--FOSTER'S PONDS DAM--

PHASE I

INSPECTION / EVALUATION REPORT

Dam Name:	Foster's Pond Dam
NID ID#:	MA00153
Owner:	Foster's Pond Corporation
Town:	Andover, MA
Consultant:	GEI Consultants, Inc.
Date of Inspection:	November 5, 2021

GEI Consultan

EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the inspection and evaluation of Foster's Pond Dam located in Andover, Massachusetts. The inspection was conducted on November 5, 2021 by Lee Wooten, P.E., of GEI Consultants, Inc. Foster's Pond Dam is classified as an Intermediate size, Significant (Class II) hazard potential dam.

In general, the overall condition of Foster's Pond Dam is Satisfactory. The dam was found to have the following minor deficiencies:

1. The left embankment has a history of sinkholes due internal erosion of embankment material caused by seepage through the upstream face carrying soil out through the downstream masonry wall. The owner, Foster's Pond Corporation (FPC) has undertaken repairs on several occasions (2010, 2014, and 2015) to seal the backside of the upstream masonry with concrete and to place clay fill in the eroded areas to reduce seepage. Clear seepage (~0.5 gpm) was noted at the toe of the downstream masonry wall on both sides of the spillway during our inspection.
2. Small bare areas (but no erosion) were noted on the upstream slope and crest. Try to reestablish grass cover in bare areas. Consider use of bio-degradable erosion control matting or blankets to protect seeded areas from pedestrian traffic, geese, and washout.
3. The Operations and Maintenance (O&M) plan predates the 2019 Emergency Action Plan (EAP) and references outdated emergency response actions.

The following table summarizes the deficiencies reported in the 2016 Phase I report and the status of those deficiencies:

Previously Identified Deficiency	***Resolution or Current Condition***
The left embankment has a history of sinkholes due internal erosion of embankment material caused by seepage through the upstream face carrying soil out through the downstream masonry wall. The owner, Foster's Pond Corporation (FPC) has undertaken repairs on several occasions (2010, 2014, and 2015) to seal the backside of the upstream masonry with concrete and to place clay fill in the eroded areas to reduce seepage. Seepage appeared to have been reduced at the time of our visit, but we could not judge if it had been eliminated as a potential issue. The FPC should continue to monitor for seepage erosion (sediment in the seepage) and sinkholes.	The FPC monitors for seepage erosion and sinkholes as prescribed in the O&M Manual. Clear seepage (~0.5 gpm) was noted at the toe of the downstream masonry wall on both sides of the spillway. Monitoring should continue.

We recommend that the Foster's Pond Corporation undertake the following actions to address the minor deficiencies noted above:

- Continue with the maintenance and monitoring activities described in the O&M Manual and as practiced over the past few years.
- Reestablish grass cover in bare areas. Consider use of bio-degradable erosion control matting or blankets to protect seeded areas from pedestrian traffic, geese, and washout.
- Update the O&M Plan to reference the 2019 EAP.

Dam Evaluation Summary Detail Sheet

1. NID ID:	**MA00153**	**4. Inspection Date:**	**November 5, 2021**
2. Dam Name:	**Foster's Pond Dam**	**5. Last Insp. Date:**	**December 6, 2016**
3. Dam Location:	**Andover, MA**	**6. Next Inspection:**	**November 5, 2026**
7. Inspector:	**Lee Wooten, P.E.**		
8. Consultant:	**GEI Consultants, Inc.**		
9. Hazard Code:	**Significant**	**9a. Is Hazard Code Change Requested?:**	**No**
10. Insp. Frequency:	**5 Years**	**11. Overall Physical Condition of Dam:**	**SATISFACTORY**
12. Spillway Capacity (% SDF)	**>100% SDF w/ no actions by Caretaker**		

E1. Design Methodology:	**1**	**E7. Low-Level Discharge Capacity:**	**1**
E2. Level of Maintenance:	**5**	**E8. Low-Level Outlet Physical Condition:**	**1**
E3. Emergency Action Plan:	**5**	**E9. Spillway Design Flood Capacity:**	**5**
E4. Embankment Seepage:	**4**	**E10. Overall Physical Condition of the Dam:**	**4**
E5. Embankment Condition:	**4**	**E11. Estimated Repair Cost:**	**$0**
E6. Concrete Condition:	**5**		

Evaluation Description

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post design analysis show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR, annual training

E4: SEEPAGE (Embankments, Foundations, & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (See Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

E6: CONCRETE CONDITION (See Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low level outlet, no provisions (e.g. pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 50-90% of the SDF
3. 90 - 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g. open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF DAM
1. UNSAFE – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. POOR - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. FAIR - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. GOOD - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST

Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Changes/Deviations to Database Information since Last Inspection

PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the dam was based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

R. Lee Wooten, P.E.
Massachusetts License No. 31830
License Type: Civil

Principal
GEI Consultants, Inc.

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SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

Foster's Pond Corporation retained GEI Consultants, Inc. to perform a visual inspection and develop a report of conditions for the Foster's Pond Dam in Andover, MA, Essex County, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR10.07 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the site; 3) evaluate the status of an emergency action plan for the site and, 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions, and opinion of probable costs.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix D. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; and 5) miscellaneous.

1.2 Description of Project

1.2.1 Location

Foster's Pond Dam is located off Rattlesnake Hill Road within Essex County in the Town of Andover, Massachusetts. The dam impounds water that flows into wetlands immediately downstream of the dam and eventually into the Shawsheen River above the Ballardvale Dam and into an urban area. The structure and the impoundment are shown on the Google Earth website at 42.61361°N latitude and 71.14146°W longitude. The dam can be reached from I-93 in Wilmington via:

- Exit 35 – Route 125 East to
- Andover Street, north (left) to
- Woburn Street, north (straight), to
- Rattlesnake Hill Road, north (right).

1.2.2 Owner/Caretaker

See Table 1.1 for current owner and caretaker data (names and contact information).

1.2.3 Purpose of the Dam

The dam, reportedly constructed in the 1850's, was originally under joint control of mill owners on the Shawsheen River and was used to store water for generating power for the mills. The purpose of Foster's Pond Dam today is to provide a recreational impoundment (Foster's Pond).

1.2.4 Description of the Dam and Appurtenances

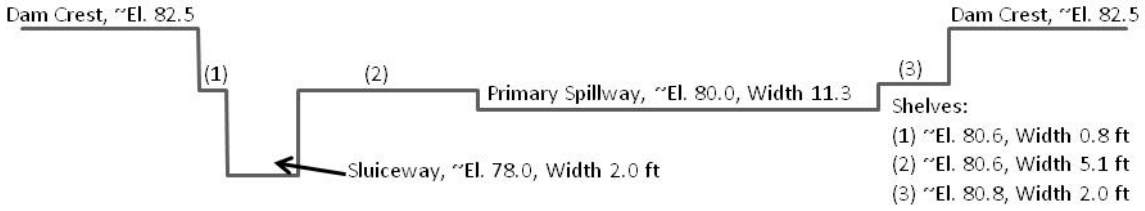
Foster's Pond Dam impounds water to form Foster's Pond, which discharges to wetlands downstream and eventually flows into the Shawsheen River. The reservoir is irregularly shaped, with a maximum length (north to south) of approximately 5,000 feet and a maximum width (east to west) of approximately 4,000 feet. The dam impoundment is shown in Fig. 1, Site Location Map and in Fig. 2, an aerial photograph of the pond area.

Foster's Pond Dam is an earthfill dam with a sloped embankment on the upstream side and a mostly unmortared stone masonry wall on the downstream side. As shown in the Dam Site Plan Sketch, Fig. 5, the dam incorporates a main spillway structure, a sluiceway (primary outlet structure), and a swale along its right abutment that serves as an auxiliary spillway. The dam has a structural height of approximately 10.1 feet, a hydraulic height of approximately 7.6 feet, and an overall length of approximately 150 feet.

The upstream side of the embankment appears to be a very flat slope. Previous inspection records indicate slopes as flat as 6H:1V. Large gravel and cobble-sized (3 inch to 6 inch) riprap covers the slope with the top of the slope being grass covered. The crest of the embankment is approximately 10 feet wide at its narrowest point and grass covered.

The downstream side of the dam consists of a mostly unmortared stone masonry wall. Outside the plunge pool, the area at the toe of the masonry wall area is covered with large, rounded gravel. Rattlesnake Hill Road runs approximately parallel and approximately 20 feet downstream of the stone masonry wall. Large boulders along the edge of Rattlesnake Hill Road and a metal chain gate at the access path near the right abutment prevent access of unauthorized vehicles to the dam.

The main spillway for the dam is a stone masonry and concrete broad-crested weir overflow structure located approximately 50 feet from the right abutment. The main spillway has a total width of about 21.2 feet with an approximate weir profile as shown below:



in the sluiceway. The spillway is flanked and contained by training walls, which are constructed of mortared granite curb stones. The stone masonry of the training walls is backed by a section of mass concrete about 1 to 2 feet thick, which was placed in 2010. The approach to the spillway is a slope covered with geomembrane and overlaid by clay, extending approximately 6 feet upstream into the pond. Discharges flow over the concrete spillway apron onto a pile of grouted riprap within the plunge pool downstream. A mortared stone masonry training wall surrounds the plunge pool and prevents flows from impacting Rattlesnake Hill Road. Flows entering the plunge pool are carried under the road through two 42-inch concrete pipe culverts to the wooded wetlands downstream.

The primary lower outlet for the dam is a sluiceway controlled with stoplogs and located on the left side of the main spillway. Based on review of inspection reports dating back to 1913, the sluiceway was originally constructed in 1937 and has been backfilled and restored several times since then. A valve-controlled 8-inch cast-iron low-level outlet pipe was installed through the sluiceway sometime in the past to provide a means of lowering the pond water level. The low-level outlet was reportedly last used in 1973 and has since corroded and is now filled with concrete and abandoned.

The sluiceway was restored in October of 2005 to accommodate winter drawdowns and provide excess freeboard to the dam. As shown on Fig. 2, the sluiceway varies in width and depth from approximately 3 feet wide and 2.5 feet deep on the upstream side to a 2-foot width and a depth of 4.5 feet on the downstream side. The 2-foot width by 2.5-foot depth at the stoplogs controls the maximum flow capacity. There are two sets of offsets behind which stoplogs can be set. Three stoplogs, each 10 inches deep, can currently be set in the middle offset. Stainless steel brackets or slots for the stoplogs were installed in 2015. The new brackets allow for installation of a padlock to prevent unauthorized removal or installation of the stoplogs. Flows through the sluiceway enter the downstream plunge pool and are carried under Rattlesnake Hill Road through the two 42-inch concrete pipe culverts.

At the right abutment, a swale extending from the pond to Rattlesnake Hill Road serves as the emergency spillway. Flows from the emergency spillway would cross over the road. The emergency spillway has a 1.5-foot-deep channel with a base width of 9 feet and a top width of 18 feet. The emergency spillway channel is lined with a geotextile, which is covered with gravel. The gravel and the geotextile extend from the pond to Rattlesnake Hill Road for the gravel or to within a couple of feet of the road for the geotextile.

1.2.5 Operations and Maintenance

The dam is operated and maintained by Foster's Pond Corporation, a community-based non-profit organization. The Corporation was formed in 1939 to maintain, repair, and operate the dam and to regulate the flow of water from Foster's Pond. The stop logs are set at a level approximately 2 inches above the of the dam's primary spillway between the months of April and November. A winter drawdown to create reserve capacity for the dam commences in November. Removal of the three stoplogs, one at a time, reduces the water level gradually to no more than 18 inches below the spillway level, the maximum allowed by the Andover Conservation Commission and DEP Superseding Order of Conditions. An Operations and Maintenance Manual has been prepared for this structure.

1.2.6 DCR Size Classification

Foster's Pond Dam has a height of approximately 10.1 feet and a maximum storage capacity of 867 acre-feet. Refer to Appendix D for definitions of height of dam and storage. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, 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, Foster's Pond Dam is an Intermediate size structure.

1.2.7 DCR Hazard Potential Classification

Foster's Pond Dam is located within a suburban area. Rattlesnake Hill Road crosses the downstream channel immediately downstream of the spillway. Twin pipe culverts carry flows from the dam under the road to a downstream wetlands area. Woburn Street, approximately 1,300 feet downstream of the dam, crosses the wetlands area and is reportedly prone to flooding during high storm events. Scattered residences in the downstream area appear to be at distances and elevations that would not be impacted by failure of this dam. Fig. 4 shows the area downstream of the dam on the USGS topographic map.

It appears that a failure of the dam at maximum pool could result in flooding and damage to Rattlesnake Hill Road. 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, Foster's Pond Dam should be classified as a Significant hazard potential dam. The Hazard Potential Classification recommendation is consistent with the Hazard Potential Classification on record with the Office of Dam Safety for Foster's Pond Dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Foster's Pond Dam is approximately 1.58 square miles and extends through the communities of Andover, Wilmington, and North Reading. Fig. 3 shows the drainage area estimated by the USGS Massachusetts StreamStats program for Foster's Pond. The StreamStats calculates an average area slope of 2.0%, the area of forest as 40%, and area of sand and gravel deposits as 58% for the basin. At its northeasterly point the pond is fed by Frye's Brook. The area is primarily suburban and much of it is undeveloped. The area is moderately hilly, especially west of the pond.

1.3.2 Reservoir

See Table 1.1 for data about normal, maximum, and spillway design flood (SDF) pools. The normal pool volume was provided to us and was estimated from a bathymetric survey by Aquatic Control Technology, the lake management consultant to the Foster's Pond Corporation. Maximum and spillway design flood pools were calculated based on interpolation of areas measured on topographic maps for the El. 80 pool and the El. 90 contour and using the U.S. Army Corps of Engineers Conic Method for Reservoir Values.

1.3.3 Discharges at the Dam Site

No records of discharges at the dam are maintained. The dam has been reportedly overtopped in May 1954, March of 2001, the spring of 2002, April of 2004, and May of 2006. The dam has not been overtopped since major maintenance efforts were commenced in 2006.

1.3.4 General Elevations (feet)[1]

A.	Top of Dam	~El. 82.5
B.	Spillway Design Flood Pool	~El. 82.3 with sluiceway boards in place ~El. 82.1 with sluiceway boards out
C.	Normal Pool	~El.80.0
D.	Spillway Crest	~El.80.0
E.	Upstream Water at Time of Inspection	~El.79.5
F.	Downstream Water at Time of Inspection	~El.72.1
G.	Streambed at Toe of the Dam	~El.72.1
H.	Low Point along Toe of the Dam	~El.72.1 in plunge pool

1.3.5 Main Spillway Data

A.	Type	Masonry & Concrete Broad-Crested Weir
B.	Weir Length	~21.2 feet
C.	Weir Crest Elevation	Varies, ~El.80.0 for primary spillway
D.	Upstream Channel	Unknown (underwater)
E.	Downstream Channel	~El.72.1
F.	Downstream Outlet Invert or Channel Bottom Elevation	~El.72.1

1.3.6 Additional Data – Sluiceway (Outlet Structure)

A.	Type	Sluicegate with three stoplogs
B.	Length	2 feet (at downstream side)
C.	Invert Elevation	~78.0 feet

Additional Data - Auxiliary/Emergency Spillway

A.	Type	Swale
B.	Length	18 feet at ~El.82.5, 9 feet at ~El. 81.0
C.	Invert Elevation	~81.0 feet

1.3.7 Design and Construction Records and History

The Foster's Pond Corporation has performed major maintenance efforts on the dam since the 2006 Phase I Report. The first effort corrected deficiencies identified in the 2006 report and was performed in 2007 and reported in our May 8, 2008 "Foster's Pond Dam Follow-Up Inspection / Evaluation Report." Specific maintenance activities in 2007 included:

[1] Survey information is not available for this structure. Elevations are referenced to an assumed spillway crest of El. 80.0. This elevation is consistent with elevation contours in the area depicted in the USGS maps.

- Mortared stone masonry wingwalls, about 1.7 feet high, were constructed out of granite curbstones on both sides of the spillway to protect the dam crest from spillway flows and to allow the dam crest to be maintained at a level grade. The effect of the wingwalls has been to increase the safe flow capacity of the primary spillway.
- The dam crest was rehabilitated to a level, grassed surface on both sides of the spillway. Trees and brush were removed from the crest, upstream slope, and areas immediately downstream. Sinkholes were filled. Fill was placed across the crest to create the level grade. A geotextile layer was placed under the seeded loam on the right embankment. Grass growth was established on both embankments.
- The emergency spillway at the right abutment was cleaned up with minor regrading to form a 1.5-foot-deep channel with a base width of 9 feet and a top width of 18 feet. The spillway channel surface was finished with cobbles upstream, grass cover across the spillway crest, and mulch cover downstream of the spillway. Geotextile was placed under all portions of the emergency spillway prior to placing both the upstream cobble cover and the downstream seeded loam.
- Cobble cover over geotextile was placed across the entire upstream face of the embankment as erosion protection.
- Riprap was placed in the plunge pool across the width of the primary spillway and sluice way as scour protection.

Significant damage to the spillway and crest adjacent to the spillway was observed following large storms in March of 2010. The damage was described in our letter of April 6, 2010 as:

- Several sinkholes had formed on the crest of the left / southwest embankment of the dam immediately adjacent to the mortared masonry wingwall. The deepest sinkhole was at least 3.5 feet deep. The sinkholes extended through the upper embankment soil, which appeared to consist of sandy silt / silty sand.
- The mortared masonry blocks of the upstream part of the left spillway wingwall had moved out (away from the embankment) and had gaps of up to about ¾ inch at joints between the masonry blocks. The movement may be the result of frost action pushing on the wingwall.
- At least two holes appeared in the concrete crest of the spillway, which opened into voids that extended 1 to 2 feet into the crest structure. The voids appeared to be formed in a cobble, gravel, and soil matrix.

To repair the damage, the FPC lowered the pond using the sluiceway and performed the following remedial maintenance in 2010:

- Much of the concrete cover of the spillway was removed to expose the full extent of voids in the masonry below. Flowable mortar mix and concrete were placed into the cavities that formed in the spillway. About 2 tons of concrete were placed and the surface of the spillway was restored.
- Soil behind the two spillway training walls was excavated down to the drawdown pool level and 1- to 2-foot-thick mass concrete sections were constructed behind the walls. About 7 tons of concrete were placed in the sections. The excavations were backfilled and the embankment crest was re-loamed and re-seeded.

- With the pond lowered, the area upstream of the left training wall and the sluiceway was exposed to reveal wall undercuts and water entry holes. Concrete was placed over the entire exposed area to plug holes, fill in undercuts, and cover the sloped area upstream of the sluiceway.
- Several tons of large, crushed stone gravel were added to the upstream slopes of the dam.

The FPC undertook minor repairs in 2012 to place additional crushed stone on the upstream face of the dam and to place loam fill in areas of the crest to provide a level profile with grass for erosion protection.

The FPC has monitored and repaired seepage-related sinkholes on the left abutment several times since the 2010 repairs. In 2013, the FPC placed additional gravel on the upstream face and excavated and backfilled part of the left embankment to install clay fill in areas where seepage had been observed. In 2014, in response to the development of a sinkhole behind the sluiceway wall, the FPC again excavated and backfilled part of the left embankment to install clay fill in the area of the sinkhole. These efforts were repeated in 2015, with the excavation extending to a depth of about 8 feet and with the clay backfill placement of about 500 pounds (dry) of bentonite clay.

In May 2021, the FPC undertook additional maintenance activities. The remedial maintenance included replacement of the reinforced (welded-wire) spillway crest slab and placement of 15 tons of crushed stone on the upstream slope and 6.5 tons of river stone on the auxiliary spillway as erosion protection. The new spillway slab replaced a cracked and unreinforced concrete slab and required 3.5 cubic yards of concrete. Photos from the FPC website of the work are included in Appendix A as Photos 12, 13, 14, and 15.

1.3.8 Operating Records

Operating records such as winter drawdown schedules and notifications are maintained by the Foster's Pond Corporation President, Stephen Cotton, at 19 Pomeroy Road in Andover. Significant maintenance activities at the dam are reported by Stephen Cotton on the Foster's Pond Corporation web site.

1.4 Summary Data Table

Refer to the following Table 1.1 for the DCR formatted tabulation of the data required for the Phase I reporting.

1.1 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA00153
Dam Name	Foster's Pond Dam
Dam Name (Alternate)	0
River Name	Frye's Brook (inflow) to Shawsheen River about 1 mile downstream
Impoundment Name	Fosters Pond
Hazard Class	Significant
Size Class	Intermediate
Dam Type	Earthfill w/ downstream stone masonry
Dam Purpose	Recreational
Structural Height of Dam (feet)	~10.1
Hydraulic Height of Dam (feet)	~7.6
Drainage Area (sq. mi.)	1.58
Reservoir Surface Area (acres)	~120
Normal Impoundment Volume (acre-feet)	~538
Max Impoundment Volume ((top of dam) acre-feet)	~867
SDF Impoundment Volume* (acre-feet)	~838
Spillway Type	Broad crested weir
Spillway Length (feet)	21.2
Freeboard at Normal Pool (feet)	2.5
Principal Spillway Capacity* (cfs)	~194
Auxiliary Spillway Capacity* (cfs)	0 cfs but overtopping not likely to breach
Low-Level Outlet Capacity* (cfs)	~33 with full pool
Spillway Design Flood* (flow rate - cfs)	100-year / 184 cfs
Winter Drawdown (feet below normal pool)	2.5
Drawdown Impoundment Vol. (acre-feet)	~200
Latitude	42.61361ºN
Longitude	71.14146ºW
City/Town	Andover
County Name	Essex
Public Road on Crest	None
Public Bridge over Spillway	None
EAP Date (if applicable)	September 2019
Owner Name	Foster's Pond Corporation
Owner Address	19 Pomeroy Road
Owner Town	Andover, MA 01810
Owner Phone	978-475-5679
Owner Emergency Phone	978-475-5679
Owner Type	Private Association or other non-profit
Caretaker Name	David Brown - Treasurer
Caretaker Address	31 Glenwood Road
Caretaker Town	Andover, MA 01810
Caretaker Phone	978-470-0454
Caretaker Emergency Phone	978-470-0454
Date of Field Inspection	11/5/2021
Consultant Firm Name	GEI Consultants, Inc.
Inspecting Engineer	Lee Wooten, P.E.
Engineer Phone Number	781-721-4034

*In the event a hydraulic and hydrologic analysis has not been completed for the dam, indicate "No H&H" in this table, recommendation section shall include specific recommendation to hire a qualified dam engineering consultant to conduct analysis to determine spillway adequacy in conformance with 302 CMR 10.00.

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Foster's Pond Dam was inspected on November 5, 2021. At the time of the inspection, the weather was sunny with temperatures in the 40°'s F. Photographs to document the conditions at the dam were taken during the inspection and are included in Appendix A. The level of the impoundment was about 0.1 foot above the primary spillway crest, and one board had been removed from the sluiceway to start the winter drawdown. Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Foster's Pond Dam was found to be in Satisfactory condition with no major dam safety deficiencies. The observations and specific concerns are identified in more detail in the sections below:

2.1.2 Dam

- Abutments (Photographs 1, 2, 4, 5, 6, 7, 8)

  The left and right abutments appear to be in good condition with no evidence of seepage, erosion, or cracking.

- Upstream face (Photographs 1, 2, 6, 7, 8)

  The upper part of the upstream face of the embankment was visible at the time of our visit and was covered with gravel and small cobble / crushed stone to near the crest level. Above the gravel cover, grassed topsoil protected much of the upstream face except for a few bare spots. There were no signs of erosion. The grass was very short, likely because of consumption by geese. The geotextile that underlies the riprap and cover soils was covered by the gravel and topsoil.

- Crest (Photographs 1, 2, 3, 4, 8, 9)

  The crest of the embankment mostly had vegetation cover that included short grass, violets, and ferns. A few bare spots were noted but no erosion has taken place. The crest has a relatively consistent grade along its entire length with a slight slope upstream and downstream from its center. A small stone bench has been constructed on the right embankment.

- Downstream slope and face (Photographs 3, 4, 5, 6, 7, 8, 9, 10, 11)

  The downstream face of the dam consists of a masonry stone wall with an irregular profile. The masonry is largely unmortared except for below the spillway. We noted slight seepage flows (~0.5 gallons/minute [gpm]) on at the toe of the stone masonry wall on both sides of the spillway. The seepage appeared to be clear.

- Drains

  There are no design records available for the dam, and it does not appear that the embankment contains a filtered collection drain system.

- Instrumentation

  No instrumentation has been installed at Foster's Pond Dam.

- Access Roads and Gates

  The dam is accessed from Rattlesnake Hill Road. A guard rail and boulders along most of the frontage on Rattlesnake Road prevent vehicle access to the dam. Vehicle access to the right embankment is possible at the emergency spillway on the right abutment and is blocked off with a metal chain strung between boulders.

2.1.3 Appurtenant Structures

- Primary Spillway (Photographs 1-4, 6-11)

  The primary spillway is in generally good condition. Major repairs as described in Chapter 1 have upgraded the structural condition of the spillway and provided containment for flood flows.

- Sluiceway Low-Level Outlet (Photographs 3, 8-11)

  The sluiceway is in good condition. An 8-inch cast-iron pipe, described as being installed through the sluiceway and serving as the low-level outlet, has reportedly corroded and been abandoned. The pipe was reportedly filled and covered with concrete when the sluiceway was restored in 2005. Flows through the sluiceway are directed into the same plunge pool as flows from the main spillway. Stainless-steel brackets / slots provide a secure means of securing the stoplogs.

- Auxiliary/Emergency Spillway (Photographs 2, 4, 5, 7)

  The swale along the right abutment of the dam serves as an emergency spillway and is in good condition. The emergency spillway channel is lined with a geotextile, which is covered with gravel. The gravel extends from the pond to Rattlesnake Hill Road.

2.1.4 Downstream Area (Photos 1-9)

Rattlesnake Hill Road is located approximately 20 feet downstream of the dam. Flow from the primary spillway and the sluiceway passes under Rattlesnake Hill Road through two 42-inch-diameter concrete pipe culverts. Downstream of Rattlesnake Hill Road, water flows through wooded wetlands towards Woburn Street and eventually flows into the Shawsheen River upstream of the Ballardvale Dam.

2.1.5 Reservoir Area

Foster's Pond orientation is shown in Figs. 1 and 2. The impoundment is located within a suburban area with private homes located along the shoreline. The shoreline is primarily wooded with generally gentle to moderate slopes around the pond perimeter. The slopes along portions of the west side of the impoundment are hilly. The pond has several branches with the deepest areas

located away from the dam. The shallow channel to the dam would constrain the release of much of the pond if the dam were to fail.

2.2 Caretaker Interview

Foster's Pond Corporation is responsible for the operation and maintenance of the Dam. Mr. Stephen Cotton, the Corporation President, was present during the inspection. Information provided by Mr. Cotton on this and previous visits, along with the information from the website for the Corporation (https://www.fosterspond.org/), has been incorporated into this report.

2.3 Operation and Maintenance Procedures

Mr. Cotton provided us with the three-page Operation and Maintenance (O&M) Manual. The document is generally suitable for the size and hazard of the dam but should be updated to reference the 2019 Emergency Action Plan (EAP). See Section 2.4 for comments relative to the EAP.

2.3.1 Operational Procedures

The pond level is annually drawn down a maximum of 18 inches below the spillway level during the winter months. The maximum drawdown is mandated by the Andover Conservation Commission and DEP Superseding Order of Conditions. The sluiceway has the capacity to drawdown the water a maximum of 24 inches below spillway crest. The drawdown is performed to allow for reserve storage capacity of the dam during snow melt and storm events in the spring. Advance written notification of the drawdown is provided annually to the Andover Conservation Commission and the Massachusetts Division of Fisheries & Wildlife. The annual drawdown commences on or after November 1. It is performed by sequentially removing stoplogs from the sluiceway to lower the water by approximately 1 inch per day to the maximum of 18 inches by December 1. This level is maintained through the winter months. Depending on weather conditions, stoplogs are installed and the water level is allowed to rise on about March 15 with a target refill of early April. The water level is maintained within a few inches of the primary spillway crest elevation for the remainder of the year. Announcements of significant operational events are posted and preserved on the FPC website.

2.3.2 Maintenance of Dam and Operating Facilities

According to the O&M manual, the FPC monitors the dam semiannually for:

- Evidence of seepage or leaks on the downstream face (with note to notify the Office of Dam Safety in the event of change in amount or color of water seepage).
- Voids, cracks, sinkholes, and erosion on the upstream face and crest.
- Cracks and voids in the concrete spillway and sluiceway.
- Debris and blockages in the stilling basin and Rattlesnake Hill Road culverts (notify the Andover Public Works Department of any culvert blockages that the FPC is unable to remove).
- Sinkholes in Rattlesnake Hill Road in the area of the culverts (notify the Andover Public Works Department).
- Brushy growth on the slopes and crest.
- Damage to the stoplogs and sluiceway.

Annually, the Foster's Pond Corporation will:

- Patch, grade and fill areas and repair eroded areas as needed.
- Repair cracks and voids in concrete surfaces of the spillway and sluiceway, as needed.
- Remove brushy growth from slopes and crest.
- Replace stoplogs, as needed.
- Add clay as needed to repair erosion.
- Remove debris from plunge pool and culverts.
- Weed and re-seed grass cover on crest.

2.4 Emergency Warning System

The EAP for Foster's Pond Dam was updated by GEI in 2020 (GEI 2020). The EAP provides guidance to emergency responders in the event of an unusual or emergency condition, the most likely being a high pond level that might overtop the embankment. Prescribed procedures include notification of appropriate agencies, warnings to downstream residents, road closures (especially Rattlesnake Hill Road), and monitoring of conditions. Responsibilities for various officials and the FPC are described. The Town of Andover Emergency Management Director (and Police Chief) is assigned responsibility as the manager for emergency incident responses at the dam. The plan also shows the area estimated to be inundated if the dam were to fail, which we have incorporated as Fig. 4 to this report. We understand that the FPC reviews the plan annually to ensure that contact information is current.

2.5 Awareness of Potential Dam Related Safety Hazards at, near, and on Dams

The dam site is readily accessible to the public from Rattlesnake Road and serves as a recreational asset (scenic vista, boating access) for the community. Potential hazards might include falls from the walls and spillway.

The dam owner is reminded that the Dam Safety Regulations *302 CMR Section 10.13: Liability (1),* states: *The owner shall be responsible and liable for damage to property of others or injury to persons, including but not limited to, loss of life resulting from the operation, failure of or mis-operation of a dam.*

2.6 Hydrologic/Hydraulic Data

Following the major maintenance performed in 2007, we evaluated the Spillway Design Flood (SDF) and the capacities of the main spillway (with and without the stoplogs in the sluiceway) and of the emergency spillway. The SDF for Foster's Pond Dam, as an Intermediate size, Significant hazard potential dam, is the 100-year-return-period flood (100-year flood).

We previously estimated the 100-year flood flow to be 191 cubic foot per second (cfs) using a regression equation for eastern Massachusetts streams from the USGS Water Supply Paper 2214 (Wandle, 1983). We updated this estimate of the 100-year flood flow to be 184 cfs with the StreamStats tool, which estimates flows using a more recently published method (Zarriello, 2017) and calculates parameters for the estimate from the on-line GIS database within StreamStats.

We note that the 100-year flood has an annual probability of exceedance of 1%, a 50% probability of exceedance in any 69-year period, a 63.5% probability of exceedance in a 100-year period, and a 26% chance of exceedance during a 30-year period of a typical mortgage. We also note that watershed changes, especially increased urbanization, and climate change affect actual storm frequencies and that the pond watershed characteristics may differ from those of the watersheds used as the basis for the estimate.

We estimated capacities for the main and emergency spillways using weir equations for broad-crested weirs. We used a sharp-crested weir equation for flow over the sluiceway stoplogs. Our capacity estimates are summarized below for the maximum flood pool (~El.82.5) at the top of the dam.

Feature	Flow Capacity
Main spillway with stoplogs in place	194 cfs
Main spillway without stoplogs	227 cfs
Emergency spillway	57 cfs
Total capacity with stoplogs in place	251 cfs
Total capacity without stoplogs in place	284 cfs

Based on our calculations, the combined spillways have the capacity to pass the SDF without overtopping except by waves. Wave action on the pond should be limited by the narrow reach of the pond near the dam and the height of the hills on either side of this section of the pond. The height of water that would cause the weir equation flow estimates to match the SDF were about 0.2 foot below the top of the dam with the stoplogs in place or about 0.4 foot below the top of the dam with the stoplogs removed.

2.7 Structural and Seepage Stability

2.7.1 Embankment Structural Stability

No stability analyses were available for review. The downstream masonry stone wall face of the dam has exhibited some signs of distress with some missing and misaligned stones. The condition of the embankment and wall has improved since the 2006 inspection with the major maintenance, which included removal of trees and brush, placement of geotextile across the dam, establishment of a grassed soil cover, and identification and reduction of seepage. The upstream dam slope appears to be very flat. Based on the above, the dam structural stability appears satisfactory but should be monitored.

2.7.2 Structural Stability of Non-Embankment Structures

The spillway is the only non-embankment structure on the dam, and it appears to be in good structural condition after the repair activities of 2010, 2014, 2015, and 2021. The spillway's low height, broad base, and the placement of grouted riprap downstream of the spillway all contribute to its overall stability.

2.7.3 Seepage Stability

The numerous efforts to reduce seepage flow from the sluiceway into the stone masonry on the left embankment appear to have been partially successful. However, the dam does not have a filtered seepage collection system and may be vulnerable to seepage at either higher pond levels or if the embankment degrades (e.g., frost heave). We judge the current seepage stability to be satisfactory, but we recommend continued regular monitoring for new seepage with sediment and for sinkholes.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of Foster's Pond Dam is Satisfactory. The dam was found to have the following minor deficiencies:

1. The left embankment has a history of sinkholes due internal erosion of embankment material caused by seepage through the upstream face carrying soil out through the downstream masonry wall. The owner, Foster's Pond Corporation (FPC) has undertaken repairs on several occasions (2010, 2014, and 2015) to seal the backside of the upstream masonry with concrete and to place clay fill in the eroded areas to reduce seepage. Clear seepage (~0.5 gpm) was noted at the toe of the downstream masonry wall on both sides of the spillway during our inspection.
2. Small bare areas (but no erosion) were noted on the upstream slope and crest. Try to reestablish grass cover in bare areas. Consider use of bio-degradable erosion control matting or blankets to protect seeded areas from pedestrian traffic, geese, and washout.
3. The O&M plan predates the 2019 EAP and references outdated emergency response actions.

The following table summarizes the deficiencies reported in the 2016 Phase I report and the status of those deficiencies:

Previously Identified Deficiency	***Resolution or Current Condition***
The left embankment has a history of sinkholes due internal erosion of embankment material caused by seepage through the upstream face carrying soil out through the downstream masonry wall. The owner, Foster's Pond Corporation (FPC) has undertaken repairs on several occasions (2010, 2014, and 2015) to seal the backside of the upstream masonry with concrete and to place clay fill in the eroded areas to reduce seepage. Seepage appeared to have been reduced at the time of our visit, but we could not judge if it had been eliminated as a potential issue. The FPC should continue to monitor for seepage erosion (sediment in the seepage) and sinkholes.	The FPC monitors for seepage erosion and sinkholes as prescribed in the O&M Manual. Clear seepage (~0.5 gpm) was noted at the toe of the downstream masonry wall on both sides of the spillway. Monitoring should continue.

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs, or remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, MADEP, or other regulatory agencies.

3.2 Studies and Analyses

Only one minor update is recommended, as follows:

- Update the O&M Plan to reference the 2019 EAP.

3.3 Recurrent Maintenance Recommendations

Recurrent Maintenance recommendations are as follows:

- Continue with the maintenance and monitoring activities described in the O&M Manual and as practiced over the past few years.
- Reestablish grass cover in bare areas. Consider use of bio-degradable erosion control matting or blankets to protect seeded areas from pedestrian traffic, geese, and washout.

3.4 Minor Repair Recommendations

None recommended.

3.5 Remedial Modifications Recommendations

None recommended.

3.6 Alternatives

None recommended.

3.7 Opinion of Probable Construction Costs

No construction activities are currently recommended.

SECTION 4

4.0 LIMITATIONS

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no other warranty, express or implied, is made. Limitations on our recommendations are contained in the attached "Important Information about your Geotechnical Engineering Report."

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

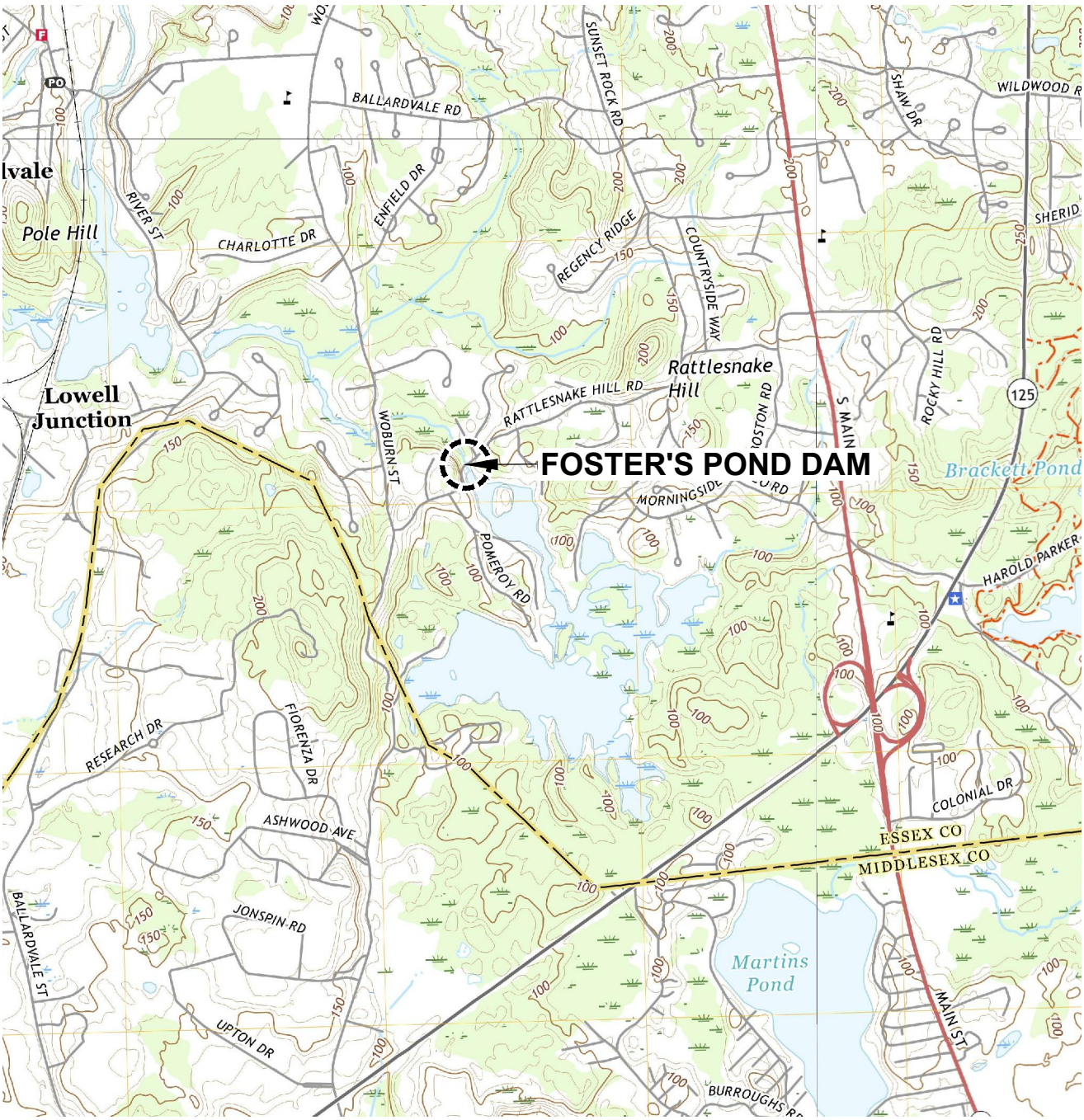
Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

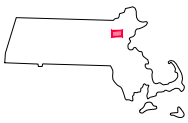
FIGURES



0 1000 2000 4000 6000

SCALE, FEET

FOSTER'S POND DAM
NID MA00153
ANDOVER, MA
U.S.G.S. TOPOGRAPHIC 7.5 MINUTE SERIES
WILMINGTON AND READING, MA QUADRANGLES, 2021.
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W
DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
CONTOUR INTERVAL IS 10 FEET.



MASSACHUSETTS
QUADRANGLE LOCATION

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	SITE LOCATION MAP
Foster's Pond Corporation Andover, Massachusetts	Project 2104192	November 5, 2021 Fig. 1

B:\Working\FOSTERS POND CORPORATION\2104192 Foster's Pond Dam 2021 Phase I Inspection\00_CAD\Figures\Ph I IR\2104192-01

0 500 1000 2000 3000

SCALE, FEET

FOSTER'S POND DAM
NID MA00153
ANDOVER, MA
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W
MICROSOFT BING MAPS IMAGE 2021

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	AERIAL PHOTOGRAPH
Foster's Pond Corporation Andover, Massachusetts	Project 2104192	November 5, 2021 Fig. 2

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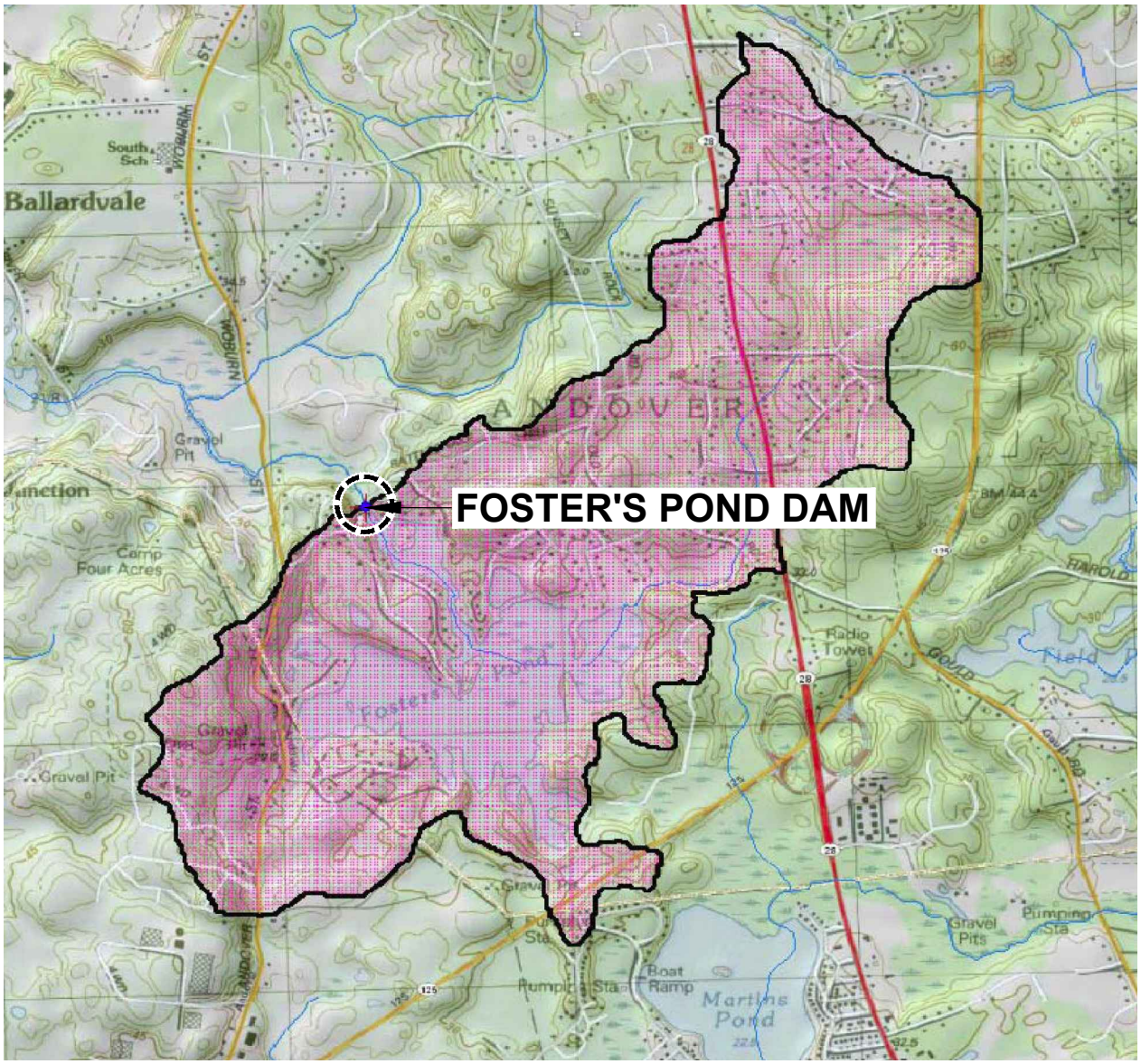

FOSTER'S POND DAM
NID ID MA00153
DRAINAGE AREA = 1.58 SQUARE MILES
ANDOVER, MA
READING & LAWRENCE, MA QUADRANGLES
SOURCE: USGS PROGRAM MASSACHUSETTS STREAMSTATS
LATITUDE: 42.61361°N
LONGITUDE: 71.14146°W

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	DRAINAGE AREA
Foster's Pond Corporation Andover, Massachusetts	Project 2104192	November 5, 2021 Fig. 3

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LEGEND:

Inundation

Inundated roads

NOTES:
Foster's Pond Dam
NID ID# MA00153
Andover, MA
Reading and Lawrence, MA Quadrangles
Source: MassGIS
Latitude: 42.61361° N
Longitude: 71.14146° W

N
W E
S

0 200 400 800
Feet

Emergency Action Plan Mapping Foster's Pond Dam Andover, Massachusetts	GEI Consultants	ESTIMATED DOWNSTREAM INUNDATION AREA FROM 2019 EAP
Foster's Pond Corporation Andover, Massachusetts	Project 2104192	November 5, 2021 Fig. 4

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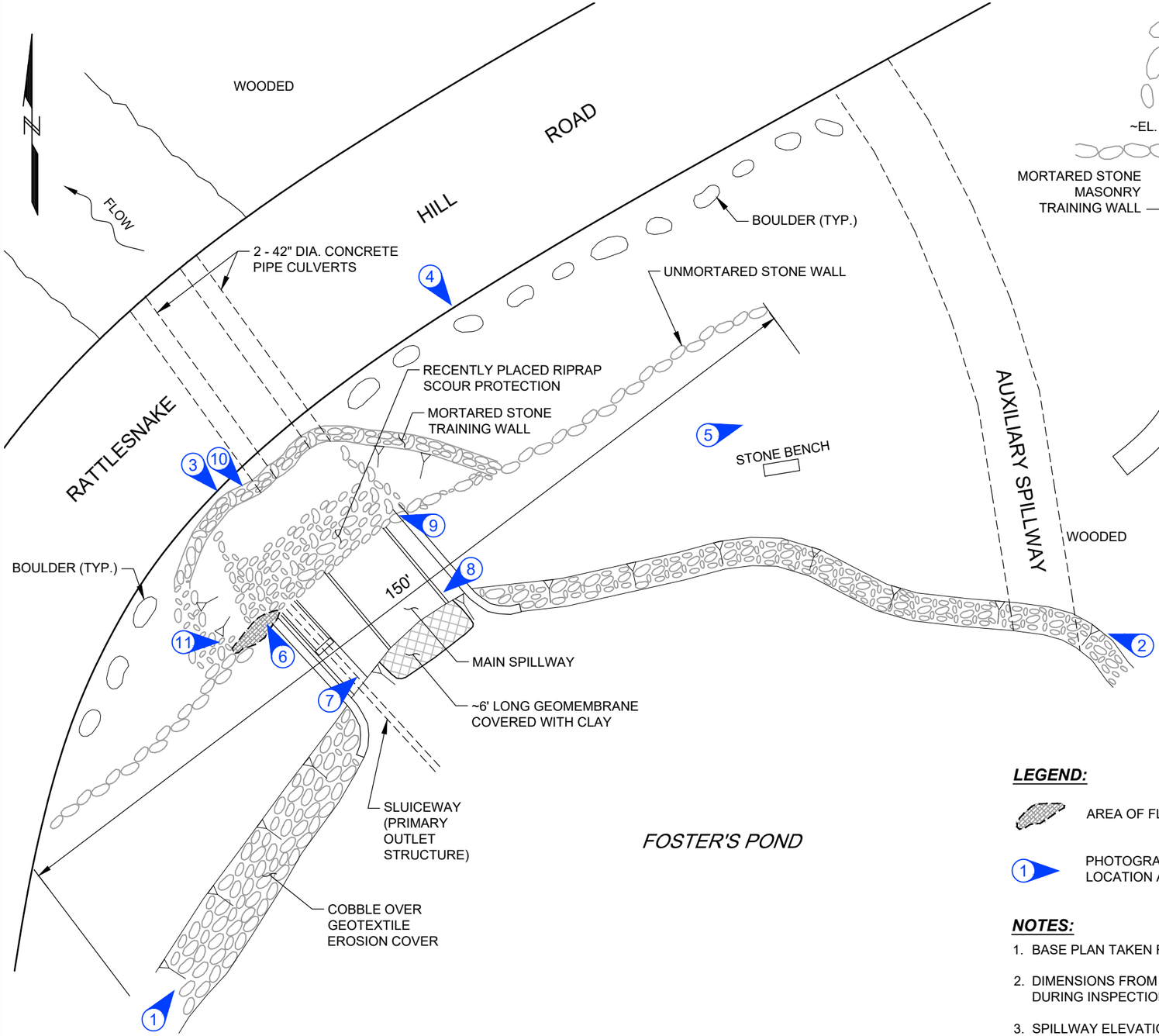
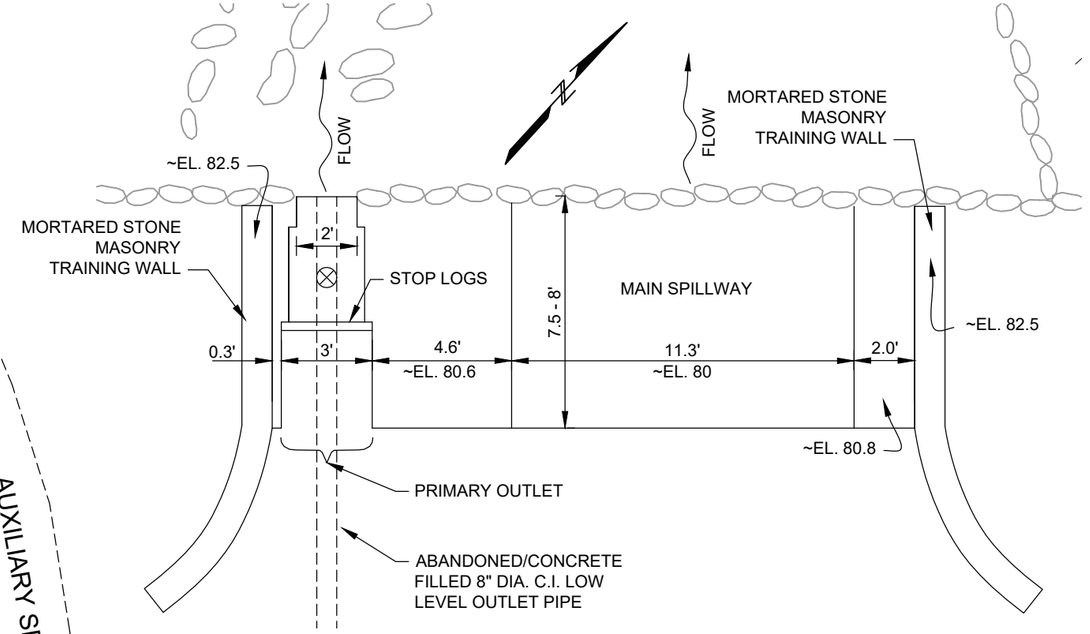


FOSTER'S POND DAM

NOT TO SCALE



DETAIL - MAIN SPILLWAY AND PRIMARY OUTLET

LEGEND:

AREA OF FLOW FROM WALL

PHOTOGRAPH NUMBER LOCATION AND DIRECTION

NOTES:

1. BASE PLAN TAKEN FROM SITE PLAN PREPARED BY FOSTER'S POND CORP. MEMBERS.
2. DIMENSIONS FROM HISTORIC INSPECTION RECORDS AND MEASUREMENTS TAKEN DURING INSPECTION ON NOVEMBER 10, 2006 AND MAY 8, 2008.
3. SPILLWAY ELEVATIONS ASSUME SPILLWAY CREST AT EL. 80.0.

Foster's Pond Dam Andover, Massachusetts	GEI Consultants	DAM SITE PLAN SKETCH
Foster's Pond Corporation Andover, Massachusetts	Project 2104192	November 5, 2021 Fig. 5

B:\Working\FOSTERS POND CORPORATION\2104192 Foster's Pond Dam 2021 Phase I Inspection\00_CAD\Figures\Ph I IR\2104192-05

APPENDIX A
Inspection Photographs

Photo 1 – Upstream slope and crest from left*

Photo 2 – Upstream slope and crest from right*

*Note: Distortions and color or light irregularities in panoramic composite photos are due to discontinuities between individual photographic images used to create panoramic composites.

Photo 3 – Downstream side of dam at spillway*

Photo 4 – Downstream side, right embankment*

Photo 5 – Right abutment and auxiliary spillway*

Photo 6 – View downstream from dam crest, including embankments, spillway, plunge pool, Rattlesnake Road*

Photo 7 – Right embankment, spillway, and plunge pool from crest*

Photo 8 – Left embankment, spillway, sluiceway, and plunge pool from crest*

Photo 9 – Spillway, plunge pool, and downstream from right crest*

Photo 10 (left) – Spillway and sluiceway from downstream (arrows show general seepage sites)*
Photo 11 (right) – Right downstream embankment wall at spillway (arrows show general seepage site)*




Photos 12 (upper left), 13 (upper right), 14 (lower left), 15 (lower right) – May 2021 maintenance activities – replacing spillway slab (12, 13, 14) and placement of additional gravel on upstream slope (15). Gravel also placed over auxiliary spillway. Photos from Foster's Pond Corporation website.

APPENDIX B
Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST INSTRUCTION PAGE

The checklist (Excel file) includes sections applicable to a variety of dam structure types. Carefully follow the instructions on the first tab of the checklist. Complete those pages pertaining to each structure and omit pages that are not relevant or mark them "Not Applicable." The Checklist must be signed by the inspecting engineer and a clean, neat copy included in the final inspection report. Use the checklist to generate the Dam Evaluation Summary Detail Sheet (should immediately follow the Executive Summary) and Table 1.1 (should immediately follow Section 1.0).

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post-design analyses show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance, and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available, filed with MADCR, annual training

E4: EMBANKMENT SEEPAGE (Embankment, Foundation & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but monitored seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (see Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained, healthy uniform grass cover

E6: CONCRETE CONDITION (see Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no mis-alignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low-level outlet, no provisions (e.g., pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 51- 90% of the SDF
3. 91- 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g., open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF THE DAM
1. *UNSAFE* – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. *POOR* - Significant structural, operation and maintenance deficiencies are clearly recognized for normal loading conditions
3. *FAIR* - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. *SATISFACTORY* - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.
5. *GOOD* - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST

Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Guidelines and Notes for Evaluations

Each of the evaluation categories has 5 rating levels. In general, the rating levels in each category are intended to reflect the following conditions:

1. Unsafe
2. Poor
3. Fair
4. Satisfactory
5. Good

E10-Overall Safety Rating Guideline

Unless the inspecting engineer presents compelling data, analyses, and observations that justify a higher rating, E10-Overall Safety Rating of the Dam shall not be higher than the lowest ranking in these high importance categories:

-E4-Seepage,

-E5-Embankment Condition (for embankment dams), and

-E6-Concrete Condition (for dams where concrete structures retain water).

Note 1 - Embankment Condition Factor of Safety Criteria
In addition to the inspection conditions listed, the embankment condition rating should consider the slope stability Factor of Safety (FS) according to the following guidelines for downstream (D/S) and upstream slopes (U/S).

	Normal Pool	**SDF**	**Seismic**	**Rapid Drawdown**
Rating	**D/S & U/S FS**	**D/S FS**	**D/S & U/S FS**	**U/S FS**
1	<1.3	<1.1	<1.0	<1.0
2	<1.5	<1.4	<1.0	<1.1
3	>1.5	<1.5	<1.1	<1.2
4	>1.5	>1.5	>1.1	>1.2
5	>1.5	>1.5	>1.1	>1.2

In the absence of stability analyses, use the following factors to evaluate the stability component of the embankment rating. The inspecting engineer will need to consider all factors in combination as the exact combination of conditions listed will rarely occur. For slopes, > indicates "steeper than."

Rating	**Slopes**	**Seepage**	**Material**	**Compaction**
1	>2H:1V	>5' above toe	SP, ML*, SM*	Loose or unknown
2	>2.5H:1V	>2' above toe	ML**, MH	Loose or unknown
3	>3H:1V	at toe	SM**, SW, CH	Likely compacted
4	<3H:1V	DS of toe	SC, CL	Compacted
5	<3H:1V	None	Suitably Zoned	Compacted

ML* - Non-plastic silt or any silt or clay susceptible to dispersion
ML** - Silt with some plasticity (non-dispersive)
SM* - Uniform silty fine sand
SM** - Widely graded silty sand

Note 2 - Concrete Condition Factor of Safety Criteria
In addition to the inspection conditions listed, ratings should consider the sliding stability Factors of Safety (FS) for any concrete structures that retain water according to the following guidelines.

FS Criteria for Dams with Limited Structure and Foundation Information and Testing

Rating	**Normal Pool FS**	**SDF FS**	**Ice Loading FS**	**Seismic FS**
1	<2.0	<1.3	<1.3	<1.0
2	<3.0	<2.0	<2.0	<1.3
3	>3.0	>2.0	>2.0	<1.5
4	>3.0	>2.0	>2.0	>1.5
5	>3.0	>2.0	>2.0	>1.5

FS Criteria for Dams with Well Defined Structure and Foundation Information and Testing

Rating	**Normal Pool FS**	**SDF FS**	**Ice Loading FS**	**Seismic FS**
1	<1.5	<1.3	<1.3	<1.0
2	<2.0	<1.7	<1.7	<1.0
3	<3.0	<2.0	<2.0	<1.1
4	>3.0	>2.0	>2.0	<1.3
5	>3.0	>2.0	>2.0	>1.3

See Appendix D for a complete listing of dam orientation and terminology definitions.

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: Foster's Pond Dam

STATE ID #: 5-5-9-10

REGISTERED: ☑ YES ☐ NO

NID ID #: MA00153

STATE SIZE CLASSIFICATION: Intermediate

STATE HAZARD CLASSIFICATION: Significant

CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Andover

COUNTY: Essex

DAM LOCATION: (street address if known) Off Rattlesnake Hill Road

ALTERNATE DAM NAME:

USGS QUAD.: Reading

LAT.: 42.61361°N

LONG.: 71.14146°W

DRAINAGE BASIN: Shawsheen

RIVER: Frye's Brook (inflow) to Shawsheen River about 1 mile downstream

IMPOUNDMENT NAME(S): Fosters Pond

GENERAL DAM INFORMATION

TYPE OF DAM: Earthfill w/ downstream stone masonry

OVERALL LENGTH (FT): ~150

PURPOSE OF DAM: Recreational

NORMAL POOL STORAGE (ACRE-FT): ~538

YEAR BUILT: ~1850s

MAXIMUM POOL STORAGE (ACRE-FT): ~867

STRUCTURAL HEIGHT (FT): ~10.1

EL. NORMAL POOL (FT): ~78.5-79.8 (assumed spillway El.=80 ft)

HYDRAULIC HEIGHT (FT): ~7.6

EL. MAXIMUM POOL (FT): ~82.5

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO

CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: Foster's Pond Dam | STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 | NID ID #: MA00153

INSPECTION SUMMARY

DATE OF INSPECTION: November 5, 2021 | DATE OF PREVIOUS INSPECTION: December 6, 2016

TEMPERATURE/WEATHER: ~40°F / Sunny | ARMY CORPS PHASE I: ☐ YES ☑ NO | If YES, date

CONSULTANT: GEI Consultants, Inc. | PREVIOUS DCR PHASE I: ☐ YES ☑ NO | If YES, date 12/6/2016

BENCHMARK/DATUM: Not available; 80 ft used as a reference datum equal to the main spillway crest elevation

OVERALL PHYSICAL CONDITION OF DAM: SATISFACTORY | DATE OF LAST REHABILITATION: May 2021 - spillway concrete repair, cover gravel

SPILLWAY CAPACITY: >100% SDF w/ no actions by Caretaker

EL. POOL DURING INSP.: ~80.1 | EL. TAILWATER DURING INSP.: ~72.2

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
Lee Wooten, P.E.	Engineer	GEI Consultants, Inc.
Stephen Cotton	FPC President	Foster's Pond Corporation - (FPC)

EVALUATION INFORMATION

		Click on box to select E-code
E1)	TYPE OF DESIGN	1
E2)	LEVEL OF MAINTENANCE	5
E3)	EMERGENCY ACTION PLAN	5
E4)	EMBANKMENT SEEPAGE	4
E5)	EMBANKMENT CONDITION	4
E6)	CONCRETE CONDITION	5
E7)	LOW-LEVEL OUTLET CAPACITY	1

		Click on box to select E-code
E8)	LOW-LEVEL OUTLET CONDITION	1
E9)	SPILLWAY DESIGN FLOOD CAPACITY	5
E10)	OVERALL PHYSICAL CONDITION	4
E11)	ESTIMATED REPAIR COST	$0
	ROADWAY OVER CREST	NO
	BRIDGE NEAR DAM	NO

NAME OF INSPECTING ENGINEER: Lee Wooten, P.E. | SIGNATURE: Lee Wooten

NAME OF DAM: Foster's Pond Dam

STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021

NID ID #: MA00153

OWNER:		CARETAKER:	
ORGANIZATION	Foster's Pond Corporation	ORGANIZATION	Foster's Pond Corporation
NAME/TITLE	Stephen E. Cotton - President	NAME/TITLE	David Brown - Treasurer
STREET	19 Pomeroy Road	STREET	31 Glenwood Road
TOWN, STATE, ZIP	Andover, MA 01810	TOWN, STATE, ZIP	Andover, MA 01810
PHONE	978-475-5679	PHONE	978-470-0454
EMERGENCY PH. #	978-475-5679	EMERGENCY PH. #	978-470-0454
FAX		FAX	978-470-2066
EMAIL	scotton@fosterspond.org	EMAIL	davebrown@alum.mit.edu
OWNER TYPE	Private Association or other non-profit		

PRIMARY SPILLWAY TYPE: Broad crested weir

SPILLWAY LENGTH (FT): 21.2

SPILLWAY CAPACITY (CFS): ~194

AUXILIARY SPILLWAY TYPE: Gravel covered swale

AUX. SPILLWAY CAPACITY (CFS): 0 cfs but overtopping not likely to breach

NUMBER OF OUTLETS: 1 sluiceway

OUTLET(S) CAPACITY (CFS): ~33 with full pool

TYPE OF OUTLETS: Sluiceway with stoplogs (operational)

TOTAL DISCHARGE CAPACITY (CFS): ~284

DRAINAGE AREA (SQ MI): 1.58

SPILLWAY DESIGN FLOOD (PERIOD/CFS): 100-year / 184 cfs

HAS DAM BEEN BREACHED OR OVERTOPPED: ☑ YES ☐ NO IF YES, PROVIDE DATE(S): overtopped 05/54, 03/01, Sprng '02, 04/04, 05/14/06

FISH LADDER (LIST TYPE IF PRESENT): None

DOES CREST SUPPORT PUBLIC ROAD? ☐ YES ☑ NO IF YES, ROAD NAME:

PUBLIC BRIDGE WITHIN 50' OF DAM? ☐ YES ☑ NO IF YES, ROAD/BRIDGE NAME:

MHD BRIDGE NO. (IF APPLICABLE)

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Soil with grass cover		x	
	2. SURFACE CRACKING	None observed		x	
	3. SINKHOLES, ANIMAL BURROWS	None observed		x	
	4. VERTICAL ALIGNMENT (DEPRESSIONS	Uniform crest elevation after recent maintenance		x	
	5. HORIZONTAL ALIGNMENT	No visible horizontal displacements	x		
	6. RUTS AND/OR PUDDLES	None observed		x	
	7. GRASS COVER CONDITION	Grass, flower (violets), and fern cover, with some bare spots		x	x
	8. WOODY VEGETATION (TREES/BRUSH)	None observed		x	
	9. ABUTMENT CONTACT	Good condition, indistinct	x		

ADDITIONAL COMMENTS: The maintenance actions have restored and maintained a uniform grade to the embankment crest and established a grass cover over the crest. Geotextile was placed below seeded topsoil on embankment crest. Recommend grass re-establishment in bare spots (seed & cover with biogradable erosion matting).

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	Wet areas near spillway at toe of wall		x	
	2. SEEPAGE	Seepage near spillway at toe of wall		x	
	3. SLIDE, SLOUGH, SCARP	Irregular unmortared stone masonry wall		x	
	4. EMB.-ABUTMENT CONTACT	Good	x		
	5. SINKHOLE/ANIMAL BURROWS	None observed		x	
	6. EROSION	None observed		x	
	7. UNUSUAL MOVEMENT	None observed	x		
	8. GRASS COVER CONDITION	No vegetation in masonry wall		x	
	9. WOODY VEGETATION (TREES/BRUSH)	None observed		x	

ADDITIONAL COMMENTS: Low flow clear seepage (< 0.5 gpm) noted at downstream toe of dam / stone masonry wall near spillway. Likely source is stonework that underlies the spillway.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

EMBANKMENT (U/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	None observed	x		
	2. SLOPE PROTECTION TYPE AND COND.	Cobble (3 inch to 6 inch) & gravel placed over geotextile (Note 1)		x	
	3. SINKHOLE/ANIMAL BURROWS	None observed		x	
	4. EMB.-ABUTMENT CONTACT	Good	x		
	5. EROSION	None observed		x	
	6. UNUSUAL MOVEMENT	None observed	x		
	7. GRASS COVER CONDITION	Grass cover and bare areas in areas above gravel erosion protection (Note 1)		x	x
	8. WOODY VEGETATION (TREES/BRUSH)	None observed		x	

ADDITIONAL COMMENTS: 1. Most of the upstream slope is covered with 3- to 6-inch cobbles and gravel placed over a geotextile. The upper few feet of the slope are covered with grassed soil. Geotextile was placed below seeded toposoil on right embankment crest and is covered with seeded topsoil or gravel to prevent degradation by sunlight.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	None	x		
	2. OBSERVATION WELLS	None	x		
	3. STAFF GAGE AND RECORDER	None	x		
	4. WEIRS	None	x		
	5. INCLINOMETERS	None	x		
	6. SURVEY MONUMENTS	None	x		
	7. DRAINS	None	x		
	8. FREQUENCY OF READINGS	NA	x		
	9. LOCATION OF READINGS	NA	x		

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None observed	x		
	2. FOUNDATION SEEPAGE	None observed		x	
	3. SLIDE, SLOUGH, SCARP	None observed	x		
	4. WEIRS	None	x		
	5. DRAINAGE SYSTEM	Two 42-inch concrete culverts carry dam flow downstream under Rattlesnake Hill Rd	x		
	6. INSTRUMENTATION	None	x		
	7. VEGETATION WITHIN 15 FT	Mulched & grass cover to Rattlesnake Hill Rd, wooded wetlands area beyond road		x	
	8. ACCESSIBILITY	Good; Rattlesnake Hill Road	x		
	9. DOWNSTREAM HAZARD DESCRIPTION	Local roads, Rattlesnake Hill Road immediately downstream and Woburn Street ~1300 ft downstream beyond heavily vegetated wooded wetlands area			

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	4.5 feet (538 acre-feet / 120 acres)
	2. RESERVOIR SHORELINE	Wooded and grass, residential homes
	3. RESERVOIR SLOPES	Gentle to moderate slopes; hilly along west side of impoundment
	4. ACCESS ROADS	Adjacent to Rattlesnake Hill Road on downstream side of dam
	5. SECURITY DEVICES	Boulders along downstream side and metal chain gate at access path on right embankment
	6. WATER PUBLIC HAZARDS & PROTECTION	Area accessible for public recreation. Shallow depths and low flows at dam.
	7. LAND-SIDE PUBLIC HAZARDS & PROTECTION	Normal visible / obvious fall hazards at spillway and downstream wall
	7. VANDALISM OR TRESPASS	☐ YES ☑ NO WHAT:
	8. AVAILABILITY OF PLANS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	10. AVAILABILITY OF EAP/LAST UPDATE	☑ YES ☐ NO DATE: September 2019
	11. AVAILABILITY OF O&M MANUAL	☐ YES ☑ NO DATE:
	12. CARETAKER/OWNER AVAILABLE	☑ YES ☐ NO DATE: November 5, 2021
	13. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Concrete/masonry, broad-crested	x		
	WEIR TYPE	Broad-crested weir, 11.9 ft long	x		
	SPILLWAY CONDITION	Good - see note 1		x	
	TRAINING WALLS	Good - granite curbstone training walls added as erosion protection (Note 1)		x	
	SPILLWAY CONTROLS AND CONDITION	No controls other than sluiceway boards	x		
	UNUSUAL MOVEMENT	Downstream left side of spillway is slightly lower, possible past movement		x	
	APPROACH AREA	Shallow slope. Upstream slope covered w/ geomembrane & clay ~6 ft into basin.		x	
	DISCHARGE AREA	Stilling basin is enclosed by a mortared stone training wall (note 2)		x	
	DEBRIS	None observed		x	

ADDITIONAL COMMENTS: 1. Training walls originally upgraded in 2007 with the construction of the current granite block walls. In 2010, 2014, & 2015, FPC has repaired internal erosion of the embankment behind the spillway walls by excavating at sinkholes, placing concrete to seal seepage entry points, and by backfilling behind the concrete with clay. In 2021, the spillway cover slab was replaced.
2. Plunge pool has been maintained with the addition of dumped riprap below the spillway for erosion protection.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Grass covered swale along right abutment (Note 1)	x		
	WEIR TYPE	Earth-lined with gravel cover, broad-crested	x		
	SPILLWAY CONDITION	Good		x	
	TRAINING WALLS	None	x		
	SPILLWAY CONTROLS AND CONDITION	None	x		
	UNUSUAL MOVEMENT	None observed	x		
	APPROACH AREA	Clear, covered with large gravel	x		
	DISCHARGE AREA	Rattlesnake Hill Rd, wetlands beyond	x		
	DEBRIS	None observed	x		

ADDITIONAL COMMENTS: 1. Existing swale emergency spillway along the right abutment with a low point ~1 ft higher than primary spillway intake elevation, has been maintained by regrading, placement of gravel cover. A geotextile was also placed under the upstream covered portions of the spillway previously.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Sluiceway controlled with stoplogs	x		
	INTAKE STRUCTURE	Concrete sluiceway, 3 ft to 2 ft wide, 2.6 feet deep (note 1)		x	
	TRASHRACK	None	x		
	PRIMARY CLOSURE	Three 10-inch-deep stoplogs	x		
	SECONDARY CLOSURE	None	x		
	CONDUIT	8-inch low-level outlet pipe thru sluiceway reportedly corroded, filled w/ concrete	x		
	OUTLET STRUCTURE/HEADWALL	None	x		
	EROSION ALONG TOE OF DAM	None		x	
	SEEPAGE/LEAKAGE	Clear seepage noted at toe of stone masonry wall on both sides of spillway		x	
	DEBRIS/BLOCKAGE	None observed		x	
	UNUSUAL MOVEMENT	None observed		x	
	DOWNSTREAM AREA	Riprapped plunge pool (riprap placed as part of 2007 maintenance)		x	
	MISCELLANEOUS	Stone masonry training walls on left side of sluiceway repaired/upgraded in 2007		x	

ADDITIONAL COMMENTS: 1. Condition of concrete good. No cracks observed.

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

CONCRETE/MASONRY DAMS (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	TYPE	NA - Dam crest is the grassed embankment.	x		
	SURFACE CONDITIONS	NA	x		
	CONDITIONS OF JOINTS	NA	x		
	UNUSUAL MOVEMENT	NA	x		
	HORIZONTAL ALIGNMENT	NA	x		
	VERTICAL ALIGNMENT	NA	x		

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

CONCRETE/MASONRY DAMS (DOWNSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S FACE	TYPE	Downsteam dam face is a mostly unmortared stone masonry wall.	x		
	SURFACE CONDITIONS	Irregular alignment of stones in masonry wall (probably as-built condition).		x	
	CONDITIONS OF JOINTS	Fair		x	
	UNUSUAL MOVEMENT	None observed	x		
	ABUTMENT CONTACT	No problems	x		
	LEAKAGE	Clear seepage noted at toe of wall (~0.5 gpm) on both sides of spillway	x		

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond Dam STATE ID #: 5-5-9-10

INSPECTION DATE: November 5, 2021 NID ID #: MA00153

CONCRETE/MASONRY DAMS (UPSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S FACE	TYPE	No upstream masonry walls	x		
	SURFACE CONDITIONS	NA	x		
	CONDITIONS OF JOINTS	NA	x		
	UNUSUAL MOVEMENT	NA	x		
	ABUTMENT CONTACTS	NA	x		

ADDITIONAL COMMENTS: 1. Concrete face on upstream side of dam repaired in 2018.

APPENDIX C
Previous Reports and References

PREVIOUS REPORTS AND REFERENCES

The following is a list of reports that were located during the file review or were referenced in previous reports.

1. GEI Consultants, Inc., 2016, "Fosters Pond Dam Phase I Inspection / Evaluation Report," December 6.
2. Foster's Pond Corporation, 2016, "Foster's Pond Dam Operations and Maintenance Manual & Emergency Procedures," December 6.
3. Foster's Pond Corporation, 2016, "Foster's Pond Corporation" website, http://www.fosterspond.org/.
4. GEI Consultants, Inc., 2011, "Fosters Pond Dam Phase I Inspection / Evaluation Report," November 18.
5. GEI Consultants, Inc., 2010, "Site Visit Observations and Preliminary Recommendations, Fosters Pond Dam, NID # MA00153, Andover, Massachusetts," April 6.
6. GEI Consultants, Inc., 2008, "Foster's Pond Dam Follow-Up Inspection / Evaluation Report," May 8.
7. GEI Consultants, Inc., 2006, "Fosters Pond Dam Phase I Inspection / Evaluation Report," November 10.
8. Foster's Pond Corporation, 2005, "Foster's Pond Dam, Operations and Maintenance Manual," October 12.
9. Department of Conservation and Recreation, Office of Dam Safety, 2003, Letter to Mr. Stephen Cotton with complete Foster's Pond Dam file Information including inspection reports from 1913 to 1973, dated August 12.
10. Department of Environmental Management, Office of Dam Safety, 2001, Foster's Pond Dam Notice of Inspection Letter and Inspection Summary, April 2.
11. Town of Andover, Andover, Massachusetts, 2001, Foster's Pond Dam, Letter to Department of Environmental Management, Office of Dam Safety, March 23.
12. Massachusetts Department of Public Works, 1973, Foster Pond Dam, Letter to Foster's Pond Corporation, October 29.
13. Lee Chisholm, 1973, Foster's Pond Dam, Letter to Massachusetts De Department of Public Works, October 4.

The following references were utilized during the preparation of this report and the development of the recommendations presented herein.

1. Commonwealth of Massachusetts, Department of Conservation and Recreation, 2009, "302 CMR10.00: Dam Safety," June 26.
2. Wandle, S. William, Jr., 1983, "Estimating Peak Discharges of Small Rural Streams in Massachusetts," USGS Water Supply Paper 2214.
3. Zarriello, P.J., 2017, "Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geologic Survey Scientific Investigations Report 2016-5156.

APPENDIX D
Definitions

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exist, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

Size Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

Hazard Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

General

EAP – Emergency Action Plan – Shall mean a predetermined (and properly documented) plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam failure.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre-feet.

Height of Dam (Structural Height) – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the lowest point on the crest of the dam.

Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.

Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.

Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.

Condition Rating

Unsafe – Major structural*, operational, and maintenance deficiencies exist under normal operating conditions.

Poor – Significant structural*, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair – Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory – Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good – No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

* Structural deficiencies include but are not limited to the following:

- Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
- Missing riprap with resulting erosion of slope
- Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
- Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
- Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
- Inoperable outlets (gates and valves that have not been operated for many years or are broken)