

Warners Pond Dam

Phase I Inspection / Evaluation Report

Concord, Massachusetts

Dam Name: **Warners Pond Dam**

NID ID#: **MA00440**

Owner: **Town of Concord**

Town: **Concord**

Consultant: **Pare Corporation**

Date of Inspection: **June 9, 2023**



Dam Evaluation Summary Detail Sheet

1. NID ID:	MA00440	4. Inspection Date:	June 9, 2023
2. Dam Name:	Warners Pond Dam	5. Last Insp. Date:	April 11, 2018
3. Dam Location:	Concord, MA	6. Next Inspection:	June 9, 2028
7. Inspector:	0		
8. Consultant:	Pare Corporation		
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)	90-100% of the SDF		
E1. Design Methodology:	4	E7. Low-Level Discharge Capacity:	4
E2. Level of Maintenance:	3	E8. Low-Level Outlet Physical Condition:	4
E3. Emergency Action Plan:	4	E9. Spillway Design Flood Capacity:	3
E4. Embankment Seepage:	5	E10. Overall Physical Condition of the Dam:	4
E5. Embankment Condition:	4	E11. Estimated Repair Cost:	\$41-\$118
E6. Concrete Condition:	4		

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

EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the inspection and evaluation of the Warners Pond Dam, located in Concord, Massachusetts. The inspection was completed on June 9, 2023 by Pare Corporation of Foxboro, Massachusetts. Warners Pond Dam is an approximately 320-foot long dam with a maximum structural height of approximately 9 feet. The dam is currently classified as an **Intermediate** sized, **Significant** (Class II) hazard potential dam.

No operations and maintenance (O&M) manual is known to exist for this structure.

An Emergency Action Plan (EAP) was developed for this dam in April 2020; no updates to the plan were available at the time of the inspection.

In general, Warners Pond Dam was found to be in **Satisfactory** condition with the following observations noted:

1. Areas of unmaintained vegetation and developing woody vegetation in many areas of the dam.
2. Areas of exposed turf reinforcement mat (TRM)
3. Dislodged stone on the surface of the right training wall immediately downstream of the spillway with observed leakage
4. Possible settlement of one isolated area of the riprap toe of the downstream slope between the spillways, a possible result of the elevated islands within the downstream channel resulting in concentrated flow along this area;
5. Previously reported bubbling flow at the toe of the slope at the downstream end of the left training wall of the auxiliary spillway with unknown source;
6. Several potential concerns which may impact performance during the spillway design flood (SDF) including:
 - a. An apparent lower left abutment prone to overtopping with unknown ability to accommodate overtopping flows.
 - b. A predicted 0.2 feet of overtopping at the dam crest with only turf reinforcement mats as overtopping protection.
 - c. Areas of the crest that are apparently lower than the design top of dam elevation that would be prone to higher overtopping depths than the original design;
7. Additional maintenance deficiencies and potential dam safety concerns.

More detailed descriptions, additional deficiencies, recommended repairs, and opinions of probable repair costs are provided within this report.

Based upon the size and hazard potential of this structure, the spillway design flood (SDF) is the 100-year storm event. Based upon the preliminary hydrologic and hydraulic (H&H) analysis completed as part of the 2006 Phase II and in support of the design of the 2006 rehabilitation project, a predicted peak inflow of 3,200 cfs results in a peak pool elevation during the SDF of El. 123.2, resulting in 0.2 feet of overtopping.

In general, the condition of the dam is similar to that previous reported; as such, Pare Corporation continues to recommend that the recommended actions identified in the 2018 Phase I Report be taken to address the deficiencies found at the dam during this inspection and evaluation:

1. Remove developing weed and brush vegetation from the crest and downstream slope and establish a healthy stand of grass including all areas of exposed TRM. *Note: Maintenance was completed in Fall 2023 to address unmaintained vegetation observations.*
2. Replace the dislodged stone at the right training wall of the primary spillway. Further evaluate the leakage during a lower pool level and seal the source of the leakage, which is likely occurring along the vertical joint between the spillway weir and right training wall;
3. Further evaluate the area of possible settlement along the riprap toe of the downstream slope of the embankment between the spillways. Address the area as appropriate
4. Further evaluate the bubbling flow at the toe of the slope at the downstream end of the left training wall of the auxiliary spillway with unknown source
5. Address the concerns during the spillway design flood (SDF) including:
 - a. Update the H&H analysis to support the assessment of the noted concerns. The effects of tailwater on the hydraulic capacity of the dam's outlet structures (spillways, sluiceway, low level outlet, overtopping of the dam, overtopping of the left abutment) should be considered.
 - b. Assess the apparent lower left abutment's ability to accommodate the predicted overtopping flows.
 - c. Assess the ability of the TRM along the crest and downstream slope of the dam embankments to accommodate the predicted overtopping flows.
 - d. Assess the need to regrade lower areas of the crest to the design top of dam elevation, dependent upon the updated H&H analysis as well as the ability of the TRM to accommodate the predicted overtopping flows.
6. Conduct additional studies, evaluations, maintenance, and repairs as noted herein.

These repairs should be made in accordance with standard design practices, specifications, and construction methods. Design of the repairs, analyses to confirm the extent of the work, and observation to verify materials/methods used should be completed by a qualified engineer experienced in the design and rehabilitation of earthen dams throughout the evaluation, design, and construction process.

Prior to undertaking recommended maintenance, repairs and remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of the local conservation commission, MADEP, or other regulatory agencies.

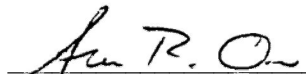


PREFACE

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 is evolutionary in nature and depends on numerous and constantly changing internal and external conditions. 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.


Allen R. Orsi, P.E., Senior Vice President
Pare Corporation
Massachusetts License No.: 46904
License Type: Civil

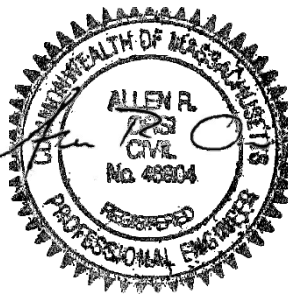


TABLE OF CONTENTS

	Page No.
EXECUTIVE SUMMARY	i
PREFACE	iii
1.0 DESCRIPTION OF PROJECT	1-1
1.1 General	1-1
1.1.1 Authority	1-1
1.1.2 Purpose of Work	1-1
1.1.3 Definitions	1-1
1.2 Description of Project	1-1
1.2.1 General	1-1
1.2.2 Location	1-2
1.2.3 Owner/Operator	1-2
1.2.4 Purpose of the Dam	1-2
1.2.5 Description of the Dam and Appurtenances	1-2
1.2.6 Operations and Maintenance	1-4
1.2.7 DCR Size Classification	1-5
1.2.8 DCR Hazard Classification	1-5
1.3 Engineering Data	1-5
1.3.1 Drainage Area	1-5
1.3.2 Reservoir	1-6
1.3.3 Discharges at the Dam Site	1-6
1.3.4 General Elevations (feet)	1-6
1.3.5 Primary Spillway	1-7
1.3.6 Sluiceway	1-7
1.3.7 Auxiliary Spillway	1-7
1.3.8 Low Level Outlet	1-7
1.3.9 Design and Construction Records	1-7
1.3.10 Operating Records	1-7
1.4 Summary Data Table	1-8
2.0 INSPECTION	2-1
2.1 Visual Inspection	2-1
2.1.1 General Findings	2-1
2.1.2 Dam	2-1
2.1.3 Appurtenant Structures	2-4
2.1.4 Downstream Area	2-5
2.1.5 Reservoir Area	2-5
2.2 Caretaker Interview	2-6
2.3 Operation and Maintenance Procedures	2-6
2.3.1 Operational Procedures	2-6
2.3.2 Maintenance of Dam	2-6
2.4 Emergency Warning System	2-6
2.5 Awareness of Potential Dam related Safety Hazards at, near, and on Dams	2-6
2.6 Hydraulic/Hydrologic Data	2-7
2.7 Structural and Seepage Stability	2-8



2.7.1	Embankment Structural Stability	2-8
2.7.2	Structural Stability of Non-Embankment Structures	2-9
2.7.3	Seepage Stability	2-9
3.0	ASSESSMENTS AND RECOMMENDATIONS	3-1
3.1	Assessments	3-1
3.2	Studies and Analyses	3-2
3.3	Yearly & Recurrent Maintenance Recommendations	3-3
3.4	Minor Repair Recommendations	3-4
3.5	Remedial Modification Recommendations	3-4
3.6	Alternatives	3-5
3.7	Opinion of Probable Costs	3-5
3.8	Site Safety Considerations	3-6

TABLES

Table 1-1	Reservoir Properties	1-6
Table 1-2	Summary Data Table	1-8
Table 2-1	Potential Related Safety Hazards At, Near, and On Dams	2-7
Table 2-2	H&H Data Summary During the 100-yr Event	2-7
Table 3-1	Deficiency Summary	3-1
Table 3-2	Previously Reported Deficiencies & Current Status Summary	3-1

FIGURES

Figure 1:	Locus Plan
Figure 2:	Aerial Plan
Figure 3:	Drainage Area Plan
Figure 4:	Site Sketch

APPENDICES

Appendix A:	Photographs
Appendix B:	Inspection Checklist
Appendix C:	Previous Reports and References
Appendix D:	Common Dam Safety Definitions
Appendix E:	Visual Dam Inspection Limitations



SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The Town of Concord, Massachusetts has retained Pare Corporation (Pare) to perform a visual inspection and develop a report of conditions for the Warners Pond Dam in Concord, Plymouth County, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws.

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 CMR10.04 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 and need for an emergency action plan for the site and; 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations for remedial actions, and opinions 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; 5) general; and, 6) condition rating.

1.2 Description of Project

1.2.1 General

Sections of this report are based upon available documentation, including previous inspection reports and other available information as identified in Appendix C. Other historical information obtained during the inspection, including information provided by the caretaker has also been incorporated into this report. This material is intended to provide general information. The accuracy of this referenced information was not verified as it was outside the scope of work for this inspection.

The completion of detailed hydrologic/hydraulic studies, stability analyses, subsurface investigations, and underwater investigations is beyond the scope of this evaluation.



1.2.2 Location

Warners Pond Dam is located within Middlesex County in the Town of Concord, Massachusetts, near the center of West Concord. The dam impounds water along the Nashoba Brook, a tributary to the Assabet River, to form the impoundment, Warners Pond. The structure and impoundment are shown on the Maynard, Massachusetts USGS quadrangle map near coordinates 42.45880°N, 71.39777W¹. The dam is located at the southeastern corner of the impoundment, as indicated on Figure 1: Locus Plan.

Access to the dam is via Commonwealth Avenue. From Interstate 95, take Exit 45B to merge onto MA-2 W toward Acton/Fitchburg for 7.6 miles; bear left to continue on MA-2 W/2A W/Concord Turnpike towards Littleton/Ayer for 3.3 miles. At the traffic circle, take the fifth exit onto Commonwealth Avenue. Continue onto Commonwealth Avenue for 0.3 miles. Warners Pond Dam is located to the left side of the roadway.

1.2.3 Owner/Operator

The dam is currently owned by the Town of Concord. The Department of Public Works serves as the primary caretaker of the dam.

1.2.4 Purpose of the Dam

The dam is currently owned by the Town of Concord. The Department of Public Works serves as the primary caretaker of the dam.

1.2.5 Description of the Dam and Appurtenances

As shown on Figure 4: Site Sketch, Warners Pond Dam is a roughly 320-foot long earthen embankment with a 40.2-foot long stone masonry weir located near the center of the structure that serves as the primary spillway, a 18-foot long concrete weir located at the right end of the dam that serves as the auxiliary/secondary spillway, a 5-foot wide stop log controlled rectangular sluiceway channel left of the spillway, and a gate valve controlled 24-inch diameter low level outlet pipe. The structural and hydraulic heights are 9 and 5 feet, respectively.

The dam was rehabilitated in 2007-2008 as documented within the June 2011 Record Drawings of the Warners Pond Dam Rehabilitation project (Reference #3). The following description of the components of the dam are based on information provided within those drawings.

There are two separate embankment sections along the dam, one left of the primary spillway, and one between the primary and auxiliary spillways. Both embankment sections consist of a riprap protected 3H:1V upstream slope, a 10-foot wide grassed crest, and a 3H:1V grassed downstream slope with a riprap toe. The riprap sections along the upstream slope and downstream toe include riprap armor stone overlying a crushed stone bedding layer overlying a monofilament polypropylene woven geotextile fabric. A turf reinforcement mat (TRM) (P550) is present along the surface of the crest and downstream slope and is intended to provide overtopping protection of the embankment sections.

¹ Based on Office of Dam Safety Dam Locations Database for Google Earth.



The composition of the embankment between the spillways is believed to be in accordance with the design plans which shows a low permeability core material extending from below the surficial materials down to the base of the embankment near El. 114, with a 2-foot wide key along the centerline that extends down an additional 2 feet to El. 112. The embankment core material was specified to extend down to natural soils or bedrock. An 18-inch layer of sand and gravel is called for as a filter layer between the core material and the riprap downstream toe.

The composition of the embankment left of the spillway was modified during the construction project due to timber logs that were encountered along the base of existing dam near El. 110. The revised composition included allowing the existing embankment fills as well as the timber logs located beneath the existing embankment fills to remain and modifying the limits of low permeability core to consist of a reduced core thickness relocated towards the upstream side of the embankment. The core consisted of flowable fill from the bottom elevation of El. 108 up to El. 112 and then low permeability soil from El. 112 to the surficial materials. It does not appear that the sand and gravel filtration layer was installed between the core material and the riprap toe. For detailed sections of the embankment, refer to the As-Built Drawings

The primary spillway, located between the two embankment sections, consists of a 40.2 foot long concrete/stone masonry weir that spans between the right training wall and the sluiceway structure. The original spillway section (prior to 2007-2008 rehabilitation) consisted of a stone masonry weir. As part of the rehabilitation the existing stones were removed entirely down to bedrock, which reportedly slopes up from the left end (where it is believed to be near El. 110) to the right end (where it may be as high as El. 116). A concrete leveling course was then installed along the footprint of the new (current spillway) and anchored to the bedrock foundation with dowels. The stone weir was then reconstructed with all joints mortared/pointed. A reinforced concrete gravity section with a 1-foot top width and a 1H:2V upstream batter was then placed along the upstream face of the stone masonry weir that was anchored to the stones of the weir as well as the underlying concrete leveling pad and bedrock foundation with dowels. The right training wall of the spillway consists of a cantilevered reinforced concrete wall with a 1.3-foot thick wall stem with a stone masonry façade on the exposed surfaces and a 1.3-foot thick by 5.6-foot wide footing founded on and anchored to bedrock with dowels. The wall stem is anchored into the stones of the spillway weir with dowels.

The sluiceway structure, located left of the spillway, consists of a 5-foot wide channel formed by a cantilevered left training wall and a square pier. Both are reinforced concrete with a stone masonry façade on all exposed faces, similar to the right training wall. Both are supported on a 1.3-foot thick concrete footing with a base elevation of El. 110 (or possibly higher if bedrock was encountered). The square pier and footing are anchored into the stones of the stone masonry weir of the primary spillway. The width of the footing varies along the length (upstream to downstream) of the structure and is 7.3 feet wide upstream and downstream of the sluiceway control section (where it is just the left training wall) and is 16 feet wide in the areas of the control section. A 5-foot long cutoff wall extends left of the left training wall near the upstream edge of the crest that is also supported on the footing. The control section consists of timber stop logs within steel angle stop logs slots. A buried concrete weir wall extends from the base of the stop logs (El. 115) down to the top of the footing (El. 111.3).

The auxiliary spillway, located at the right end of the dam, consists of a 18-foot long reinforced concrete weir. The weir consists of a 2.75-foot wide concrete wall atop a 2-foot thick by 10-foot wide footing with a base elevation of El. 110 (or possibly higher if bedrock was encountered). The wall and footing continues 11 feet to either side of the weir to form left and right training walls for the spillway, both with stone masonry façade along all exposed faces. A training wall extends into the downstream direction



along the left edge of the downstream channel and is of the same construction and geometry as the left training wall of the sluiceway.

The low level outlet consists of a 24-inch diameter ductile iron conduit that extends through the embankment a short distance left of the left training wall of the sluiceway structure. A gate valve is located along this line a short distance downstream of the cutoff wall that extends from the left training wall of the sluiceway. Based on the location of the gate valve, it appears that the conduit may extend through the cutoff wall. The conduit is supported on a reinforced concrete cradle. There does not appear to be any structures or trash racks at either end of the conduit.

The downstream channel of the primary spillway is a wide natural river channel with a deep section a short distance downstream that forms a stilling pool. The channel turns downstream (right) and extends towards Commonwealth Ave. The left bank of the channel is defined by a stone masonry wall while the right bank is defined by the riprap toe of the embankment between the spillways. Elevated islands at one point along the channel concentrate the flows along the toe of the embankment between the spillways. The channel flows under Commonwealth Ave via a 35-foot (estimated dimension) wide arched bridge culvert. The auxiliary spillway channel, which consist of a trapezoidal riprap protected channel, joins the main channel a short distance upstream of Commonwealth Ave.

The right abutment consists of an earthen grassed area with a residential property located a short distance from the dam. The left abutment consisted of a lightly wooded earthen area that is reportedly lower than the dam crest. The area downstream of the left abutment consists of residential properties along Commonwealth Ave. The outlet structure at the dam consists of a concrete spillway structure located near the center of the embankment. The spillway is a three-sided weir with a width of 8 feet along the upstream side and 2 feet along both the left and right return walls. Sloped sidewalls at the end of the side weirs extend approximately 5 feet to the concrete headwall at the conduit beneath the roadway. The upstream side of the weir is equipped with a single 6-inch-high stop log allowing for small drawdowns of the impoundment. At the upstream right corner of the weir, a 12-inch diameter valved low level outlet pipe provides additional drawdown capacity. A concrete platform is present over the top of the spillway intake structure to provide access to the low-level outlet gate valve. The 3-foot-wide platform extends from the top of the headwall to the edge of the crest and is supported by a circular concrete column that abuts the downstream face of the upstream weir.

Discharges over the weir and through the low-level outlet enter a 5-foot diameter reinforced concrete pipe which conveys flows through the embankment and discharges through a stone masonry outlet structure along the downstream side of the dam.

A toe drain is present along the downstream side of the dam right of the spillway. The toe drain consists of a 4-inch diameter perforated HDPE pipe within a 2-foot square $\frac{3}{4}$ " crushed stone trench wrapped with geotextile fabric. The toe drains outlets at the end of the spillway right downstream training wall and into the downstream channel

1.2.6 Operations and Maintenance

No formal operation and maintenance manual exists for this structure. There does not appear to be any operations performed at the dam as both spillways are uncontrolled. Routine maintenance performed at the dam includes maintaining vegetation and removal of debris as required.



1.2.7 DCR Size Classification

Warners Pond Dam has a maximum structural height of approximately 9 feet and a maximum storage capacity of 440 acre-feet¹. 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, Warners Pond Dam is considered an **Intermediate** sized structure.

1.2.8 DCR Hazard Classification

Warners Pond Dam is located upstream of Commonwealth Ave (100 to 200 feet downstream of the dam) and an apparent former railroad embankment (1,000 feet downstream of the dam), both of which are several feet higher in elevation than the dam, before the downstream channel discharges into the Assabet River. There is commercial development on the banks of the river between Commonwealth Ave and the former railroad embankment, all of which appear to be at or above the top of dam elevation. There are several residential properties along Commonwealth Ave left of the dam, all of which appear to be at or above top of dam.

The dam is currently classified as a **Significant** (Class II) hazard potential dam, which would indicate that a failure of the dam at maximum pool may cause loss of life and damage to homes, industrial or commercial facilities, secondary highways or railroads, or cause interruption of use or service of relatively important facilities.

The dam may warrant reclassification to Low hazard due to the limited anticipated impacts to the downstream area between the dam and the Assabet River, which is a significant river that would most likely limit the impacts further downstream of the confluence. Further, based upon inundation mapping provided within the EAP, failure during the sunny day event does not appear to impact infrastructure and incremental damage due to failure of the dam during the SDF appears to be minimal, likely due to attenuating effects provided by the culvert at Commonwealth Ave. As such, it is recommended to complete a hazard classification review to identify if reclassification to Low Hazard is warranted. As part of the review, a scour analysis of Commonwealth Ave would likely be required.

1.3 Engineering Data

1.3.1 Drainage Area

The drainage area for Warners Pond Dam is approximately 46.6 square miles as determined by Massachusetts StreamStats and as reported within previous reports. The limits extend 7 miles northwest of the dam to just southeast of I-495 and has a width (southwest to northeast) of approximately 11 miles at its widest point. The drainage area generally consists of residential and commercial development as well as wooded areas. The total drainage area consists of 15% waterbodies and wetlands, 59% forests, 33% urban development, 12% impervious area, and has an average land slope of 2.3% (250K DEM).

Based upon a review of the MADCR dam database, five other inventoried dams are located within the drainage including the significant hazard MA00195 Erikson Dam, the non-jurisdictional MA01608

¹ Previously reported at 316 acre-feet from 2006 Phase II and 253 permit application.



Flagg Hill Dam, the low hazard MA00127 Allen Dam, the significant hazard MA00129 Nagog Pond Dam, and the low hazard MA01147 Bellows Farm Mill Dam.

1.3.2 Reservoir

The following table provides a summary of general characteristics of the impoundment storage capacity.

Table 1-1 Reservoir Properties

	Elevation (ft)	Surface Area¹ (acres)	Storage Volume² (acre-feet)
Pond Bottom	114.62 ³	0	0 ¹
Normal Pool	118.77	57	93 ¹
Top of Dam (TOD)	123	73	440
SPF Pool (100-year)	123.2	74	464
1 foot above TOD	124	78	570
2 feet above TOD	125	83	752

1.3.3 Discharges at the Dam Site

No records of discharges from the dam site were made available or identified during the preparation of this report.

Based upon available aerial imagery, discharges from the structure generally flow in an easterly direction along the Nashoba Brook flowing underneath Commonwealth Ave at 100 to 200 feet downstream of the dam, an apparent former railroad embankment at 1,000 feet, and into the Assabet River at 1,300 feet downstream of the dam. The Assabet River flows in a northwesterly direction eventually flowing into the Concord River at 3 river miles downstream of the dam. The Concord River extends in a northerly direction eventually flowing into the Merrimack River at 18 river miles downstream of the dam in Lowell. The Merrimack River extends in a northeasterly direction eventually discharging into the ocean at Newburyport at 52 river miles downstream of the dam.

1.3.4 General Elevations (feet)

Elevations are based upon information provided in previous reports as well as a relative elevation survey completed during the inspection referencing the left training wall of the primary spillway with a reported elevation of 124.17 feet (NAVD 1988), as indicated on the 2011 Rehabilitation As Built Plans.

A. Top of Dam	Design: 123; Max: 123.4; Min: 122.7
B. Top of Lower Left Abutment	121 ±
C. Spillway Design Flood Pool	100-year / 123.2 (Previous H&H)
D. Normal Pool	118.77
E. Upstream Water during Inspection	119.27
F. Downstream Water during Inspection (Primary Spillway)	115.1±
G. Downstream Water during Inspection (Auxiliary Spillway)	116.5±

¹ Based on information provided within the 2006 Phase II and the 2006 253 permit application completed by GZA Environmental

² Based upon available MassGIS LiDAR contour data and as reported in the 2018 report, unless noted otherwise

³ As reported within the 2006 Phase II. Actual pond bottom may be lower as reported LLO invert is El. 113.5.



1.3.5 Primary Spillway

A. Type	Concrete/Stone Masonry Weir
B. Length of Weir	40.2 feet
C. Crest	118.77
D. US and DS Channels (Measured)	115 ±

1.3.6 Sluiceway

A. Type	Stop Log Controlled Rectangular Channel
B. Width	5 feet
C. Top of Stop Logs	119.4
D. Invert / Bottom of Stop Logs	115 ±

1.3.7 Auxiliary Spillway

A. Type	Concrete Weir
B. Length of Weir	18 feet
C. Crest	118.77
D. US Channel	118 ±
E. DS Channel	115.5 ±

1.3.8 Low Level Outlet

A. Type	Gate Valve-Controlled 12-inch diameter C.I. Pipe
B. Invert In	113.5
C. Invert Out	113.0

1.3.9 Design and Construction Records

No historical information pertaining to the original design/construction of the dam was available for review or is known to exist for this dam. The original date is reported as 1857, as indicated in a May 2023 Alternatives Analysis Report (EA Engineering, Science, and Technology, Inc.).

The auxiliary spillway (referred to as the concrete dam within previous reports) was reconstructed in 1988.

The dam was fully rehabilitated in 2007-2008, as detailed within the 2011 Record Drawings. The rehabilitation included the reconstruction of both embankments, the reconstruction of the primary and auxiliary spillways, the installation of the sluiceway structure, the installation of the low level outlet system, and the removal of the former low level outlet system.

1.3.10 Operating Records

No operating records were available or indicated to be maintained during the inspection and preparation of this report.

1.4 Summary Data Table

Table 1-2 Summary Data Table

Required Phase I Report Data	Data Provided by Inspecting Engineer
National ID #	MA00440
Dam Name	Warners Pond Dam
Dam Name (Alternate)	Warner's Pond Dam
River Name	Nashoba Brook (Tributary to Assabet River)
Impoundment Name	Warners Pond
Hazard Class	Significant
Size Class	Intermediate
Dam Type	Earthen Embankment
Dam Purpose	Original: Unknown; Current: Recreational
Structural Height of Dam (feet)	9
Hydraulic Height of Dam (feet)	5
Drainage Area (sq. mi.)	0
Reservoir Surface Area (acres)	57
Normal Impoundment Volume (acre-feet)	93
Max Impoundment Volume ((top of dam) acre-feet)	440
SDF Impoundment Volume (acre-feet)	464
Spillway Type	Concrete & Stone Masonry Weir
Spillway Length (feet)	40.2
Freeboard at Normal Pool (feet)	4.5±
Principal Spillway Capacity (cfs)	1115
Auxiliary Spillway Capacity (cfs)	480; 49 cfs O/T Dam, 1,200 cfs O/T Left Abut.
Low-Level Outlet Capacity (cfs)	Sluiceway: 318 ; LLO: 29
Spillway Design Flood (flow rate - cfs)	100-yr / 3,200cfs inflow (Prev.H&H)
Winter Drawdown (feet below normal pool)	0
Drawdown Impoundment Vol. (acre-feet)	No Drawdown
Latitude	42.45880°N
Longitude	71.39777°W
City/Town	Concord
County Name	Middlesex
Public Road on Crest	No
Public Bridge over Spillway	N/A
EAP Date (if applicable)	#REF!
Owner Name	Town of Concord
Owner Address	133 Keyes Road
Owner Town	Concord, MA 01742
Owner Phone	978-318-3206
Owner Emergency Phone	978-318-3400
Owner Type	Municipality or Political subdivision
Caretaker Name	Public Works Department
Caretaker Address	133 Keyes Road
Caretaker Town	Concord, MA 01742
Caretaker Phone	978-318-3206
Caretaker Emergency Phone	978-318-3210
Date of Field Inspection	6/9/2023
Consultant Firm Name	Pare Corporation
Inspecting Engineer	0
Engineer Phone Number	508.543.1755



SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

The Warners Pond Dam was inspected on June 9, 2023. At the time of the inspection, temperatures were near 60°F with cloudy skies. Photographs to document conditions were taken during the inspection and are included in Appendix A. Underwater areas were not evaluated during this inspection. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

Warners Pond Dam was found to be in **Satisfactory** condition. The specific concerns are identified in the sections below.

2.1.2 Dam

The following was noted along the embankment section located left of the primary spillway that spans between the left training wall of the sluiceway and the left abutment.

Upstream Side

Current Observations:	
<ul style="list-style-type: none"> ➤ <i>Left abutment, highly overgrown and primarily in accessible.</i> ➤ <i>From the tree line to 20 feet right, the right end of the dam is densely overgrown with Japanese knot weed.</i> ➤ <i>The slope angle is typically gradual with no indication of movement or depressions.</i> ➤ <i>Contact with left training wall appears good.</i> 	
Review of Previous Observations:	Comments from Current Inspection:
<ul style="list-style-type: none"> ➤ In general, the riprap is in good condition. 	<ul style="list-style-type: none"> ➤ Conditions are similar to those previously reported
<ul style="list-style-type: none"> ➤ The slope is very mild. 	<ul style="list-style-type: none"> ➤ Conditions are similar to those previously reported
<ul style="list-style-type: none"> ➤ Some brush growth is developing within the riprap, most notably along the waterline and at the left end of the dam. 	<ul style="list-style-type: none"> ➤ Generally clear of vegetation within top 10 feet of slope, fence, weed, and brush within 5 feet of the waterline.

Crest

Current Observations:	
<ul style="list-style-type: none"> ➤ <i>A 6-foot diameter bare area is present near the tree line at left end of maintained portion of the crest; the area appears to be the result of an animal (dog) digging.</i> 	
Review of Previous Observations:	Comments from Current Inspection:
<ul style="list-style-type: none"> ➤ The TRM is exposed along the transition between the grassed crest and riprap upstream slope. Some areas of soil loss were noted along this transition. 	<ul style="list-style-type: none"> ➤ Conditions are similar to those previously reported



<ul style="list-style-type: none"> ➤ The crest is vegetated with a mixture of grass, weeds, and brush, all of which is well maintained. There are isolated bare areas throughout. 	<ul style="list-style-type: none"> ➤ Crest left of spillway, typically overgrown with tall grass and weeds from spillway to 90 feet left of spillway. ➤ Worn path present, near center of crest, with no erosion or exposed embankment soil apparent. ➤ Crest is well maintained grass from 90 feet left of spillway to tree line approaching left abutment. Grass is thin in areas and mixed with weeds. ➤ Crest left of the tree line is typically , overgrown and inaccessible.
<ul style="list-style-type: none"> ➤ The left abutment is wooded and appears lower in elevation than the crest of the dam. 	<ul style="list-style-type: none"> ➤ Conditions are similar to those previously reported; density of vegetation limited inspection.
<ul style="list-style-type: none"> ➤ Minor vertical irregularities were noted throughout. 	<ul style="list-style-type: none"> ➤ Conditions are similar to those previously reported

Downstream Side

Current Observations:	
<ul style="list-style-type: none"> ➤ <i>No areas of seepage apparent within rock toe.</i> 	
Review of Previous Observations:	Comments from Current Inspection:
<ul style="list-style-type: none"> ➤ The downstream slope is vegetated similar to that of the crest. Brush growth is more prominent along the right half of the slope. 	<ul style="list-style-type: none"> ➤ Downstream slope, left of tree line, is densely overgrown with variety of woody, vegetation, and dumped yard debris. Access for inspection was limited. ➤ Downstream slope right of tree line to 90 feet left of spillway is well maintain grass mixed with weeds and minor thin to bare areas. No areas of sloughs or slides apparent. ➤ Downstream slope 90 feet left of spillway to spillway overgrown with 3-foot high weeds and tall grass. Minimal to no woody vegetation.
<ul style="list-style-type: none"> ➤ Minor vertical irregularities were noted throughout. 	<ul style="list-style-type: none"> ➤ Conditions are similar to those previously reported
<ul style="list-style-type: none"> ➤ The riprap toe appears to be in good condition, although most of the riprap was submerged below the downstream water, limiting the inspection. Areas of crushed stone was visible along the surface immediately upstream of the riprap. 	<ul style="list-style-type: none"> ➤ Non submerged portions of the toe/slope are dry with no indication of seepage. ➤ Toe scour stones in good condition with no apparent displacement. Minor weed development, in some voids typical.

The following was noted along the embankment section located between the spillways that spans between the right training wall of the primary spillway and the left training wall of the auxiliary spillway. *At the time of the inspection, this area was unmaintained with tall weeds and other vegetation limiting access for inspection.*



Upstream Side

Current Observations:	
<i>None</i>	
Review of Previous Observations:	Comments from Current Inspection:
➤ In general, the riprap is in good condition.	➤ Conditions are similar to those previously reported with minor vegetation growth
➤ Isolated area of maintained small saplings were noted within the riprap.	➤ Cut stumps remain

Crest

Current Observations:	
<i>None</i>	
Review of Previous Observations:	Comments from Current Inspection:
➤ No exposed TRM was apparent.	➤ Conditions are similar to those previously reported
➤ The crest is vegetated with a mixture of grass, weeds, and brush, all of which is well maintained.	➤ Conditions are similar to those previously reported
➤ Minor vertical irregularities were noted throughout.	➤ Conditions are similar to those previously reported

Downstream Side

Current Observations:	
➤ <i>Rock toe at downstream toe in fair condition with possible displacement of several stones at the waterline.</i> ➤ <i>Several developing woody sumac trees and other plants with trunk diameters up to 5 inches.</i>	
Review of Previous Observations:	Comments from Current Inspection:
➤ The downstream slope is vegetated similar to that of the crest.	➤ <i>Downstream, slope, overgrown with tall grass, and weeds limiting inspection.</i>
➤ Isolated areas of exposed TRM were noted.	➤ Conditions are similar to those previously reported
➤ At about the midpoint of the embankment (left to right) a 10-foot long section of the riprap toe appears lower than the rest. The following was noted in this area: <ul style="list-style-type: none"> ○ This is an area where flow within the channel is concentrated along the toe due to the elevated island areas within the channel. The channel appears to be deep in this area. ○ One area of the grassed slope in this area is scaped 4 inches in height with exposed TRM. It is unclear if this is a result of turf damage from maintenance activities, indicative of settlement / soil loss, or scour during elevated flows within the downstream channel. 	➤ Variable horizontal alignment remains along the waterline with deeper pools present at the toe of the slope in the noted areas.
➤ Bubbling flow, approximated at 30-50 GPM was observed at the toe of the slope towards the downstream end of the left training wall. It was	➤ Not observed during the current inspection, potential due to higher



unclear at the time of the inspection of the flow was associated with flow through the auxiliary spillway channel, seepage through the dam, or leakage through the auxiliary spillway system.	tailwater conditions and/or density of vegetation.
---	--

2.1.3 Appurtenant Structures

Primary Spillway

Current Observations:	
<ul style="list-style-type: none"> ➤ <i>Open joints typical along downstream face of spillway, no apparent displacement, but obscured by water flow.</i> ➤ <i>Left training wall is in good condition with only minor cracking of mortar between stone facing pieces.</i> ➤ <i>Minor brush development in riprap along downstream side of right training wall.</i> ➤ <i>Crack in capstone on top of right training wall approximately 6 feet upstream of spillway. Underlying concrete appears in good condition.</i> 	
Review of Previous Observations:	Comments from Current Inspection:
➤ The approach and discharge areas are clear of debris.	➤ Conditions are similar to those previously reported, with flow on stone apron being directed towards left side of apron.
➤ Significant flows over the spillway weir limited the inspection of the weir.	➤ Conditions are similar to those previously reported.
➤ The upstream concrete section appeared to be in good condition, as viewed through the water flowing over the spillway.	➤ Conditions are similar to those previously reported.
➤ Some irregularities in the flow over the stone masonry section of the weir were noted, likely due to vertical irregularities along this section of the weir.	➤ Some areas of crest irregularity, including approximately 2-inch lowered section near middle and 4-inch lowered section at right training wall. Not clear, if as built or indication of movement.
➤ The downstream face of the weir was not visible.	➤ Conditions are similar to those previously reported.
➤ The visible sections of the square pier at the left end of the weir appeared to be in good condition.	➤ Conditions are similar to those previously reported.
<ul style="list-style-type: none"> ➤ The visible section of the right training wall appeared to be in fair condition. <ul style="list-style-type: none"> ○ One stone from the stone façade is missing immediately downstream of the spillway weir. ○ Leakage approximated at 3-5 GPM was observed through joint of this missing stone, possibly the result of leakage through the joint between the spillway weir and the training wall. 	<ul style="list-style-type: none"> ➤ Missing, facing stone on right training wall, downstream of right end of spillway, approximately 6-inch diameter, and 6 inches deep. ➤ No observed flow.
➤ The floor of the downstream channel was not visible due to the depth of water within the channel.	➤ Conditions are similar to those previously reported.

Sluiceway

Current Observations: None	
Review of Previous Observations:	Comments from Current Inspection:
➤ The approach and discharge areas are clear of debris.	➤ Approach and discharge areas remain clear of significant debris



➤ No apparent deficiencies were noted along the stop logs or stop log channels; however, the stop logs were underwater during the inspection.	➤ Stop logs were above water. Stop logs in left sluiceway bay appear in good condition with minimal leakage. Appear functional.
➤ The visible sections of the square pier and left training wall are in good condition.	➤ Conditions are similar to those previously reported.

Auxiliary Spillway

Current Observations:	
<ul style="list-style-type: none"> ➤ <i>Downstream channel appeared clear</i> ➤ <i>Flow conditions prevented inspection for scour.</i> ➤ <i>Overgrown vegetation is typical within riprap along right side of channel, limiting inspection.</i> 	
Review of Previous Observations:	Comments from Current Inspection:
➤ The approach and discharge areas are clear of debris. One log was noted below the waterline upstream of the weir. Developing aquatic vegetation was observed below the waterline at the approach.	➤ Conditions are similar to those previously reported. Vegetation is unlikely to affect flow.
➤ Significant flows over the spillway weir limited the inspection of the weir.	➤ Weir appears in good condition as viewed through flowing water.
➤ Flows over the weir appear uniform.	➤ Conditions are similar to those previously reported.
<ul style="list-style-type: none"> ➤ The visible section of the left and right training walls and the left downstream training wall appear good. <ul style="list-style-type: none"> ○ A displaced cap stone was noted on top of the left training wall. 	➤ Training walls in good condition with minimal cracking of mortar on Stone facing
➤ One section of the right bank of the downstream channel is steep along the grassed upper portion with exposed TRM. It was unclear is this was an as-built condition or the result of erosion/scour.	➤ Overgrown vegetation prevented access for inspection of this area.
➤ As noted above, bubbling flow, approximated at 30-50 GPM was observed at the toe of the slope towards the downstream end of the left training wall. It was unclear at the time of the inspection of the flow was associated with flow through the auxiliary spillway channel, seepage through the dam, or leakage through the auxiliary spillway system.	➤ Not observed during current inspection; may have been obscured by flow and/or vegetation.

2.1.4 Downstream Area

- The downstream channel appears clear of debris.
- Two isolated islands within the channel force flows along the toe of the embankment between the spillways.
- The arched bridge culvert under Commonwealth Ave (approximated at 35 feet wide) appears clear of debris.

2.1.5 Reservoir Area

The banks of the reservoir are primarily wooded, with some light residential development along the shoreline near the dam. The slopes surrounding the impoundment that were observed from the dam are



generally flat to moderate. The left abutment of the dam appears lower than the crest of the dam and will likely experience overtopping/flooding prior to the dam overtopping.

The reservoir is irregular in shape with most of the storage of the reservoir northwest of the control structure; the pond then becomes narrow in shape at the southeast corner of the pond near the dam. In general, the control structure is located in the southeastern end of the impoundment. The shape of the impoundment limits the effective fetch to which the dam embankments are exposed.

As indicated in a May 2023 Alternatives Analysis Report for the impoundment, Warner's Pond contains a significant accumulation of sediment, with sediment accumulations of up to 5 feet typical. Water depths are typically in the range of 5 feet.

2.2 Caretaker Interview

Mr. Salomon Ybarra of the Town of Concord Public Works Department was present during the inspection and available during the preparation of this report. Information provided by Mr. Ybarra has been incorporated into this report.

2.3 Operation and Maintenance Procedures

2.3.1 Operational Procedures

A formal Operations and Maintenance (O&M) Manual is not known to exist for this structure.

2.3.2 Maintenance of Dam

Routine maintenance performed at the dam includes maintenance of vegetated surfaces and removal of debris as required; however, access restrictions limit the frequency of vegetation maintenance.

In response to the conditions reported to the Owner during the inspection, maintenance activities to control vegetation were completed in the Fall of 2023; pictures of post clearing conditions were provided to Pare by the Town and are included in Appendix A.

2.4 Emergency Warning System

An EAP was prepared for the dam in April 2020; no updates to the plan were available.

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

The following section identifies a list of potential dam related safety hazards which may be present in the vicinity of a dam. As part of the field inspection, the site was reviewed for the presence of these potential hazards. This list may be incomplete, and it is the responsibility of the Dam Owner to ensure compliance with Local, State, and Federal Laws, inclusive of OSHA, ADA, MADPH, and other applicable safety regulators. It is the intent of this section to inform the Dam Owner of potential safety risks that may be present.

It should be noted that the scope of the safety assessment is limited to observations noted during the inspection. Pare recommends that the Owner consider completing a comprehensive site safety assessment



by trained risk reduction and hazard assessment specialists.

Table 2-1 Potential Related Safety Hazards At, Near, and On Dams

Hazard Category Checked	Hazard Present?		Comments
	Yes	No	
Fall Hazard	X		Retaining wall present a fall hazard
Submerged Inlet	X		Low level outlet intake
Boater Safety	X		There is no safety boom or signage present around spillways
Roll Dam	X		During high tailwater conditions and high flow events, the potential for a reverse current exists
Sudden Releases		X	Relative size of the outlets to the downstream channel are unlikely to result in releases that represent unsafe conditions downstream
Confined Space		X	None observed
Ergonomic Safety	X		Stop log operations
Others	X		Limited access to the center embankment section without crossing flowing channels

Dam Safety Regulations 302 CMR Section 10.13: Liability (1), states “The owner shall be responsible and liable for damage to property of others or injury to persons, including but not limited to, loss of life resulting from the operation, failure of or mis-operation of a dam.” Implementation of any recommendations may require local, state, or federal permits as well as securing property rights if subject areas are not owned by the dam owner. Securing such permits and/or land rights is the sole responsibility of the dam owner.

2.6 Hydraulic/Hydrologic Data

Based upon the size (**Intermediate**) and hazard potential (**Significant** (Class II)) of this structure, the spillway design flood (SDF) for the dam is the 100-year storm event.

The following table includes information presented within the 2006 Phase II report as well as the 2006 Jurisdictional Determination Chapter 253 Permit Application in which a preliminary H&H analysis was completed by GZA GeoEnvironmental in support of the design of the rehabilitation project:

Table 2-2 H&H Data Summary During the 100-yr Event

Storm Event	Rainfall Depth (in)	Peak Inflow (cfs)	Peak Outflow	Peak WSEL (feet)	FB / OT depth (feet)
100-year	6.8	3200	3200	123.2	-0.2 at dam -2.2 at left abutment

The following table includes the reported capacities / predicted flows of all the dam’s outlet works during the SDF based upon information provided within the 2006 Jurisdictional Determination Chapter 253 Permit Application.



Table 2-3 Flow Capacities of Outlet Works during SDF

Outlet Works	Depth of Flow (FT)	Capacity (CFS)	Percentage of SDF (%)
Primary Spillway	4.4	1115	35%
Auxiliary Spillway	4.4	480	15%
Sluiceway (All SL's removed)	8.2	318	10%
Low Level Outlet (Fully Open)	9.7	29	1%
Overtopping of Dam (El. 123)	0.2	49	1.5%
Overtopping of Left Abutment (El. 121)	2.2	1200	37.5%
TOTAL		3191	100%

Based on this information, the dam embankments are predicted to experience 0.2 feet of overtopping while the lower left abutment is predicted to experience 2.2 feet of overtopping during the SDF. No analysis as to whether or not these areas can accommodate the predicted overtopping flows was available for review during the development of this report. Also, it does not appear that any effects of tailwater were taken into account during this analysis.

As part of the 2020 EAP development, impoundment inflows were approximated based upon available FEMA FIS and USGS Streamstats data; flow rates presented in the EAP are in general agreement with the 2006 studies data.

2.7 Structural and Seepage Stability

Formal structural and seepage stability calculations are beyond the scope of this report. The design of the recent rehabilitation project (designed in 2006 and constructed in 2007-2008) likely included calculations/analyses showing that the embankment sections and outlet structures meet stability requirements.

2.7.1 Embankment Structural Stability

No indications of immediate instability were noted along the embankment portions of the dam during the inspection, which include, the embankment left of the primary spillway, the embankment between the spillways, and the left and right earthen abutments.

However, the following should be addressed and/or further evaluated to protect the integrity of the embankments:

- Grass coverage along the embankments should be improved including bare areas of the TRM.
- Further evaluate the possible settlement/scoured section of the riprap toe of the downstream slope between the spillways
- Crest elevations lower than the design elevation should be further evaluated and raised if required.
- Lower left abutment should be further evaluated.
- Ability of the dam to accommodate overtopping should be further evaluated.



2.7.2 Structural Stability of Non-Embankment Structures

Non-embankment structures include the primary spillway, auxiliary spillway, sluiceway, and low level outlet.

No indications of instability were noted along the non-embankment structures during the inspection.

However, the following should be addressed / further evaluated to protect the integrity of the non-embankment structures:

- Complete an inspection at a lower pool level to assess the condition of the components that were inaccessible during the current inspection. During that inspection, inspect components that were underwater during the current inspection, confirm operation of the low level outlet gate, evaluate the leakage observed at the right training wall of the primary spillway and at the end of the left training wall at the auxiliary spillway.

2.7.3 Seepage Stability

At the time of the inspection, no signs of immediate stability concern due to seepage were observed. However, the leakage observed at the right training wall of the primary spillway and previously reported at the end of the left training wall at the auxiliary spillway should be further evaluated.



SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of Warners Pond Dam is **Satisfactory**, similar to that previously reported, with the following deficiencies identified:

Table 3-1 Deficiency Summary

<i>Deficiency Number</i>	<i>Description</i>
1.	Areas of unmaintained vegetation and developing woody vegetation in many areas of the dam.
2.	Areas of exposed turf reinforcement mat (TRM)
3.	Dislodged stone on the surface of the right training wall immediately downstream of the spillway with observed leakage
4.	Possible settlement of one isolated area of the riprap toe of the downstream slope between the spillways, a possible result of the elevated islands within the downstream channel resulting in concentrated flow along this area;
5.	Previously reported bubbling flow at the toe of the slope at the downstream end of the left training wall of the auxiliary spillway with unknown source;
6.	Several potential concerns which may impact performance during the spillway design flood (SDF) including: <ol style="list-style-type: none"> a. An apparent lower left abutment prone to overtopping with unknown ability to accommodate overtopping flows. b. A predicted 0.2 feet of overtopping at the dam crest with only turf reinforcement mats as overtopping protection. c. Areas of the crest that are apparently lower than the design top of dam elevation that would be prone to higher overtopping depths than the original design;
7.	Additional maintenance deficiencies and potential dam safety concerns.

In general, the conditions observed during this inspection are similar to those described within the previous Phase I inspection completed in April 2018, which rated the condition of the structure as Satisfactory. The following table provides a summary of previous recommendations and their status at the time of the inspection:

Table 3-2 Previously Reported Deficiencies & Current Status Summary

<i>Previously Noted Deficiency/ Recommendation</i>	<i>Resolution or Current Condition</i>
Exposed TRM and vegetation development on the embankment slopes and crest	Exposed TRM not observed, vegetation has advanced / Complete regular maintenance to control vegetation
Possible settlement / scour of riprap at downstream toe; Evaluate cause of settlement	Conditions Remains; no apparent advancement / Same recommendation
Dislodged stone on the surface of the right training wall immediately downstream of the spillway with observed leakage / Evaluate and reset stone	Condition remains / Same recommendation



Bubbling flow at the toe of the slope at the downstream end of the left training wall of the auxiliary spillway with unknown source; Complete evaluation	Condition assumed to remain / Same recommendation
Complete inspection during lower pool levels	No apparent action / Same recommendation
Inspect/evaluate area of missing stone and leak at right end of the spillway	No apparent action / Same recommendation
Review current hazard potential classification	No apparent action / Same recommendation
Review/update H&H analysis	No apparent action / Same recommendation
Prepare an EAP	Complete
Developed an O&M	No apparent action / Same recommendation
Implement routine inspection and monitoring	Regulatory inspection completed along with informal inspections / Same recommendation
Complete regular maintenance	Periodic maintenance completed / Same recommendation
Review/update EAP	No apparent action / Same recommendation
Establish/restore grass coverage	No apparent action / Same recommendation
Replace missing stone at right end of primary spillway	No apparent action / Same recommendation

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 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

1. Complete an inspection during a lower pool level to inspect the components of the dam that were underwater and not accessible during the current inspection, either via temporary drawdown or by diver.

The areas to inspect include.

- a. Both spillway weirs;
- b. The below water portions of the training walls and square pier;
- c. The sluiceway controls;
- d. The low level outlet components;
- e. The below water portions of the embankments including the lower section of the upstream slope and the downstream toe;
- f. The downstream channels;

Pending the results of the inspection(s), develop and implement means of addressing any deficiencies or dam safety concerns identified (if any), as discussed in remedial modification #1.

2. During the inspection described in evaluation #1 above, further evaluate the possible settlement of one isolated area of the riprap toe of the downstream slope of the embankment between the spillways, a possible result of the elevated islands within the downstream channel resulting in concentrated flow along this area. Pending the results of the evaluation, develop and implement means of addressing the settlement/scour, as discussed in remedial modification #2.

3. During the inspection described in evaluation #1 above, further evaluate the leakage observed at the right training wall of the primary spillway. Pending the results of the evaluation, develop and implement means of addressing the leakage, as discussed in remedial modification #3.
4. During the inspection described in evaluation #1 above, further evaluate the bubbling flow observed at the toe of the downstream slope immediately left of the left training wall of the auxiliary spillway. Pending the results of the evaluation, develop and implement means of addressing the seepage/leakage, as discussed in remedial modification #4.
5. Complete a detailed hazard classification review to identify if reclassifying the dam from significant hazard to low hazard is warranted given the apparent limited anticipated impacts to the area downstream in event of dam failure at maximum pool. The review would need to include a dam break analysis to show the anticipated impacts to the downstream area and potentially a scour analysis of the Commonwealth Ave bridge culvert. If reclassified from significant hazard to low hazard, the following would change:
 - The SDF would be reduced from the 100-year storm to the 50-year storm event, which may alleviate some of the concerns noted in evaluation #6 below.
 - The Phase I Inspection frequency would be reduced from once every 5 years to once every 10 years.
 - An EAP would not be required, although it would still be recommended.
6. Further evaluate the noted concerns associated with the SDF:
 - a. Update the H&H analysis to support the assessment of the noted concerns. The effects of tailwater on the hydraulic capacity of the dam's outlet structures (spillways, sluiceway, low level outlet, overtopping of the dam, overtopping of the left abutment) should be considered.
 - b. Assess the apparent lower left abutment's ability to accommodate the predicted overtopping flows.
 - c. Assess the ability of the TRM along the crest and downstream slope of the dam embankments to accommodate the predicted overtopping flows.
 - d. Assess the need to regrade lower areas of the crest to the design top of dam elevation, dependent upon the updated H&H analysis as well as the ability of the TRM to accommodate the predicted overtopping flows.
7. Complete a site-specific safety assessment to further identify potential safety hazards at the dam.
8. Develop an Operations and Maintenance (O&M) Manual for the dam. This manual should include procedures for maintaining the level of the impoundment, including adjusting the level of the impoundment seasonally to provide additional freeboard during the wetter months. Additionally, the manual should include periodic inspection schedules and operational and maintenance procedures required to ensure satisfactory operation and to minimize deterioration of the facility.

3.3 Yearly & Recurrent Maintenance Recommendations

The following recommendations should be performed on a regular schedule and allotted for within yearly operational budgets for the structure:

1. Perform regular monitoring and inspection of the dam and appurtenant structures, inclusive of checking for the following:
 - a. Accumulated debris within the approach and discharge of the spillway, and the approach and discharge of the outlet pipe.



- b. Areas of suspected soil movement (e.g.: erosion, holes, depression, bulge, slides, slough)
 - c. Areas of seepage within the embankment.
 - d. Complete formal Phase I Inspections of the dam; as the dam is currently considered a significant hazard potential structure, formal inspection is required every 5 years.
2. Complete regular maintenance activities at the site; inclusive of the following:
 - a. Routine removal of accumulated debris (fallen branches, logs, leaves, etc.) from the approach of the spillway and at the outlet pipe.
 - b. Control vegetation at the dam and downstream area including hand clearing of woody vegetation within the upstream slope and downstream area.
 - c. Address issue identified during the regular monitoring and inspection activities.
 3. Review and update EAP as needed.

3.4 Minor Repair Recommendations

The minor repairs presented below should be implemented to help maintain the integrity of the structure.

1. *Grass Establishment:* Remove areas of unwanted weed and brush vegetation from the embankment and establish a healthy stand of grass, including all areas of bare TRM.
2. *Replace Missing Stone from Right Training Wall:* Replace the missing stone of the stone façade of the right training wall at the primary spillway.

3.5 Remedial Modification Recommendations

Remedial modifications may be necessary if additional evaluations and/or observations at the dam identify dam safety deficiencies beyond those apparent at the time of the inspection. While the applicability of the following recommendations is currently unknown, the following provides a list of potential remedial modifications that may be necessary:

1. *Additional Deficiencies / Dam Safety Concerns:* Pending the results of the additional inspection(s) identified in evaluation #1, develop and implement means of addressing any deficiencies or dam safety concerns identified (if any).
2. *Possible Settled/Scoured Section of Downstream Toe:* Pending the results of the additional evaluation #2, develop and implement means of addressing the settlement/scouring of the section of the downstream toe of the embankment between the spillways. A potential alternative to address the settlement/scour includes removing the elevated islands that are resulting in concentrated flows at this location and providing additional riprap in this location.
3. *Primary Spillway Training Wall Leakage:* Pending the results of the evaluation #3, develop and implement means of addressing the leakage observed in the right training wall of the primary spillway.
4. *Leakage/Seepage Left of Auxiliary Spillway Training Wall:* Pending the results of the evaluation #4, develop and implement means of addressing the bubbling flow observed along the toe of the slope left of the left training wall of the auxiliary spillway.



5. *SDF Concerns:* Pending the results of the evaluation #6, develop and implement means of addressing the noted concerns including the lower left abutment, TRM ability to accommodate overtopping flow, and areas of the crest lower than the design top of dam.

Following the implementation of the monitoring and inspection program identified in Section 3.3 of this report, and the completion of the additional analyses, inspections, and evaluations identified in Section 3.2 of this report, the need to implement additional remedial modifications may become apparent in the future.

3.6 Alternatives

The following alternatives are presented based upon a conceptual review of the concerns. Additional studies and or considerations may indicate that some or all of the options presented below are not suitable for the conditions specific to this dam and dam site.

All Recommendations: Alternative to implementing any of the repairs noted above, breaching of the dam is a viable alternative for addressing safety and stability concerns at the dam. While this alternative will address the safety concerns, it will result in the loss of the recreational, flood attenuation and environmental resource created by the dam. Further, while this will result in elimination of yearly operating and maintenance expenses, permitting activities and construction costs associated with dam removal may exceed those of rehabilitation and operations and maintenance.

3.7 Opinion of Probable Costs

The following conceptual opinions of probable costs have been developed for the recommendations and remedial measures noted above. The costs shown herein are based on a limited investigation and are provided for general information only. This should not be considered an engineer's estimate, as actual costs may be somewhat less or considerably more than indicated.

Studies and Analyses

1. Additional Inspection	\$	3,000	-	\$	8,000
2. Settled/Scoured Toe Evaluation	\$	2,000	-	\$	3,500
3. Primary Spillway Leakage Evaluation	\$	1,000	-	\$	1,500
4. Auxiliary Spillway Leakage/Seepage Evaluation	\$	2,000	-	\$	4,000
5. Hazard Classification Review	\$	8,000	-	\$	10,000
6. SDF Evaluations	\$	6,000	-	\$	8,000
7. Site Safety Assessment	\$	1,000	-	\$	2,000
8. Develop O&M Manual	\$	3,000	-	\$	5,000
Subtotal	\$	26,000	-	\$	42,000

Yearly Recommendations

1. Inspection and Monitoring	\$	2,000	-	\$	4,000
2. Regular Maintenance	\$	2,000	-	\$	4,000
3. Review and Update EAP	\$	1,000	-	\$	3,000
Subtotal	\$	5,000	-	\$	11,000



Minor Repairs Recommendations

1. Grass Establishment	\$	10,000	-	\$	20,000
2. Replace Missing Stone					Complete as part of Routine Maintenance
	Subtotal	\$ 10,000	-	\$ 20,000	
	Engineering & Design	\$	NA	-	\$ NA
	Permitting	\$	NA	-	\$ NA
	30% Contingency	\$	NA	-	\$ NA
	Subtotal	\$ 10,000	-	\$ 20,000	

Remedial Modification Recommendations

1. Additional Deficiencies / Dam Safety Concerns	\$	0	-	\$	A.I.R.
2. Settled/Scoured Section of Toe	\$	0	-	\$	20,000
3. Primary Spillway Leakage	\$	0	-	\$	5,000
4. Auxiliary Spillway Leakage	\$	0	-	\$	A.I.R.
5. SDF Concerns	\$	0	-	\$	A.I.R.
	Subtotal	\$ 0	-	\$ 25,000	
	Engineering & Design	\$	0	-	\$ 5,000
	Permitting	\$	0	-	\$ 5,000
	30% Contingency	\$	0	-	\$ 10,000
	Subtotal	\$ 0	-	\$ 45,000	

RECOMMENDATIONS TOTAL \$ 41,000 - \$ 118,000

When comparing costs, the total cost including design, engineering, permitting, construction and long-term maintenance should be considered.

While most of these activities can be undertaken as maintenance activities under 302 CMR 10 Dam Safety and will only require that the Office of Dam Safety be notified of the activities, the applicability of other environmental permits (ie., NOI, PGP, Water Quality Certificate, etc.) needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of MADEP, the local conservation commission or other regulatory agency.

3.8 Site Safety Considerations

Based upon the site safety screening completed as part of the inspection, Pare recommends that the owner complete the recommended site safety assessments (See Section 3.2). The following presents a list of potential site safety improvements that should be considered. It should be noted that a detailed site safety assessment may find that some of these measures are not required and may identify additional hazards that are not identified herein.

- Provide signage and/or barriers at the approach to the spillways to warn boaters of the presence of the spillway.
- Provide warning buoy and/or signage warning the public of the presence of a submerged inlet
- Install railings or fencing along the top retaining walls or other structures with more than a 30-inch drop.

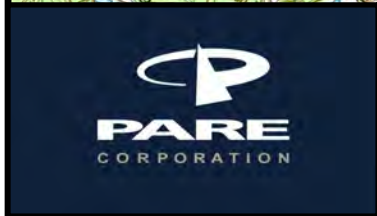
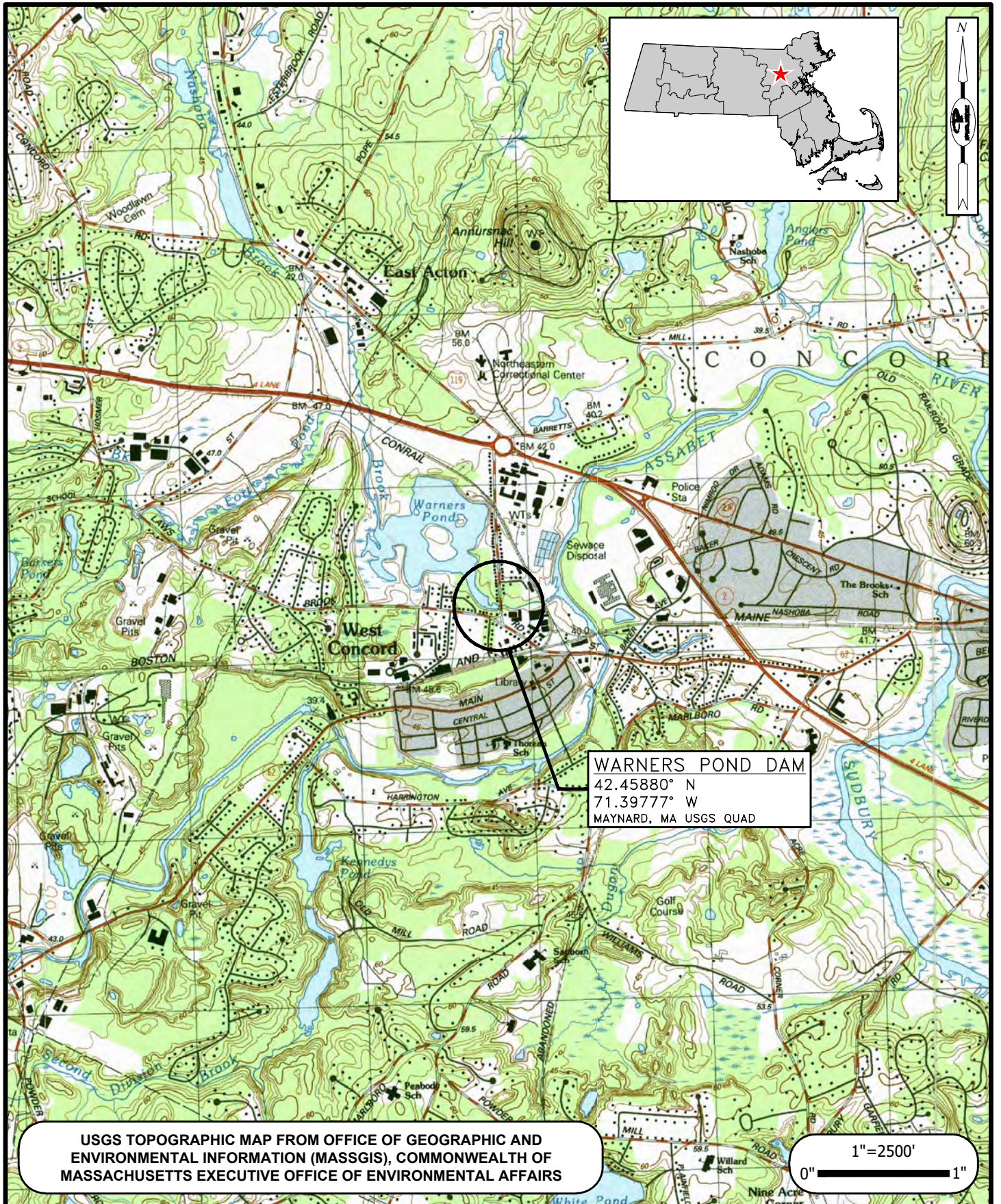


- Provide sluiceway stoplog removal operations procedures to reduce physical requirements for operation
- Provide a catwalk or other means of accessing the embankment between the spillways.



Warners Pond Dam
Concord, MA

FIGURES

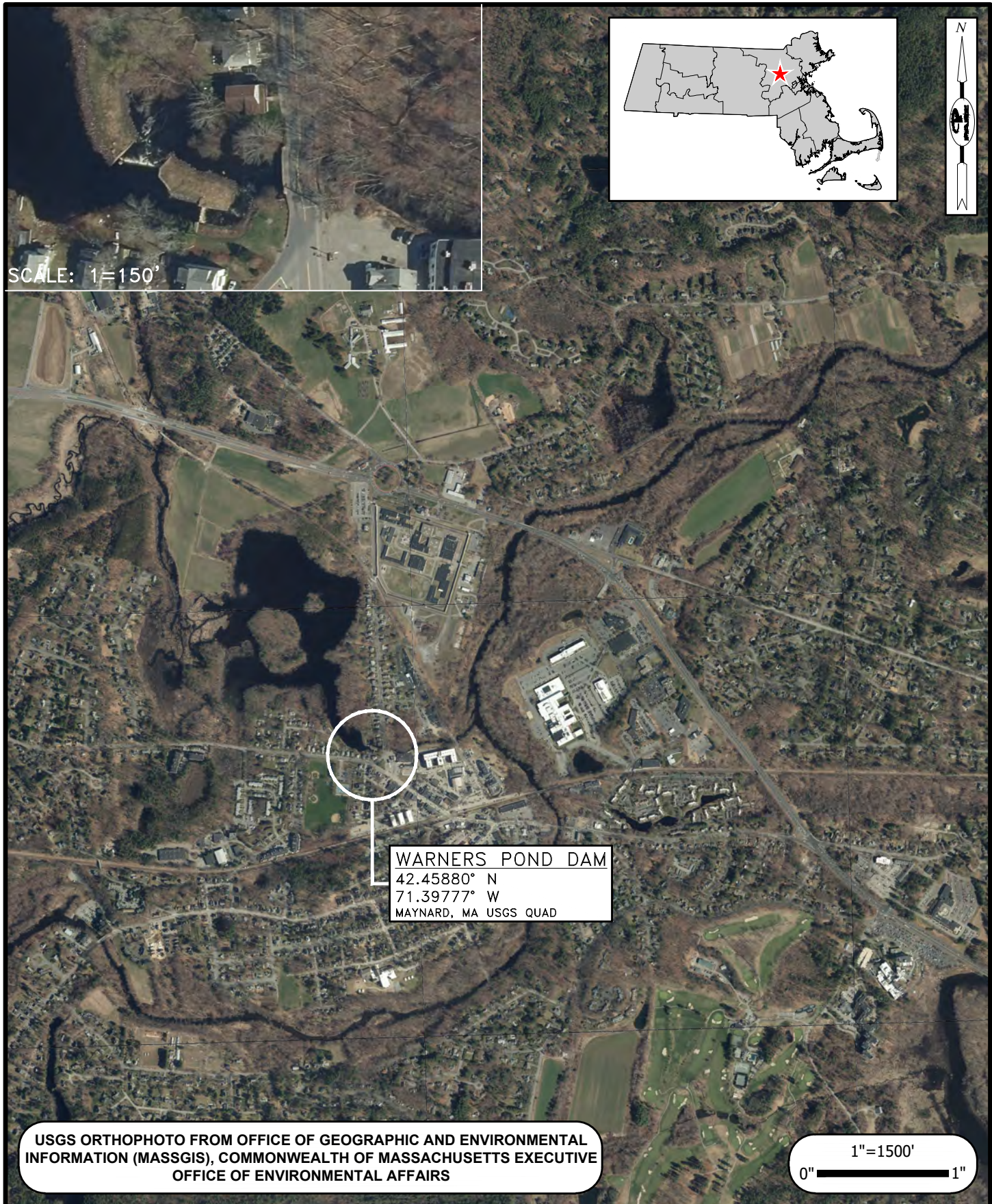


WARNERS POND DAM
 MA00440 / 4-9-67-4
 CONCORD, MASSACHUSETTS

OWNER: TOWN OF CONCORD

LOCUS PLAN

OCTOBER 2023 FIGURE 1

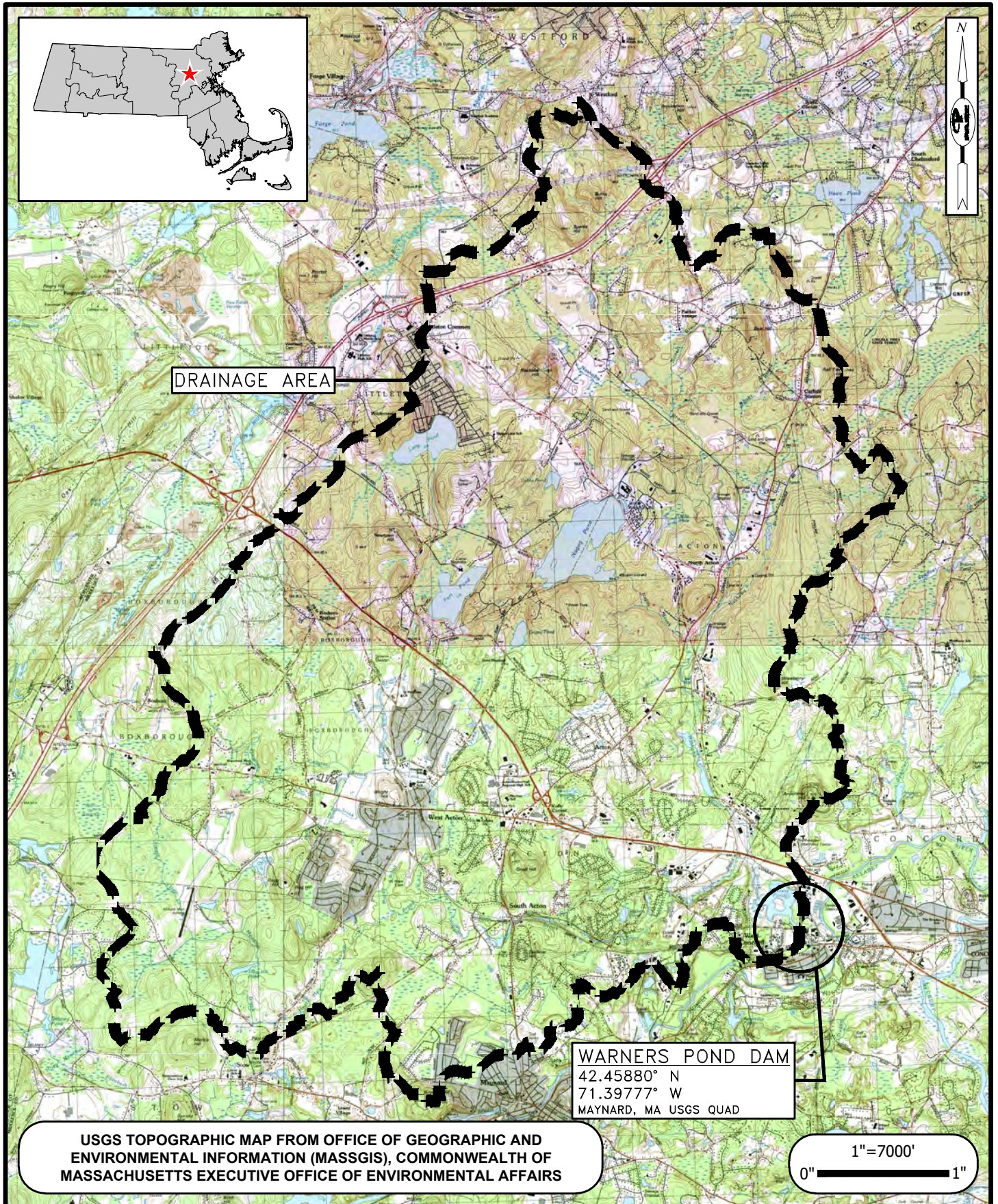


WARNERS POND DAM
 MA00440 / 4-9-67-4
 CONCORD, MASSACHUSETTS

OWNER: TOWN OF CONCORD

AERIAL PLAN

OCTOBER 2023 FIGURE 2



DRAINAGE AREA

WARNERS POND DAM
 42.45880° N
 71.39777° W
 MAYNARD, MA USGS QUAD

USGS TOPOGRAPHIC MAP FROM OFFICE OF GEOGRAPHIC AND ENVIRONMENTAL INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

1" = 7000'
 0" ————— 1"



WARNERS POND DAM
 MA00440 / 4-9-67-4
 CONCORD, MASSACHUSETTS

OWNER: TOWN OF CONCORD

DRAINAGE AREA PLAN

OCTOBER 2023 FIGURE 3

Warners Pond Dam
Concord, MA

APPENDIX A
PHOTOGRAPHS



Photo No. 1.: Overview of the impoundment from the auxiliary spillway looking upstream and left



Photo No. 2.: Upstream slope near 1+30 looking left.



Photo No. 3.: Upstream slope near 1+30 looking right



Photo No. 4.: Crest and downstream slope near 0+50 looking left. Note the apparent lower left abutment



Photo No. 5.: Crest and downstream slope from the left abutment looking right



Photo No. 6.: Downstream slope from the embankment between the spillways looking left.



Photo No. 7.: Overview of the embankment between the spillways



Photo No. 8.: Upstream slope of the embankment between the spillways



Photo No. 9.: Downstream toe of embankment between the spillway



Photo No. 10.: Approach to the primary spillway



Photo No. 11.: Primary spillway crest from the left training wall.



Photo No. 12.: Downstream side of the primary spillway.



Photo No. 13.: Primary spillway near the right training wall.



Photo No. 14.: Left training wall of primary spillway / sluiceway



Photo No. 15.: Right training wall of primary spillway. Note the location of the missing stone and the leakage through one of the masonry joints



Photo No. 16.: Location of missing stone in right training wall



Photo No. 17.: Upstream side of the auxiliary spillway



Photo No. 18.: Auxiliary spillway weir and right training wall



Photo No. 19.: Auxiliary spillway left training wall



Photo No. 20.: Overview of the downstream side of the auxiliary spillway.



Photo No. 21.: Downstream channel of the auxiliary spillway.



Photo No. 22.: Downstream channel from the embankment between spillways looking towards the Commonwealth Ave. culvert



Photo No. 23.: Overview of the upstream slope between spillways and downstream slope left of the primary spillway post clearing (Provided by Town 2023-11-29).




Photo No. 24.: Overview of center embankment section post clearing (Provided by Town 2023-11-29).

Warners Pond Dam
Concord, MA

APPENDIX B
INSPECTION CHECKLIST

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: <u>Warners Pond Dam</u>	STATE ID #: <u>4-9-67-4</u>
REGISTERED: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	NID ID #: <u>MA00440</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>Concord</u>	COUNTY: <u>Middlesex</u>
DAM LOCATION: <u>Upstream of Commonwealth Ave</u> (street address if known)	ALTERNATE DAM NAME: <u>Warner's Pond Dam</u>
USGS QUAD.: <u>Maynard</u>	LAT.: <u>42.45880°N</u> LONG.: <u>71.39777°W</u>
DRAINAGE BASIN: <u>Concord</u>	RIVER: <u>Nashoba Brook (Tributary to Assabet River)</u>
IMPOUNDMENT NAME(S): <u>Warners Pond</u>	
<u>GENERAL DAM INFORMATION</u>	
TYPE OF DAM: <u>Earthen Embankment</u>	OVERALL LENGTH (FT): <u>320 ±</u>
PURPOSE OF DAM: <u>Original: Unknown; Current: Recreational</u>	NORMAL POOL STORAGE (ACRE-FT): <u>93</u>
YEAR BUILT: <u>Unknown; 2007-2008 Rehabilitation</u>	MAXIMUM POOL STORAGE (ACRE-FT): <u>440</u>
STRUCTURAL HEIGHT (FT): <u>9</u>	EL. NORMAL POOL (FT): <u>118.8</u>
HYDRAULIC HEIGHT (FT): <u>5</u>	EL. MAXIMUM POOL (FT): <u>123 ± (Design TOD)</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>Warners Pond Dam</u>		STATE ID #: <u>4-9-67-4</u>	
INSPECTION DATE: <u>June 9, 2023</u>		NID ID #: <u>MA00440</u>	
<u>INSPECTION SUMMARY</u>			
DATE OF INSPECTION: <u>June 9, 2023</u>		DATE OF PREVIOUS INSPECTION: <u>April 11, 2018</u>	
TEMPERATURE/WEATHER: <u>60°±, Cloudy</u>		ARMY CORPS PHASE I: <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO If YES, date _____	
CONSULTANT: <u>Pare Corporation</u>		PREVIOUS DCR PHASE I: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO If YES, date <u>April 11, 2018</u>	
BENCHMARK/DATUM: <u>Top of left training wall of sluiceway at El. 124.17 (NAVD88)</u>			
OVERALL PHYSICAL CONDITION OF DAM: <u>SATISFACTORY</u>		DATE OF LAST REHABILITATION: <u>2007-2008 Rehabilitation</u>	
SPILLWAY CAPACITY: <u>90-100% of the SDF</u>			
EL. POOL DURING INSP.: <u>119.3±</u>		EL. TAILWATER DURING INSP.: <u>115.1±</u>	
<u>PERSONS PRESENT AT INSPECTION</u>			
<u>NAME</u>	<u>TITLE/POSITION</u>	<u>REPRESENTING</u>	
<u>Allen R. Orsi, P.E.</u>	<u>Sr. Vice President</u>	<u>Pare Corporation</u>	
<u>Tyler Donahue</u>	<u>Engineer I</u>	<u>Pare Corporation</u>	
<u>Salomon Ybarra</u>	<u>Environmental Engineer - St</u>	<u>Town of Concord DPW</u>	
<u>EVALUATION INFORMATION</u>			
Click on box to select E-code		Click on box to select E-code	
E1) TYPE OF DESIGN	<input type="text" value="4"/>	E8) LOW-LEVEL OUTLET CONDITION	<input type="text" value="4"/>
E2) LEVEL OF MAINTENANCE	<input type="text" value="3"/>	E9) SPILLWAY DESIGN FLOOD CAPACITY	<input type="text" value="3"/>
E3) EMERGENCY ACTION PLAN	<input type="text" value="4"/>	E10) OVERALL PHYSICAL CONDITION	<input type="text" value="4"/>
E4) EMBANKMENT SEEPAGE	<input type="text" value="5"/>	E11) ESTIMATED REPAIR COST	<input type="text" value="\$41-\$118"/>
E5) EMBANKMENT CONDITION	<input type="text" value="4"/>	ROADWAY OVER CREST	<input type="text" value="NO"/>
E6) CONCRETE CONDITION	<input type="text" value="4"/>	BRIDGE NEAR DAM	<input type="text" value="NO"/>
E7) LOW-LEVEL OUTLET CAPACITY	<input type="text" value="4"/>		
NAME OF INSPECTING ENGINEER: <u>Allen R. Orsi, P.E.</u>		SIGNATURE: <u></u>	

NAME OF DAM: <u>Warners Pond Dam</u>		STATE ID #: <u>4-9-67-4</u>	
INSPECTION DATE: <u>June 9, 2023</u>		NID ID #: <u>MA00440</u>	
OWNER: ORGANIZATION	<u>Town of Concord</u>	CARETAKER: ORGANIZATION	<u>Town of Concord</u>
NAME/TITLE	<u>Public Works Department</u>	NAME/TITLE	<u>Public Works Department</u>
STREET	<u>133 Keyes Road</u>	STREET	<u>133 Keyes Road</u>
TOWN, STATE, ZIP	<u>Concord, MA 01742</u>	TOWN, STATE, ZIP	<u>Concord, MA 01742</u>
PHONE	<u>978-318-3206</u>	PHONE	<u>978-318-3206</u>
EMERGENCY PH. #	<u>978-318-3400</u>	ALT PHONE	<u>978-318-3210</u>
FAX	<u>978-318-3206</u>	FAX	<u>978-318-3206</u>
EMAIL		EMAIL	<u>sybarra@concordma.gov</u>
OWNER TYPE	<u>Municipality or Political subdivision</u>		
PRIMARY SPILLWAY TYPE	<u>Concrete & Stone Masonry Weir</u>		
SPILLWAY LENGTH (FT)	<u>40.2</u>	SPILLWAY CAPACITY (CFS)	<u>1,115</u>
AUXILIARY SPILLWAY TYPE	<u>Concrete Weir 18 feet long</u>		
AUX. SPILLWAY CAPACITY (CFS)	<u>480; 49 cfs O/T Dam, 1,200 cfs O/T Left Abut.</u>		
NUMBER OF OUTLETS	<u>2</u>	OUTLET(S) CAPACITY (CFS)	<u>Sluiceway: 318 ; LLO: 29</u>
TYPE OF OUTLETS	<u>Sluiceway Channel ; 24" LLO conduit</u>		
TOTAL DISCHARGE CAPACITY (CFS)	<u>1,942 + 1,249 O/T = 3,191 total (SDF)</u>		
DRAINAGE AREA (SQ MI)	<u>46.6</u>	SPILLWAY DESIGN FLOOD (PERIOD/CFS)	<u>100-yr / 3,200cfs inflow (Prev.H&H)</u>
HAS DAM BEEN BREACHED OR OVERTOPPED	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	IF YES, PROVIDE DATE(S)	<u>2006 (Prior to rehabilitation)</u>
FISH LADDER (LIST TYPE IF PRESENT)	<u>None</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 type="checkbox"/> YES <input checked="" type="checkbox"/> NO	IF YES, ROAD/BRIDGE NAME:	
		MHD BRIDGE NO. (IF APPLICABLE)	

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Vegetated earthen		X	
	2. SURFACE CRACKING	None observed		X	
	3. SINKHOLES, ANIMAL BURROWS	None observed		X	
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	Generally regular		X	
	5. HORIZONTAL ALIGNMENT	Appears OK; nonlinear by design		X	
	6. RUTS AND/OR PUDDLES	None observed		X	
	7. GRASS COVER CONDITION	Overgrown left abutment, unmaintained vegetation limiting inspection center embankment and right half of embankment left of spillway		X	X
	8. WOODY VEGETATION (TREES/BRUSH)	Woody vegetation developing		X	X
	9. ABUTMENT CONTACT	Left abutment low, overgrown		X	X

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	None observed; toe submerged along most of dam		X	
	2. SEEPAGE	None observed; inspection limited by vegetation		X	
	3. SLIDE, SLOUGH, SCARP	None observed		X	
	4. EMB.-ABUTMENT CONTACT	Abutment contract overgrown, limiting inspection		X	X
	5. SINKHOLE/ANIMAL BURROWS	None observed		X	
	6. EROSION	None observed		X	
	7. UNUSUAL MOVEMENT	None observed		X	
	8. GRASS COVER CONDITION	Long grass and maturing sumac trees limit inspection		X	X
	9. WOODY VEGETATION (TREES/BRUSH)	Sumac trees approaching 5" diameter		X	X

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

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.	Stone riprap generally in good condition		X	
	3. SINKHOLE/ANIMAL BURROWS	None observed		X	
	4. EMB.-ABUTMENT CONTACT	Left abutment overgrown		X	X
	5. EROSION	None observed		X	
	6. UNUSUAL MOVEMENT	None observed		X	
	7. GRASS COVER CONDITION	N/A; stone slope protection		X	
	8. WOODY VEGETATION (TREES/BRUSH)	Woody vegetation developing at left abutment		X	X

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	None present	X		
	2. OBSERVATION WELLS	None present.	X		
	3. STAFF GAGE AND RECORDER	None present	X		
	4. WEIRS	None present	X		
	5. INCLINOMETERS	None present	X		
	6. SURVEY MONUMENTS	Survey disk in top of cutoff wall left of left training wall of sluiceway (Town of Concord) (Unknown elevation); Construction benchmark (spike in UP#14 along Commonwealth Ave, El. 126.65)	X		
	7. DRAINS	None observed	X		
	8. FREQUENCY OF READINGS	Not applicable	X		
	9. LOCATION OF READINGS	Not applicable	X		

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None observed		X	
	2. FOUNDATION SEEPAGE	None observed		X	
	3. SLIDE, SLOUGH, SCARP	None observed		X	
	4. WEIRS	None observed		X	
	5. DRAINAGE SYSTEM	None observed		X	
	6. INSTRUMENTATION	None observed		X	
	7. VEGETATION WITHIN 15 FT	Abutments overgrown		X	
	8. ACCESSIBILITY	No access to center embankment, good access thru private property to left end		X	
	9. DOWNSTREAM HAZARD DESCRIPTION	Commonwealth Ave (100 to 200 feet downstream of the dam) and an apparent former railroad embankment (1,000 feet downstream of the dam), both of which are several feet higher in elevation than the dam, before the downstream channel discharges into the Assabet River. Commercial development on the banks of the river between Commonwealth Ave and the former railroad embankment, all of which appear to be at or above the top of dam elevation. There are several residential properties along Commonwealth Ave left of the dam, all of which appear to be at or above top of dam			X

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	5 ft±
	2. RESERVOIR SHORELINE	Woody, generally undeveloped
	3. RESERVOIR SLOPES	Flat to mild
	4. ACCESS ROADS	Access drive off of Commonwealth Ave to Right abutment; Access through residential property to left abutment
	5. SECURITY DEVICES	None apparent
	6. WATER PUBLIC HAZARDS & PROTECTION	No warning signs for spillways, no indication of submerged inlet
	7. LAND-SIDE PUBLIC HAZARDS & PROTECTION	No railing present
	7. VANDALISM OR TRESPASS	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO WHAT:
	8. AVAILABILITY OF PLANS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: 2007-08 Rehabilitation
	9. AVAILABILITY OF DESIGN CALCS	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: 2007-08 Rehabilitation
	10. AVAILABILITY OF EAP/LAST UPDATE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: Apr-20
	11. AVAILABILITY OF O&M MANUAL	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO DATE:
	12. CARETAKER/OWNER AVAILABLE	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO DATE: During inspection
13. CONFINED SPACE ENTRY REQUIRED	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO PURPOSE:	

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Broad crested stone masonry and concrete		X	
	WEIR TYPE	Broad crested		X	
	SPILLWAY CONDITION	Fair; flow limited inspection; potential discontinuity in flow noted		X	X
	TRAINING WALLS	General fair to good condition; missing stone and leak at right end		X	X
	SPILLWAY CONTROLS AND CONDITION	None		X	
	UNUSUAL MOVEMENT	None noted		X	
	APPROACH AREA	Clear		X	
	DISCHARGE AREA	Clear		X	
	DEBRIS	None observed		X	

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Concrete weir		X	
	WEIR TYPE	Broad crested, uncontrolled		X	
	SPILLWAY CONDITION	Appears ok		X	
	TRAINING WALLS	Appear in good condition		X	
	SPILLWAY CONTROLS AND CONDITION	None		X	
	UNUSUAL MOVEMENT	None observed; bubbling flow previously reported in downstream channel at end of left wall		X	
	APPROACH AREA	Clear		X	
	DISCHARGE AREA	Clear		X	
	DEBRIS	None noted		X	

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Stop Log Bay Gated LLO			
	INTAKE STRUCTURE	None		X	
	TRASHRACK	None		X	
	PRIMARY CLOSURE	Aluminum stoplogs - OK		X	
	SECONDARY CLOSURE	None		X	
	CONDUIT	None		X	
	OUTLET STRUCTURE/HEADWALL	None observed		X	
	EROSION ALONG TOE OF DAM	None observed		X	
	SEEPAGE/LEAKAGE	Minor leakage noted		X	
	DEBRIS/BLOCKAGE	None observed		X	
	UNUSUAL MOVEMENT	None observed		X	
	DOWNSTREAM AREA	Clear (Spillway channel)		X	
MISCELLANEOUS	NA	NA			

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

CONCRETE/MASONRY DAMS (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO	ACTION	MONITOR	REPAIR
CREST	TYPE	NOT APPLICABLE TO THIS DAM				
	SURFACE CONDITIONS					
	CONDITIONS OF JOINTS					
	UNUSUAL MOVEMENT					
	HORIZONTAL ALIGNMENT					
	VERTICAL ALIGNMENT					

ADDITIONAL COMMENTS: _____

NAME OF DAM: Warners Pond Dam

STATE ID #: 4-9-67-4

INSPECTION DATE: June 9, 2023

NID ID #: MA00440

CONCRETE/MASONRY DAMS (UPSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR	
U/S FACE	TYPE	NOT				
	SURFACE CONDITIONS					
	CONDITIONS OF JOINTS					
	UNUSUAL MOVEMENT					
	ABUTMENT CONTACTS					
		APPLICABLE TO				
			THIS DAM			

ADDITIONAL COMMENTS:

Warners Pond Dam
Concord, MA

APPENDIX C
PREVIOUS REPORTS AND REFERENCES

PREVIOUS REPORTS AND REFERENCES

During the development of the report PARE also reviewed available information included within the following databases:

1. 2023: “Warner’s Pond Alternatives Analysis Report”, EA Engineering, Science, and Technology, Inc., May 2023
2. 2020: “Warners Pond Dam Emergency Action Plan”, prepared by Pare Corporation, April 2020.
3. 2019: “Dredging Feasibility Assessment and Conceptual Engineering Design for Warner’s Pond, ESS Group, November 2018
4. 2018: “Phase I Inspection/Evaluation Report – Warners Pond Dam”, prepared by Pare Corporation, date of inspection April 11, 2018.
5. 2012: “Phase I Inspection/Evaluation Report – Warners Pond Dam”, prepared by Pare Corporation, date of inspection December 13, 2012.
6. 2011: “Dam Safety Certificate of Completion Application – Warner Pond Dam Rehabilitation”, prepared by CMA Engineers, dated June 10, 2011.
7. 2011: Record Drawings of “Warner’s Pond Dam Rehabilitation – Spillway and Embankment Improvements”, Prepared by CMA Engineers, Inc, dated June 2011.
8. 2006: Contract Documents of “Warners Pond Dam Rehabilitation - Spillway and Embankment Improvements”, Prepared by GZA GeoEnvironmental, dated June 2006.
9. 2006: Jurisdictional Determination Chapter 253 Permit Application for “Warners Pond Dam Rehabilitation - Spillway and Embankment Improvements”, prepared by GZA GeoEnvironmental, dated December 28, 2006.
10. 2006: “Phase II Dam Inspection Report”, GZA GeoEnvironmental, April 13, 2006.
11. 1999: “DEM Inspection/Evaluation Report”, Haley & Aldrich, Inc., April 30, 1999.
12. “MA00440 – Warners Pond Dam”, National Inventory of Dams Database, U.S. Army Corp of Engineers, <https://nid.usace.army.mil/>.

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

1. “Design of Small Dams”, United States Department of the Interior Bureau of Reclamation, 1987.
2. “ER 110-2-106 - Recommended Guidelines for Safety Inspection of Dams”, Department of the Army, September 26, 1979.
3. “Guidelines for Reporting the Performance of Dams” National Performance of Dams Program, August 1994.
4. 302 CMR: Department of Conservation and Recreation Section 10.00 Dam Safety.



Warners Pond Dam
Concord, MA

APPENDIX D
COMMON DAM SAFETY DEFINITIONS

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR 10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exists, 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; LLO 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 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 break.

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 – 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.

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.

Condition Rating

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

Poor - Significant structural, operational 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.



Warners Pond Dam
Concord, MA

APPENDIX E
VISUAL DAM INSPECTION LIMITATIONS

VISUAL DAM INSPECTION LIMITATIONS

Visual Inspection

1. 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.
2. 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.
3. 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.
4. It is critical to note that the condition of the dam is evolutionary in nature and depends on numerous and constantly changing internal and external conditions. 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.

Use of Report

1. The applicability of other environmental permits (ie., NOI, PGP, Water Quality Certificate, etc.) needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of MADEP, the local conservation commission or other regulatory agency.
2. This report has been prepared for the exclusive use of the Town of Concord for specific application to the Warners Pond Dam in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.
3. This report has been prepared for this project by Pare. This report is for preliminary evaluation purposes only and is not necessarily sufficient to support design or repairs or recommendations or to prepare an accurate bid.

