSG C | 1S, 2S, 4S, 5S, 7S, 8S, 10S, 11S, 13S, 14S |
| 155.487 | HSG D | 1S, 4S, 7S, 10S, 13S |
| 0.000 | Other | |
| **3,127.766** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 59.231 | 325.752 | 0.000 | 0.000 | 384.983 | 1 acre lots, 20% imp | 1S, 4S, 7S, 10S, 13S |
| 0.000 | 39.442 | 143.407 | 0.937 | 0.000 | 183.786 | Pasture/grassland/range, Good | 1S, 4S, 7S, 10S, 13S |
| 0.000 | 0.000 | 209.378 | 0.000 | 0.000 | 209.378 | Water Surface | 4S, 5S, 8S, 11S, 14S |
| 0.000 | 0.000 | 53.901 | 0.000 | 0.000 | 53.901 | Water Surface, 0% imp | 2S |
| 0.000 | 521.770 | 1,619.398 | 154.550 | 0.000 | 2,295.718 | Woods, Good | 1S, 4S, 7S, 10S, 13S |
| **0.000** | **620.443** | **2,351.836** | **155.487** | **0.000** | **3,127.766** | **TOTAL AREA** | |

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Area 1-1** Runoff Area=411.454 ac 5.72% Impervious Runoff Depth>3.06"
Flow Length=4,785' Slope=0.0525 '/' Tc=66.5 min CN=69 Runoff=551.38 cfs 104.898 af

**Subcatchment 2S: Area 1-2** Runoff Area=53.901 ac 0.00% Impervious Runoff Depth>6.26"
Flow Length=2,500' Tc=3.3 min CN=98 Runoff=378.29 cfs 28.113 af

**Subcatchment 4S: Area 2-1** Runoff Area=667.890 ac 0.63% Impervious Runoff Depth>2.84"
Flow Length=6,024' Slope=0.0383 '/' Tc=98.7 min CN=67 Runoff=637.60 cfs 158.068 af

**Subcatchment 5S: Area 2-2** Runoff Area=11.658 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=1,540' Tc=2.0 min CN=98 Runoff=85.72 cfs 6.082 af

**Subcatchment 7S: Area 3-1** Runoff Area=286.135 ac 0.35% Impervious Runoff Depth>2.57"
Flow Length=4,084' Slope=0.0394 '/' Tc=77.1 min CN=64 Runoff=288.43 cfs 61.364 af

**Subcatchment 8S: Area 3-2** Runoff Area=31.267 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=2,160' Tc=2.8 min CN=98 Runoff=223.51 cfs 16.309 af

**Subcatchment 10S: Area 4-1** Runoff Area=459.666 ac 0.86% Impervious Runoff Depth>3.06"
Flow Length=3,334' Slope=0.0280 '/' Tc=68.2 min CN=69 Runoff=606.08 cfs 117.138 af

**Subcatchment 11S: Area 4-2** Runoff Area=39.207 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=3,700' Tc=4.9 min CN=98 Runoff=259.79 cfs 20.445 af

**Subcatchment 13S: Area 5-1** Runoff Area=1,042.248 ac 4.53% Impervious Runoff Depth>3.01"
Flow Length=8,740' Slope=0.0118 '/' Tc=221.2 min CN=70 Runoff=629.06 cfs 261.248 af

**Subcatchment 14S: Area 5-2** Runoff Area=124.340 ac 100.00% Impervious Runoff Depth>6.26"
Flow Length=4,326' Tc=5.7 min CN=98 Runoff=801.12 cfs 64.830 af

**Reach 16R: K.B.R. to Waite Pond** Avg. Flow Depth=3.53' Max Vel=3.44 fps Inflow=614.30 cfs 367.453 af
n=0.070 L=1,620.0' S=0.0100 '/' Capacity=3,087.40 cfs Outflow=612.16 cfs 360.683 af

**Reach 17R: KBR 2 to KBR 1** Avg. Flow Depth=2.07' Max Vel=5.45 fps Inflow=276.29 cfs 232.803 af
n=0.050 L=5,320.0' S=0.0240 '/' Capacity=11,169.75 cfs Outflow=275.93 cfs 221.898 af

**Reach 18R: KBR 3 to KBR 2** Avg. Flow Depth=2.43' Max Vel=4.22 fps Inflow=227.49 cfs 202.299 af
n=0.050 L=2,060.0' S=0.0113 '/' Capacity=5,794.51 cfs Outflow=227.48 cfs 197.546 af

**Reach 19R: KBR 4 to KBR 3** Inflow=189.32 cfs 134.029 af
Outflow=189.32 cfs 134.029 af

**Pond 3P: Waite Pond** Peak Elev=821.97' Storage=150.533 af Inflow=811.80 cfs 493.694 af
Outflow=501.14 cfs 376.051 af

**Pond 6P: Kettle Brook Reservoir No. 1** Peak Elev=852.95' Storage=34.232 af Inflow=721.36 cfs 386.048 af
Outflow=614.30 cfs 367.453 af

**Pond 9P: Kettle Brook Reservoir No. 2** Peak Elev=996.46' Storage=47.203 af Inflow=397.49 cfs 275.218 af
Outflow=276.29 cfs 232.803 af

**Pond 12P: Kettle Brook Reservoir No. 3** Peak Elev=1,041.75' Storage=73.767 af Inflow=648.86 cfs 271.612 af
Outflow=227.49 cfs 202.299 af

**Pond 15P: Kettle Brook Reservoir No. 4** Peak Elev=1,088.80' Storage=213.882 af Inflow=830.65 cfs 326.079 af
Outflow=189.32 cfs 134.029 af

**Total Runoff Area = 3,127.766 ac Runoff Volume = 838.494 af Average Runoff Depth = 3.22"**
**90.84% Pervious = 2,841.391 ac 9.16% Impervious = 286.375 ac**

## Summary for Subcatchment 1S: Area 1-1

Overland runoff to Waite Pond.

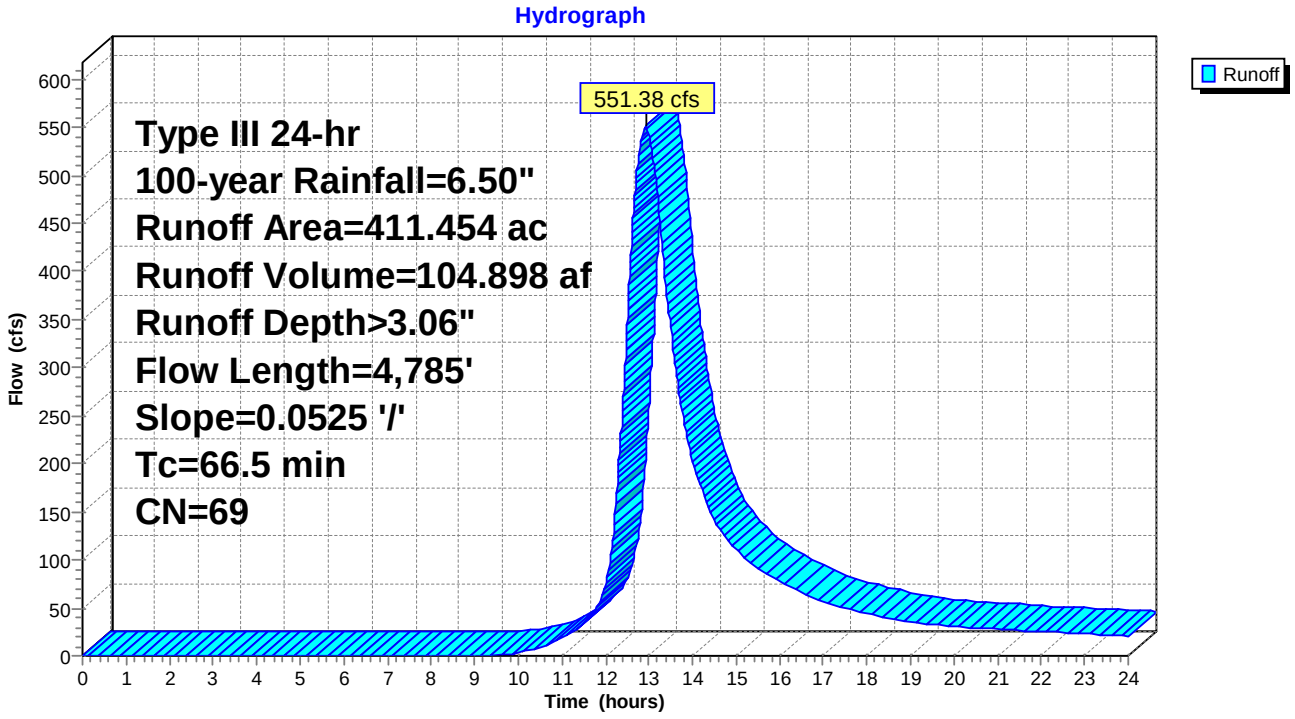
Runoff = 551.38 cfs @ 12.93 hrs, Volume= 104.898 af, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 49.447 | 68 | 1 acre lots, 20% imp, HSG B |
| 13.446 | 61 | Pasture/grassland/range, Good, HSG B |
| 70.642 | 55 | Woods, Good, HSG B |
| 68.149 | 79 | 1 acre lots, 20% imp, HSG C |
| 4.689 | 74 | Pasture/grassland/range, Good, HSG C |
| 170.963 | 70 | Woods, Good, HSG C |
| 34.118 | 77 | Woods, Good, HSG D |
| 411.454 | 69 | Weighted Average |
| 387.935 | | 94.28% Pervious Area |
| 23.519 | | 5.72% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 66.5 | 4,785 | 0.0525 | 1.20 | | **Lag/CN Method,** |

### Subcatchment 1S: Area 1-1



## Summary for Subcatchment 2S: Area 1-2

Direct precipitation to Waite Pond.

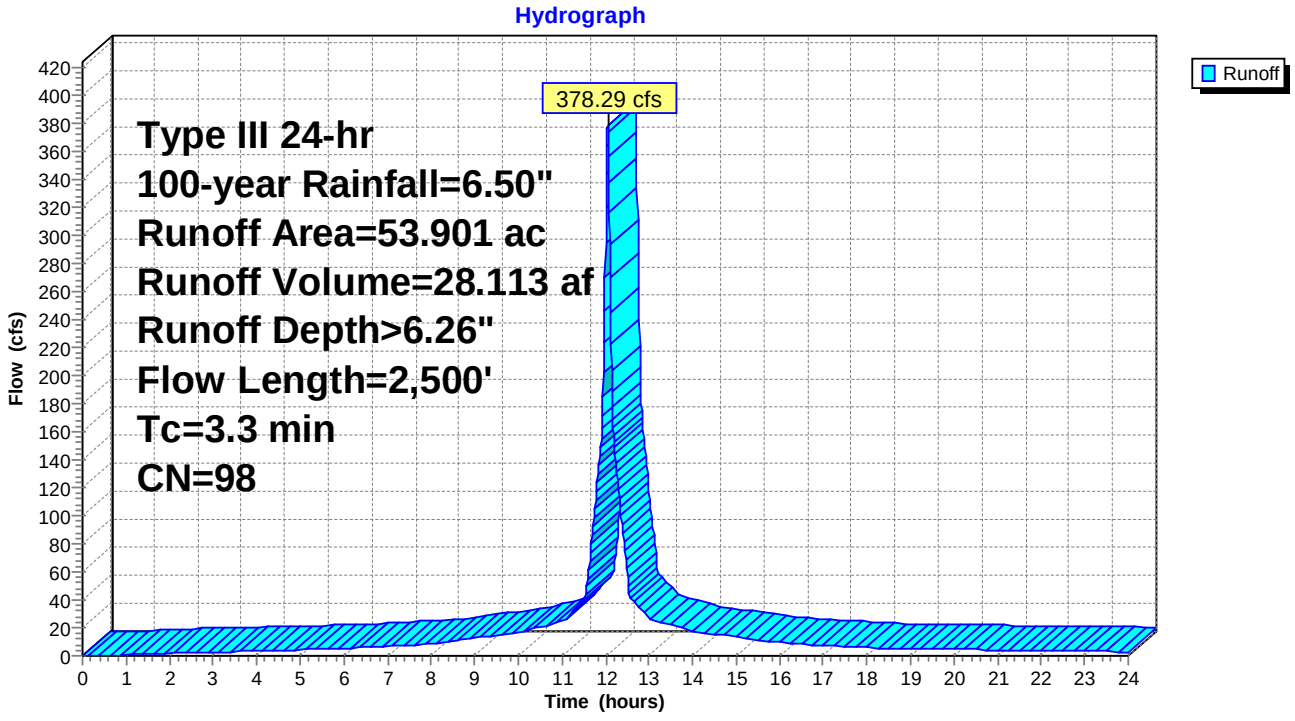
Runoff = 378.29 cfs @ 12.05 hrs, Volume= 28.113 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 53.901 | 98 | Water Surface, 0% imp, HSG C |
| 53.901 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.3 | 2,500 | | 12.69 | | **Lake or Reservoir, Estimated travel time through Waite Pond.** Mean Depth= 5.00' |

### Subcatchment 2S: Area 1-2



## Summary for Subcatchment 4S: Area 2-1

Overland runoff to Kettle Brook Reservoir No. 1.

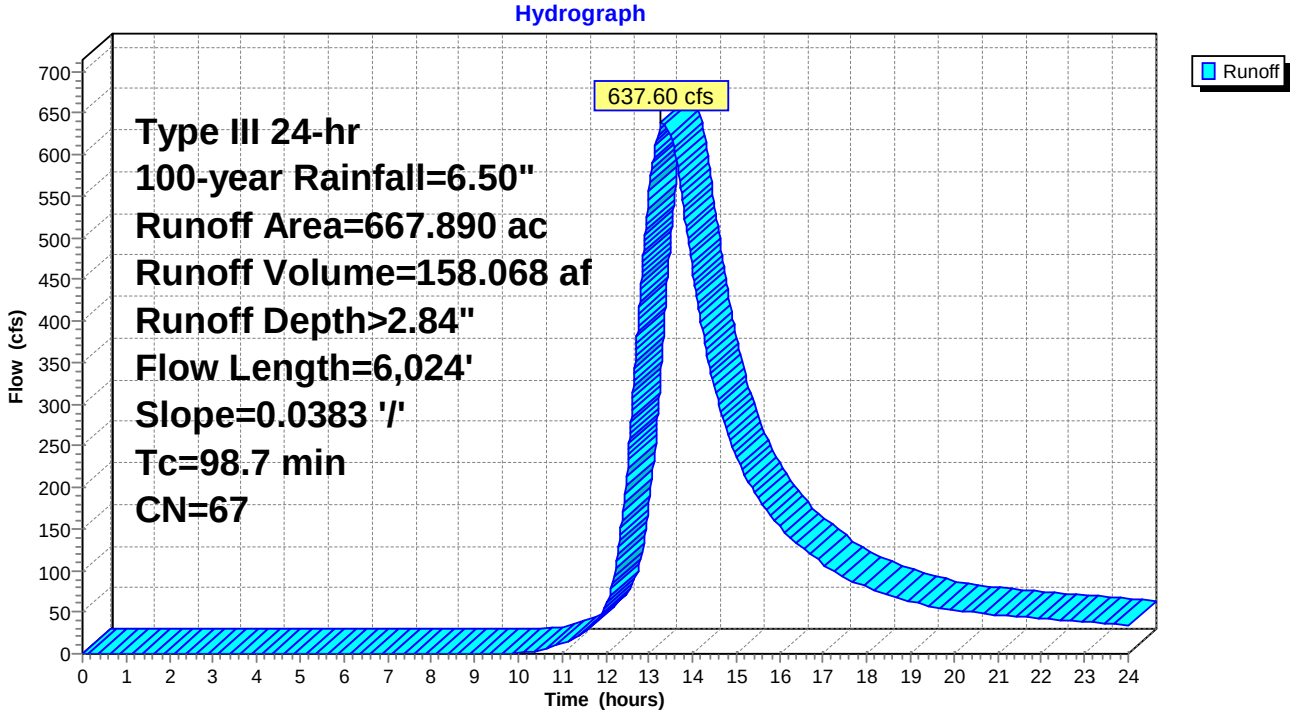
Runoff = 637.60 cfs @ 13.28 hrs, Volume= 158.068 af, Depth> 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 6.557 | 79 | 1 acre lots, 20% imp, HSG C |
| 23.867 | 61 | Pasture/grassland/range, Good, HSG B |
| 95.923 | 74 | Pasture/grassland/range, Good, HSG C |
| 0.937 | 80 | Pasture/grassland/range, Good, HSG D |
| 152.437 | 55 | Woods, Good, HSG B |
| 348.095 | 70 | Woods, Good, HSG C |
| 37.168 | 77 | Woods, Good, HSG D |
| 2.906 | 98 | Water Surface, HSG C |
| 667.890 | 67 | Weighted Average |
| 663.673 | | 99.37% Pervious Area |
| 4.217 | | 0.63% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 98.7 | 6,024 | 0.0383 | 1.02 | | **Lag/CN Method,** |

### Subcatchment 4S: Area 2-1



## Summary for Subcatchment 5S: Area 2-2

Direct precipitation to Kettle Brook Reservoir No. 1.

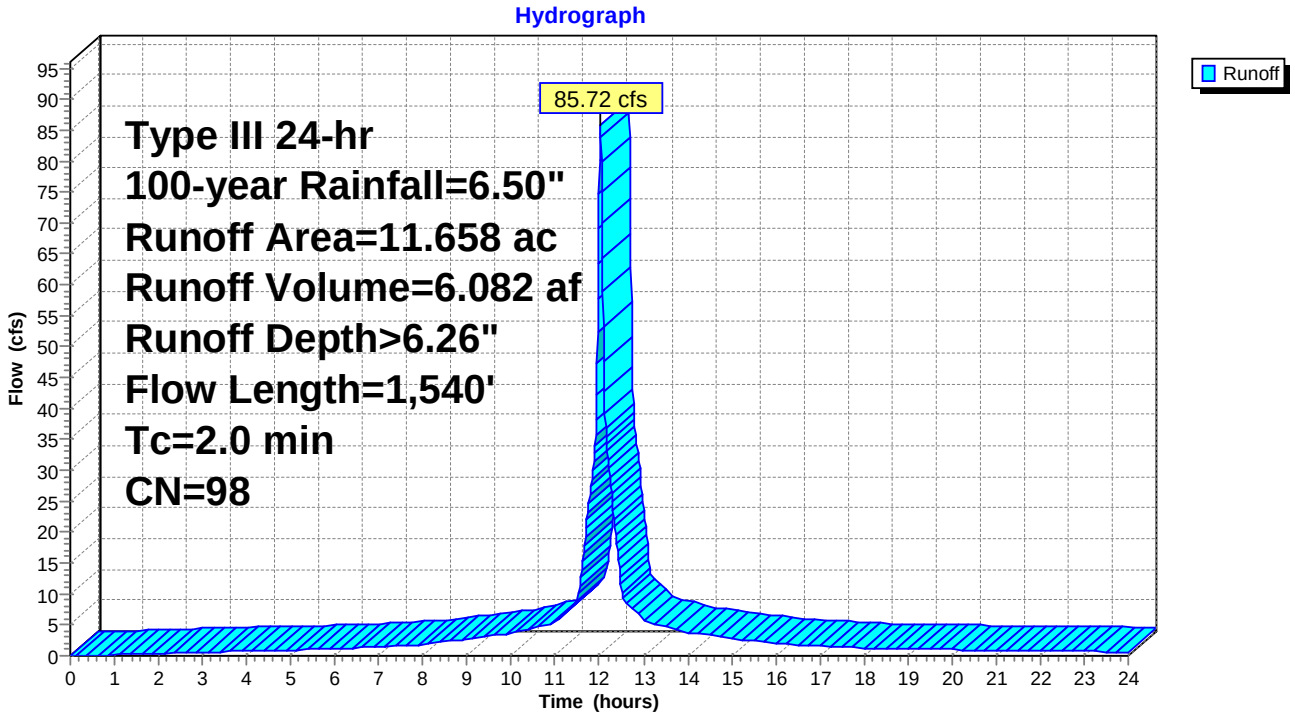
Runoff = 85.72 cfs @ 12.03 hrs, Volume= 6.082 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 11.658 | 98 | Water Surface, HSG C |
| 11.658 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.0 | 1,540 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 5S: Area 2-2



## Summary for Subcatchment 7S: Area 3-1

Overland runoff to Kettle Brook Reservoir No. 2.

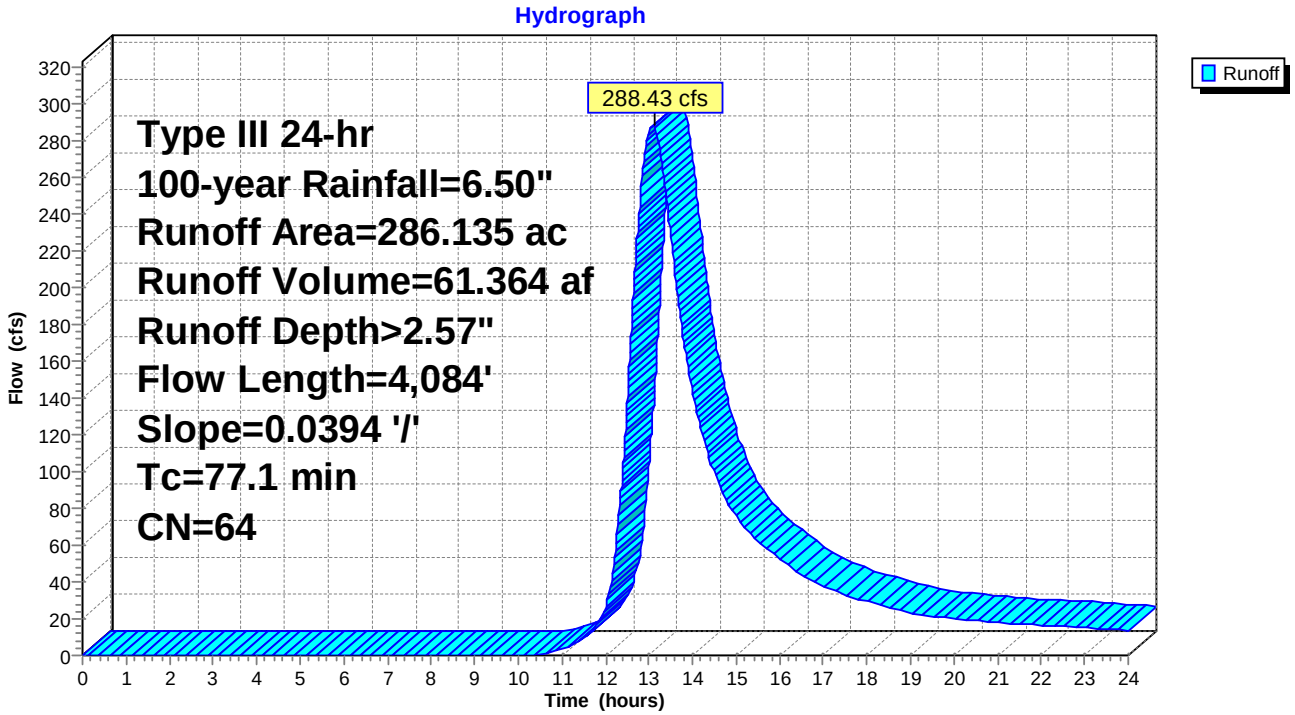
Runoff = 288.43 cfs @ 13.10 hrs, Volume= 61.364 af, Depth> 2.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 5.050 | 79 | 1 acre lots, 20% imp, HSG C |
| 2.129 | 61 | Pasture/grassland/range, Good, HSG B |
| 14.941 | 74 | Pasture/grassland/range, Good, HSG C |
| 115.991 | 55 | Woods, Good, HSG B |
| 139.035 | 70 | Woods, Good, HSG C |
| 8.989 | 77 | Woods, Good, HSG D |
| 286.135 | 64 | Weighted Average |
| 285.125 | | 99.65% Pervious Area |
| 1.010 | | 0.35% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 77.1 | 4,084 | 0.0394 | 0.88 | | **Lag/CN Method,** |

### Subcatchment 7S: Area 3-1



## Summary for Subcatchment 8S: Area 3-2

Direct precipitation to Kettle Brook Reservoir No. 2.

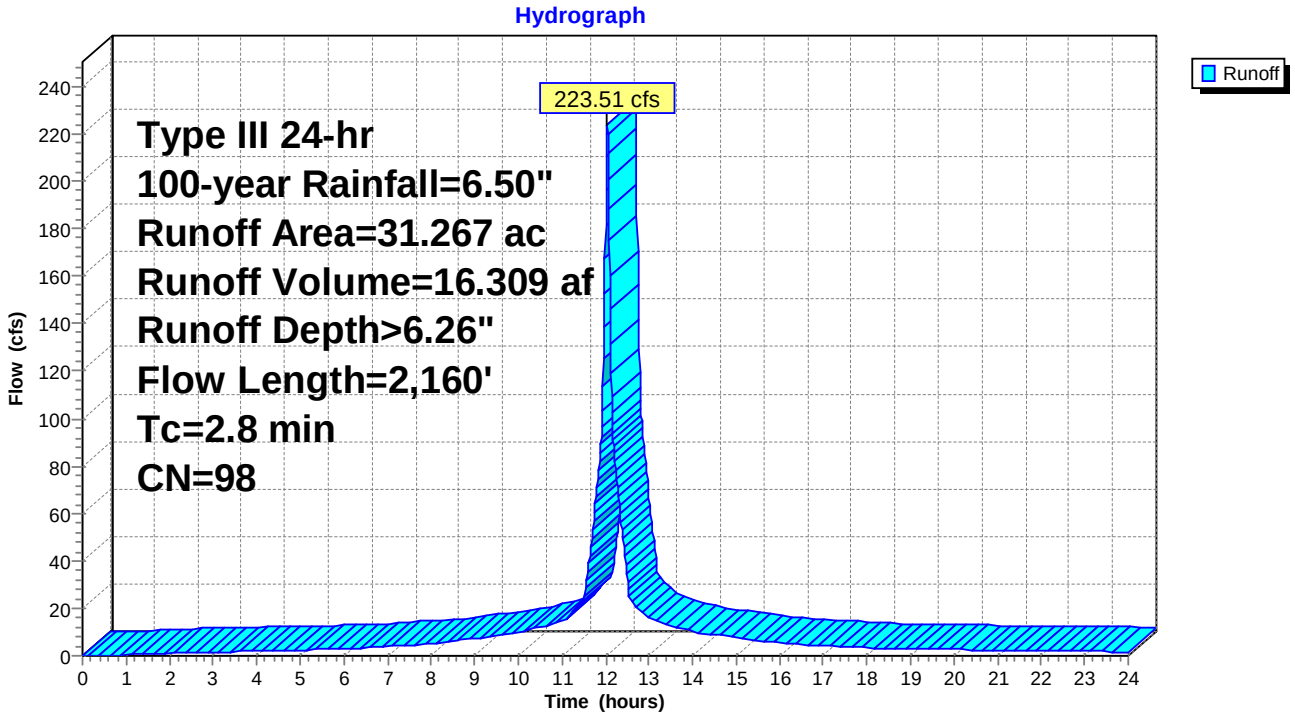
Runoff = 223.51 cfs @ 12.04 hrs, Volume= 16.309 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 31.267 | 98 | Water Surface, HSG C |
| 31.267 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.8 | 2,160 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 8S: Area 3-2



## Summary for Subcatchment 10S: Area 4-1

Overland runoff to Kettle Brook Reservoir No. 3.

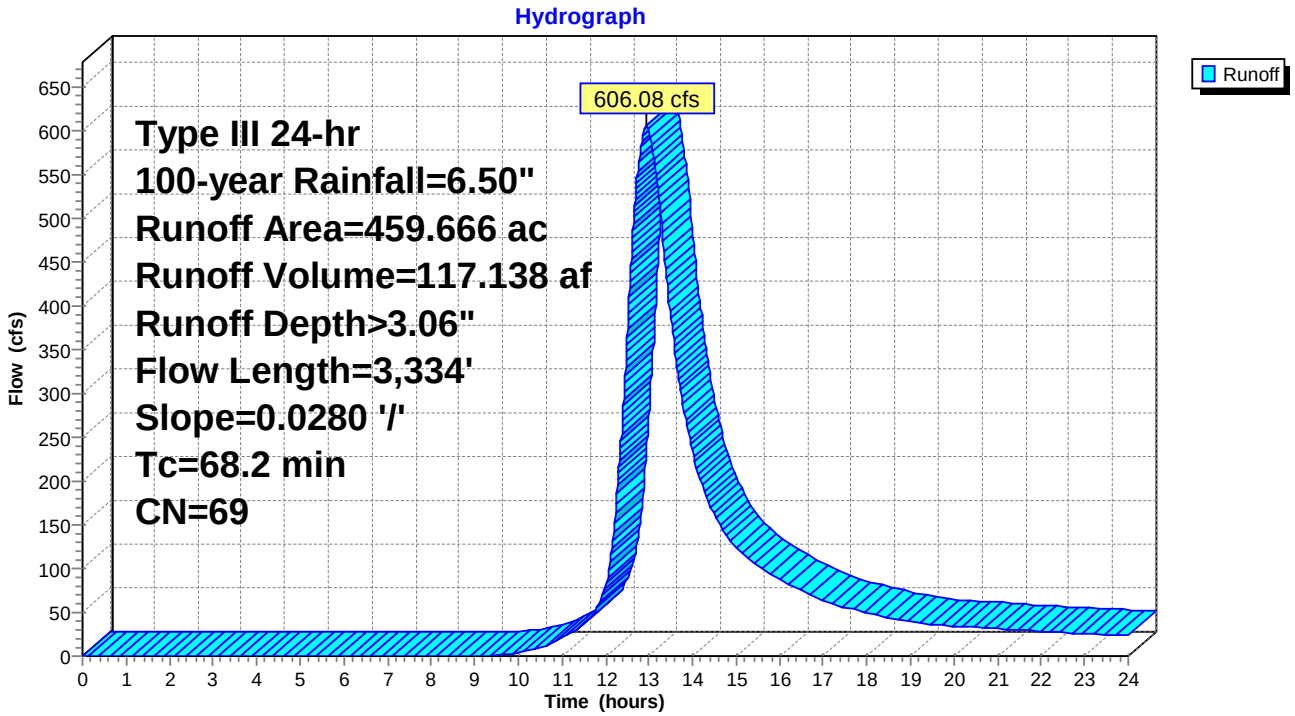
Runoff = 606.08 cfs @ 12.96 hrs, Volume= 117.138 af, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 19.759 | 79 | 1 acre lots, 20% imp, HSG C |
| 7.916 | 74 | Pasture/grassland/range, Good, HSG C |
| 48.751 | 55 | Woods, Good, HSG B |
| 367.701 | 70 | Woods, Good, HSG C |
| 15.539 | 77 | Woods, Good, HSG D |
| 459.666 | 69 | Weighted Average |
| 455.714 | | 99.14% Pervious Area |
| 3.952 | | 0.86% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 68.2 | 3,334 | 0.0280 | 0.81 | | **Lag/CN Method,** |

### Subcatchment 10S: Area 4-1



## Summary for Subcatchment 11S: Area 4-2

Direct precipitation to Kettle Brook Reservoir No. 3.

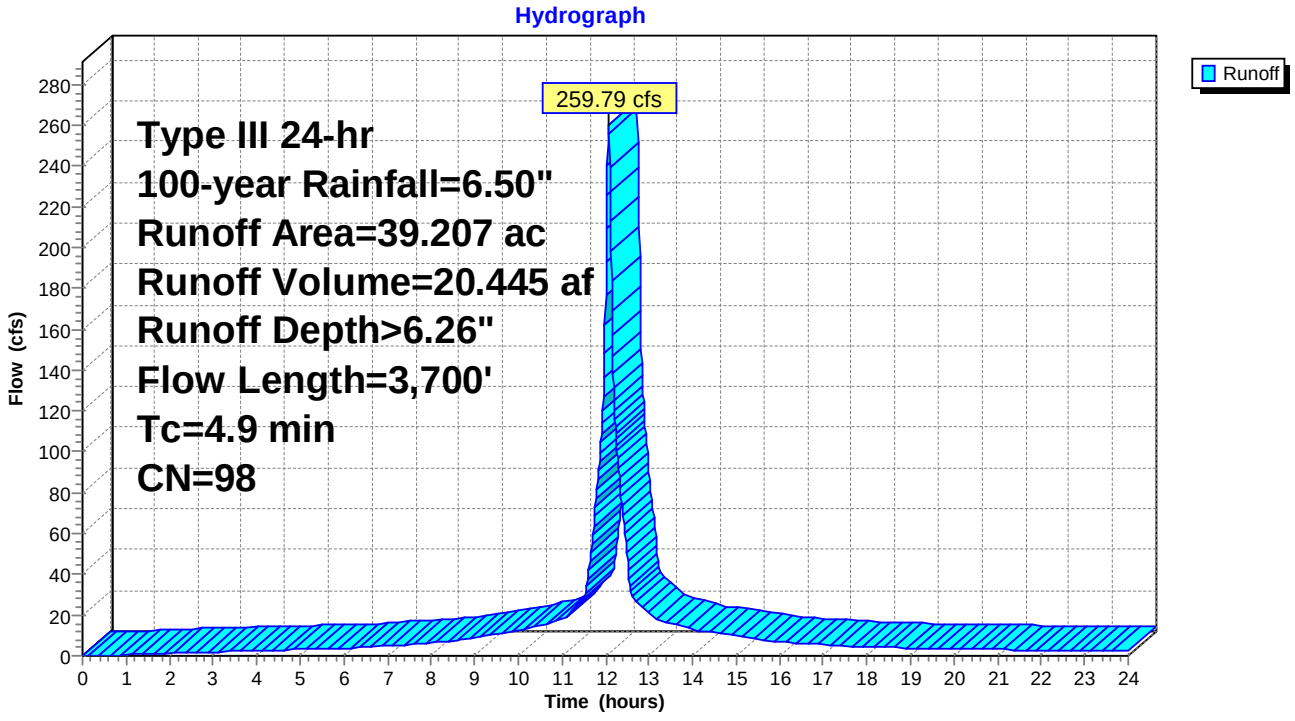
Runoff = 259.79 cfs @ 12.07 hrs, Volume= 20.445 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 39.207 | 98 | Water Surface, HSG C |
| 39.207 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.9 | 3,700 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 11S: Area 4-2



## Summary for Subcatchment 13S: Area 5-1

Overland runoff to Kettle Brook Reservoir No. 4.

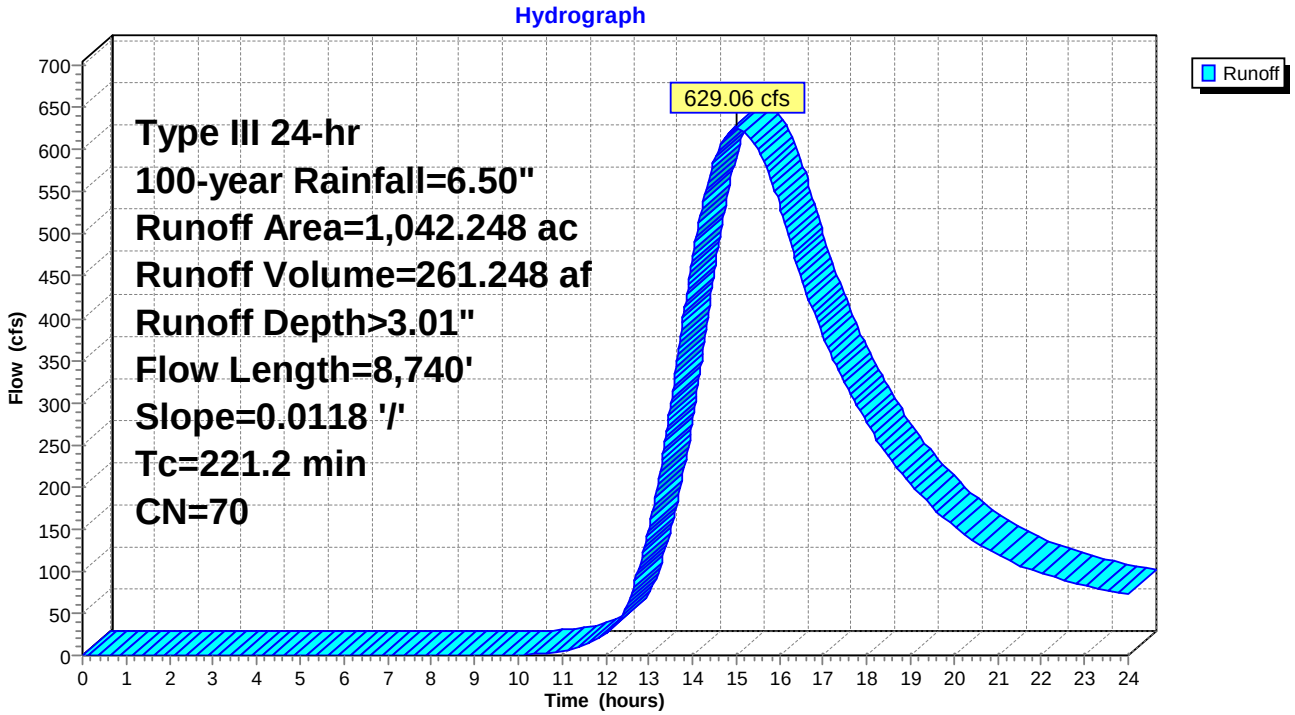
Runoff = 629.06 cfs @ 14.99 hrs, Volume= 261.248 af, Depth> 3.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 9.784 | 68 | 1 acre lots, 20% imp, HSG B |
| 226.237 | 79 | 1 acre lots, 20% imp, HSG C |
| 19.938 | 74 | Pasture/grassland/range, Good, HSG C |
| 133.949 | 55 | Woods, Good, HSG B |
| 593.604 | 70 | Woods, Good, HSG C |
| 58.736 | 77 | Woods, Good, HSG D |
| 1,042.248 | 70 | Weighted Average |
| 995.044 | | 95.47% Pervious Area |
| 47.204 | | 4.53% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 221.2 | 8,740 | 0.0118 | 0.66 | | **Lag/CN Method,** |

### Subcatchment 13S: Area 5-1



## Summary for Subcatchment 14S: Area 5-2

Direct precipitation to Kettle Brook Reservoir No. 4.

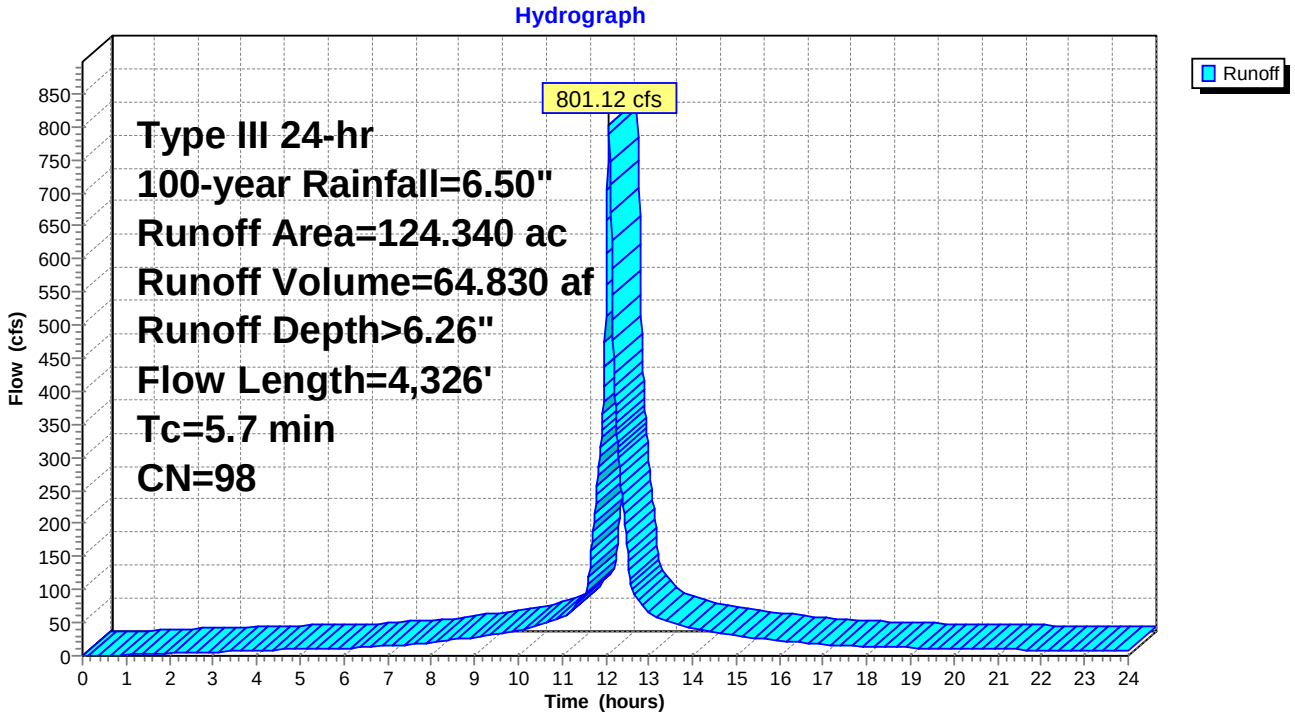
Runoff = 801.12 cfs @ 12.08 hrs, Volume= 64.830 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 124.340 | 98 | Water Surface, HSG C |
| 124.340 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 5.7 | 4,326 | | 12.69 | | **Lake or Reservoir,** Mean Depth= 5.00' |

### Subcatchment 14S: Area 5-2



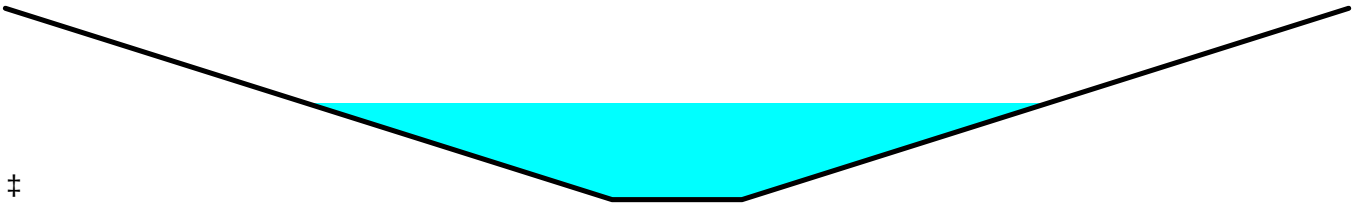
## Summary for Reach 16R: K.B.R. to Waite Pond

Inflow Area = 2,662.411 ac, 9.87% Impervious, Inflow Depth > 1.66" for 100-year event
Inflow = 614.30 cfs @ 14.06 hrs, Volume= 367.453 af
Outflow = 612.16 cfs @ 14.30 hrs, Volume= 360.683 af, Atten= 0%, Lag= 14.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.44 fps, Min. Travel Time= 7.8 min
Avg. Velocity = 1.81 fps, Avg. Travel Time= 14.9 min

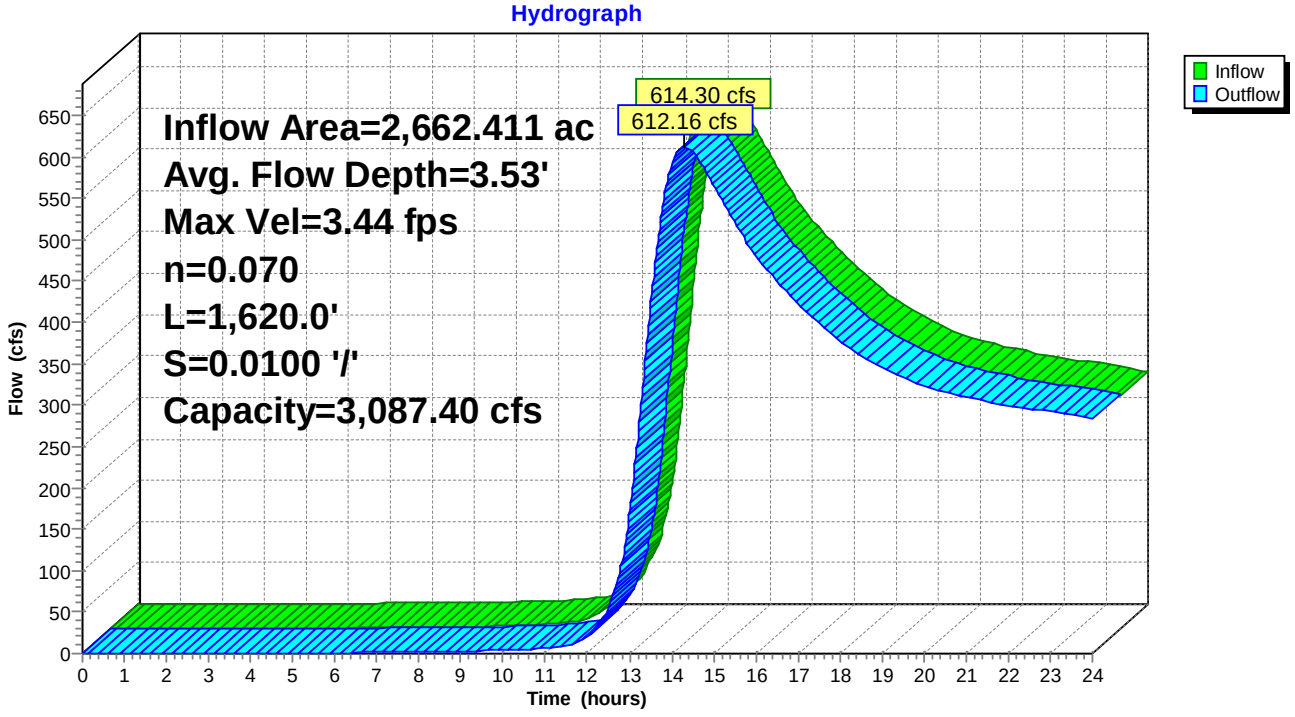
Peak Storage= 287,899 cf @ 14.17 hrs
Average Depth at Peak Storage= 3.53'
Bank-Full Depth= 7.00' Flow Area= 595.0 sf, Capacity= 3,087.40 cfs

15.00' x 7.00' deep channel, n= 0.070 Sluggish weedy reaches w/pools
Side Slope Z-value= 10.0 '/' Top Width= 155.00'
Length= 1,620.0' Slope= 0.0100 '/'
Inlet Invert= 838.00', Outlet Invert= 821.80'



‡

## Reach 16R: K.B.R. to Waite Pond



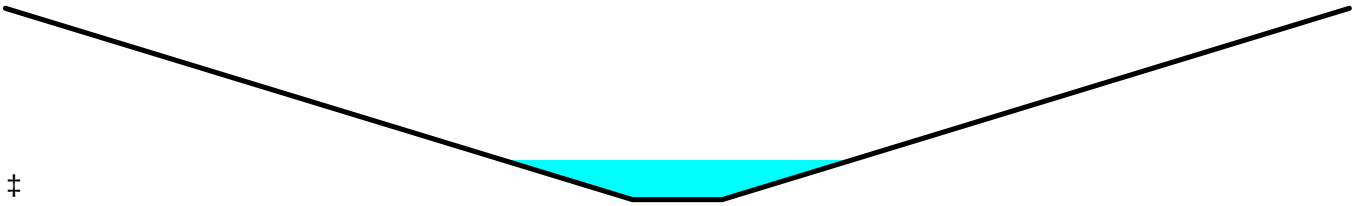
## Summary for Reach 17R: KBR 2 to KBR 1

Inflow Area = 1,982.863 ac, 12.46% Impervious, Inflow Depth > 1.41" for 100-year event
Inflow = 276.29 cfs @ 15.85 hrs, Volume= 232.803 af
Outflow = 275.93 cfs @ 16.35 hrs, Volume= 221.898 af, Atten= 0%, Lag= 30.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.45 fps, Min. Travel Time= 16.3 min
Avg. Velocity = 3.22 fps, Avg. Travel Time= 27.6 min

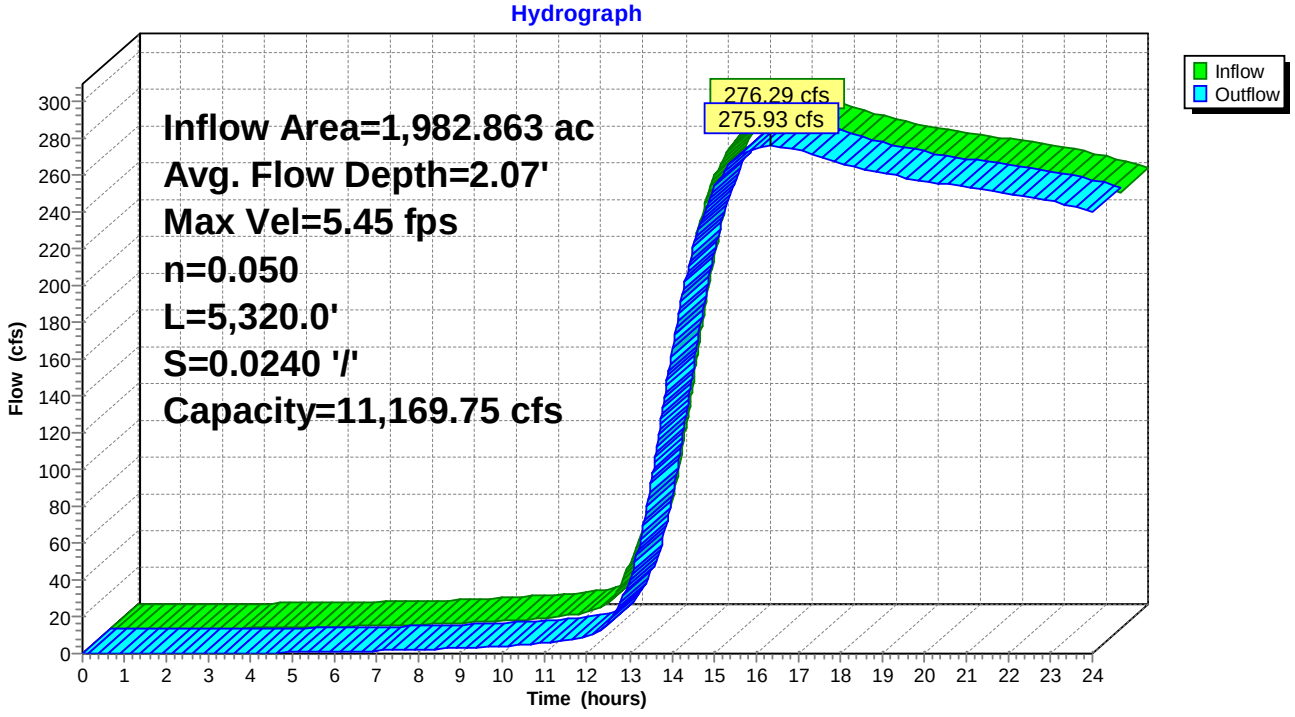
Peak Storage= 269,143 cf @ 16.08 hrs
Average Depth at Peak Storage= 2.07'
Bank-Full Depth= 10.00' Flow Area= 800.0 sf, Capacity= 11,169.75 cfs

10.00' x 10.00' deep channel, n= 0.050
Side Slope Z-value= 7.0 '/' Top Width= 150.00'
Length= 5,320.0' Slope= 0.0240 '/'
Inlet Invert= 979.00', Outlet Invert= 851.40'



‡

### Reach 17R: KBR 2 to KBR 1



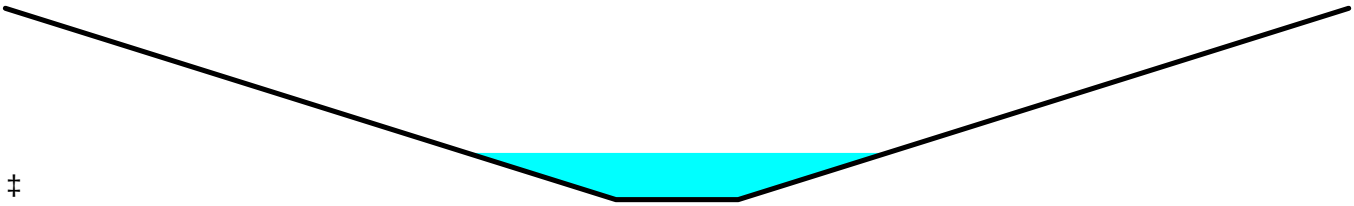
## Summary for Reach 18R: KBR 3 to KBR 2

Inflow Area = 1,665.461 ac, 12.89% Impervious, Inflow Depth > 1.46" for 100-year event
Inflow = 227.49 cfs @ 19.87 hrs, Volume= 202.299 af
Outflow = 227.48 cfs @ 20.11 hrs, Volume= 197.546 af, Atten= 0%, Lag= 14.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.22 fps, Min. Travel Time= 8.1 min
Avg. Velocity = 2.50 fps, Avg. Travel Time= 13.7 min

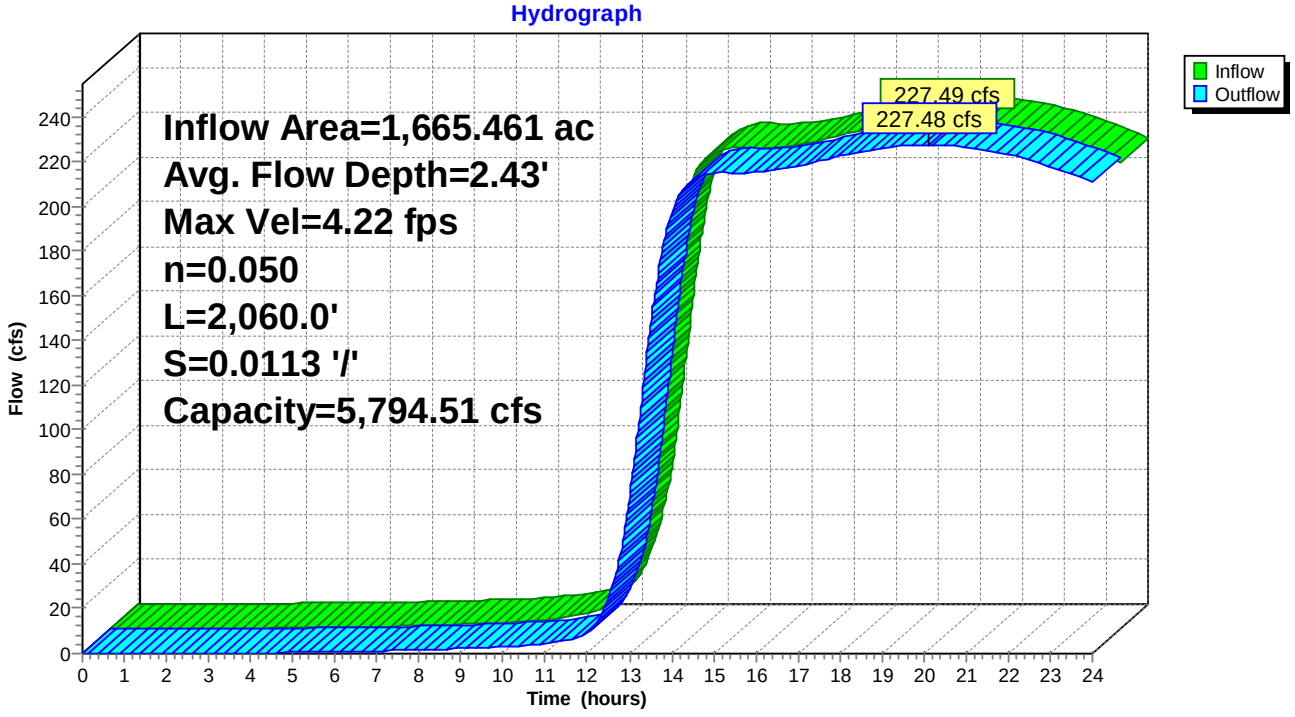
Peak Storage= 110,991 cf @ 19.97 hrs
Average Depth at Peak Storage= 2.43'
Bank-Full Depth= 10.00' Flow Area= 600.0 sf, Capacity= 5,794.51 cfs

10.00' x 10.00' deep channel, n= 0.050
Side Slope Z-value= 5.0 '/' Top Width= 110.00'
Length= 2,060.0' Slope= 0.0113 '/'
Inlet Invert= 1,014.00', Outlet Invert= 990.80'



‡

## Reach 18R: KBR 3 to KBR 2



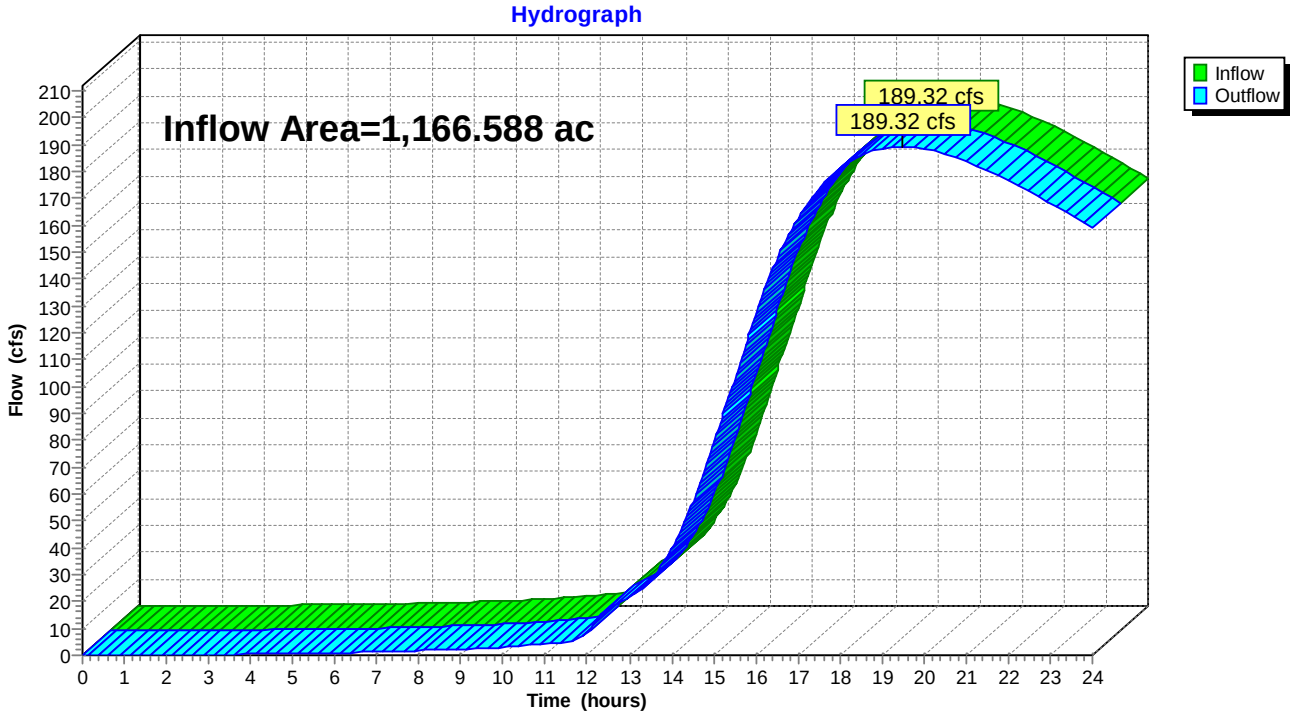
## Summary for Reach 19R: KBR 4 to KBR 3

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1,166.588 ac, 14.70% Impervious, Inflow Depth > 1.38" for 100-year event
Inflow = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af
Outflow = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

### Reach 19R: KBR 4 to KBR 3



## Summary for Pond 3P: Waite Pond

[61] Hint: Exceeded Reach 16R outlet invert by 0.17' @ 16.80 hrs

Inflow Area = 3,127.766 ac, 9.16% Impervious, Inflow Depth > 1.89" for 100-year event
Inflow = 811.80 cfs @ 13.95 hrs, Volume= 493.694 af
Outflow = 501.14 cfs @ 16.80 hrs, Volume= 376.051 af, Atten= 38%, Lag= 171.1 min
Primary = 501.14 cfs @ 16.80 hrs, Volume= 376.051 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 821.97' @ 16.80 hrs Surf.Area= 55.983 ac Storage= 150.533 af

Plug-Flow detention time= 195.8 min calculated for 376.051 af (76% of inflow)
Center-of-Mass det. time= 101.6 min ( 1,108.7 - 1,007.1 )

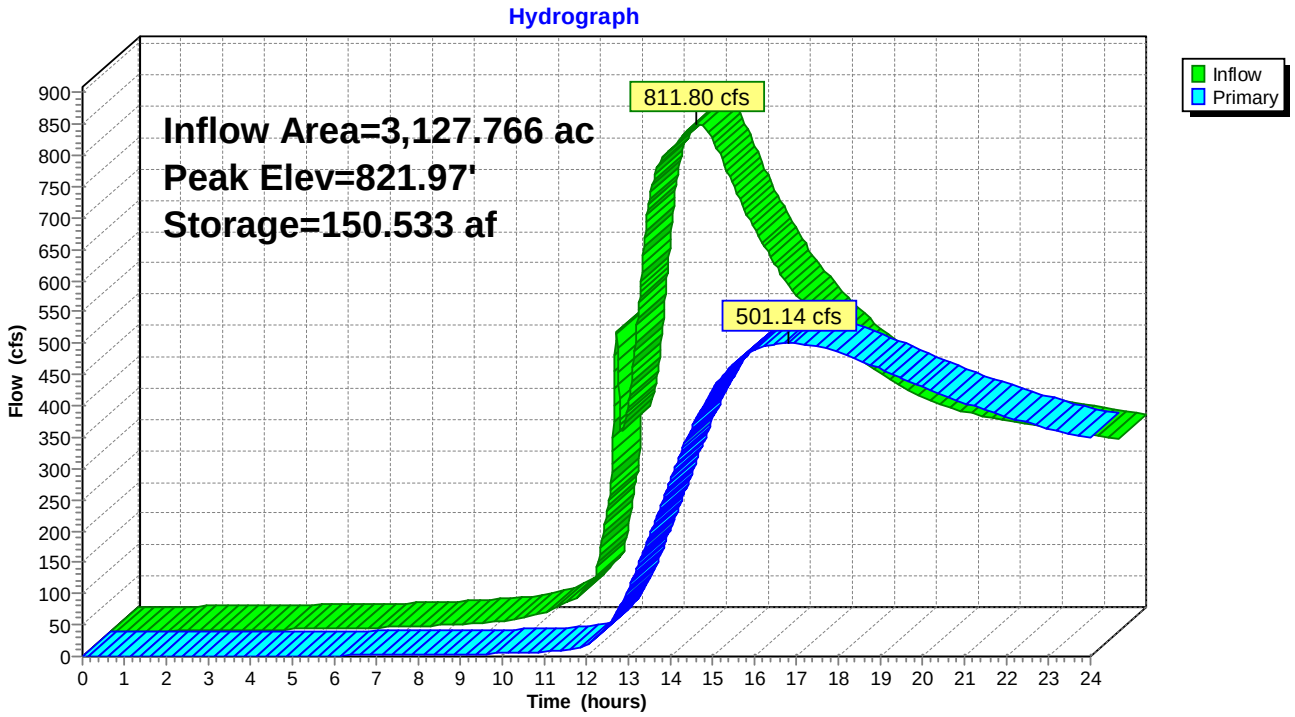
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 819.23' | 2,648.447 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 819.23 | 53.901 | 0.000 | 0.000 | 53.901 |
| 826.80 | 59.750 | 429.979 | 429.979 | 59.830 |
| 836.60 | 115.614 | 844.361 | 1,274.340 | 115.715 |
| 846.40 | 166.350 | 1,374.107 | 2,648.447 | 166.489 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 819.23' | **42.0' long x 32.0' breadth Primary Spillway** |
| | | | Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 |
| | | | Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 823.50' | **44.0' long x 25.0' breadth Right Embankment Crest** |
| | | | Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 |
| | | | Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #3 | Primary | 823.50' | **36.0' long x 25.0' breadth Left Embankment Crest** |
| | | | Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 |
| | | | Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=501.00 cfs @ 16.80 hrs HW=821.97' (Free Discharge)
- **1=Primary Spillway** (Weir Controls 501.00 cfs @ 4.35 fps)
- **2=Right Embankment Crest** ( Controls 0.00 cfs)
- **3=Left Embankment Crest** ( Controls 0.00 cfs)

## Pond 3P: Waite Pond



## Summary for Pond 6P: Kettle Brook Reservoir No. 1

[61] Hint: Exceeded Reach 17R outlet invert by 1.55' @ 14.06 hrs

Inflow Area = 2,662.411 ac, 9.87% Impervious, Inflow Depth > 1.74" for 100-year event
Inflow = 721.36 cfs @ 13.49 hrs, Volume= 386.048 af
Outflow = 614.30 cfs @ 14.06 hrs, Volume= 367.453 af, Atten= 15%, Lag= 34.5 min
Primary = 614.30 cfs @ 14.06 hrs, Volume= 367.453 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 852.95' @ 14.06 hrs Surf.Area= 17.746 ac Storage= 34.232 af

Plug-Flow detention time= 44.0 min calculated for 367.453 af (95% of inflow)
Center-of-Mass det. time= 24.5 min ( 1,054.2 - 1,029.7 )

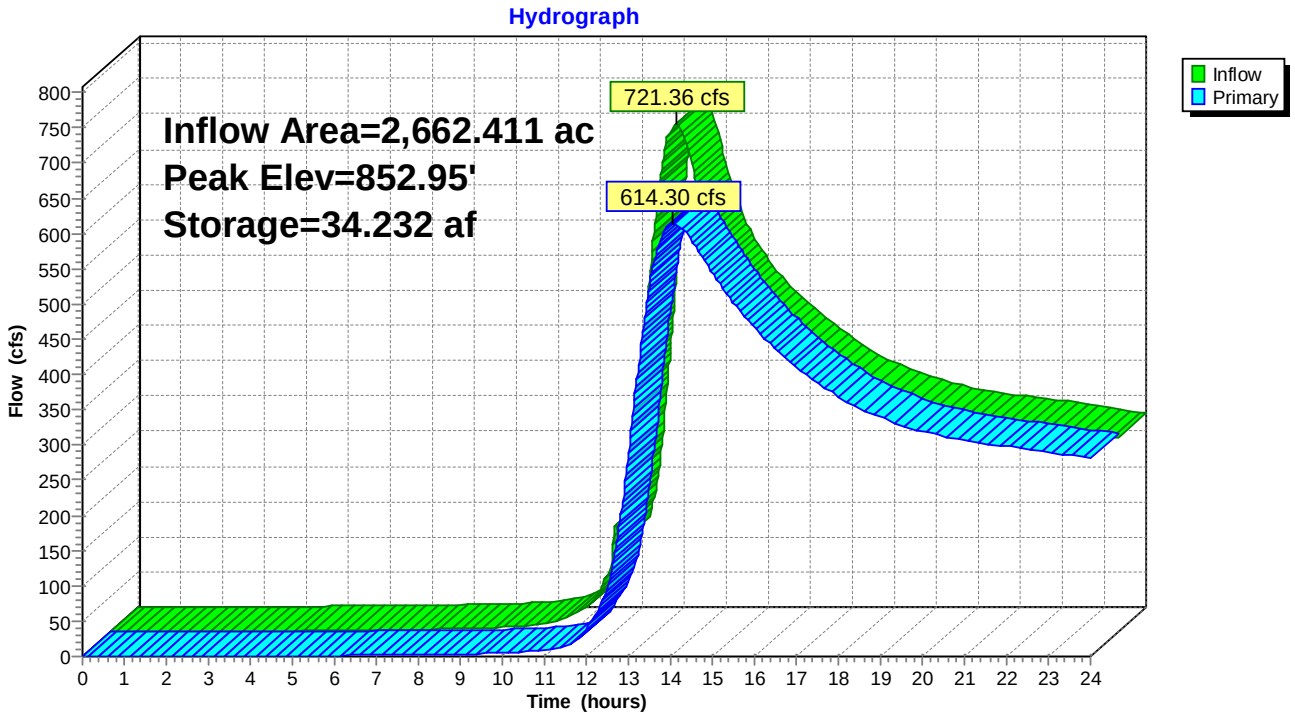
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 850.60' | 476.839 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 850.60 | 11.658 | 0.000 | 0.000 | 11.658 |
| 856.30 | 28.670 | 111.359 | 111.359 | 28.675 |
| 866.10 | 46.643 | 365.480 | 476.839 | 46.677 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 850.60' | **45.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 |
| #2 | Primary | 855.00' | **580.0' long x 25.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=614.18 cfs @ 14.06 hrs HW=852.95' (Free Discharge)
└**1=Primary Spillway** (Weir Controls 614.18 cfs @ 5.82 fps)
└**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 6P: Kettle Brook Reservoir No. 1



## Summary for Pond 9P: Kettle Brook Reservoir No. 2

[62] Hint: Exceeded Reach 18R OUTLET depth by 4.20' @ 1.03 hrs

Inflow Area = 1,982.863 ac, 12.46% Impervious, Inflow Depth > 1.67" for 100-year event
Inflow = 397.49 cfs @ 13.28 hrs, Volume= 275.218 af
Outflow = 276.29 cfs @ 15.85 hrs, Volume= 232.803 af, Atten= 30%, Lag= 154.0 min
Primary = 276.29 cfs @ 15.85 hrs, Volume= 232.803 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 996.46' @ 15.85 hrs Surf.Area= 33.243 ac Storage= 47.203 af

Plug-Flow detention time= 118.9 min calculated for 232.706 af (85% of inflow)
Center-of-Mass det. time= 58.9 min ( 1,103.6 - 1,044.7 )

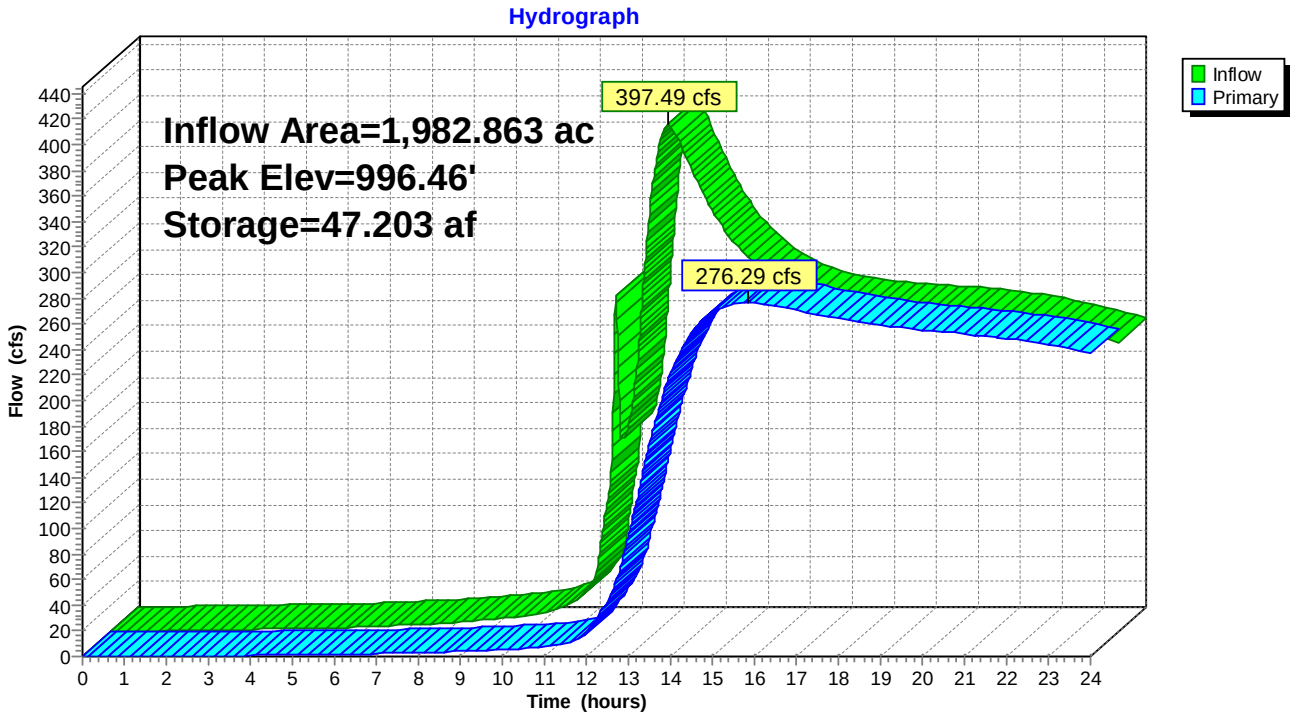
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 995.00' | 1,660.546 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 995.00 | 31.267 | 0.000 | 0.000 | 31.267 |
| 1,003.90 | 44.217 | 334.244 | 334.244 | 44.250 |
| 1,013.80 | 68.192 | 552.157 | 886.401 | 68.258 |
| 1,023.60 | 90.314 | 774.146 | 1,660.546 | 90.429 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 995.00' | **41.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 3.80 |
| #2 | Primary | 1,000.00' | **600.0' long x 15.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=275.89 cfs @ 15.85 hrs HW=996.46' (Free Discharge)
└**1=Primary Spillway** (Weir Controls 275.89 cfs @ 4.60 fps)
└**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 9P: Kettle Brook Reservoir No. 2



## Summary for Pond 12P: Kettle Brook Reservoir No. 3

Inflow Area = 1,665.461 ac, 12.89% Impervious, Inflow Depth > 1.96" for 100-year event
Inflow = 648.86 cfs @ 12.96 hrs, Volume= 271.612 af
Outflow = 227.49 cfs @ 19.87 hrs, Volume= 202.299 af, Atten= 65%, Lag= 414.8 min
Primary = 227.49 cfs @ 19.87 hrs, Volume= 202.299 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 1,041.75' @ 19.87 hrs Surf.Area= 45.036 ac Storage= 73.767 af

Plug-Flow detention time= 203.0 min calculated for 202.299 af (74% of inflow)
Center-of-Mass det. time= 97.8 min ( 1,105.3 - 1,007.6 )

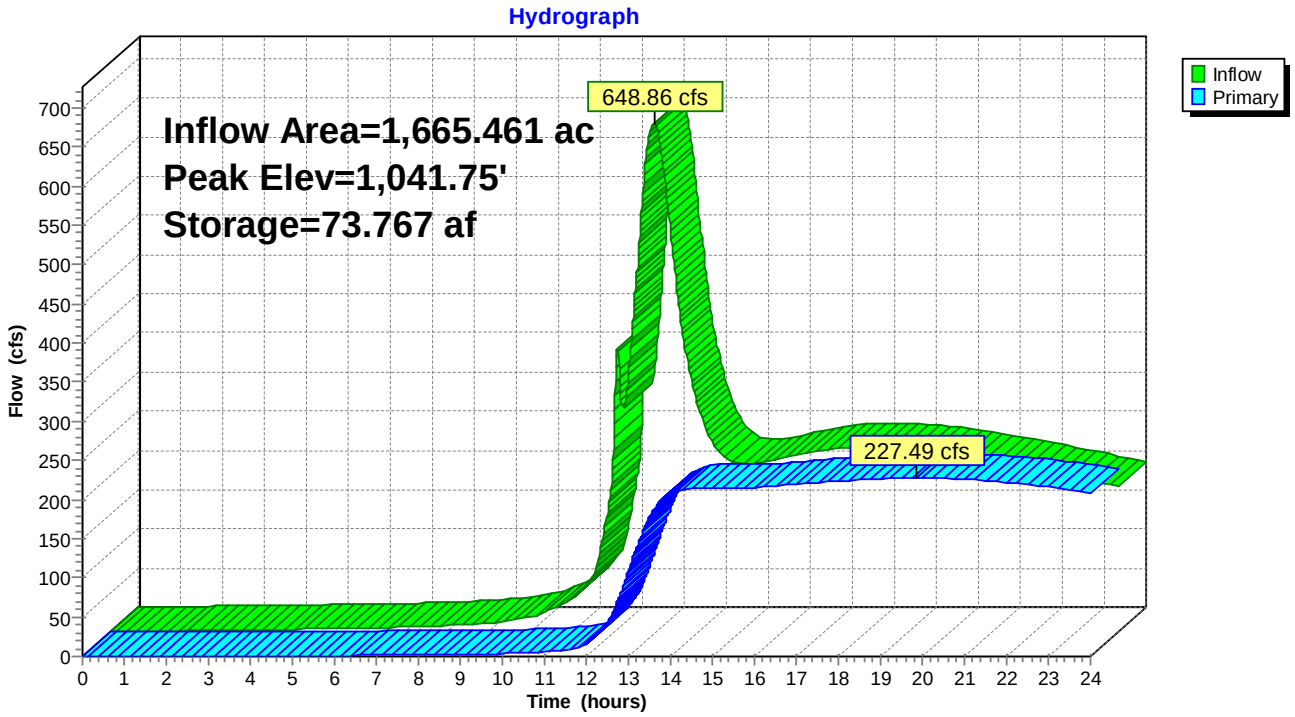
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,040.00' | 2,031.123 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 1,040.00 | 39.207 | 0.000 | 0.000 | 39.207 |
| 1,043.30 | 50.517 | 147.651 | 147.651 | 50.523 |
| 1,053.10 | 97.200 | 711.448 | 859.099 | 97.228 |
| 1,063.00 | 140.922 | 1,172.024 | 2,031.123 | 140.988 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,040.00' | **34.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 |
| #2 | Primary | 1,044.60' | **329.0' long x 15.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=227.40 cfs @ 19.87 hrs HW=1,041.75' (Free Discharge)
└**1=Primary Spillway** (Weir Controls 227.40 cfs @ 3.82 fps)
└**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 12P: Kettle Brook Reservoir No. 3



## Summary for Pond 15P: Kettle Brook Reservoir No. 4

Inflow Area = 1,166.588 ac, 14.70% Impervious, Inflow Depth > 3.35" for 100-year event
Inflow = 830.65 cfs @ 12.08 hrs, Volume= 326.079 af
Outflow = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af, Atten= 77%, Lag= 443.2 min
Primary = 189.32 cfs @ 19.47 hrs, Volume= 134.029 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 1,088.80' @ 19.47 hrs Surf.Area= 128.987 ac Storage= 213.882 af

Plug-Flow detention time= 380.8 min calculated for 133.973 af (41% of inflow)
Center-of-Mass det. time= 207.0 min ( 1,155.3 - 948.3 )

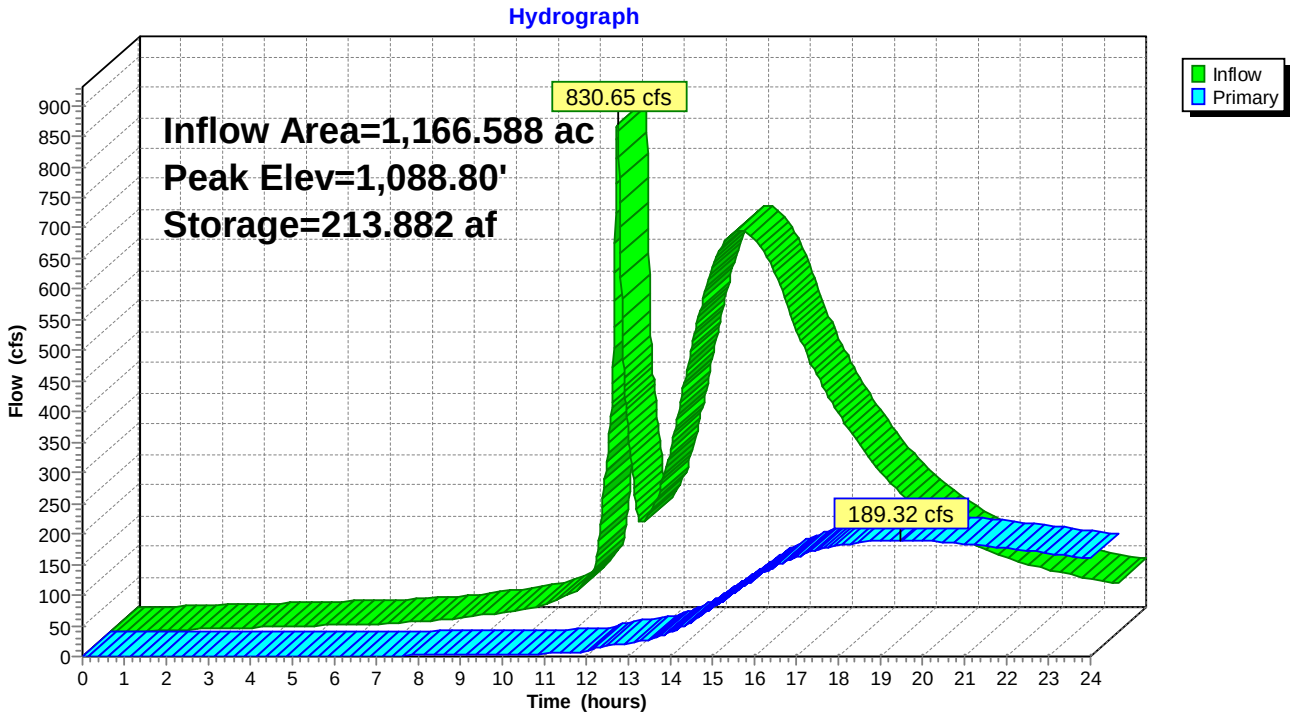
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 1,087.11' | 4,375.774 af | **Custom Stage Data (Conic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (acres) | Inc.Store (acre-feet) | Cum.Store (acre-feet) | Wet.Area (acres) |
|---|---|---|---|---|
| 1,087.11 | 124.340 | 0.000 | 0.000 | 124.340 |
| 1,092.50 | 139.470 | 710.578 | 710.578 | 139.506 |
| 1,102.30 | 181.000 | 1,565.889 | 2,276.467 | 181.090 |
| 1,112.20 | 244.700 | 2,099.307 | 4,375.774 | 244.837 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,087.11' | **30.0' long x 2.0' breadth Primary Spillway**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50<br>Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 |
| #2 | Primary | 1,091.12' | **1,100.0' long x 15.0' breadth Dam Embankment Crest**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=189.96 cfs @ 19.47 hrs HW=1,088.80' (Free Discharge)
**1=Primary Spillway** (Weir Controls 189.96 cfs @ 3.75 fps)
**2=Dam Embankment Crest** ( Controls 0.00 cfs)

## Pond 15P: Kettle Brook Reservoir No. 4



# Appendix C

## Soil Boring Logs

| FUSS & O'NEILL, INC.<br>CONSULTING ENGINEERS<br>MANCHESTER, CT | **BORING LOG**<br>**Project: Waite Pond Dam**<br>**Location: Leicester, MA** | **Boring ID: B-1**<br>**Sheet 1 of 1**<br>**Project No.:20081286.A10** |
|---|---|---|

Contractor: Martin Geo Environmental
Operator: Jeremy Martin, Derrick Murphy
F&O Rep.: Manju Sharma
Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon (2" OD)
Hammer Wt.: 140 lbs Hammer Fall (in.): 30
Boring Location: See Plan
Ground Elevation:
Date Start: 1/14/2014 Date Finish: 1/14/2014

Water Level Measurements

| Date | Ref. Pt. | Depth | Time |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| Depth (ft) | Sample No. | Sample Depth (ft) | Rec/ Pen | Blows/ 6" | Sample Description | Strata Change | USCS Class. | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | |
| 1 | S-1 | 0-2 | 9/24 | 17-30<br>35-15 | Very dense, yellow-brown fine to medium SAND,trace Silt, trace Gravel.Dry | | SP | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | S-2 | 5-7 | 20/24 | 6-11<br>15-25 | Medium dense yellow-brown fine to medium SAND, some Silt. Moist. | Sand | SM | |
| 7 | | | | | | | | 1 |
| 8 | | | | | | | | |
| 9 | | | | | | | | 2 |
| 10 | | | | | | | | |
| 11 | S-3 | 10-10.4 | 5/5 | 100/5" | Very dense yellow-brown fine to medium SAND, some Silt.Wet. | | SM | |
| 12 | | | | | | | | 3 |
| 13 | | | | | Rock core from 12' and 17'<br>Recovery = 100%; RQD = 83% | | | |
| 14 | | | | | Granite | Bed Rock | | |
| 15 | | | | | | | | |
| 16 | | | | | Boring terminated at 17' | | | |

**MINOR CONSTITUENT PROPORTIONS:**

| | | | |
|---|---|---|---|
| **Trace** | **0 to 10%** | **Some** | **20 to 35%** |
| **Little** | **10 to 20%** | **And** | **35 to 50%** |

**REMARKS:**
1. Difficult augering between 7' and 10'.
2. Ground water encountered at 9 feet.
3.Auger refusal at 12 feet.

| FUSS & O'NEILL, INC.<br>CONSULTING ENGINEERS<br>MANCHESTER, CT | **BORING LOG**<br>**Project: Waite Pond Dam**<br>**Location: Leicester, MA** | **Boring ID: B-2**<br>**Sheet 1 of 1**<br>**Project No.:20081286.A10** |
|---|---|---|

Contractor: Martin Geo Environmental
Operator: Jeremy Martin, Derrick Murphy
F&O Rep.: Manju Sharma
Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon (2" OD)
Hammer Wt.: 140 lbs Hammer Fall (in.): 30
Boring Location: See Plan
Ground Elevation:
Date Start: 1/14/2014 Date Finish: 1/14/2014

Water Level Measurements

| Date | Ref. Pt. | Depth | Time |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| Depth (ft) | Sample No. | Sample Depth (ft) | Rec/ Pen | Blows/ 6" | Sample Description | Strata Change | USCS Class. | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | |
| 1 | S-1 | 0-2 | 9/24 | 5-28<br>17-4 | Dense, brown fine to medium SAND,little Gravel, trace Silt. Dry | | SP | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | S-2 | 5-7 | 4/24 | 1-3<br>2-2 | Loose dark grey fine to medium SAND, some Silt. Wet | Sand | SM | 1 |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | S-3 | 10-11.91 | 23/23 | 68-50<br>68-100/5" | Very dense grey fine to medium SAND,little Gravel. Wet | | SP | 2 |
| 12 | | | | | | | | |
| 13 | | | | | Auger refusal at 13 feet | | | 3 |
| 14 | | | | | | Rock | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |

**MINOR CONSTITUENT PROPORTIONS:**

| | | | |
|---|---|---|---|
| **Trace** | **0 to 10%** | **Some** | **20 to 35%** |
| **Little** | **10 to 20%** | **And** | **35 to 50%** |

**REMARKS:**
1. Ground water encountered at approximately 6 feet.
2. Rock fragments in split spoon.
3. Auger refusal at 13 feet.

# Appendix D

## Opinion of Construction Cost Worksheet

# FUSS & O'NEILL, INC.

146 Hartford Road
Manchester, CT 06040

| OPINION OF COST Order of Magnitude Level | | DATE PREPARED : 01/16/15 | SHEET 1 OF 1 |
|---|---|---|---|
| PROJECT : | Waite Pond Dam | BASIS : Previous Experience | |
| LOCATION : | Leicester, MA | | |
| DESCRIPTION: | Dam repair and improvements | | |
| DRAWING NO. : | | ESTIMATOR : KCM | CHECKED BY : |

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

| ITEM NO. | ITEM DESCRIPTION | UNIT MEAS. | NO. UNITS | PER UNIT | TOTAL COST |
|---|---|---|---|---|---|
| **SITE PREPARATION** | | | | | |
| | Tree and Stump Removal | L.S. | 1 | $ 3,000.00 | $ 3,000.00 |
| | Clearing and Grubbing | AC | 0.2 | $ 7,000.00 | $ 1,400.00 |
| | | | | | |
| **WATER CONTROL** | | | | | |
| | Coffer Dam, Pump Systems, Bypass Pipes | L.S. | 1 | $ 75,000.00 | $ 75,000.00 |
| | | | | | |
| **DEMOLITION** | | | | | |
| | Concrete Walls | L.F. | 130 | $ 300.00 | $ 39,000.00 |
| | Concrete/Stone Stilling Basin | L.F. | 42 | $ 200.00 | $ 8,400.00 |
| | Stone Masonry Walls | L.F. | 140 | $ 100.00 | $ 14,000.00 |
| | Low-Level Outlet Pipe | L.F. | 90 | $ 25.00 | $ 2,250.00 |
| | Gate House, Foundation, Gate, Hardware | L.S. | 1 | $ 5,000.00 | $ 5,000.00 |
| | | | | | |
| | | | | | |
| **EROSION AND SEDIMENT CONTROL** | | | | | |
| | Slit Fence & Maintenance | L.F. | 120 | $ 7.50 | $ 900.00 |
| | Anti-Tracking Apron | L.S. | 1 | $ 2,000.00 | $ 2,000.00 |
| | Pumping Settling Basin & Maintenance | E.A. | 1 | $ 3,500.00 | $ 3,500.00 |
| | | | | | |
| | | | | | |
| **LOW-LEVEL OUTLET & VALVE CHAMBER** | | | | | |
| | Cement Lined D.I. Pipe (24" diameter) | L.F. | 95 | $ 130.00 | $ 12,350.00 |
| | Concrete Encasement - Class C | C.Y. | 45 | $ 400.00 | $ 18,000.00 |
| | Gate Valve | E.A. | 1 | $ 5,000.00 | $ 5,000.00 |
| | Trash Rack | E.A. | 1 | $ 1,200.00 | $ 1,200.00 |
| | Valve Chamber (4' diameter manhole) | E.A. | 1 | $ 10,000.00 | $ 10,000.00 |
| | | | | | |
| **SPILLWAY & RETAINING WALL REPLACEMENT** | | | | | |
| | Excavation | C.Y. | 4,500 | $ 20.00 | $ 90,000.00 |
| | Soil Stockpiling | L.S | 1 | $ 20,000.00 | $ 20,000.00 |
| | Concrete - Class F | C.Y. | 280 | $ 620.00 | $ 173,600.00 |
| | | | | | |
| | | | | | |
| **SITE STABILIZATION WORK** | | | | | |
| | Topsoil, Seed, Mulch, Fertilize | S.Y. | 970 | $ 4.25 | $ 4,122.50 |
| | **SUBTOTAL OPINION OF CONSTRUCTION COST** | | | | **$ 488,722.50** |
| | | | | | |
| **ENGINEERING/ PERMITTING** | | | | | |
| | Engineering and Permitting | LS | 1 | $ 80,000.00 | $ 80,000.00 |
| | Survey/As-Built Mapping | LS | 1 | $ 5,000.00 | $ 5,000.00 |
| | Construction Administration | LS | 1 | $ 50,000.00 | $ 50,000.00 |
| | Mobilization & Demobilization | LS | 1 | $ 20,000.00 | $ 20,000.00 |
| | Testing Laboratory- Concrete | LS | 1 | $ 5,000.00 | $ 5,000.00 |
| | Insurance and Bonds | LS | 1 | $ 25,000.00 | $ 25,000.00 |
| | Escalation/Inflation | % | 1 | 3%/year | |
| | | | | | |
| | | | | | |
| | **TOTAL OPINION OF CONSTRUCTION COST** | | | | **$ 673,722.50** |
| | **CONTINGENCY (20%)** | | | | **$ 134,744.50** |
| | | | | | |
| | **TOTAL OPINION OF COST (ROUNDED TO NEAREST $1,000)** | | | | **$ 808,000.00** |

# Appendix E

## Inland Resource Area Delineation Report

FUSS & O'NEILL

# Site Investigation and Inland Resource Area Delineation Report

**Report Date:** October 30, 2013

**Prepared For:** Robert T. Reed
Town Administrator
Town of Leicester
3 Washburn Square
Leicester, Massachusetts 01524

**Site Location:** Waite Pond Dam, Leicester, MA

**Inspection Date:** September 17, 2013

**Regulated Inland Wetland Resource Areas:**

- ☒ Bank
- ☒ Land Under Water Bodies and Waterways
- ☒ Riverfront Area
- ☒ Buffer Zone
- ☐ Vernal Pool
- ☒ Bordering Vegetated Wetland (BVW)
- ☒ Land Subject to Flooding (BLSF/ILSF)
- ☐ Isolated Vegetated Wetland
- ☐ Estimated Habitats of Rare Wildlife

**Delineated Resource Area Field Numbering Sequence** *[as depicted on the attached Resource Map]***:**

**Bank/LUWW:** A099 to A111; B100 to B112 **BVW:** C100 to C106

*Wetland and watercourse resource areas were delineated in accordance with applicable local, state and federal statutes, as detailed within the Resource Area Description attachment. This delineation does not constitute an official wetland boundary until such time as it is accepted and approved by local, state or federal regulatory agencies.*

The wetlands delineation was conducted by:

Sara S. Fusco, CPESC
Wetland Scientist/Soil Scientist

att

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**ATTACHMENTS**

- Resource Area Description
- DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Forms
- NRCS Soil Map and Soil Report
- Resource Area Sketch Map
- MassGIS: OLIVER generated FEMA Map

Fuss & O'Neill Inc. performed a wetland resource area field inspection and delineation within 100 feet of Waite Pond Dam in Leicester, Massachusetts on September 17, 2013. The purpose of the delineation was to locate the jurisdictional limits of areas regulated under the Wetland Protection Act (M.G.L. c. 131 sec. 40) and the associated Wetland Protection regulations (310 CMR 10). The extent of the resource area determination is referred to herein as "the area of interest" and depicted on the attached Wetland Sketch Map. Inland wetland resource areas identified in the area of interest during the field inspection include: Bordering Vegetated Wetlands (BVW), Bank, Land Under Water Bodies and Waterways (LUWW), Riverfront Area, and Buffer Zone. MA Natural Heritage Endangered Species Program (NHESP) Priority Habitat for Rare Species and Estimated Habitat for Rare Wildlife are not depicted within the area of interest on maps retrieved from MassGIS.

## Resource Area Descriptions

### Bordering Vegetated Wetlands (BVW): Regulatory Framework and Delineation Methodology

As stated in 310 CMR (2)(a), "*Bordering Vegetated Wetlands are freshwater wetlands which border on creeks, rivers, streams, ponds and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps and bogs. Bordering Vegetated Wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. The ground and surface water regime and the vegetation community which occur in each type of freshwater wetland are specified in M.G.L. c 131 sec. 40*."

Fuss & O'Neill Inc. delineated bordering vegetated wetlands within 100 feet of Waite Pond Dam in accordance with methodology provided in the Massachusetts DEP handbook, Delineating Bordering Vegetated Wetlands under the Massachusetts Wetlands Protection Act, dated March 1995, the 1987 Corps of Engineers Wetlands Delineation Manual, and the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Northcentral and Northeast Region, dated 2012. Consecutively numbered flags were placed in the field to demarcate the wetland boundary and data regarding vegetation, soils, and hydrology was gathered to complete the required MassDEP BVW delineation field forms, attached. Wetlands were categorized in accordance with Classification of Wetlands and Deepwater Habitats of the United States, Cowardin et.al. 1979.

Hydric soil determinations were made in accordance with Field Indicators for Identifying Hydric Soils in New England (NEIWPCC, 2004). The Wetland Indicator Status for plant species was ascertained using the USACE Northcentral and Northeast 2013 Regional Wetland Plant List. The Wetland Indicator Status is used to designate a plant species' preference for growth in a wetland or upland habitat as follows:

- Obligate Wetland (OBL): Hydrophyte, almost always occur in wetlands
- Facultative Wetland (FACW): Hydrophyte, usually occur in wetlands, but may occur in non-wetlands
- Facultative (FAC): Hydrophyte, occur in wetlands and non-wetlands

- Facultative Upland (FACU): nonhydrophyte, usually occur in non-wetlands, but may occur in wetlands
- Upland (UPL): Nonhydrophyte, almost never occur in wetlands

**BVW: Resource Area Description**

Vegetation

The BVW within the area of interest is a palustrine emergent groundwater seep. It is located on a concave hillslope east of the dam and south of Kettle Brook (wetland flags: C100 to C106). Common vegetation identified within the hillside seep included: arrow-wood, *Viburnum dentatum* (FAC); jewelweed, *Impatiens capensis* (FACW); Jack-in-the-pulpit, *Arisaema triphyllum* (FAC); cinnamon fern, *Osmundastrum cinnamomeum* (FACW); and, royal fern, *Osmunda regalis* (OBL).

Hydrology

The delineated BVW is hydrologically connected to Kettle Brook, which flows southeast from Waite Pond. Groundwater was observed seeping from the hillside during the investigation.

Soils

The Natural Resource Conservation Service (NRCS) mapped soil types adjacent to the dam include: well drained Paxton, fine sandy loam; and, very poorly drained Whitman, sandy loam. Detailed information regarding each of these soil series is included within the NRCS Soil Map and Soil Report attachment. Results of the detailed field analyses of soils within the area of interest were generally consistent with the published NRCS soil mapping. The area north of Kettle Brook is mapped as Whitman sandy loam but was found to consist of rip rap, stone retaining walls and well drained human transported material (HTM). These materials are present due to historic disturbances associated with the channelization of the watercourse and construction of the parking area adjacent to Chapel Street.

**Bank: Regulatory Framework and Delineation Methodology**

Bank is defined under 310 CMR 10.54(2)(c) as "*the portion of the land surface which normally abuts and confines a water body. It occurs between a water body and a vegetated bordering wetland and adjacent flood plain, or, in the absence of these, it occurs between a water body and an upland*." Fuss & O'Neill Inc. performed a delineation of Bank within the area of interest using consecutively numbered flags placed in the field to demarcate the Bank of a perennial stream (Kettle Brook) as well as the Banks of Waite Pond in the vicinity of the dam.

**Bank: Resource Description**

Bank along the perennial watercourse (Kettle Brook) coincided with the Mean Annual High-Water Line (MAHWL)/bankfull, as defined under 310 CMR 10.58 (2)(a)(2). Bank along Waite Pond is located between the surrounding upland and the water body. Bank was located in the field by the first observable break in topography (flags: A099 to A111 and B100 to B112).

**Riverfront Area: Regulatory Framework and Delineation Methodology**

Riverfront Area is defined under 310 CMR 10.58(2)(a) as "*the area of land between a river's mean annual high water line and a parallel line measured horizontally*." 310 CMR 10.58(2)(a)(1) defines rivers as, "*any natural flowing body of water that empties to any ocean, lake, pond or other river and which flows throughout the year. Rivers include streams (see 310 CMR 10.04: Stream) that are perennial because surface water flows within them throughout the year. Intermittent streams are not rivers as defined herein because surface water does not flow within them throughout the year*." 310 CMR 10.58(2)(a)(2) further specifies that "*The Riverfront Area is the area of land between a river's mean annual high-water line measured horizontally outward from the river and a parallel line located 200 feet away, …*" continuing with exceptions that are not applicable to the area of interest.

The extent of the Riverfront Area adjacent to Waite Pond dam is determined by measuring a horizontal line 200 feet from the delineated mean annual high-water line of the perennial watercourse, Kettle Brook. As previously detailed, the mean annual high water line of the brook coincides with the delineated Bank resource.

**Riverfront Area: Resource Area Description**

The Riverfront Area within the area of interest includes the following regulated resource areas: Bordering Land Subject to Flooding (BLSF), BVW, Bank, Land Under Water Bodies and Waterways, and Buffer. No vernal pools, isolated vegetated wetlands, or Natural Heritage Endangered Species Program habitats of rare species or rare wildlife are located within the Riverfront Area in the area of interest. The Riverfront Area within the area of interest also includes roadways and private residential properties. Evidence of wildlife usage within the Riverfront Area was limited to sightings of common songbirds.

**Land Under Water Bodies and Waterways (LUWW)**

LUWW is defined under 310 CMR 10.56 (2)(a) as "*the land beneath any creek, river, stream, pond or lake. Said land may be composed of organic muck or peat, fine sediments, rocks or bedrock.*" The boundary of LUWW is defined as the mean annual low water level (310 CMR 10.56 (2)(c). LUWW was not specifically field delineated. For the intents and purposes of this resource area delineation, the delineated Banks of the perennial stream and Waite Pond are analogous to the limits of LUWW.

**Land Subject to Flooding (LSF)**

Bordering Land Subject to Flooding (BLSF) is defined in 310 CMR 10.57 (2)(a)(1) as "*an area with low, flat topography adjacent to and inundated by flood waters rising from creeks, rivers, streams, ponds or lakes. It extends from the banks of these waterways and water bodies; where a bordering vegetated wetland occurs, it extends from said wetlands*." 310 CMR (2)(a)(3) further states that the boundary of BLSF "*is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm*." The BLSF boundary within the area of interest was determined through use of the MassGIS's Online Mapping Tool (OLIVER), attached. The National Flood Hazard Layer is provided by the Federal Emergency Management Agency (FEMA). Information provided by FEMA is generally consistent with observed field conditions.

**Buffer Zone**

Buffer Zone is defined in 310 CRM 10.04 as "that area of land extending 100 feet horizontally outward from the boundary of any area specified in 310 CMR 10.02(1)(a). Buffer Zone within the area of interest is associated with BVW and Bank. The buffer zone in the area of interest contains roadways and private residential properties, including wooded areas and mown lawns. Common vegetation occurring within the Buffer in the area of interest includes: sugar maple, *Acer saccharum* (FACU); pignut hickory, *Carya glabra* (FACU); eastern white pine, *Pinus strubus* (FACU); red maple, *Acer rubrum* (FAC); gray birch, *Betula populifolia* (FAC); beech, *Fagus grandifolia* (FACU); staghorn sumac, *Rhyus hirta*; (not classified); Virginia creeper, *Parthenocissus quinquefolia* (FACU); bittersweet, *Celastrus orbiculatus* (not classified); tatarian honeysuckle, *Lonicera tatarica* (FACU); brambles, *rubus spp.*; Canada mayflower, *Maianthemum canadense* (FACU), and mown lawn.

- Observation Plot: 1W; Transect: 1
- Observation Plot: 2U; Transect: 1

# MassDEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant: Town of Leicester Prepared by: Sara Fusco Project location: Waite Pond Dam DEP File #:

Check all that apply:

- ☐ Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only
- ☑ Vegetation and other indicators of hydrology usedto delineateBVW boundary: fill out Sections I and II
- ☐ Method other than dominance test used (attach additional information)

## Section I.

| Vegetation | Observation Plot Number: 1W | | Transect Number: 1 | Date of Delineation: 9/17/2013 |
|---|---|---|---|---|
| A. Sample Layer & Plant Species (by common/scientific name) | B. Percent Cover (or basal Area) | C. Percent Dominance | D. Dominant Plant (yes or no) | E. Wetland Indicator Category* |
| Shrubs | | | | |
| Arrow-wood (Viburnum dentatum) | 8% | 10.2% | yes | FAC * |
| Herb | | | | |
| jewelweed (Impatiens capensis) | 20% | 25% | yes | FACW * |
| Jack-in-the-pulpit (Arisaema triphyllum) | 5% | 6.25% | No | FAC * |
| Cinnamon fern osmondastrum cinnamomeum) | 30% | 37.5% | yes | FACW * |
| royal fern (osmonda regalis) | 25% | 31.25% | yes | OBL * |

* *Use an asterisk to mark wetland indicator plants: plant species listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; plants listed as FAC, FAC+, FACW-, FACW, FACW+, or OBL; or plants with physiological or morphological adaptations. If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk.*

### Vegetation conclusion:

Number of dominant wetland indicator plants: 4 Number of dominant non-wetland indicator plants: 0

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? (yes) no

If vegetation alone is presumed adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent

## Section II. Indicators of Hydrology

### *Hydric Soil Interpretation*

**1. Soil Survey**

Is there a published soil survey for this site? (yes) no
title/date:
map number: NRCS Web Soil
soil type mapped:
hydric soil inclusions: Survey.

Are field observations consistent with soil survey? yes no
Remarks:
General consistent with the exception of disturbed areas north of Kettle Brook.

**2. Soil Description**

| Horizon | Depth | Matrix Color | Mottles Color |
|---|---|---|---|
| Ap | 8" | 10YR 4/1 | |
| Bg | — | 7.5YR 2/1 | 2.5YR 5/4 |

Remarks:
Very rocky ≥ 20%; could not dig below +/- 12"

**3. Other:**
Ground water observed in test hole

Conclusion: Is soil hydric? (yes) no

**Other Indicators of Hydrology: (check all that apply & describe)**

- ☐ Site Inundated: _____
- ☑ Depth to free water in observation hole: +/- 4"
- ☑ Depth to soil saturation in observation hole: a surface
- ☑ Water marks: _____
- ☐ Drift lines: _____
- ☐ Sediment Deposits: _____
- ☐ Drainage patterns in BVW: _____
- ☐ Oxidized rhizospheres: _____
- ☑ Water-stained leaves: _____
- ☐ Recorded Data (streams, lake, or tidal gauge; aerial photo; other): _____
- ☐ Other: _____

**Vegetation and Hydrology Conclusion**

| | Yes | No |
|---|---|---|
| Number of wetland indicator plants ≥ # of non-wetland indicator plants | ✓ | |
| **Wetland hydrology present:** | | |
| Hydric soil present | ✓ | |
| Other indicators of hydrology present | ✓ | |
| **Sample location is in a BVW** | ✓ | |

*Submit this form with the Request for Determination of Applicability or Notice of Intent.*

# MassDEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant: Town of Leicester Prepared by: Sara Fusco Project location: Waite Pond Dam DEP File #: _____

Check all that apply:

- ☑ Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only
- ☐ Vegetation and other indicators of hydrology usedto delineateBVW boundary: fill out Sections I and II
- ☐ Method other than dominance test used (attach additional information)

## Section I.

| Vegetation | Observation Plot Number: 2W | | Transect Number: 1 | Date of Delineation: 9/17/2013 |
|---|---|---|---|---|
| A. Sample Layer & Plant Species (by common/scientific name) | B. Percent Cover (or basal Area) | C. Percent Dominance | D. Dominant Plant (yes or no) | E. Wetland Indicator Category* |
| Tree | | | | |
| Sugar Maple (Acer saccharum) | 30% | 60% | yes | ~~FA~~ FACU |
| Pignut Hickory (Carya glabra) | 20% | 40% | yes | FACU |
| Liana | | | | |
| V. creeper (Parthenocissus quinquefolia) | 10% | 55.5% | yes | FACU |
| Bittersweet (Celastrus orbiculatus) | 8% | 44.6% | yes | Not classified |
| shrub | | | | |
| Staghorn sumac (Rhus hirta) | 10% | 100% | yes | Not classified. |
| Herb | | | | |
| NY Fern (Parathelypteris noveboracensis) | 10% | 14.2% | NO | FAC. |
| Mown Lawn | 60% | 85.7% | yes | |

* *Use an asterisk to mark wetland indicator plants: plant species listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; plants listed as FAC, FAC+, FACW-, FACW, FACW+, or OBL; or plants with physiological or morphological adaptations. If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk.*

### Vegetation conclusion:

Number of dominant wetland indicator plants: 0 Number of dominant non-wetland indicator plants: 3

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? yes (no)

If vegetation alone is presumed adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent

## NRCS Soil Map and Soil Report

Soil Map—Worcester County, Massachusetts, Southern Part
(Waite Pond)


Map Scale: 1:1,100 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

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

**Water Features**
- Streams and Canals

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

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

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

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

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

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 5, Jan 30, 2007

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

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

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

# Map Unit Legend

| Worcester County, Massachusetts, Southern Part (MA615) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| 1 | Water | 1.2 | 23.2% |
| 73A | Whitman sandy loam, 0 to 3 percent slopes, extremely stony | 0.9 | 16.9% |
| 305C | Paxton fine sandy loam, 8 to 15 percent slopes | 3.1 | 59.8% |
| **Totals for Area of Interest** | | **5.1** | **100.0%** |

# Map Unit Description (Brief, Generated)

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

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

The Map Unit Description (Brief, Generated) report displays a generated description of the major soils that occur in a map unit. Descriptions of non-soil (miscellaneous areas) and minor map unit components are not included. This description is generated from the underlying soil attribute data.

Additional information about the map units described in this report is available in other Soil Data Mart reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the Soil Data Mart reports define some of the properties included in the map unit descriptions.

## Report—Map Unit Description (Brief, Generated)

### Worcester County, Massachusetts, Southern Part

**Map Unit:** 1—Water

**Component:** Water (100%)

Generated brief soil descriptions are created for major soil components. The Water is a miscellaneous area.

**Map Unit:** 73A—Whitman sandy loam, 0 to 3 percent slopes, extremely stony

**Component:** Whitman (70%)

The Whitman component makes up 70 percent of the map unit. Slopes are 0 to 3 percent. This component is on depressions on till plains. The parent material consists of friable coarse-loamy eolian deposits over dense coarse-loamy lodgment till derived from metamorphic rock. Depth to a root restrictive layer, densic material, is 12 to 30 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches during January, February, March, April, May, June, September, October, November, December. Organic matter content in the surface horizon is about 74 percent. Nonirrigated land capability classification is 7s. This soil meets hydric criteria.

**Component:** RIDGEBURY (10%)

Generated brief soil descriptions are created for major components. The RIDGEBURY soil is a minor component.

**Component:** SWANSEA (10%)

Generated brief soil descriptions are created for major components. The SWANSEA soil is a minor component.

**Component:** other soils (10%)

Generated brief soil descriptions are created for major components. The other soils soil is a minor component.

**Map Unit:** 305C—Paxton fine sandy loam, 8 to 15 percent slopes

**Component:** Paxton (75%)

The Paxton component makes up 75 percent of the map unit. Slopes are 8 to 15 percent. This component is on drumlins on uplands, drumlinoid ridges on uplands. The parent material consists of friable coarse-loamy eolian deposits over dense coarse-loamy lodgment till derived from schist. Depth to a root restrictive layer, densic material, is 18 to 38 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 24 inches during February, March, April. Organic matter content in the surface horizon is about 4 percent. Nonirrigated land capability classification is 3e. This soil does not meet hydric criteria.

**Component:** CHARLTON (10%)

Generated brief soil descriptions are created for major components. The CHARLTON soil is a minor component.

**Component:** CANTON (8%)

Generated brief soil descriptions are created for major components. The CANTON soil is a minor component.

**Component:** WOODBRIDGE (5%)

Generated brief soil descriptions are created for major components. The WOODBRIDGE soil is a minor component.

**Component:** RIDGEBURY (2%)

Generated brief soil descriptions are created for major components. The RIDGEBURY soil is a minor component.

## Data Source Information

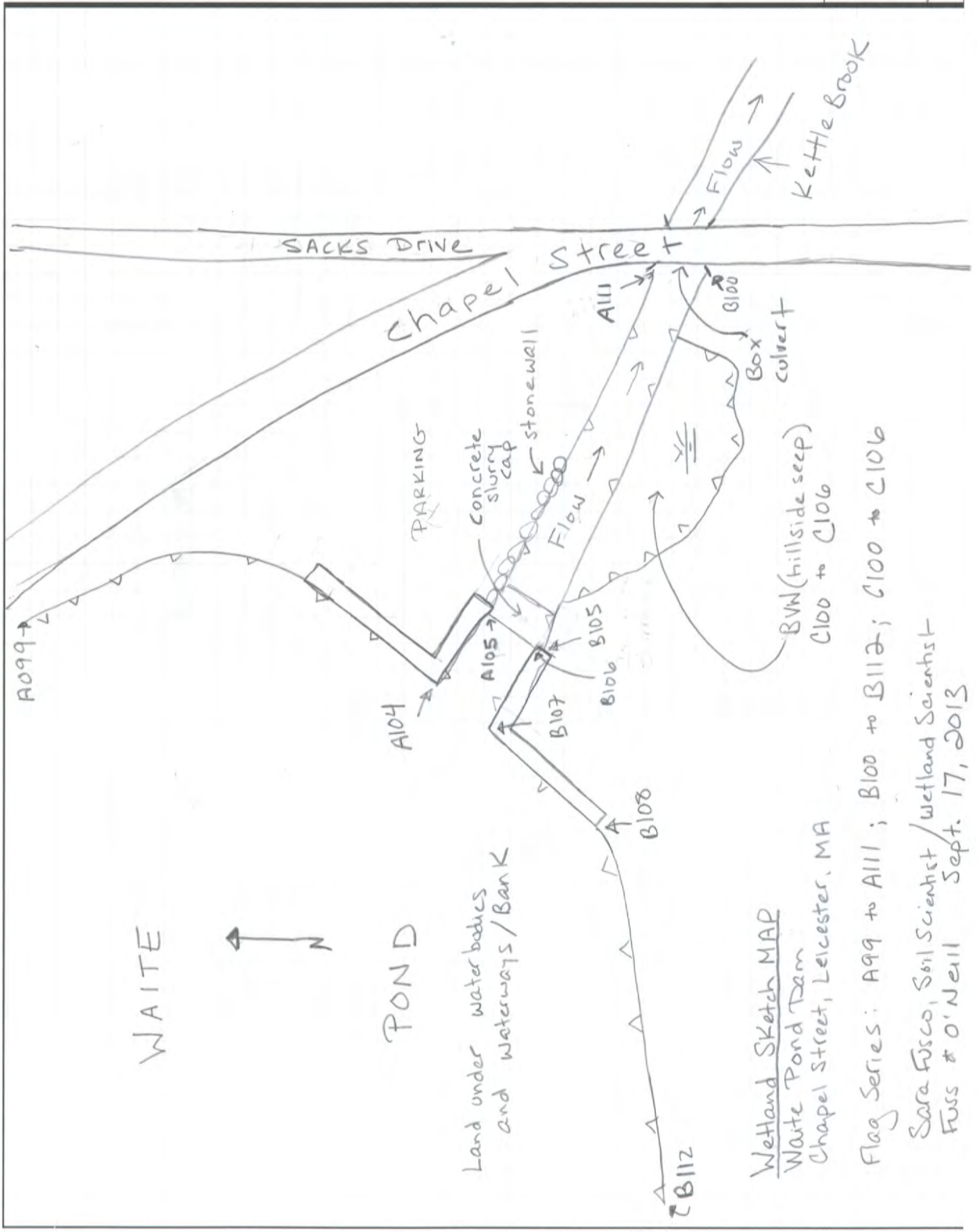
Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 5, Jan 30, 2007

## Wetland Sketch Map

FUSS & O'NEILL

| Prepared By | Date | Checked By | Date | Project No |
|---|---|---|---|---|
| SSF | 9/17/13 | | | 20081286.A10 |

Sheet No / of




Wetland Sketch MAP
Waite Pond Dam
Chapel Street, Leicester, MA

Flag Series: A99 to A111; B100 to B112; C100 to C106

Sara Fusco, Soil Scientist/Wetland Scientist
Fuss & O'Neill Sept. 17, 2013

## MassGIS: Oliver Generated FEMA Map