

-- FOSTER'S POND DAM --
PHASE I
INSPECTION / EVALUATION REPORT



Dam Name: Foster's Pond Dam
State Dam ID#: 5-5-9-10
NID ID#: MA00153
Owner: Foster's Pond Corporation
Town: Andover, Massachusetts
Consultant: GEI Consultants, Inc.
Date of Inspection: November 18, 2011

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 18, 2011 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 EAP section of the O&M Manual should be expanded as described in Section 3.2.
2. A small area of geotextile on the right embankment is exposed.

The owner of the dam, the Foster's Pond Corporation, has performed major remedial maintenance on the dam during two phases since the 2006 Phase I inspection. The first major remedial maintenance addressed the deficiencies identified in the 2006 Phase I inspection and included the following:

- Upgrading of the stone masonry spillway training walls. The effect of the training walls has been to increase the safe flow capacity of the primary spillway.
- Embankment crest rest rehabilitation involving tree and brush removal, sinkhole filling, regrading for an even crest elevation, placement of a geotextile across the crest, and covering the geotextile with grassed topsoil.
- Rehabilitation of the emergency spillway at the right abutment with minor regrading, geotextile placement and covering with grassed topsoil (downstream) and cobble (upstream) to form a 1.5-foot-deep channel with a base width of 9 feet and a top width of 18 feet.
- Cobble cover over geotextile across the entire upstream face as erosion protection.
- Grouted riprap placement 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. To repair the damage (sinkholes, training wall movement), the Foster's Pond Corporation lowered the pond using the sluiceway and performed the following remedial maintenance:

- Placement of flowable mortar mix and concrete into the cavities that formed in the spillway structure.
- Construction of 1- to 2-foot-thick mass concrete sections behind the training walls.
- Placement of concrete over much of the slope and along or under the training walls upstream of the sluiceway.
- Placement of several tons of large crushed stone on the upstream slopes of the dam.

The repairs were completed and the sluiceway was closed to raise the pond in June 2010.

The following table summarizes the deficiencies reported in the 2006 Phase I report and the status of those deficiencies:

| <i>Previously Identified Deficiency</i> | <i>Resolution or Current Condition</i> |
|--|---|
| The spillway cannot pass the spillway design flood (SDF). | The rehabilitation of the main and emergency spillways provides a spillway capacity estimated to be in excess of the estimated SDF. |
| The embankment crest is very uneven with sinkholes, erosion gullies and eroded zones. | The embankment crest has been regraded to provide an even crest with a healthy grass cover and without sinkholes. |
| Seepage is observed at the base of the downstream unmortared masonry stone wall and through the masonry wall below the spillway. | Repairs and patching of spillway and sluiceway sides appears to have eliminated or significantly reduced seepage. |
| Portions of the main spillway appear to have sunk or settled. | The main spillway has been rehabilitated with the placement of flowable mortar mix and concrete in voids. |
| The downstream masonry wall has some misplaced and misaligned stones. | The downstream wall masonry remains irregular but appears to have suitable stability. |
| There is some tree growth on the downstream crest and right abutment. | Trees have been removed. |
| The left side of the training wall surrounding the plunge pool has collapsed. | Both training walls have been rebuilt. |
| There are areas of missing riprap on the upstream slope. | Cobble riprap and crushed stone over geotextile has been placed across the entire upstream slope. |

We recommend the following actions be taken to address the deficiencies observed at the dam during this inspection and evaluation:

- The EAP section of the O&M Manual should be expanded as described in Section 3.2.
- Cover the exposed geotextile on the right embankment with seeded topsoil to protect it from degradation.

Dam Evaluation Summary Detail Sheet

| | | | |
|-------------------------------|--------------------------------------|---|-------------------|
| 1. NID ID: | MA00153 | 4. Inspection Date: | November 18, 2011 |
| 2. Dam Name: | Foster's Pond Dam | 5. Last Insp. Date: | November 10, 2006 |
| 3. Dam Location: | Andover, MA | 6. Next Inspection: | November 18, 2016 |
| 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: | 4 | E9. Spillway Design Flood Capacity: | 5 |
| E4. Embankment Seepage: | 4 | E10. Overall Physical Condition of the Dam: | 4 |
| E5. Embankment Condition: | 5 | E11. Estimated Repair Cost: | \$1600 to \$5000 |
| 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

Structural, hydraulic height changes based on measurement after major maintenance activities
 Impoundment volumes changes based on bathymetric surveys (normal pool) and calculated volumes above normal pool
 Spillway capacities changes based on calculations after major maintenance activities

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.

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License Type: Civil

Principal

GEI Consultants, Inc.

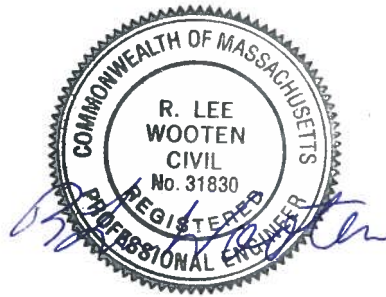


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SECTION 1

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 41 – 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

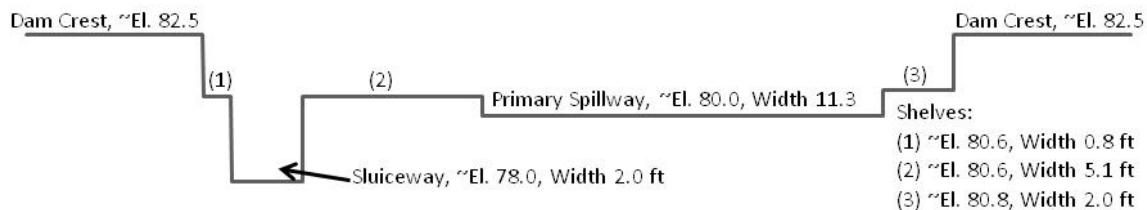
Foster's Pond Dam impounds water to form Foster's Pond, which discharges to wetlands downstream and eventually flows into the Shawsheen River. The reservoir is irregularly shaped, with a maximum length (north to south) of approximately 5,000 feet and a maximum width (east to west) of approximately 4,000 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. 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 mulch or grass covered. 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:



Normal outflows are conveyed by the primary spillway section of the main spillway profile shown above, except during the winter drawdown, when outflows are through the sluiceway. High flows will extend over the three shelves shown in the profile and over any stoplogs in place 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 basin. 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. 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 spillway channel surface has been finished with cobbles upstream and topsoil with grass or mulch cover from the spillway crest downstream. Geotextile has been placed under all portions of the emergency spillway cover.

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 water level control at the dam is maintained at approximately 2 inches below the bottom 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. Figure 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. Figure 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 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 described in Section 1.3.7, below, 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.80.0 |
| 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 Survey information is not available for this structure. Elevations are referenced to spillway crest arbitrarily set at 80 feet. This elevation is consistent with elevation contours in the area depicted in the USGS maps.

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 | Sluiceway 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 two major maintenance efforts on the dam since the 2006 Phase I Report. The first effort corrected deficiencies identified in the 2006 report and was reported in our May 8, 2008 "Foster's Pond Dam Follow-Up Inspection / Evaluation Report." Specific maintenance activities are described below:

- 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 the 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 sink-holes had formed on the crest of the left / southwest embankment of the dam immediately adjacent to the mortared masonry wingwall (see Photos 3 & 4). 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 Foster's Pond Corporation lowered the pond using the sluiceway and performed the following remedial maintenance:

- 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 two 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 were added to the upstream slopes of the dam.

The repairs were completed and the sluiceway was closed to raise the pond in June 2010.

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 Table 1.1.

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Foster's Pond Dam was inspected on November 18, 2011. 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 just at 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- 6, 14)

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

- Upstream Face (Photographs 1, 2, 7-9)

The lower part of the upstream face of the embankment was underwater and not observed. The visible, upper portions of the upstream face were covered with small cobble / crushed stone to within about a ½ foot of the crest. Generally, grassed topsoil covers the top of the upstream face. The geotextile that underlies the riprap and cover soils was exposed on the upper part of the right embankment near the emergency spillway.

- Crest (Photographs 1-12)

The crest of the embankment is grass-covered and approximately 8 feet wide at its narrowest point. 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 Face (Photographs 3-6, 11, 12, 15-17)

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. One seepage area was noted at the dam toe within the plunge pool area, a few feet southwest of the sluiceway (see Photo 15).

Subsequent to our site visit, the Foster's Pond Corporation investigated the seepage and reported that:

- The seepage stopped when the sluiceway was closed and that the seepage appeared to be water that was flowing from the end of the sluiceway back into the open masonry.
 - They sealed the sides of the sluiceway outlet with new concrete to prevent the inflow of water into the masonry (see Photo 16).
 - The seepage has ceased (see Photo 17).
- Drains

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

- Instrumentation

There are no instruments installed at this dam.

- Access Roads and Gates (Photographs 1, 3-6, 8, 10, 12, 14)

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 1-5, 7-13)

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, 9-11, 16)

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 been corroded and abandoned. The pipe was reportedly filled and covered with concrete when the sluiceway was restored in 2005. Flows through the sluiceway are directed in the same plunge pool as flows from the main spillway.

- Auxiliary/Emergency Spillway (Photographs 1, 2, 6, 14)

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 cobbles upstream, grass cover across the spillway crest, and mulch cover downstream of the spillway.

2.1.4 Downstream Area (Photographs 1, 3, 5, 10, 12)

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, has been incorporated into this report.

2.3 Operation and Maintenance Procedures

Mr. Cotton provided us with the Operation and Maintenance (O&M) Manual which consists of a three page document that includes Emergency Action Plan (EAP) procedures. The document is generally suitable for the size and hazard of the dam. 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 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. 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 invert elevation for the remainder of the year. Announcements of significant operational events are posted and preserved on the Foster's Pond Corporation website.

2.3.2 Maintenance of Dam and Operating Facilities

According to the O&M manual, the Foster's Pond Corporation monitors the dam semiannually for:

- Evidence of seepage, voids, cracks, sinkholes and erosion and will notify the Office of Dam Safety if changes in seepage volumes or color are observed.
- Blockage of the culverts, debris in the plunge pool and sinkholes on Rattlesnake Hill Road and will notify the Andover Public Works Department, if appropriate.
- Brushy growth and damaged or rotted stoplogs.

Annually, the Foster's Pond Corporation will:

- Patch, grade and fill areas and repair eroded areas as needed.
- Repair cracks and voids in concrete surface, as needed.
- Remove brushy growth from dam.
- Replace stoplogs, and paint sluiceway angle irons, as needed.
- Add clay as needed to repair erosion.
- Remove debris from plunge pool and culverts.

2.4 Emergency Warning System

The O & M Manual briefly addresses the state and municipal agencies that will be notified in the event of severe overtopping or other conditions that may indicate potential failure of the dam but does not include the telephone numbers of the identified agencies. The O&M Manual also describes stop log removal in the event of heavy rain when overtopping is a concern.

2.5 Hydrologic/Hydraulic Data

Following the major maintenance performed in 2007 and 2008, we evaluated the Spillway Design Flood (SDF) and the capacities of the main spillway (with and without the stop logs 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 estimated a 191 cubic foot per second (cfs) flow for the 100-year flood flow using a regression equation for eastern Massachusetts streams from the USGS Water Supply Paper 2214 (Wandle, 1983). 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 stop logs. 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 stop logs in place | 194 cfs |
| Main spillway without stop logs | 227 cfs |
| Emergency spillway | 57 cfs |
| Total capacity with stop logs in place | 251 cfs |
| Total capacity without stop logs 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 feet below the top of the dam with the stop logs in place or about 0.4 feet below the top of the dam with the stop logs removed.

2.6 Structural and Seepage Stability

2.6.1 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 elimination of areas 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.

2.6.2 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 2010 major maintenance. The spillway's low height, broad base, and the placement of grouted riprap downstream of the spillway all contribute to its overall stability. The recent placement of flowable mortar mix and concrete into structural voids appears to have rehabilitated the condition of the masonry.

2.6.3 Seepage Stability

With the recent measures to block flow from the end of the sluiceway into the stone masonry, the observed locations of seepage have been eliminated. 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 regular monitoring for new seepage.

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 EAP section of the O&M Manual should be expanded as described in Section 3.2.
2. A small area of geotextile on the right embankment is exposed.

The following table summarizes the deficiencies reported in the 2006 Phase I report and the status of those deficiencies:

| <i>Previously Identified Deficiency</i> | <i>Resolution or Current Condition</i> |
|--|---|
| The spillway cannot pass the spillway design flood (SDF). | The rehabilitation of the main and emergency spillways provides a spillway capacity in excess of the estimated SDF. |
| The embankment crest is very uneven with sinkholes, erosion gullies and eroded zones. | The embankment crest has been regraded to provide an even crest with a healthy grass cover and without sinkholes. |
| Seepage is observed at the base of the downstream unmortared masonry stone wall and through the masonry wall below the spillway. | Repairs and patching of spillway and sluiceway sides appears to have eliminated or significantly reduced seepage. |
| Portions of the main spillway appear to have sunk or settled. | The main spillway has been rehabilitated with the placement of flowable mortar mix and concrete in voids. |
| The downstream masonry wall has some misplaced and misaligned stones. | The downstream wall masonry remains irregular but appears to have suitable stability. |
| There is some tree growth on the downstream crest and right abutment. | Trees have been removed. |
| The left side of the training wall surrounding the plunge pool has collapsed. | Both training walls have been rebuilt. |
| There are areas of missing riprap on the upstream slope. | Cobble riprap and crushed stone over geotextile has been placed across the entire upstream slope. |

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

The EAP section of the O&M Manual should be expanded to include:

1. Phone numbers for emergency contacts.
2. The recommendation to communicate to local police that Rattlesnake Hill Road be closed in the event that overtopping or other dam distress is observed.
3. A directive to operators that stop logs be removed only if access to the stop logs is safe. Safe removal can be facilitated by using long handled hooked tools.
4. Monitoring to be performed during flooding (frequent observations, measurement and recording of pond level trends) or other distress such as high seepage (frequent observations, estimation of flow quantities and presence of sediment in seepage).
5. Emergency measures that may be used in the event of overtopping or piping.

3.3 Recurrent Maintenance Recommendations

Continue with the maintenance activities described in the O&M Manual and as practiced over the past few years.

3.4 Minor Repair Recommendations

Cover the exposed geotextile on the right embankment with seeded topsoil to protect it from degradation.

3.5 Remedial Modifications Recommendations

No remedial modifications appear to be needed at this time.

3.6 Alternatives

No alternative remedial measures are needed at this time.

3.7 Opinion of Probable Construction Costs

The following conceptual opinions of probable construction costs have been developed for regular maintenance, the EAP recommendations, and minor repair measures noted above. The costs shown herein are based on a limited analysis and are provided for general information only. This should not be considered an engineer's estimate, as actual costs may vary from the costs indicated.

Studies and Analyses

| | |
|--|---------------|
| EAP expansion (range from internal effort to outside prep) | \$0 - \$1,000 |
|--|---------------|

Yearly Recommendations⁽¹⁾

| | |
|--|-----------------|
| 1. Maintaining grassed cover on dam | \$500 - \$1,000 |
| 2. Monitoring and inspection of dam (seepage, erosion, etc.) | \$0 - \$500 |
| 3. Removal of debris from plunge pool and culverts | \$500 - \$1,000 |
| 4. Other regular maintenance activities | \$500 - \$1,000 |

Minor Repairs

| | |
|--|---------------|
| Cover exposed geotextile with seeded topsoil | \$100 - \$500 |
|--|---------------|

| | |
|-------|-------------------|
| TOTAL | \$1,600 - \$5,000 |
|-------|-------------------|

⁽¹⁾ Our cost estimates for repairs assume that work is done by contracted companies. Routine maintenance and minor repairs are performed by volunteers and members of Foster's Pond Corporation. Maintenance and minor repair costs may be less than identified above.

TABLES

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 |
| 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 (sq. mi.) | 0.19 |
| 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) | 11.9 |
| Freeboard at Normal Pool (feet) | 5 |
| Principal Spillway Capacity* (cfs) | ~194 |
| Auxiliary Spillway Capacity* (cfs) | ~57 |
| Low-Level Outlet Capacity* (cfs) | ~33 with full pool |
| Spillway Design Flood* (flow rate - cfs) | 100-year / 191 cfs |
| Winter Drawdown (feet below normal pool) | 2.5 |
| Drawdown Impoundment Vol. (acre-feet) | ~200 |
| Latitude | 42.61361°N |
| Longitude | 71.14146°W |
| City/Town | Andover |
| County Name | Essex |
| Public Road on Crest | None |
| Public Bridge over Spillway | None |
| EAP Date (if applicable) | October 12, 2005 - see Note 2 Misc page |
| 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 | 11/18/2011 |
| Consultant Firm Name | GEI Consultants, Inc. |
| Inspecting Engineer | Lee Wooten, P.E. |
| Engineer Phone Number | |

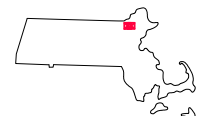
*In the event a hydraulic and hydrologic analysis has not been completed for the dam, indicate "No H&H" in this table, recommendation section shall include specific recommendation to hire a qualified dam engineering consultant to conduct analysis to determine spillway adequacy in conformance with 302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

FIGURES



APPROXIMATE SCALE, FEET

FOSTERS POND DAM
 NID ID# MA00153
 ANDOVER, MA
 READING & LAWRENCE, MA QUADRANGLES
 SOURCE: MassGIS
 LATITUDE: 42.61631°N
 LONGITUDE: 71.14146°W



MASSACHUSETTS
 QUADRANGLE LOCATION

Fosters Pond Dam
 Andover, Massachusetts

Fosters Pond Corporation
 Andover, Massachusetts

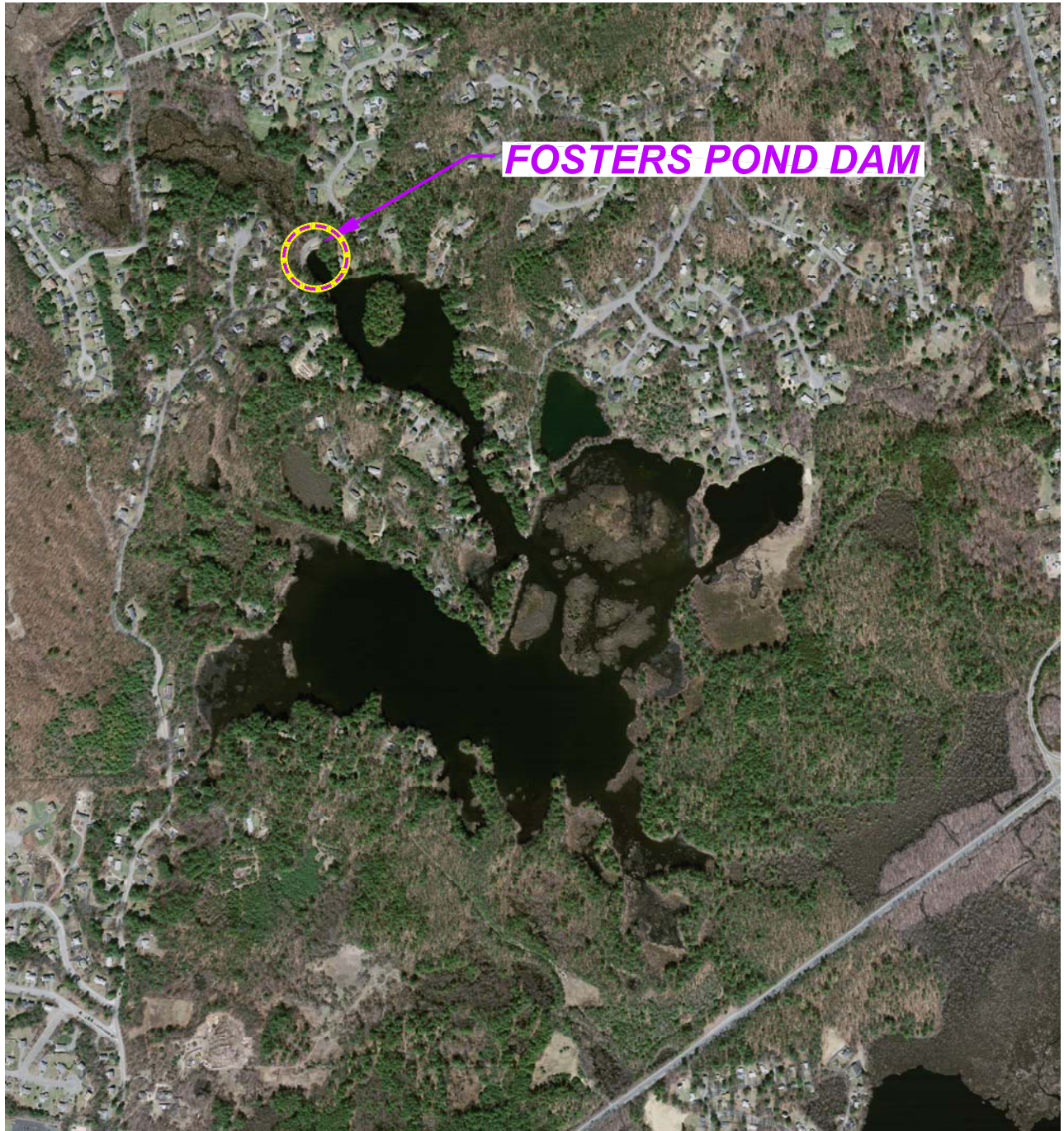


Project 06463-3

SITE LOCATION MAP

November 18, 2011

Fig. 1



APPROXIMATE SCALE, FEET

FOSTERS POND DAM
 NID ID# MA00153
 ANDOVER, MA
 READING & LAWRENCE, MA QUADRANGLES
 SOURCE: MassGIS
 LATITUDE: 42.61631°N
 LONGITUDE: 71.14146°W



Fosters Pond Dam
 Andover, Massachusetts

Fosters Pond Corporation
 Andover, Massachusetts

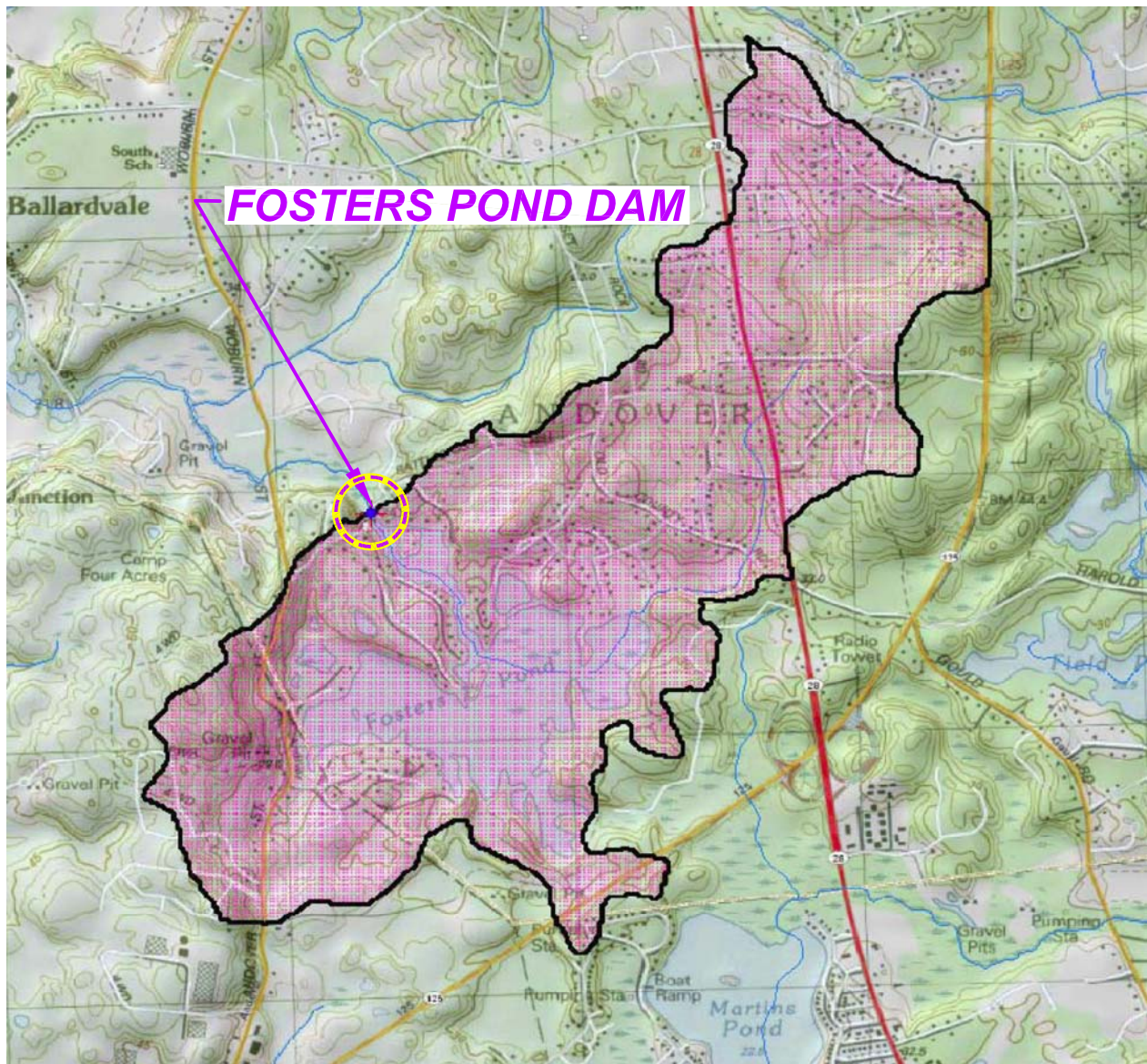


Project 06463-3

AERIAL
 PHOTOGRAPH

November 18, 2011

Fig. 2



APPROXIMATE SCALE, FEET

FOSTERS POND DAM
 NID ID# MA00153
 DRAINAGE AREA = 1.58 SQUARE MILES
 ANDOVER, MA
 READING & LAWRENCE, MA QUADRANGLES
 SOURCE: USGS PROGRAM MASSACHUSETTS STREAMSTATS
 LATITUDE: 42.61631°N
 LONGITUDE: 71.14146°W

Fosters Pond Dam
 Andover, Massachusetts

Fosters Pond Corporation
 Andover, Massachusetts

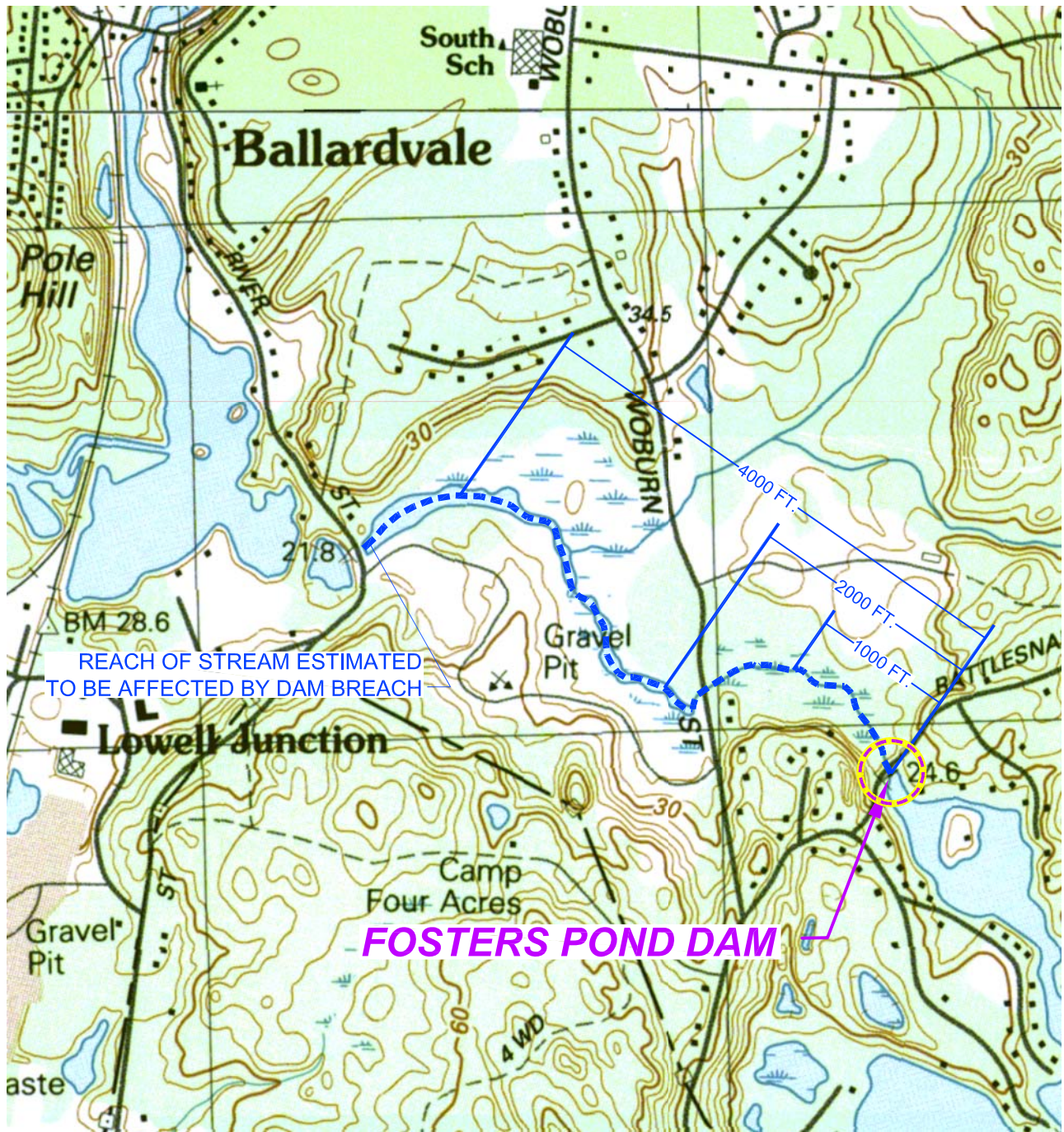


Project 06463-3

DRAINAGE AREA

November 18, 2011

Fig. 3



0 500 1000 2000 3000
 APPROXIMATE SCALE, FEET

FOSTERS POND DAM
 NID ID# MA00153
 ANDOVER, MA
 READING & LAWRENCE, MA QUADRANGLES
 SOURCE: MassGIS
 LATITUDE: 42.61631°N
 LONGITUDE: 71.14146°W



Fosters Pond Dam
 Andover, Massachusetts

Fosters Pond Corporation
 Andover, Massachusetts

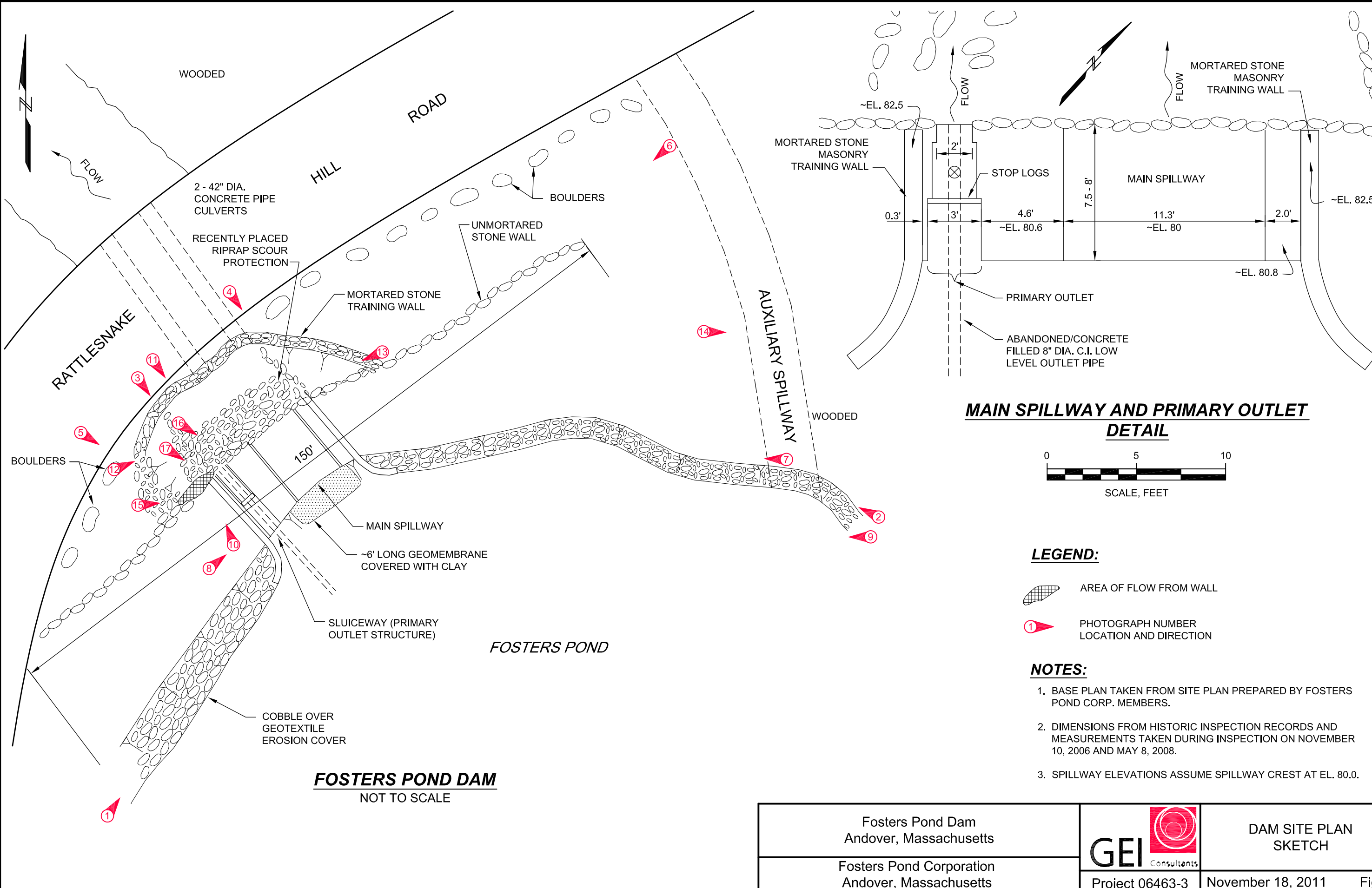



Project 06463-3

DAM AND AREA
 DOWNSTREAM FROM POND

November 18, 2011

Fig. 4



| | | | | |
|--|--|---|-------------------------|-------------------------------|
| Fosters Pond Dam Andover, Massachusetts | |  | DAM SITE PLAN SKETCH | |
| Fosters Pond Corporation Andover, Massachusetts | | | Project 06463-3 | November 18, 2011 Fig. 5 |

APPENDIX A
Photographs



Photo 1 – Panoramic composite - Upstream slope and crest from left*



Photo 2 – Panoramic composite - 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 – Panoramic composite – Downstream side of dam at spillway*



Photo 4 – Panoramic composite – Downstream side, right embankment*



Photo 5 – Panoramic composite – Downstream side, left embankment*



Photo 6 – Panoramic composite – Right embankment and auxiliary spillway*

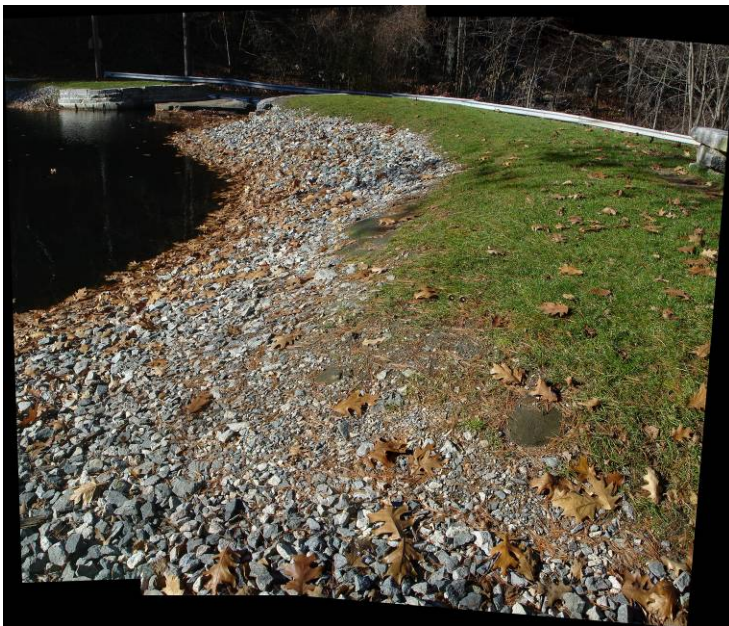


Photo 7 – Panoramic composite – Right embankment upstream face*



Photo 8 – Panoramic composite – Right embankment and right spillway training wall*



Photo 9 – Panoramic composite – Left embankment and left spillway training wall*



Photo 10 – Panoramic composite – Spillway from upstream*



Photo 11 – Panoramic composite – Spillway and plunge pool from downstream*



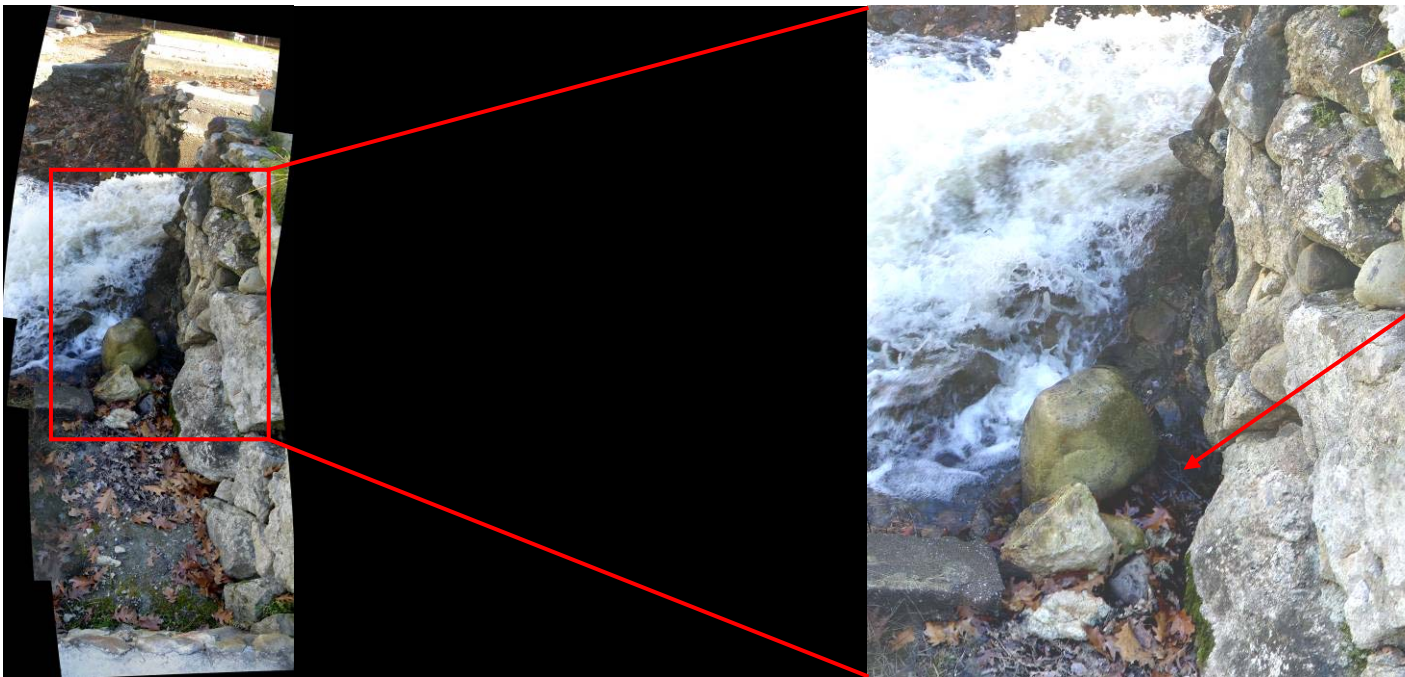
Photo 12 – Panoramic composite – Plunge pool from left*



Photo 13 – Panoramic composite – Plunge pool from right*



Photo 14 – Panoramic composite – Auxiliary spillway*



Water flow from wall at
toe of left embankment
in plunge pool before fix

Photo 15 – Panoramic composite – seepage area near sluiceway*



Photo 16 – Sluiceway repair**

New concrete placed in
sluiceway to cut off flow
being diverted to behind
the wall



Photo 17 – Area of previous flow from wall after fix**

**Photos by Steve Cotton
on December 5, 2011

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 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. 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: <u>Foster's Pond Dam</u> | STATE ID #: <u>5-5-9-10</u> |
| REGISTERED: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO | NID ID #: <u>MA00153</u> |
| STATE SIZE CLASSIFICATION: <u>Intermediate</u> | STATE HAZARD CLASSIFICATION: <u>Significant</u> |
| | CHANGE IN HAZARD CLASSIFICATION REQUESTED?: <u>No</u> |
| <u>DAM LOCATION INFORMATION</u> | |
| CITY/TOWN: <u>Andover</u> | COUNTY: <u>Essex</u> |
| DAM LOCATION: <u>Off Rattlesnake Hill Road</u> (street address if known) | ALTERNATE DAM NAME: _____ |
| USGS QUAD.: <u>Reading</u> | LAT.: <u>42.61361°N</u> LONG.: <u>71.14146°W</u> |
| DRAINAGE BASIN: <u>Shawsheen</u> | RIVER: <u>Frye's Brook (inflow) to Shawsheen River about 1 mile downstream</u> |
| IMPOUNDMENT NAME(S): <u>Fosters Pond</u> | |
| <u>GENERAL DAM INFORMATION</u> | |
| TYPE OF DAM: <u>Earthfill w/ downstream stone masonry</u> | OVERALL LENGTH (FT): <u>~150</u> |
| PURPOSE OF DAM: <u>Recreational</u> | NORMAL POOL STORAGE (ACRE-FT): <u>~538</u> |
| YEAR BUILT: <u>~1850s</u> | MAXIMUM POOL STORAGE (ACRE-FT): <u>~867</u> |
| STRUCTURAL HEIGHT (FT): <u>~10.1</u> | EL. NORMAL POOL (FT): <u>~78.5-79.8 (assumed spillway El.=80 ft)</u> |
| HYDRAULIC HEIGHT (FT): <u>~7.6</u> | EL. MAXIMUM POOL (FT): <u>~82.5</u> |
| <u>FOR INTERNAL MADCR USE ONLY</u> | |
| FOLLOW-UP INSPECTION REQUIRED: <input type="checkbox"/> YES <input type="checkbox"/> NO | CONDITIONAL LETTER: <input type="checkbox"/> YES <input type="checkbox"/> NO |

| | | |
|---|--|--|
| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> |
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> |
| <u>INSPECTION SUMMARY</u> | | |
| DATE OF INSPECTION: <u>November 18, 2011</u> | | DATE OF PREVIOUS INSPECTION: <u>November 10, 2006</u> |
| TEMPERATURE/WEATHER: <u>Sunny, ~40 degrees F</u> | ARMY CORPS PHASE I: <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO If YES, date _____ | |
| CONSULTANT: <u>GEI Consultants, Inc.</u> | PREVIOUS DCR PHASE I: <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO If YES, date _____ | |
| BENCHMARK/DATUM: <u>Not available; 80 ft used as a reference datum equal to the main spillway crest elevation</u> | | |
| OVERALL PHYSICAL CONDITION OF DAM: <u>SATISFACTORY</u> | | DATE OF LAST REHABILITATION: <u>Maintenance in 2007-2008, 2010, 2011</u> |
| SPILLWAY CAPACITY: <u>>100% SDF w/ no actions by Caretaker</u> | | |
| EL. POOL DURING INSP.: <u>~80.0</u> | | EL. TAILWATER DURING INSP.: <u>~72.2</u> |
| <u>PERSONS PRESENT AT INSPECTION</u> | | |
| <u>NAME</u> | <u>TITLE/POSITION</u> | <u>REPRESENTING</u> |
| Lee Wooten, P.E. | Principal | GEI Consultants, Inc. |
| Stephen Cotton | FPC President | Foster's Pond Corporation - (FPC) |
| | | |
| | | |
| | | |
| <u>EVALUATION INFORMATION</u> | | |
| Click on box to select E-code | | |
| E1) TYPE OF DESIGN | 1 | E8) LOW-LEVEL OUTLET CONDITION |
| E2) LEVEL OF MAINTENANCE | 5 | E9) SPILLWAY DESIGN FLOOD CAPACITY |
| E3) EMERGENCY ACTION PLAN | 4 | E10) OVERALL PHYSICAL CONDITION |
| E4) EMBANKMENT SEEPAGE | 4 | E11) ESTIMATED REPAIR COST |
| E5) EMBANKMENT CONDITION | 5 | ROADWAY OVER CREST |
| E6) CONCRETE CONDITION | 5 | BRIDGE NEAR DAM |
| E7) LOW-LEVEL OUTLET CAPACITY | 1 | |
| | | Click on box to select E-code |
| | | 1 |
| | | 5 |
| | | 4 |
| | | \$1600 to \$5000 |
| | | NO |
| | | YES |
| NAME OF INSPECTING ENGINEER: <u>Lee Wooten, P.E.</u> SIGNATURE: <u>Lee Wooten</u> | | |

| | | | |
|---|---|--|---|
| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | |
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | |
| | | | |
| OWNER: | ORGANIZATION | CARETAKER: | ORGANIZATION |
| | <u>Foster's Pond Corporation</u> | | <u>Foster's Pond Corporation</u> |
| | NAME/TITLE | | NAME/TITLE |
| | <u>Stephen E. Cotton - President</u> | | <u>David Brown - Treasurer</u> |
| | STREET | | STREET |
| | <u>19 Pomeroy Road</u> | | <u>31 Glenwood Road</u> |
| | TOWN, STATE, ZIP | | TOWN, STATE, ZIP |
| | <u>Andover, MA 01810</u> | | <u>Andover, MA 01810</u> |
| | PHONE | | PHONE |
| | <u>978-475-5679</u> | | <u>978-470-0454</u> |
| | EMERGENCY PH. # | | EMERGENCY PH. # |
| | <u>978-475-5679</u> | | <u>978-470-0454</u> |
| | FAX | | FAX |
| | | | <u>978-470-2066</u> |
| | EMAIL | | EMAIL |
| | <u>scotton@fosterspond.com</u> | | <u>davebrown@alum.mit.edu</u> |
| | OWNER TYPE | | |
| | <u>Private Association or other non-profit</u> | | |
| | | | |
| PRIMARY SPILLWAY TYPE | | <u>Broad crested weir</u> | |
| SPILLWAY LENGTH (FT) | | <u>11.9</u> | |
| AUXILIARY SPILLWAY TYPE | | <u>Grass covered swale</u> | |
| NUMBER OF OUTLETS | | <u>1 sluiceway</u> | |
| TYPE OF OUTLETS | | <u>Suiceway with stoplogs (operational)</u> | |
| DRAINAGE AREA (SQ MI) | | <u>1.58</u> | |
| HAS DAM BEEN BREACHED OR OVERTOPPED | | <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO IF YES, PROVIDE DATE(S) <u>overtopped 03/01, Spring '02, 04/06, 05/14/06</u> | |
| FISH LADDER (LIST TYPE IF PRESENT) | | <u>No</u> | |
| DOES CREST SUPPORT PUBLIC ROAD? | | <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO IF YES, ROAD NAME: _____ | |
| PUBLIC BRIDGE WITHIN 50' OF DAM? | | <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO IF YES, ROAD/BRIDGE NAME: <u>Rattlesnake Hill Road</u> | |
| | | MHD BRIDGE NO. (IF APPLICABLE) _____ | |

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | | | |
|---|-------------------------------------|--|--------------|---------|--------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | | | |
| EMBANKMENT (CREST) | | | | | |
| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
| CREST | 1. SURFACE TYPE | 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. VEGETATION (PRESENCE/CONDITION) | Grass cover | | X | X |
| | 8. ABUTMENT CONTACT | Good | X | | |
| | | | | | |
| | | | | | |
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| | | | | | |
| ADDITIONAL COMMENTS: <u>The aggressive maintenance actions have restored a uniform grade to the embankment crest and established a grass cover over the crest. Geotextile was placed below seeded toposoil on embankment crest and is partially exposed near the emergency spillway. The exposed geotextile should be covered with seeded topsoil to prevent degradation by sunlight.</u> | | | | | |

NAME OF DAM: Foster's Pond DamSTATE ID #: 5-5-9-10INSPECTION DATE: November 18, 2011NID ID #: MA00153**EMBANKMENT (D/S SLOPE)**

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|-------------------|------------------------------------|---|--------------|---------|--------|
| D/S SLOPE | 1. WET AREAS (NO FLOW) | None observed | | X | |
| | 2. SEEPAGE | None observed | | 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. VEGETATION (PRESENCE/CONDITION) | No vegetation in masonry wall | | X | |
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ADDITIONAL COMMENTS: A stone masonry wall retains most of the downstream side of the dam. See "Masonry Walls" page for additional information.

NAME OF DAM: Foster's Pond DamSTATE ID #: 5-5-9-10INSPECTION DATE: November 18, 2011NID 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 | 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. VEGETATION (PRESENCE/CONDITION) | Grass cover above cobble erosion protection (Note 1) | | x | x |
| | | | | | |
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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 topsoil on right embankment crest and is partially exposed near the emergency spillway. The exposed geotextile should be covered with seeded topsoil to prevent degradation by sunlight.

NAME OF DAM: Foster's Pond DamSTATE ID #: 5-5-9-10INSPECTION DATE: November 18, 2011NID 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 observed | X | | |
| | 7. DRAINS | None | X | | |
| | 8. FREQUENCY OF READINGS | N/A | X | | |
| | 9. LOCATION OF READINGS | N/A | X | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

ADDITIONAL COMMENTS:

NAME OF DAM: Foster's Pond DamSTATE ID #: 5-5-9-10INSPECTION DATE: November 18, 2011NID ID #: MA00153**DOWNSTREAM MASONRY WALLS**

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|-------------------|-----------------------------------|---|--------------|---------|--------|
| D/S WALLS | 1. WALL TYPE | Downsteam dam face is a mostly unmortared stone masonry wall | x | | |
| | 2. WALL ALIGNMENT | Irregular alignment of stones in masonry wall (probably as-built condition) | | x | |
| | 3. WALL CONDITION | Fair | | x | |
| | 4. HEIGHT: TOP OF WALL TO MUDLINE | min: 0 ft max: 8 ft avg: 4 ft | x | | |
| | 5. SEEPAGE OR LEAKAGE | See comments below | | x | |
| | 6. ABUTMENT CONTACT | Good | x | | |
| | 7. EROSION/SINKHOLES BEHIND WALL | None observed | | x | |
| | 8. ANIMAL BURROWS | None observed | | x | |
| | 9. UNUSUAL MOVEMENT | None observed | | x | |
| | 10. WET AREAS AT TOE OF WALL | See note 1 | | x | |
| | | | | | |
| | | | | | |
| | | | | | |

ADDITIONAL COMMENTS: We observed seepage from the base of the wall located a few feet to the west (left looking downstream) on the day of our visit.
Based on subsequent correspondence with Mr. Cotton, we understand that the FPC found that the source of the water was the sluiceway, that they repaired or sealed the entry location for the water in the sluiceway, and that water flow is no longer observed at this location.

NAME OF DAM: Foster's Pond Dam

STATE ID #: 5-5-9-10

INSPECTION DATE: November 18, 2011

NID ID #: MA00153

UPSTREAM MASONRY WALLS

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|-------------------|-----------------------------------|--|--------------|---------|--------|
| U/S WALLS | 1. WALL TYPE | No upstream masonry walls other than spillway wing walls | | | |
| | 2. WALL ALIGNMENT | NA | | | |
| | 3. WALL CONDITION | NA | | | |
| | 4. HEIGHT: TOP OF WALL TO MUDLINE | min: max: avg: | | | |
| | 5. ABUTMENT CONTACT | NA | | | |
| | 6. EROSION/SINKHOLES BEHIND WALL | NA | | | |
| | 7. ANIMAL BURROWS | NA | | | |
| | 8. UNUSUAL MOVEMENT | NA | | | |
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ADDITIONAL COMMENTS: _____

NAME OF DAM: Foster's Pond DamSTATE ID #: 5-5-9-10INSPECTION DATE: November 18, 2011NID 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 other than that described at base of downstream stone masonry wall | | x | |
| | 3. SLIDE, SLOUGH, SCARP | None observed | x | | |
| | 4. WEIRS | None | x | | |
| | 5. DRAINAGE SYSTEM | 2-42 inch concrete culverts carry dam flow downstream under Rattlesnake Hill Rd | x | | |
| | 6. INSTRUMENTATION | None | x | | |
| | 7. VEGETATION | 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 and Woburn Street ~1300 ft downstream beyond heavily vegetated wooded wetlands area | | | |
| | 10. DATE OF LAST EAP UPDATE | October 12, 2005 - see Note 2 Misc page | | | |

ADDITIONAL COMMENTS:

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> |
|--|------------------------------------|--|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> |
| 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 |
| | 5. SECURITY DEVICES | Boulders along downstream side and metal chain gate at access path near right (see Note 1) |
| | 6. VANDALISM OR TRESPASS | <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO WHAT: |
| | 7. AVAILABILITY OF PLANS | <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE: |
| | 8. AVAILABILITY OF DESIGN CALCS | <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE: |
| | 9. AVAILABILITY OF EAP/LAST UPDATE | <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE: October 12, 2005 - see Note 2 Misc page |
| | 10. AVAILABILITY OF O&M MANUAL | <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: October 12, 2005 - see Note 2 |
| | 11. CARETAKER/OWNER AVAILABLE | <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: November 18, 2011 |
| | 12. CONFINED SPACE ENTRY REQUIRED | <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO PURPOSE: |
| | | |
| | | |
| ADDITIONAL COMMENTS: <u>1. Steep abutment grades prevent access of unauthorized vehicles.</u> <u>2. The O&M Manual is a three page document that includes EAP paragraphs, specifically directions on operation of the sluiceway during potential overtopping events and directions for emergency notifications. The document is generally suitable for the size and hazard of the dam but should be expanded.</u> | | |

NAME OF DAM: Foster's Pond DamSTATE ID #: 5-5-9-10INSPECTION DATE: November 18, 2011NID ID #: MA00153**PRIMARY SPILLWAY**

| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
|-------------------|-----------------------------------|--|--------------|---------|--------|
| SPILLWAY | SPILLWAY TYPE | Concrete/Masonry | 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 | Underwater. 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 | |
| | WATER LEVEL AT TIME OF INSPECTION | At upstream edge of spillway (~El. 80 ft - reference datum) | x | | |
| | | | | | |
| | | | | | |
| | | | | | |

ADDITIONAL COMMENTS: 1. Taining walls originally upgraded in 2006 with the construction of the current granite block walls. In 2010, much of the backfill behind the training walls was replaced with concrete, essentially thickening the walls. Also in 2010, about 2 tons of concrete and grout were placed in the main spillway structure to fill voids exposed by a March 2010 flood.

2. Plunge pool has been maintained with the addition of dumped riprap below the spillway for erosion protection.

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | | | |
|--|-----------------------------------|---|--------------|---------|--------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | | | |
| 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, broad-crested | X | | |
| | SPILLWAY CONDITION | Good | | X | |
| | TRAINING WALLS | None | X | | |
| | SPILLWAY CONTROLS AND CONDITION | None | X | | |
| | UNUSUAL MOVEMENT | None observed | X | | |
| | APPROACH AREA | Underwater. Not observed | X | | |
| | DISCHARGE AREA | Rattlesnake Hill Rd, wetlands beyond | X | | |
| | DEBRIS | None observed | X | | |
| | WATER LEVEL AT TIME OF INSPECTION | ~1.0 feet below low point on swale | X | | |
| | | | | | |
| | | | | | |
| ADDITIONAL COMMENTS: <u>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 cobble cover on upstream side and establishment of grass cover across crest. A geotextile was also placed under the cobble and seeded topsoil cover portions of the spillway.</u> | | | | | |

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | | | |
|--|---------------------------|---|--------------|---------|--------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | | | |
| 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 | None observed | | x | |
| | DEBRIS/BLOCKAGE | None observed | | x | |
| | UNUSUAL MOVEMENT | None observed | | x | |
| | DOWNSTREAM AREA | Riprapped plunge pool (riprap placed as part of 2006 maintenance) | | x | |
| | | | | | |
| | MISCELLANEOUS | Stone masonry training walls on left side of sluiceway recently repaired/upgraded | | x | |
| ADDITIONAL COMMENTS: <u>1. Condition of concrete good. No cracks observed. Minor concrete patch placed in sluiceway in Dec. 2011 to cut off water flow into masonry wall.</u> <hr/> <hr/> <hr/> | | | | | |

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | | | |
|---|------------------------------|----------------------------------|--------------|---------|--------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | | | |
| CONCRETE/MASONRY DAMS | | | | | |
| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION | MONITOR | REPAIR |
| GENERAL | TYPE | Not applicable to this structure | | | |
| | AVAILABILITY OF PLANS | Not applicable to this structure | | | |
| | AVAILABILITY OF DESIGN CALCS | Not applicable to this structure | | | |
| | PIEZOMETERS | Not applicable to this structure | | | |
| | OBSERVATION WELLS | Not applicable to this structure | | | |
| | INCLINOMETERS | Not applicable to this structure | | | |
| | SEEPAGE GALLERY | Not applicable to this structure | | | |
| | UNUSUAL MOVEMENT | Not applicable to this structure | | | |
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| ADDITIONAL COMMENTS: _____ _____ _____ _____ | | | | | |

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | |
|---|----------------------|----------------------------------|-----------------------------------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | |
| CONCRETE/MASONRY DAMS (CREST) | | | |
| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION MONITOR REPAIR |
| CREST | TYPE | Not applicable to this structure | |
| | SURFACE CONDITIONS | Not applicable to this structure | |
| | CONDITIONS OF JOINTS | Not applicable to this structure | |
| | UNUSUAL MOVEMENT | Not applicable to this structure | |
| | HORIZONTAL ALIGNMENT | Not applicable to this structure | |
| | VERTICAL ALIGNMENT | Not applicable to this structure | |
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| ADDITIONAL COMMENTS: _____ | | | |
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| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | |
|---|----------------------|----------------------------------|-----------------------------------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | |
| CONCRETE/MASONRY DAMS (DOWNSTREAM FACE) | | | |
| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION MONITOR REPAIR |
| D/S FACE | TYPE | Not applicable to this structure | |
| | SURFACE CONDITIONS | Not applicable to this structure | |
| | CONDITIONS OF JOINTS | Not applicable to this structure | |
| | UNUSUAL MOVEMENT | Not applicable to this structure | |
| | ABUTMENT CONTACT | Not applicable to this structure | |
| | LEAKAGE | | |
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| ADDITIONAL COMMENTS: _____ _____ _____ _____ | | | |

| NAME OF DAM: <u>Foster's Pond Dam</u> | | STATE ID #: <u>5-5-9-10</u> | |
|--|----------------------|----------------------------------|-----------------------------------|
| INSPECTION DATE: <u>November 18, 2011</u> | | NID ID #: <u>MA00153</u> | |
| CONCRETE/MASONRY DAMS (UPSTREAM FACE) | | | |
| AREA INSPECTED | CONDITION | OBSERVATIONS | NO ACTION MONITOR REPAIR |
| U/S FACE | TYPE | Not applicable to this structure | [] |
| | SURFACE CONDITIONS | Not applicable to this structure | [] |
| | CONDITIONS OF JOINTS | Not applicable to this structure | [] |
| | UNUSUAL MOVEMENT | Not applicable to this structure | [] |
| | ABUTMENT CONTACTS | Not applicable to this structure | [] |
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| ADDITIONAL COMMENTS: | | | [] |
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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. Foster's Pond Corporation, 2011, "Foster's Pond Corporation" website, <http://www.fosterspond.com/>.
2. GEI Consultants, Inc., 2008, "Foster's Pond Dam Follow-Up Inspection / Evaluation Report," May 8.
3. GEI Consultants, Inc., 2010, "Site Visit Observations and Preliminary Recommendations, Fosters Pond Dam, NID # MA00153, Andover, Massachusetts," April 6.
4. GEI Consultants, Inc., 2006, "Fosters Pond Dam Phase I Inspection / Evaluation Report," November 10.
5. Foster's Pond Corporation, 2005, "Foster's Pond Dam, Operations and Maintenance Manual," October 12.
6. 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.
7. Department of Environmental Management, Office of Dam Safety, 2001, Foster's Pond Dam Notice of Inspection Letter and Inspection Summary, April 2.
8. Town of Andover, Andover, Massachusetts, 2001, Foster's Pond Dam, Letter to Department of Environmental Management, Office of Dam Safety, March 23.
9. Massachusetts Department of Public Works, 1973, Foster Pond Dam, Letter to Foster's Pond Corporation, October 29.
10. Lee Chisholm, 1973, Foster's Pond Dam, Letter to Massachusetts 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.

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)