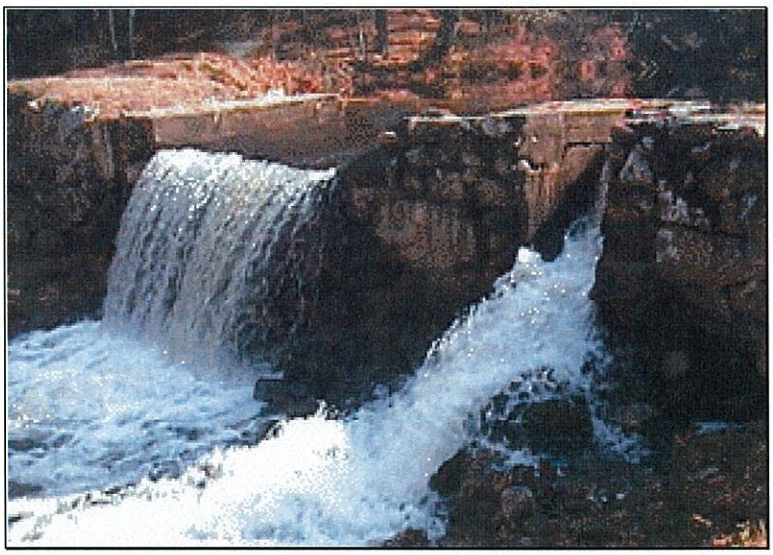
# FOSTERS POND DAM

## PHASE I

## INSPECTION / EVALUATION REPORT



| | |
|---|---|
| Dam Name: | Fosters Pond Dam |
| State Dam ID#: | 5-5-9-10 |
| NID ID#: | MA00153 |
| Owner: | Foster's Pond Corporation |
| Owner Type: | Private |
| Town: | Andover, Massachusetts |
| Consultant: | GEI Consultants, Inc. |
| Date of Inspection: | November 10, 2006 |

GEI Consultants

## EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the inspection and evaluation of Fosters Pond Dam located in Andover, Massachusetts. The inspection was conducted on November 20, 2006 by GEI Consultants, Inc. of Winchester, Massachusetts. Fosters Pond Dam is classified as an intermediate size, significant (Class II) hazard potential dam.

In general, Fosters Pond Dam is in **Poor** condition with the following deficiencies noted:

- The spillway cannot pass the spillway design flood.
- The embankment crest is very uneven with sinkholes, erosion gullies and eroded zones.
- Seepage is observed at the base of the downstream unmortared masonry stone wall and through the masonry wall below the main spillway.
- The main spillway has sunken portions of its concrete apron.
- The downstream masonry wall has some misplaced and misaligned stones.
- There is some tree growth on the downstream crest and right abutment.
- The left side of the training wall surrounding the plunge pool has collapsed.
- There are areas of missing riprap on the upstream slope.

Since the last emergency inspection in March 2001, most trees and brush have been removed from the dam embankment. Concrete repairs have been performed on the main spillway and the sluiceway (primary outlet structure). The sluiceway has been restored to accommodate winter drawdowns.

GEI Consultants, Inc. recommends the following actions to be taken to address the deficiencies observed at the dam during this inspection and evaluation:

- Evaluate the design flood for the dam and the size flood that can be passed by the spillway, sluiceway and auxiliary spillway.
- Increase spillway capacity to accommodate the spillway design flood by restoring the auxiliary spillway, and/or armor the crest and toe of the dam to allow overtopping of the dam while preventing erosion of the embankment.
- Repair plunge pool scour.
- Remove all trees and woody vegetation from right side of the dam and abutment.
- Fill sinkholes on the crest and upstream slope with clay.
- Restore crest to a consistent elevation and provide grass cover.
- Provide riprap protection along the upstream slope behind the main spillway and extending a minimum of 25 feet on either side of spillway and/or sluiceway.
- Monitor seepage for changing conditions and new locations downstream of the dam and development of sinkholes within the embankment.

# Dam Evaluation Summary Detail Sheet

| | | |
|---|---|---|
| **1. NID ID:** MA00153 | **2. Dam Name:** Fosters Pond Dam | **3. Dam Location:** Andover, MA |
| **4. Inspection Date:** Nov. 20, 2006 | **5. Last Insp. Date:** March 29, 2006 | **6. Next Inspection:** Nov. 2011 |
| **7. Inspector:** R. Lee Wooten | **8. Consultant:** GEI Consultants, Inc. | |
| **9. Hazard Code:** Significant (Class 2) | **10. Insp. Frequency:** Significant-5 yrs. | **11. Insp. Condition:** Poor |

| | | | |
|---|---|---|---|
| **E1. Design Methodology:** | 1 | **E7. Low-Level Discharge Capacity:** | 1 |
| **E2. Level of Maintenance:** | 3 | **E8. Low-Level Outlet Physical Condition:** | 1 |
| **E3. Emergency Action Plan:** | 3 | **E9. Spillway Design Flood Capacity:** | 2 |
| **E4. Embankment Seepage:** | 3 | **E10. Overall Physical Condition of the Dam:** | 2 |
| **E5. Embankment Condition:** | 2 | **E11. Estimated Repair Cost** (in thousand $): | |
| **E6. Concrete Condition:** | 2 | **$21,000 - $42,500** | |

## Evaluation Description

**E1: DESIGN METHODOLOGY**
1. Unknown Design – no design records available
3. Some standard design features
5. State of the art design – design records available

**E2: LEVEL OF MAINTENANCE**
1. No evidence of maintenance, no O&M manual
2. Very little maintenance, no O&M manual
3. Some level of maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. 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

**E4: EMBANKMENT SEEPAGE**
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Controlled seepage
5. No seepage or piping

**E5: EMBANKMENT CONDITION**
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**
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment
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
2. Outlet with insufficient drawdown capacity
3. Inoperable gate with potentially sufficient drawdown capacity
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 - 20% of the SDF
2. 21- 40% of the SDF
3. 41- 60% of the SDF
4. 61- 80% of the SDF
5. 81- 100% of the SDF

**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 under normal loading conditions
3. *FAIR* - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to. critical parameters
4. *SATISFACTORY* - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. *GOOD* - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

**E11: ESTIMATED REPAIR COST**
Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

## Changes/Deviations to Database Information since last inspection

## PREFACE

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team. In cases where an impoundment is lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

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 present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

R. Lee Wooten, P.E.
Massachusetts License No.: C31830

Vice President
GEI Consultants, Inc.

FIGURES



APPENDICES

## SECTION 1

# 1.0 DESCRIPTION OF PROJECT

## 1.1 General

### 1.1.1 Authority

Foster's Pond Corporation has retained GEI Consultants, Inc. to perform a visual inspection and develop a report of conditions for the dam at Fosters Pond in Andover, 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 is 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 is 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

Fosters 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 Reading USGS quadrangle map at 42 °36'49"N latitude and 71 °8'30"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/Operator

| | Dam Owner | Dam Caretaker |
|---|---|---|
| Name | Foster's Pond Corporation (FPC)<br>Stephen E. Cotton- President | Foster's Pond Corporation<br>David Brown –Treasurer |
| Mailing Address | 19 Pomeroy Road | 31 Glenwood Road |
| Town | Andover | Andover |
| Daytime Phone | 978-475-5679 | 978-470-0454 |
| Emergency Phone | 978-317-5627 | 617-592-3405 (Paul L. Ross Jr. –Dam Supervisor) |
| Email Address | secotton@ix.netcom.com | davebrown@alum.mit.edu |

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 Fosters Pond Dam today is to provide a recreational impoundment (Fosters Pond).

1.2.4 Description of the Dam and Appurtenances

Fosters Pond Dam impounds water to form Fosters 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.

Fosters 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 Site Plan, Fig. 2, the dam incorporates a primary spillway structure, a sluiceway (primary outlet structure), and a swale along its right abutment that could be used as an auxiliary spillway. The dam has a structural height of approximately 9 feet, a hydraulic height of approximately 8 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. Intermittent riprap covers the slope to the right and left of the main spillway with a portion of the top of the slope being grass covered. Riprap is not existent behind or near the main spillway. A geomembrane covered with clay extends approximately 6 feet into the basin along the length of the main spillway. The crest of the embankment is approximately 10 feet wide at its narrowest point and primarily grass covered. Some trees have grown along the right abutment.

The downstream side of the dam consists of a mostly unmortared stone masonry wall. Some trees have grown along the downstream edge of crest near the right abutment. Outside the plunge pool, the area at the toe of the masonry wall area is 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 concrete apron is approximately 11.9 feet long (weir length), 8 feet wide, and 10 inches deep on the upstream side. 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 into 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 outlet for the structure is a sluiceway controlled with stoplogs and located approximately 4 to 5 feet to the left 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 abandoned.

The sluiceway was last restored in October of 2005 to accommodate winter drawdowns and provide excess freeboard to the dam. As shown on Fig. 2, the sluiceway is 3 feet wide and approximately 2.5 feet deep on the upstream side. It reduces to a 2-foot width and a depth of 4.5 feet on the downstream side. There are two sets of offsets behind which stoplogs can be set. Three stoplogs, each 10-inch deep can currently be set in the middle offset. The left approach to the sluiceway is lined with an unmortared stone training wall. 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 at an elevation approximately 1.4 higher than the upstream invert elevation of the main spillway, extents from the pond to Rattlesnake Hill Road. The swale is currently grass or wood chip covered. In the past this swale could have possibly served as an auxiliary/emergency spillway for the dam.

### 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 reportedly maintain, repair and operate the dam and to regulate the flow of water from Foster's Pond. The water level in the dam is maintained at approximately 2 inches below the bottom of the dam's main 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 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

Fosters Pond Dam has a maximum structural height of approximately 9 feet and a maximum storage capacity of 550 acre-feet. 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, Fosters Pond Dam is a Intermediate size structure.

1.2.7 DCR Hazard Classification

Fosters 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 1300 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. 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, Fosters Pond Dam is classified as a Significant hazard potential dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Fosters Pond Dam is approximately 0.85 square miles and is mostly contained within the Andover town limits. A small portion of the drainage area west of the pond extends into the town of Wilmington. At its northeasterly point the pond is fed by Frye Brook. The area is primarily suburban and much of it undeveloped. The area especially west of the pond is moderately hilly.

1.3.2 Reservoir

| | Length (feet) | Width (feet) | Surface Area (acres) | Storage Volume (acre-feet) |
|---|---|---|---|---|
| Normal Pool | irregular | irregular | ~ 120 | 420 |
| Maximum Pool | * | * | * | 550 |
| SDF Pool | ** | ** | ** | ** |

* Statistics at normal and max. pool unknown, but not significantly higher
** Not calculated

1.3.3 Discharges at the Dam Site

Reportedly, no records of discharges at the site are maintained. The dam has been reportedly overtopped in May 1954, March of 2001, the spring of 2002, and in April and May of 2006.

1.3.4 General Elevations (feet)[1]

| | | |
|---|---|---|
| A. | Top of Dam | irregular, ~80.8 at low areas |
| B. | Spillway Design Flood Pool | unknown |
| C. | Normal Pool | ~78.5-79.8 |
| D. | Spillway Crest | ~80 |
| E. | Upstream Water at Time of Inspection | ~79.8 |
| F. | Streambed at Toe of the Dam | ~72.3 (in front of main spillway) |
| G. | Low Point along Toe of the Dam | unknown |

1.3.5 Main Spillway

| | | |
|---|---|---|
| A. | Type | Masonry & Concrete broad-crested weir |
| B. | Length | 11.9 ft |
| C. | Invert Elevation | ~80 ft |
| D. | Upstream Channel | unknown (underwater) |
| E. | Downstream Channel | ~72.1 ft |
| F. | Downstream Water | ~72.2 ft |

1.3.6 Additional Data – Sluiceway (Outlet Structure)

| | | |
|---|---|---|
| A. | Type | Sluicegate with three stoplogs |
| B. | Length | 2 feet (at downstream side) |
| C. | Invert Elevation | ~77.8 ft (at bottom of stoplogs) |
| D. | Crest Elevation | ~80.3 ft |

Additional Data - Auxiliary/Emergency Spillway

| | | |
|---|---|---|
| A. | Type | Swale |
| B. | Invert Elevation | ~81.4 ft |

1.3.7 Design and Construction Records

No construction records were available for review during the inspection and preparation of this report. Previous inspection reports make reference to spillway and sluiceway modifications and installation chronology and operation of the 8-inch cast iron low level outlet pipe.

1.3.8 Operating Records

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

[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 Reading Quadrangle.

## SECTION 2

## 2.0 INSPECTION

2.1 Visual Inspection

Fosters Pond Dam was inspected on November 10, 2006. At the time of the inspection, the weather was sunny with temperatures in the 60s. Photographs to document the current conditions of the dam were taken during the inspection and are included in Appendix A. Fig. 2 shows the location from which each photograph was taken. The level of the impoundment was approximately El. 79.8 feet, 0.2 feet below the upstream invert of the main spillway (arbitrary reference datum). Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Fosters Pond Dam was found to be in **Poor** condition with an inadequate spillway, seepage areas, areas of inadequate vegetative cover and slope protection, uneven crest elevations, and tree growth. During the inspection all three stoplogs were placed at the sluiceway to limit the amount of water that would come over the dam and allow observation of conditions at the plunge pool. The specific concerns are identified in more detail in the sections below:

2.1.2 Dam

- ***Abutments*** (Photographs 1 – 4)

The left and right abutments appear to be in good condition with no evidence of seepage, erosion or cracking. Trees were noted along the dam's right abutment.

- ***Upstream Face*** (Photographs 1 – 4, 10, 14, and 18)

The upstream face of the embankment was mostly underwater. Visible portions showed intermittent riprap slope protection: however, riprap was missing in places, probably by wave action, erosion from previous overtopping events and/or pedestrians (Photo 18). Riprap was not observed on or near the slope leading to the main spillway. An erosion gully caused by dam overtopping in May 2006 was noted to the right side of the main spillway (Photo 14). A sinkhole was also noted at the upstream edge of the erosion gully. An area of erosion caused by foot and canoe traffic at water's edge was noted further to the right of the main spillway (Photo 3).

- ***Crest*** (Photographs 1-4, 10, 13, 14, and 18)

The crest of the embankment is mostly grass-covered and approximately 8 feet wide at its narrowest point. The crest elevation is very uneven along its entire length (Photos 1 and 2). The crest to the left of the sluiceway (primary outlet) is lower than the crest to the right of the main spillway and reportedly is the first area outside the primary spillway to get overtopped during high storm events. The eroded area caused by foot or canoe traffic described on the upstream face extends to the crest (Photo 3). The erosion gully caused by the dam overtopping noted on the upstream face also traverses the width of the crest (Photo 14). A sinkhole was observed

immediately to the left of the sluiceway (Photo 13). Some trees have grown along the downstream edge of crest near the right abutment (Photo 3)

- ***Downstream Face*** (Photographs 5 – 9, 11, 15, and 16)

The downstream face of the dam consists of a masonry stone wall. During the inspection we noted several misaligned or missing stones along the face of the wall (Photos 5, 7, 9, 11 and 19). Two seepage areas were noted at the groin of the stone masonry wall and the dam toe within the plunge pool area; one to the left side of the sluiceway (Photo 15) and a second one to the right of the main spillway (Photo 16). Water was also observed to be flowing out of the stone masonry wall approximately 4 feet below the spillway apron near the right edge of the main spillway. The eroded area due to foot and/or canoe traffic noted in the upstream and crest areas extends to the downstream face, just above the right end of the downstream training wall (Photo 5).

- ***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***

The dam is accessed from Rattlesnake Hill Road. There is a small park area on the right abutment that is blocked off with a metal chain gate to prevent unauthorized vehicle access to the dam.

2.1.3 Appurtenant Structures

***Primary Spillway*** (Photographs 5, 7 – 11, and 19)

The primary spillway is in generally fair to poor condition. Minor cracking and spalling was noted on the spillway concrete apron. Longitudinal and transverse cracking was observed along the left training wall that also forms the right side of the sluiceway. A depression in the concrete on the top downstream side of this training wall was also visible (Photo 12). The left downstream side of the spillway apron appears to have settled relative to its right side (Photos 8 and 9). Some missing and misaligned stones below the concrete apron were also noted at this location (Photo 19). The left side of the mortared training wall enclosing the plunge pool has collapsed (Photos 5, 7, and 8). The plunge pool is heavily eroded with many boulders and concrete slabs fallen in possibly from previous overtopping events (Photo 11).

- ***Sluiceway (Primary Outlet)*** (Photographs 5, 7 – 9, 12, 13, and 15)

The sluiceway is in satisfactory condition with recent concrete repairs visible on the concrete structure. However, several longitudinal and transverse cracks are still noted on both the right and left side of the sluiceway (Photos 12 and 13). The unmortared training wall along the left approach to the sluiceway appears to be in fair condition. A trash rack was not observed

upstream of the sluiceway. An 8 inch cast iron pipe, described to have been installed through the sluiceway and serving as the low level outlet, has reportedly been corroded and abandoned. The pipe was not visible at the time of our visit. Flows through the sluiceway are directed in the same plunge pool as flows from the main spillway.

- ***Auxiliary/Emergency Spillway***

The swale along the right abutment of the dam is currently grass and woodchip covered. The swale, 1.4 feet above the primary spillway invert elevation, could have functioned as an emergency spillway during past overtopping events. However, we were not able to obtain a record of the swale being used in this fashion.

2.1.4 Downstream Area

Rattlesnake Hill Road is located approximately 20 feet downstream of the dam (Photos 1, 2, 3, 4, 7, 8, 10 and 11). Flow from the primary spillway and the sluiceway passes under Rattlesnake Hill Road through two 42-inch diameter concrete pipe culverts (Photos 7 and 11). Downstream of Rattlesnake Hill Road, water flows through wooded wetlands towards Woburn Street (Photo 21) and eventually flows into the Shawsheen River upstream of the Ballardvale Dam.

2.1.5 Reservoir Area

Fosters Pond orientation is shown in Fig. 1. The impoundment is located within a primarily suburban area with private homes located along the shoreline. The shoreline is primarily wooded with generally gentle to moderate slopes around the pond perimeter (Photo 20). The slopes along portions of the west side of the impoundment are hilly.

2.2 Caretaker Interview

Foster's Pond Corporation (FPC), is responsible for the operation and maintenance of the Dam. Mr. Stephen Cotton (FPC President), Mr. David Brown (FPC Treasurer), and Mr. Scott Fumicello (FPC Member) were present during the inspection. Information provided by them has been incorporated into this report. Mr. Stephen Cotton and Mr. David Brown informed GEI of the following items about the dam:

- Dam is believed to have been built in the late 1850s. An 1852 map shows no dam. Design drawing for the dam are not available.
- Mr. Francis Foster owned the dam up to the time that Fosters Pond Corporation was formed in 1939-1940.
- A winter drawdown of a maximum of 18 inches has been implemented, beginning in the fall of 2005. (Winter drawdowns had been implemented in the past, but not in the recent history of the dam).
- Repairs to the sluiceway to allow installation of stoplogs for the winter drawdowns were performed in the fall of 2005.
- An 8 inch pipe installed through the sluiceway in 1937 that served as the low level outlet was last operated in 1973 and has since corroded. It was encased in concrete during the repairs to the sluiceway in the fall of 2005.

- The Operation and Maintenance Manual for the dam was last updated in October 2005.
- The dam was overtopped during heavy rains in May of 2006. At first, flow overtopped the dam to the left of the sluiceway and extended to the right of the main spillway. Woburn Street and River Streets were flooded during this storm event. Some residents' yards downstream were also flooded.
- The dam has been overtopped three other times since March of 2001.

2.3 Operation and Maintenance Procedures

An Operation and Maintenance Manual has been prepared by FPC and was provided to GEI for our review. The Operations and Maintenance Manual is well prepared and was last updated in October 2005.

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 nearby residents who depend on shallow wells and the Andover Conservation Commission. The annual drawdown commences on or after November 1. It is performed by sequentially removing stoplogs from the sluiceway to lower the water no more than 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 at about March 15 with a target refill date of April 1st. The water level is maintained within a few inches of the spillway invert elevation for the remaining of the year.

2.3.2 Maintenance of Dam and Operating Facilities

According to the O & M manual FPC 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, FPC will:

- Patch, grade and fill areas and repair eroded areas as needed.
- Repair cracks and voids in concrete surface, as needed. Replace stoplogs, and paint sluiceway angle irons, as needed.
- Remove brush and trees from dam.
- Remove debris from plunge pool and culverts.

2.4 Emergency Warning System

An Emergency Action Plan (EAP) is not available for GEI to review. The O & M Manual briefly addresses the state and municipal agencies that will be notified in the event of severe overtopping or other condition that may indicated potential failure of the dam. We recommend that the telephone numbers of the identified agencies to be notified are included in this document.

2.5 Hydrologic/Hydraulic Data

No hydraulic/hydrologic analyses were available for review. The primary spillway passes flows on a regular basis and the dam has been overtopped several times in the last 5 years.

2.6 Structural Stability/Overtopping Potential

2.6.1 Structural Stability

No stability analyses were available for review. The downstream masonry stone wall face of the dam exhibits signs of distress with some missing and misaligned stones. In our opinion these conditions may have resulted from previous dam overtoppings and possible seepage through the dam. During the inspection seepage areas were noted at the foundation level of the masonry wall to the left side of the sluiceway and to the right side of the main spillway. The upstream dam slope appears to be very flat. Based on the above, it does not appear that a stability analysis of the embankment is necessary.

2.6.2 Overtopping Potential

Past flooding events have demonstrated that overtopping of the Fosters Pond Dam is likely during heavy rain events. The embankment was overtopped in the spring of 2001, 2002 and twice in the spring of 2006. Recently re-implemented winter drawdowns may make overtopping less likely during times that the water level is maintained at the lower elevation. High rain events during the rest of the year however, make overtopping of this dam a very likely possibility. A breach of the embankment would result in flooding and damage to Rattlesnake Hill Road, flooding of Woburn and River Street and potentially yards of some downstream residences. The lack of vegetative cover on portions of the upstream, crest and downstream face of the dam, as well as the uneven crest elevations, increase the potential for erosion of the crest during overtopping.

## SECTION 3

## 3.0 ASSESSMENTS AND RECOMMENDATIONS

### 3.1 Assessments

In general, the overall condition of Fosters Pond Dam is **Poor**. The dam was found to have the following areas of concern:

- The spillway cannot pass the spillway design flood (SDF).
- The embankment crest is very uneven with sinkholes, erosion gullies and eroded zones.
- Seepage is observed at the base of the downstream unmortared masonry stone wall and through the masonry wall below the spillway.
- Portions of the main spillway appear to have sunk or settled.
- The downstream masonry wall has some misplaced and misaligned stones.
- There is some tree growth on the downstream crest and right abutment.
- The left side of the training wall surrounding the plunge pool has collapsed.
- There are areas of missing riprap on the upstream slope.

There have been some improvements in the maintenance and operation of this dam following an emergency inspection by the Department of Environmental Management, Office of Dam Safety, in March of 2001, prompted by an overtopping event, including preparation of an Operations and Maintenance Manual. The overall condition of the dam however remains unchanged. The inadequacy of the main spillway has been previously reported by Office of the Dam Safety inspectors dating back to 1926. The following paragraphs list the recommendations from the 2001 inspection report and their status:

- Fill, grade and stabilize areas of earthen slopes and crest at left and right spillway abutment in a manner to prevent further damage to structure by rain or overtopping.

  *Erosion gullies, eroded areas and sinkholes still exist on the crest and slope, possibly a consequence of subsequent overtopping events.*

- Remove tree and brush growth on the earthen slopes and crest to prevent embankment damage and to allow access by inspecting personnel.

  *At time of inspection most trees and brush had been removed from the dam crest and slopes. Some trees still remain near the right downstream crest and the right abutment. Tree stumps are visible along the crest.*

- Monitor spillway abutment cracks for increase size and/or seepage. Notify Office of Dam Safety of any change in amount or color of water seepage.

- *Some concrete repairs were performed on the main spillway and primary outlet in the fall of 2005. Some cracks on these structures still remain.*

- Monitor sinkhole in the roadway for increase size or depth.

*Sinkholes were not observed on Rattlesnake Hill Road at the time of our inspection.*

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs and remedial measure, the applicability of environmental permits needs to be determined prior to undertaking 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 following studies should be performed to address concerns and meet current regulations:

1. Evaluate the spillway design flood for the dam. Because of the significant downstream hazard if the dam were to fail, and because of the intermediate size of the impoundment, the 100-year design flood will be the required SDF. Evaluate the capacity of the dam spillways to safely pass the design flood.

2. Evaluate alternatives for safe SDF passage. These alternatives include restoring the auxiliary spillway at the right abutment to pass the spillway design flood with minimum required freeboard, and/or armoring the dam embankment or portion of the embankment to allow overtopping to occur while preventing erosion of the embankment.

3.3 Yearly Recommendations

The following activities should be performed by the dam owner/caretaker on a yearly basis. Most of these items are already addressed in the owner's O & M manual.

1. Perform regular maintenance activities to control and prevent further growth of unwanted vegetation on the dam. Grass cover should be maintained on the dam crest.

2. Perform regular monitoring and inspection of the dam, especially in areas of seepage, sinkholes, erosion or cracking observed during previous inspections.

3. Remove debris and clear any blockage on the downstream culverts.

4. Replace, repair or restore damaged or deteriorated components of the primary outlet, i.e. stoplogs, angle irons, etc.

3.4 Recommendations, Maintenance, and Minor Repairs

This section presents recommended studies and activities to improve the overall condition of the dam that do not alter the current design of the dam. These recommendations may require design by a professional engineer and construction by a contractor experienced in dam repair.

1. Repair plunge pool scour by first clearing the area from accumulated rubble and placing a geotextile fabric at the base. The geotextile fabric should then be covered by a layer of gravel, smaller riprap cobbles and larger riprap. Repair mortared training wall on downstream left side of plunge pool.

2. Remove all trees from the right side of the dam crest and abutment to reduce potential for toppling and subsequent erosion of the embankment during a flood event. Remove all root systems whenever possible. If it is not possible to remove root systems along masonry wall structures, coat stumps with polyurethane to retard their decay.

3. Fill all sinkholes on the crest and upstream slope with clay and restore crest to a consistent elevation. Provide grass cover to limit potential for erosion.

4. Provide riprap protection along the upstream slope behind the main spillway and extending a minimum of 25 feet on either side of either the spillway or sluiceway.

### 3.5 Remedial Measures

The remedial measures will not be known until the SDF has been determined and alternatives for safe passage of the SDF have been evaluated. As stated in Section 3.2, these alternatives include restoring the auxiliary spillway at the right abutment to pass the spillway design flood with minimum required freeboard, and/or armoring the dam embankment or portion of the embankment to allow overtopping to occur while preventing erosion of the embankment.

### 3.6 Alternatives

- No alternatives to the recommendations above are available at this time.

### 3.7 Opinion of Probable Construction Costs

The following conceptual opinions of probable construction costs have been developed for the recommendations and remedial measures noted above. The costs shown herein are based on 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

| | | |
|---|---|---|
| 1. | Evaluate Spillway Capacity & Alternatives for SDF Passage | $ 4,000 - $ 8,000 |
| 2. | Prepare Design and Chapter 253 Permit[1] | $ 7,000 - $12,000 |

Yearly Recommendations[2]

| | | |
|---|---|---|
| 1. | Annual Clearing Brush | $ 500 - $ 1 ,000 |
| 2. | Monitoring and Inspection of Dam (seepage, erosion, etc.) | $ 0 - $ 500 |
| 3. | Remove debris from plunge pool and culverts | $ 500 - $ 1,000 |
| 4. | Other Regular Maintenance Activities | $ 500 - $ 1,000 |

Recommendations, Maintenance, and Minor Repairs[2]

| | | |
|---|---|---|
| 1. | Repair Plunge Pool Scour | $ 4,000 - $ 8,000 |
| 2. | Remove Trees | $ 500 - $ 1,000 |
| 3. | Fill Sinkholes, Eroded Areas, Restore Crest Elevation | $ 2,000 - $ 5,000 |
| 4. | Provide Limited Riprap Protection On Upstream Slope | $ 2,000 - $ 5,000 |

Remedial Measures[3]

Determine following completion of SDF passage studies.

TOTAL $21,000 - $42,500[3]

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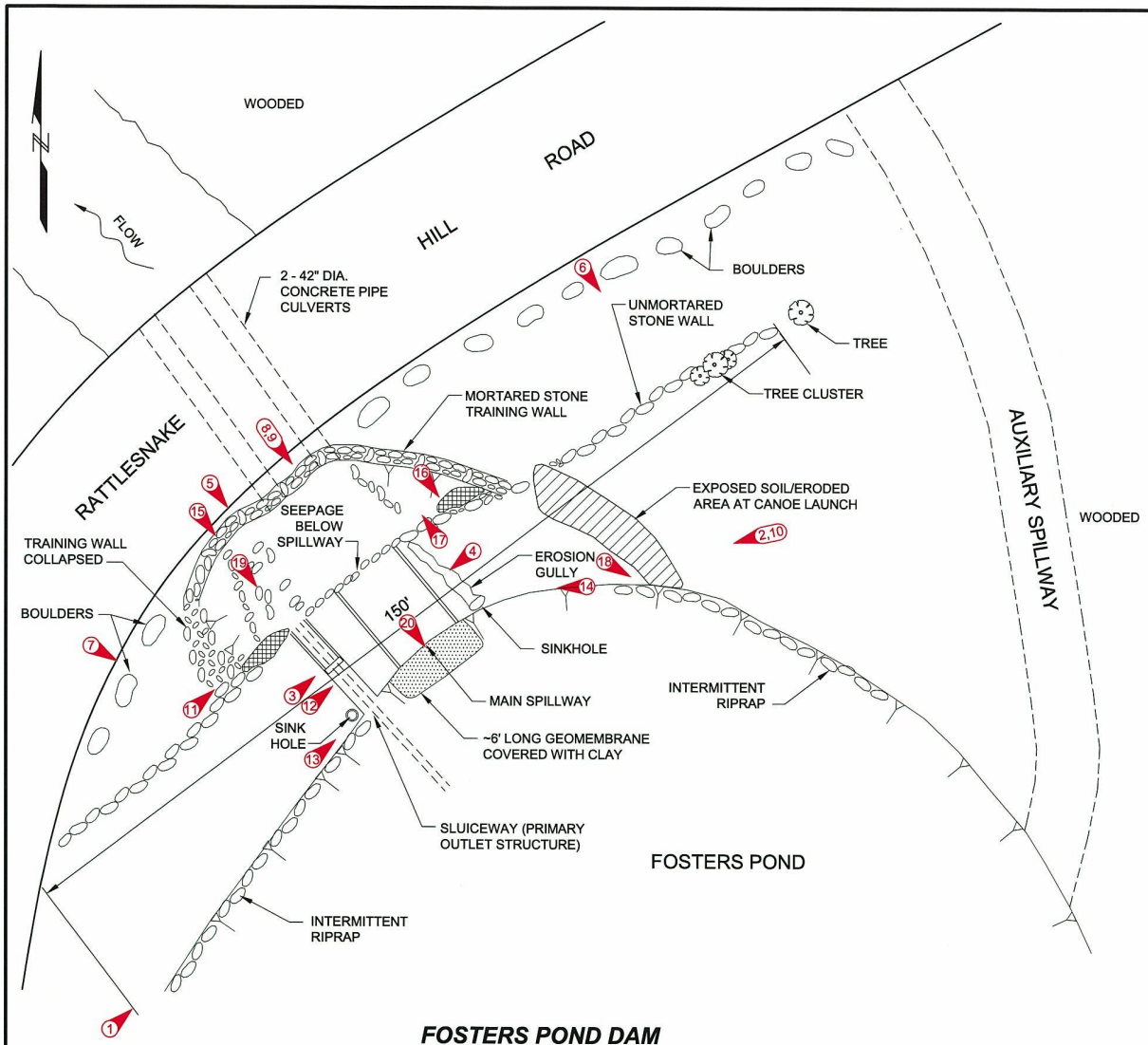
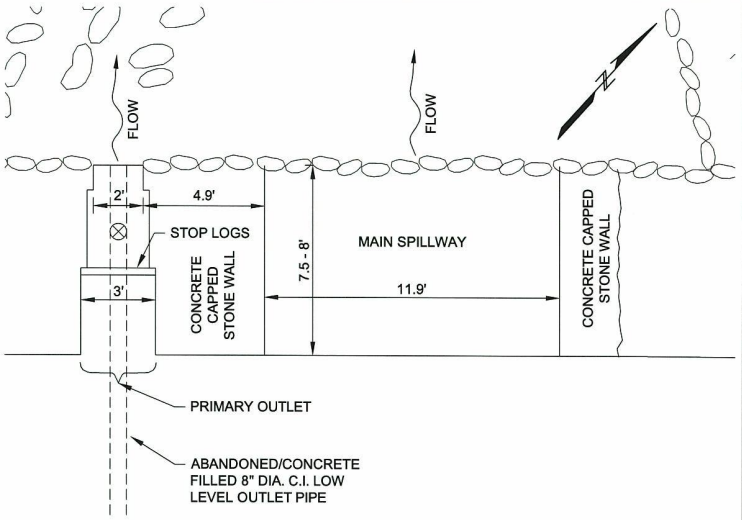
[1]Assumes wetland permitting by others.
[2]Our cost estimates for repairs assume that work is done by contracted companies. Routine maintenance and minor repairs are performed by volunteers and members of FPC. Maintenance and minor repair costs may be less than identified above.
[3]Above construction costs do not include cost of remedial measures to safely pass the SDF.




## FOSTERS POND DAM

**NOT TO SCALE**




## MAIN SPILLWAY AND PRIMARY OUTLET DETAIL

0 5 10

SCALE, FEET

### LEGEND:

SEEPAGE AREA

① PHOTOGRAPH NUMBER LOCATION AND DIRECTION

### NOTES:

1. BASE PLAN TAKEN FROM SITE PLAN PREPARED BY FOSTERS POND CORP. MEMBERS.
2. DIMENSIONS FROM HISTORIC INSPECTION RECORDS AND MEASUREMENTS TAKEN DURING INSPECTION ON NOVEMBER 10, 2006.

| | | |
|---|---|---|
| Dam Safety Inspection<br>Fosters Pond Dam, NID MA00153<br>Andover, Massachusetts | GEI Consultants | SITE PLAN |
| Fosters Pond Corporation<br>Andover, Massachusetts | Project 06463-0 | December 2006 Fig. 2 |

064630-02 djm 12/07/06