ALTERNATIVES REPORT

LAKE WINTHROP DAM

MA02949 / 4-9-136-3

HOLLISTON, MASSACHUSETTS

PREPARED FOR:

TOWN OF HOLLISTON
703 WASHINGTON STREET
HOLLISTON, MA 01746

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PARE PROJECT NO. 21214.00/203

November 2022

PARE CORPORATION

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prepared for: Town of Holliston
703 Washington Street
Holliston, MA 01746

prepared by: Pare Corporation
10 Lincoln Road Suite 210
Foxboro, MA 02035

Authority

The Town of Holliston, MA has retained Pare Corporation (Pare) to evaluate conditions of the Lake Winthrop Dam in Holliston, Massachusetts and to develop a report of conceptual design alternatives to address known deficiencies at the dam. This inspection, report, and evaluations were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws.

PREFACE

The assessment of the condition of the dam is based upon available data, visual inspections, subsurface investigations, hydrologic and hydraulic studies, topographic surveys and stability analyses as well as supplemental information developed by others during previous evaluations of the dam.

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 and other information collected as part of the evaluation.

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.
Massachusetts License No.: 46904
Senior Vice President
Pare Corporation

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1.0 PROJECT INFORMATION

1.1 General

1.1.1 Authority

The Town of Holliston has retained Pare Corporation (Pare) to develop a report of alternative approaches to address known and/or approximated deficiencies at the dam. This inspection, report, and evaluations 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 study is to utilize available information pertaining to the dam to develop an initial understanding of the level of effort which may be required to advance a variety of alternatives for the dam site including dam removal, dam repair, dam rehabilitation, and no action

This investigation consisted of six parts: 1) Review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) Complete a field review of existing conditions of the dam; 3) Develop conceptual designs to either remove, repair, or rehabilitate the dam; 4) Develop opinions of probable cost for each of the identified alternatives; and 6) Prepare and submit a final report presenting the findings of the completed work.

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 in this report. This material is intended to provide general information. The accuracy of this referenced information was not verified as part of this study.

Elevations that are included in this evaluation roughly correlate to the North American Vertical Datum of 1988 (NAVD88) based upon available data from MassGIS with approximate conversions of previously reported site elevations to NAVD88. Elevation reference should only be considered accurate to extent provided by the methods utilized.

1.2.2 Location

Lake Winthrop Dam is located in the Town of Holliston, Middlesex County, Massachusetts near coordinates 42.19299ºN/71.42678ºW. The dam is accessible from State Route 16 as follows: Follow State

Route 16 approximately 1.4 miles east from its southern intersection with State Route 126; turn right onto Exchange Street and go approximately 0.3 miles. Turn right onto Winthrop Street and go approximately 0.4 miles. Turn right onto Arch Street and go approximately 0.1 miles. Turn left onto Pleasure Point Road and go approximately 350 feet to the dam on the left side of the road. The dam is located at the northwestern end of the impoundment, as indicated on Figure 1: Locus Plan.

1.2.3 Owner/Operator

The dam is currently owned by the Town of Holliston. The Town of Holliston DPW is responsible for operation and maintenance of the dam.

Table 1-1: Owner/Operator Information

	Dam Owner	Dam Caretaker
Name	Town of Holliston	Town of Holliston DPW
Mailing Address	703 Washington Street	703 Washington Street
Town	Holliston, MA 01746	Holliston, MA 01746
Daytime Phone	508.429.0608	508.429.0615
Emergency Phone	508.429.4631 (Fire Dept)	508.429.4631 (Fire Dept)

1.2.4 Purpose of Dam

The dam currently impounds water for recreational use.

1.2.5 Description of the Dam and Appurtenances

As shown on Figure 3: Site Sketch, Lake Winthrop Dam is an earthen dam about 475 feet long oriented primarily east/west. The reported date of construction of the dam is 1966[1], though the lake existed as a natural body before this time.

The embankment consists of an approximately 5- to 10-foot-wide berm that widens to about 25 feet at the spillway. The upstream and downstream slopes are 2H:1V. The left portion of the crest carries a grass and dirt path with limited vehicle access from Pleasure Point Road to the spillway. The slopes are unprotected. The left abutment carries Pleasure Point Road, a 20-foot-wide paved roadway, to a recreation area upstream. The right abutment is a gravel driveway at the southern end of Winthrop Street.

Right of the spillway, the upstream area within 170 feet of the right abutment consists of maintained grass and a few small structures upstream of the dam embankment. This area lies at least partially below the dam crest and is subject to flooding during maximum pool elevations.

The spillway is a concrete overflow weir of varying width and is controlled by an upward operating aluminum slide gate. The clear width is 4’-0” at the gate controls and 3’-6” at its narrowest point about 2 feet further downstream. Concrete training walls extend both upstream and downstream from the gate. A 2’-6” wide concrete slab spans the opening at its narrowest point.

The impoundment is Lake Winthrop. The shoreline is primarily undeveloped but has a few residential properties and recreation areas. The slopes surrounding the lake are mild and consist primarily of woods and residential developments. The lake is fed by unnamed brooks and swamps. It lies at the head

[1] Pizan & Pare, *Inspection Report – Dams and Reservoirs*, Lake Winthrop Dam, August 16, 1973.

of the Winthrop Canal, which extends approximately 0.8 miles downstream through residential and commercial areas to Linden Pond.

Based upon available LiDAR contour data, the roadway embankments of Pleasure Point Road (from the dam north to Arch Street) and Arch Street (from Pleasant Point Road west to Off Arch Street) also function to retain the impoundment. The roadway embankment of Pleasant Point Road includes an uncontrolled culvert that provides additional discharge capacity from the system.

1.3 Pertinent Data

1.3.1 Size Classification

Lake Winthrop Dam has a maximum structural height of approximately 4.6 feet and a reported maximum storage capacity of 740 acre-feet. Therefore, given the limited structural height, and 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, Lake Winthrop Dam is a **Non-Jurisdictional** structure.

A request for jurisdictional determination was submitted to MADCR in December 2021. The dam was reclassified as **Non-Jurisdictional** per the response letter from DCR dated October 31, 2022.

1.3.2 DCR Hazard Classification

Lake Winthrop Dam is located upstream of eleven stream crossing before the channel enters the impoundment created by Factory Pond Dam (MA02952). However, the elevation of the crossings is near or above the top of dam elevation. As such, a release of water from the dam is unlikely to result in significant flooding or overtopping of the crossing. Based upon a review of infrastructure along the downstream reaches, flooding of buildings or other infrastructure is also not anticipated. Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 failure of the dam "may minimal property damage to other. Loss of life is not expected". As such, Lake Winthrop Dam is a **Class III** (**Low**) hazard potential dam.

1.4 Inspection History

Based upon a review of available information provided by the Town of Holliston and the MADCR Office of Dam Safety, the dam is currently in poor condition rating. The following tables provides a summary of the most recent inspection and noted conditions:

Table 1-2: Inspection History Summary

Date	Inspector	Dam Condition	Noted Deficiencies
9/6/2017	Lenard Engineering, Inc.	POOR	Heavy brush, trees, and woody vegetation located on and within 20 feet of the dam.
			Steep upstream slope with erosion in multiple spots.
			Erosion around the training walls.
			The toe of the downstream is generally wet.
			Beaver activities at the dam.
			Minor concrete deterioration of the spillway walls including cracks, isolated scaling, some spalling and scouring.

2.0 ENGINEERING DATA

2.1 General

2.1.1 Drainage Area

The drainage for Lake Winthrop Dam is approximately 1.7 square miles and comprised of residential development along with roadways, forest, park, and farmlands. As reported by the USGS StreamStats, the drainage area has an average slope of 1.5% (1:250K DEM) and is comprised of 38% forest, 25% water bodies, 35% urban land, and 15% wetland.

2.1.2 Reservoir Information

The following table provides a general overview of impoundment geometric properties. Data is based upon available LiDAR data from MassGIS for above normal pool storage volume and previous reports for below normal pool storage.

Table 2-1: Reservoir Properties

	Elevation	Surface Area (acres)	Storage Volume (acre-feet)
Normal Pool	180.2±	131 ±	405 ±
Maximum Pool	182.5±	162±	740±
SDF Pool	Unknown	Unknown	Unknown

2.1.3 Discharges at the Dam Site

No records of discharges at the dam site were made available during the preparation of this report.

2.1.4 General Elevations (feet)

Elevations are based upon information provided within available inspection reports. As indicated in the 2017 Phase I Inspection Evaluation Report, the previously referenced datum is assumed. Elevations have been roughly converted from the previously reported datum to NAVD88 based upon correlation of spot elevations to available LiDAR data; to approximately convert from the assumed datum to NAVD88, add 82.2 feet. The elevation datum reference s should only be considered accurate to the level of the methods used.

		Previously Reported (Assumed Datum)	Approximate Elevation NAVD88
A.	Top of Dam	100.0	182.2
B.	Spillway Design Flood Pool	No H&H Available	
C.	Normal Pool	98.0±	180.2±
D.	Downstream Channel	95.4	177.6
E.	Downstream Water	97±	179.2±

2.1.5 Spillway

A.	Type	Concrete Channel with Aluminum Slide Gate

B.	Width	4.0 feet	
C.	Elevations		
	1. Top Stop Closed Gate	98	180.2
	2. Gate Invert	95.3	177.5
	3. Top of Spillway Walls	100.6	182.8

2.2 Design and Construction Records

No design or construction records were available during the preparation of this report. As indicated in the 2017 Phase I Report, "available inspection reports indicate that the dam was constructed in 1966. Based upon visual observations, it is apparent that rehabilitations have been completed since that time. The slide gate was installed approximately in 2005. Most likely cementitious covering of the training walls also occurred in 2005 in conjunction with the gate installation."

Between 2017 and 2022, a vegetation maintenance program was implemented at the dam left of the spillway to control growth of trees and brush along the embankment slopes. Details of the program were not available for review.

3.0 BASIS OF ALTERNATIVES ANALYSIS

The scope of this study provides for the development of alternatives to comply with current state dam safety regulations and to address known deficiencies at the dam. Where available, the study references previously completed studies and detailed analyses. In the absence of detailed evaluations, the scope of the work includes developing approximations of the dam's current compliance with applicable regulations based upon available published information and the engineer's judgment. The following provides the basis for which the dam has been assessed.

3.1 Structural Stability

Available documentation for the dam includes visual inspections and assessments of the dam stability. As indicated in the 2017 Phase I Report:

> Based solely on visual observation alone, the embankment currently appears stable. However, there are deficiencies which if left uncorrected may shorten the service life of the dam. These deficiencies include:
>
> A. Heavy vegetation, trees, and brush within 20 feet of the dam and dike area.
> B. Steep upstream slope with erosion in multiples spots.
>
> Based solely on visual observation alone, the spillway currently appears stable. There are deficiencies, which if left uncorrected may shorten the service life of the dam. These deficiencies include:
>
> A. Erosion behind the spillway training walls.
> B. Debris was piled up on the left side of the spillway and at the spillway approach.
> C. Minor concrete deterioration including cracking and spalling.

Given available information, the dam has been reported to be structurally stable based upon visual observations with areas of deterioration which may lead to the development of future instability.

3.1.1 Embankment (Slope) Stability

Available documentation for the dam includes visual inspections and assessments of the dam stability. As indicated in the 2017 Phase I Report:

> At the time of the inspection the embankment was stable. However, many deficiencies exist which compromise the long-term structural capacity of the embankments.
>
> The dam was plagued with heavy vegetation on both upstream and downstream slopes. The dike was infested with matures trees and heavy brush making the dike virtually impassable. The earth in back of downstream tips of the training walls is eroded from back water and/or drainage ditch from the right downstream area. The earth in back of the upstream tip of the left training wall is also eroded, but not to the same extend as the downstream walls. Currently there does not appear to be through dam seepage behind these walls. The crest is thin (in width) with low spots and the upstream slopes are steeps in places with spots of erosion.

It appears that a vegetation maintenance program has been completed along the dam left of the spillway, which appears to have mitigated some of the previous concerns. Trees and vegetation remain right of the spillway. Further, numerous depressions were noted along the upstream edge of the crest, apparently the result of collapsed animal burrows with entrances located along the upstream slope. As such, repairs are required to address long term stability concerns associated with remaining trees and animal burrows.

3.1.2 Embankment (Seepage) Stability

As indicated in the 2017 Phase I Report:

> There were no signs of seepage at the inspection. However, it should be noted that the toe is often wet and swampy with flowing roadway and drainage ditches at the toe. Based on observation alone, the dam and dike are presumable stable against seepage. Seepage should be checked during low flow or no flow conditions at the toe

For the purposes of this study the embankment is assumed to be adequately resistant to seepage through the embankment.

3.1.3 Spillway Stability

No previous evaluations of the stability of the spillway have been completed. The alignment and condition of the spillway has generally been reported to be satisfactory as part of previous inspections. As such, the structures are presumed to be stable for the purposes of this study.

3.2 Spillway Design Flood Compliance

As the dam is Non-Jurisdictional, a regulatory spillway design flood is not required. However, Pare recommends that the dam be designed to accommodate a 50-year event.

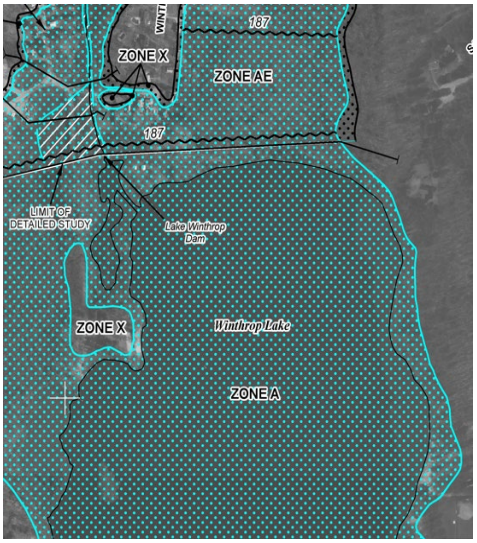


Image 3-1: *FIS Panel in Area of Lake Winthrop Dam*

As reported in the 2017 Phase I Inspection Report, "A limited scope Hydrologic and Hydraulic (H&H) Evaluation was completed as part of the 1987 Inspection Report. Based upon that evaluation, the inflow associated with the 100-year storm event is approximately ¼ Probable Maximum Flood or 450 cubic feet per second (cfs). Modifying the peak inflow to account for the storage capacity of the impoundment, an adjusted peak SDF outflow of 196 cfs was determined. At the time of that evaluation, the capacity of the spillway was approximated near 65 cfs. However, the former spillway with gate outlet has since been replaced with an upward operating gate. Based upon hydraulic calculations performed as part of this evaluation, the capacity of the spillway at maximum pool is approximately 36 cfs, assuming no tailwater effects. This capacity corresponds to approximately 18% of the SDF peak routed outflow."

The effective Flood Insurance Study (FIS) for the dam (FIS Number 25017CV008C, issued July 6, 2016) suggests that the 50-year water surface elevation will rise to near El. 186.1, overtopping the dam by 3.9 feet; however, this flood depth appears to be the result of backwater from downstream crossings as opposed to capacity restrictions at the dam.

The USGS StreamStats application also provide estimates of peak flows for recurrent storm events based upon statewide regression equations; USGS StreamStats predictions are presented in Table 3-1: Summary of Hydrologic Data.

Table 3-1: Summary of Hydrologic Data

Source	Storm Event Peak Flow (cfs)		
	50-yr	100-yr	500-yr
USGS StreamStats Value (Lower Limit-Upper Limit)	136 (62.6-295)	161 (71.8-361)	227 (93.8-549)
FEMA FIS 2016	80	100	150

Given available studies, it appears that the dam cannot accommodate the 50-year storm event. As such modification of the dam would be recommended to protect the dam.

3.3 Uncertainty

Detailed evaluations specific to the project site are not available. As such, the accuracy of critical criteria presented above is uncertain.

Detailed hydrologic and hydraulic analysis incorporating current modeling methods and data sets and accounting for routing effects of the impoundment may find SDF flows higher or lower than those presumed herein.

The assessment also assumes that past performance of structural components of the dam indicates adequate stability; however, detailed assessment may indicate that while stable, factors of safety for stability meeting current dam safety regulations requirements may not be met.

Available LiDAR contour data within the area show the Pleasant Point Road may act as a retaining structure during flooding. Portion of Arch Street downstream of the dam appeared to be lower/around the top of dam elevation. Water level during storm events seems to be controlled by Water Street culvert downstream of the dam. Further Inflow Design Flood and Incremental Damage Assessment study is recommended for the dam to further evaluate the damage if the dam breaks.

4.0 ALTERNATIVES ANALYSIS

4.1 Alternatives Analysis

For the purposes of this evaluation, four design alternatives were considered to address the concerns at the site. These alternatives include 1) Dam Repair; 2) Dam Rehabilitation; 3) Dam Removal; and 4) No Action. The general scope of each of these alternatives includes the following:

1) ***Dam Repair:*** Includes maintenance, repair, and/or replacement of existing features at the dam to restore their original design functionality. Repair generally includes upgrading existing facilities to address known structural deficiencies; however, measures to address regulatory deficiencies are beyond the scope of a repair program.

2) ***Dam Rehabilitation:*** Includes repairs and modifications to the dam to address physical deficiencies as well as protecting the dam during flooding event. Modifications including armoring the upstream and downstream slopes to allow the dam to be submerged during the rainstorm event.

3) ***Dam Removal:*** Includes complete removal of the spillway control structure and portions of the dam as necessary to fully drain the impoundment. It should be noted that ecological restoration permit process requires that the removal results in no increase to water surface elevation upstream of the dam location during a 500-year storm event; as such, extent of required removal may exceed that considered as part of this study.

4) ***No Action:*** Includes maintaining the current level of operations, maintenance, and inspection at the dam; no repairs or remedial measures are to be completed.

The scope of the alternatives analyses focusses upon the portion of the dam east of Pleasure Point Road; the extent to which the roadway embankments of Pleasure Point Road north of the left end of the dam embankment and Arch Street west of the intersection with Pleasure Point Road were not considered as part of this analysis.

4.1.1 Dam Repair

The scope of a dam repair program may include:

1. Control of Water: Given the short duration and limited work performed at the spillway, temporary water control is not anticipated. However, the work may require closure of the slide gate to provide for work to be completed in the dry.

2. Clearing and grubbing of trees and other unwanted vegetation along the length of the dam. Fill and compact resulting holes. Clearing would extend a minimum of 10 feet beyond the limits of the embankment downstream of the dam as well as into each abutment.

3. Structural repairs to the spillway and associated walls including:
   - Patching areas of spall and sealing cracks in concrete.
   - Filling erosion behind spillway training walls.
   - Removing debris at the left side of the spillway and at the spillway approach.

4. Fill noted collapsed animal burrows.

5. Provide upstream slope protection, this is assumed to include lining the normal pool waterline with riprap.

6. Regrading downstream slope and crest to uniform sections; Establish a maintainable surface covering within the limits of the dam embankment.

The dam repair program is expected to extend the serviceable life of the structure and enable the implementation of a routine maintenance program. The program may not fully address all dam safety deficiencies at the dam. For example, this repair program would not address any concerns regarding the spillway design flood compliance or seepage or stability issues that may exist and have not been visually apparent during past inspections.

The general character and limits of the dam repair program are shown on Figure 4.1: Dam Repair Concept.

4.1.2 Dam Rehabilitation

The scope of a dam rehabilitation program may include:

1. Control of Water: Given the short duration and limited work perform at the spillway, temporary water control is not anticipated. However, the work may require the closure of the slide gate to provide work to be completed in the dry.

2. Clearing and grubbing of trees and other unwanted vegetation along the length of the dam. Fill resulting holes. Clearing would extend a minimum of 10 feet beyond the limits of the embankment downstream of the dam as well as into each abutment.

3. Structural repairs to the spillway and associated walls including:
    - Patching areas of spall and sealing cracks in concrete.
    - Filling erosion behind spillway training walls.
    - Removing debris at the left side of the spillway and at the spillway approach.

4. Regrade and armor the upstream and downstream slope to provide a stable, maintainable section:
    - Clear and grub the slopes, strip organics.
    - Regrade to stable section approximately 2.5H:1V
    - Install stone riprap to provide upstream slope protection from wave action
    - Install stone riprap slope protection along the downstream slope to prevent erosion during flooding. Given downstream hydraulic structures, the dam is expected to become submerged during severe storm events; as such, design of downstream slope protection should consider measures to protect the dam during receding floodwaters.

5. Regrade the dam crest to establish a maintainable surface covering within the limits of the dam embankment. To protect the crest during flood events, crest surface treatments should be designed to limit the potential for damage during submerged and receding flood conditions.
    - Clear and grub the crest
    - Regrade to approximately El. 182.8
    - Install permanent turf reinforcement, loam and seed

The dam rehabilitation program is expected to fully address all noted deficiencies at the dam. Conceptual approaches to protect the dam during severe storm events would be intended to allow the dam to safety perform during flooding and receding flood conditions. However, should conditions change in the downstream area (i.e., increased culvert / channel conveyance hydraulic capacity), implications to hydraulic design of the spillway should be reviewed.

The general character and limits of the dam rehabilitation program are shown on Figure 4.2: Dam Rehabilitation Concept.

4.1.3 Dam Removal

Breaching of the dam and river restoration is an alternative for addressing the dam safety concerns. Lake Winthrop Dam currently only supports passive recreational activities. No water supply, wells, or other resources supported by the impoundment, or the dam have been identified as part of the current evaluation. Removal of the dam may impact peak flows during storm events to the downstream area due to the large size of the impoundment. However, downstream channel constriction may mitigate the extent downstream to which hydraulic changes would be experienced; additional hydraulic evaluation would be required to determine actual impacts.

No information pertaining to the quantity or quality of sediment is available for this site; as such, it is unknown if sediment mitigation measures would be required. However, given existing site characteristics, it does not appear that dam removal would result in the potential for mobilization of sediment from the impoundment. Consideration for sediment to be exposed by the pond drawdown may be required.

A dam removal program would likely consist of complete demolition and removal of the vertical extents of the dam in the vicinity of the spillway. Preliminary hydraulic evaluations indicate that a roughly trapezoid breach with bottom width of roughly 7 feet would be required to pass dam removal design flows, which were conservatively considered as 227 cfs for the 500-year storm event. However, to meet Massachusetts Stream Crossing Standards, an approximately 21-foot-wide channel would be required to meet the optimum goal of 1.2 times the bankfull width (given a bankfull width of 17 feet predicted by USGS StreamStats).

Impoundment area restoration would likely include a natural revegetation program with supplemental planting and bank stabilization measures as deemed necessary during final design activities; should sediment characterization and quantification indicate concerns with in-stream management of sediment or exposure of pond bottom sediments, additional measures to either remove and dispose of sediment, stabilize sediment in place, or otherwise remove sediment from the system will need to be implemented.

In addition to environmental considerations, public outreach would also play a critical role in a dam removal program.

4.1.4 No Action / Status Quo

The dam is a Non-Jurisdictional; as such, no repairs or remedial measure would be required by current state dam safety regulations. However, while specific regulations to the safe operation of the dam would not apply, the dam would remain a component of Town owned infrastructure with a degree of risk

associated with the long term performance. As such, continued inspection, operations and maintenance at the dam is recommended.

4.2 Opinions of Probable Cost

The following opinions of probable cost have been developed for the conceptual alternatives noted above based upon limited information as presented within Section 3.0. 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 construction costs may be somewhat less or considerably more than indicated. For more detailed information utilized for the development of the opinions of probable cost, refer to Appendix C.

Table 4-1: Conceptual Opinion of Probable Costs

	Alternative		
Work Item	**Repair**	**Rehabilitation**	**Removal**
General Requirements	$ 16,740.00	$ 16,740.00	$ 20,660.00
Mobilization / Demobilization	$ 25,000.00	$ 25,000.00	$ 45,000.00
Clearing and Grubbing	$ 4,405.00	$ 4,405.00	$ 4,405.00
E&S Controls	$ 5,800.00	$ 5,300.00	$ 7,300.00
Control of Water	$ -	$ -	$ 14,180.00
Embankment Work	$ 120,730.00	$ 148,145.00	$ -
Spillway Work	$ 22,000.00	$ 22,000.00	$ -
Dam Removal Work	$ -	$ -	$ 30,300.00
Sediment Management	$ -	$ -	Unknown
Subtotal w/ Bonds	$ 196,675.00	$ 224,590.00	$ 123,845.00
Design Contingency	$ 68,250.00	$ 77,700.00	$ 42,700.00
Engineering and Design	$ 30,000.00	$ 30,000.00	$ 35,000.00
Permitting	$ 15,000.00	$ 15,000.00	$ 75,000.00
Construction Administration	$ 15,000.00	$ 15,000.00	$ 20,000.00
Conceptual Opinion of Probable Cost	**$ 325,000.00**	**$ 363,000.00**	**$ 297,000.00**

When comparing costs, the total cost including design, engineering, permitting, construction and long-term maintenance should be considered. The applicability of environmental permits needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of MADEP, local conservation commissions, or other regulatory agencies.

4.3 Life Cycle Analysis

An analysis was conducted to estimate the life cycle cost over a 30-year period of analysis s in order to develop a better understanding of the true costs of each alternative. The National Institute of Standards and Technology (NIST) Life Cycle Cost Manual Handbook 135 with the 2019 Supplement was used to determine the life cycle costs for the proposed alternatives (NIST, 1995). At this level of study, a simple method was utilized that accounts for initial investment, capital replacement, energy, and operation, maintenance, and repair.

Operations and Maintenance (O&M) costs for the dam structure consists of gate operation (if provided/installed), mowing and other vegetation maintenance, debris removal, and other miscellaneous items. O&M includes routine activities but does not account for intermittent repairs or other minor repairs to address identified deficiencies.

The estimated yearly O&M cost estimate is $8,000 for Alternatives 1 (Repair) and 2 (Rehabilitation). Estimated O&M costs for Alternative 3 (Removal) are $500 to account for post-dam removal maintenance (mowing, cleanup, etc.) of any publicly accessible areas created or restored as part of the dam removal program. Estimated O&M costs for Alternative 4 (No Action) is $6,000 assuming regular inspection and maintenance is performed with a reduced level of inspection and frequency.

The present cost for each alternative was determined based on the life cycle cost period, considering initial capital costs, assumed design life, and yearly O&M costs. Capital replacement costs were determined based on the assumed design life; assuming a 15-year design life for repairs, it was assumed that capital costs equivalent to the initial capital costs would be required at Year 15. For the No Action alternative, it was assumed that a repair similar in scope to the Repair Alternative would be required at Year 25.

Note that the costs in Table 4-2 do not include environmental restoration components, allowing for a focused analysis on the infrastructure costs. Additional life cycle costs may be realized should sediment management or invasive species management be required as part of dam removal activities.

Table 4-2: Life Cycle Cost Analysis

	Alternative			
	Repair	Rehabilitation	Removal	No Action
Initial Capital Investment				
Discount Factor	1	1	1	1
Initial Capital Cost	$325,000	$363,000	$297,000	$0
Capital Replacement Cost				
Assumed Design Life (yrs)	15	30	N/A	25
Assumed CIP Cost Percentage	100%	0%	0%	0%
Discount Factor	0.642	0.412	N/A	0.478
Operations & Maintenance				
O&M Costs	$8,000	$8,000	$500	$6,000
Discount Factor	30	30	30	30
Total Present Cost	**$ 773,650**	**$ 603,000**	**$ 312,000**	**$ 505,000**

Notes: 1. Discount factors taken from 2019 supplement to NIST LCC Tables A-1 and A-3a

4.4 Potential Permitting Requirements

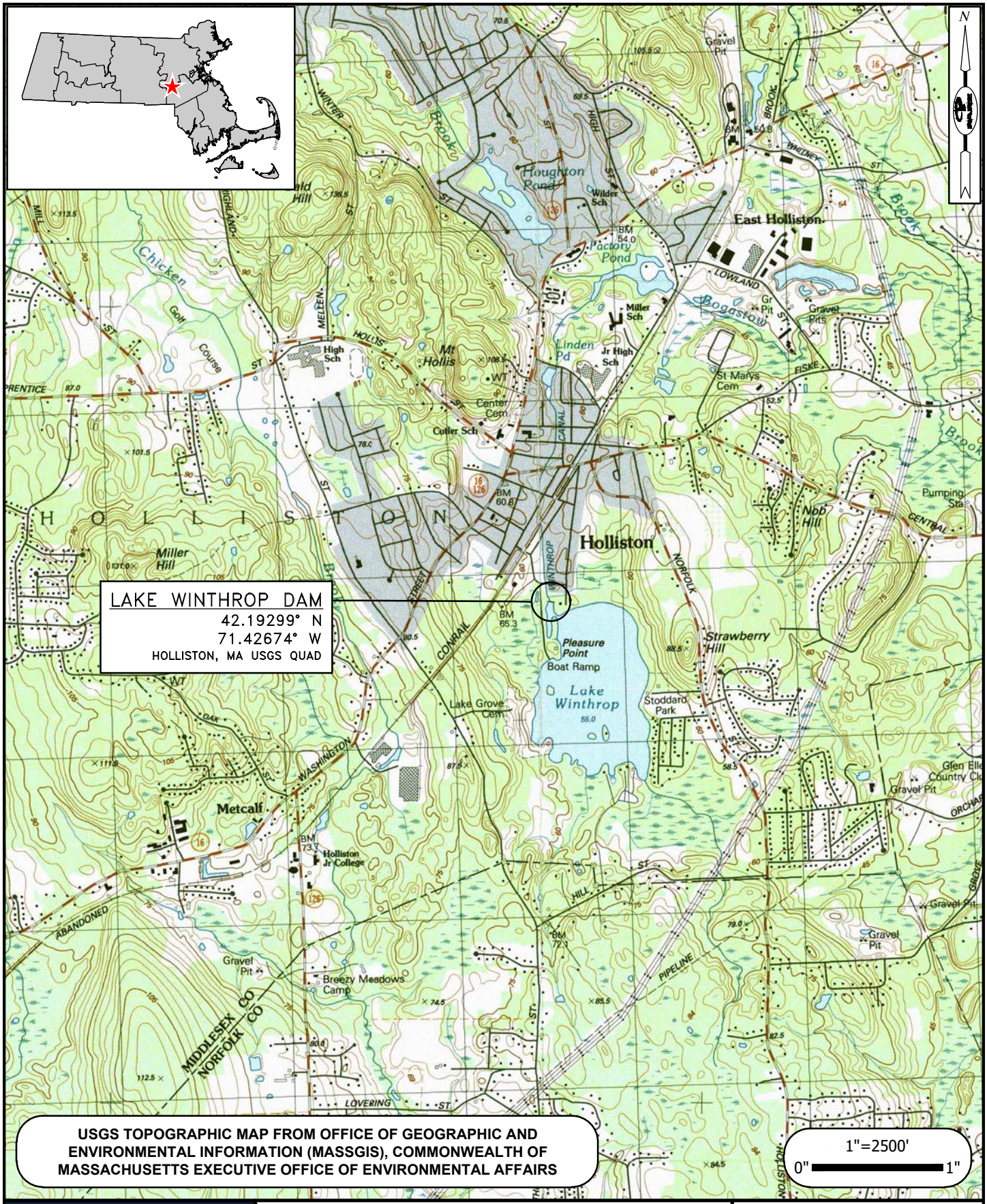
The following table presents the potential permitting requirements for each of the alternatives considered. Depending upon the final scope of work, the required permitting may vary from that set forth below.

Table 4-3: Potential Permitting Requirements

	Alternative			
	#1 Dam Repair	**#2 Dam Rehabilitation**	**#3 Dam Removal**	**#4 No Action**
NOI	Yes	Yes	Yes	Potentially
MEPA	Potentially	ENF/EENF	EIR	Unlikely
ACOE GP	SV	PCN	IP	SV Potentially
DCR Dam Safety	Part A & B	Part A & B	Part A & B	Part B
WQC	No	YES	Yes	No

FIGURES

Lake Winthrop Dam
Holliston, Massachusetts



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

PARE CORPORATION

LAKE WINTHROP DAM

MA02949 / 4-9-136-3

HOLLISTON, MASSACHUSETTS

TOWN OF HOLLISTON

LOCUS PLAN

JUNE 2022

FIGURE 1

PARE CORPORATION

LAKE WINTHROP DAM

MA02949 / 4-9-136-3

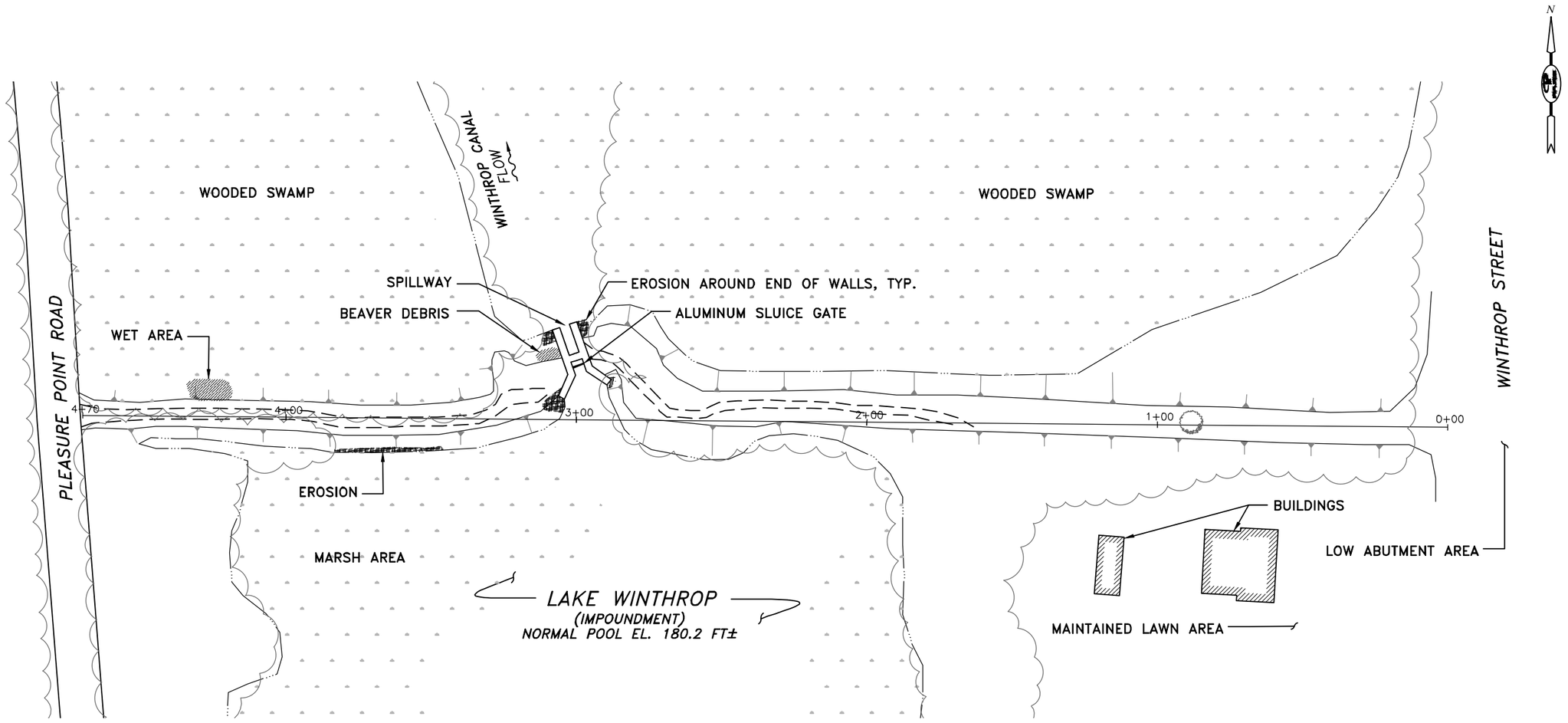
HOLLISTON, MASSACHUSETTS

TOWN OF HOLLISTON

AERIAL PLAN

JUNE 2022

FIGURE 2



SITE SKETCH

SCALE: 1"=40'

NOTES AND LEGEND

1. SKETCH DEVELOPED FROM INFORMATION OBTAINED DURING PREVIOUS INSPECTION AND AVAILABLE AERIAL PHOTOGRAPHY. THE INFORMATION INCLUDED ON THE SKETCH IS PROVIDED FOR REFERENCE PURPOSES ONLY.

PARE
PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
508-543-1755

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

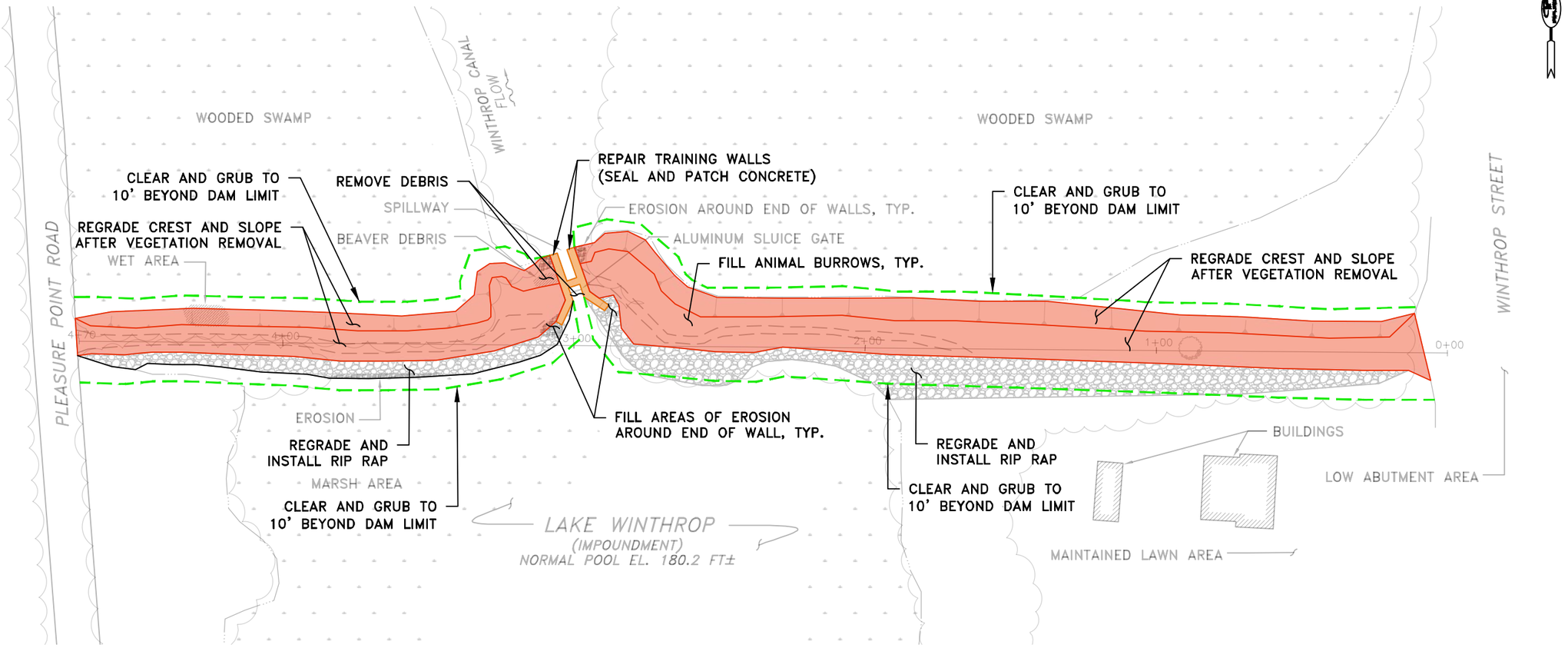
LAKE WINTHROP DAM
MA02949 / 4-9-136-3
HOLLISTON, MASSACHUSETTS
TOWN OF HOLLISTON

REVISIONS:

PROJECT NO.:	21214.00/203
DATE:	JUNE 2022
SCALE:	AS NOTED
DESIGNED BY:	MLP
CHECKED BY:	ARO
DRAWN BY:	LMC
APPROVED BY:	ARO

SITE SKETCH

FIGURE NO.:
3



DAM REPAIR

SCALE: 1"=40'

NOTES AND LEGEND

1. SKETCH DEVELOPED FROM INFORMATION OBTAINED DURING PREVIOUS INSPECTION AND AVAILABLE AERIAL PHOTOGRAPHY. THE INFORMATION INCLUDED ON THE SKETCH IS PROVIDED FOR REFERENCE PURPOSES ONLY.

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508-543-1755

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

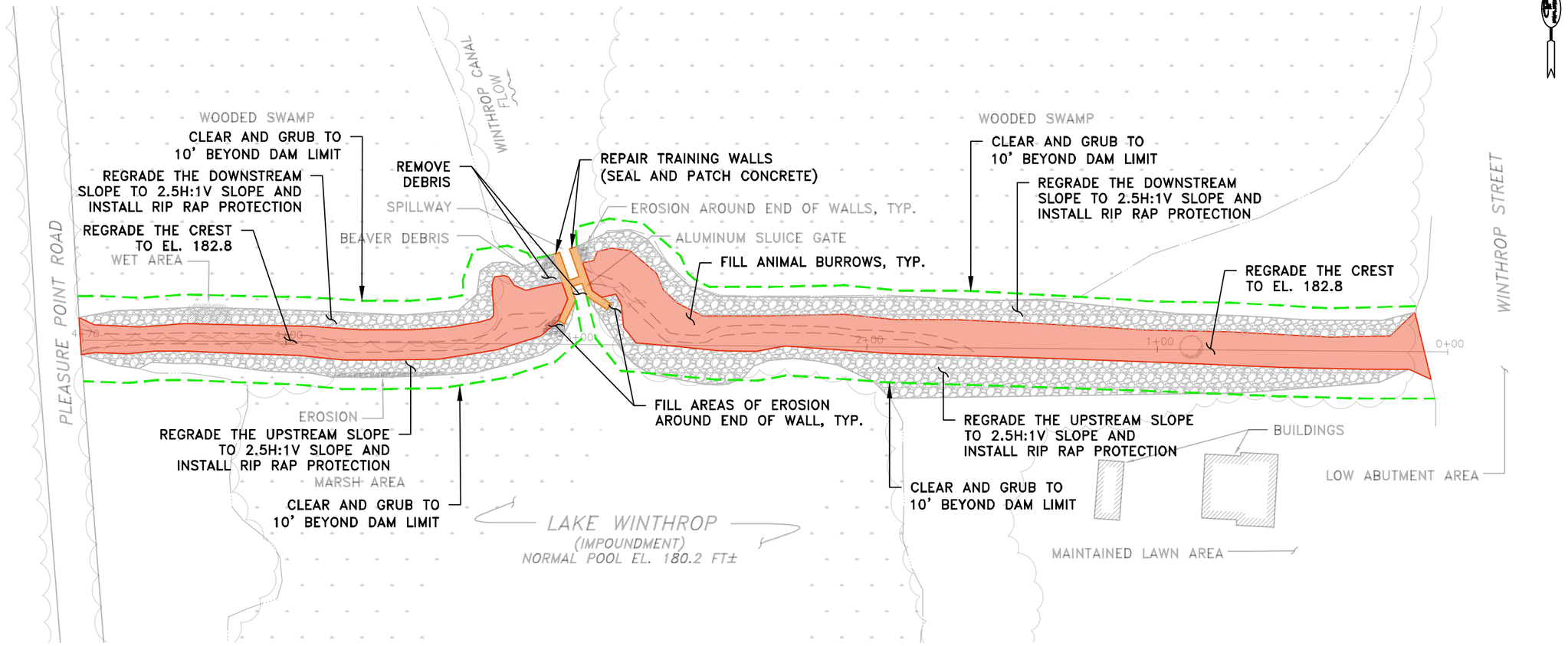
LAKE WINTHROP DAM
MA02949 / 4-9-136-3
HOLLISTON, MASSACHUSETTS
TOWN OF HOLLISTON

REVISIONS:

PROJECT NO.:	21214.00/203
DATE:	JUNE 2022
SCALE:	AS NOTED
DESIGNED BY:	MLP
CHECKED BY:	ARO
DRAWN BY:	LMC
APPROVED BY:	ARO

CONCEPTUAL PLAN DAM REPAIR

FIGURE NO.:
4.1



DAM REHABILITATION

SCALE: 1"=40'

NOTES AND LEGEND

1. SKETCH DEVELOPED FROM INFORMATION OBTAINED DURING PREVIOUS INSPECTION AND AVAILABLE AERIAL PHOTOGRAPHY. THE INFORMATION INCLUDED ON THE SKETCH IS PROVIDED FOR REFERENCE PURPOSES ONLY.

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508-543-1755

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

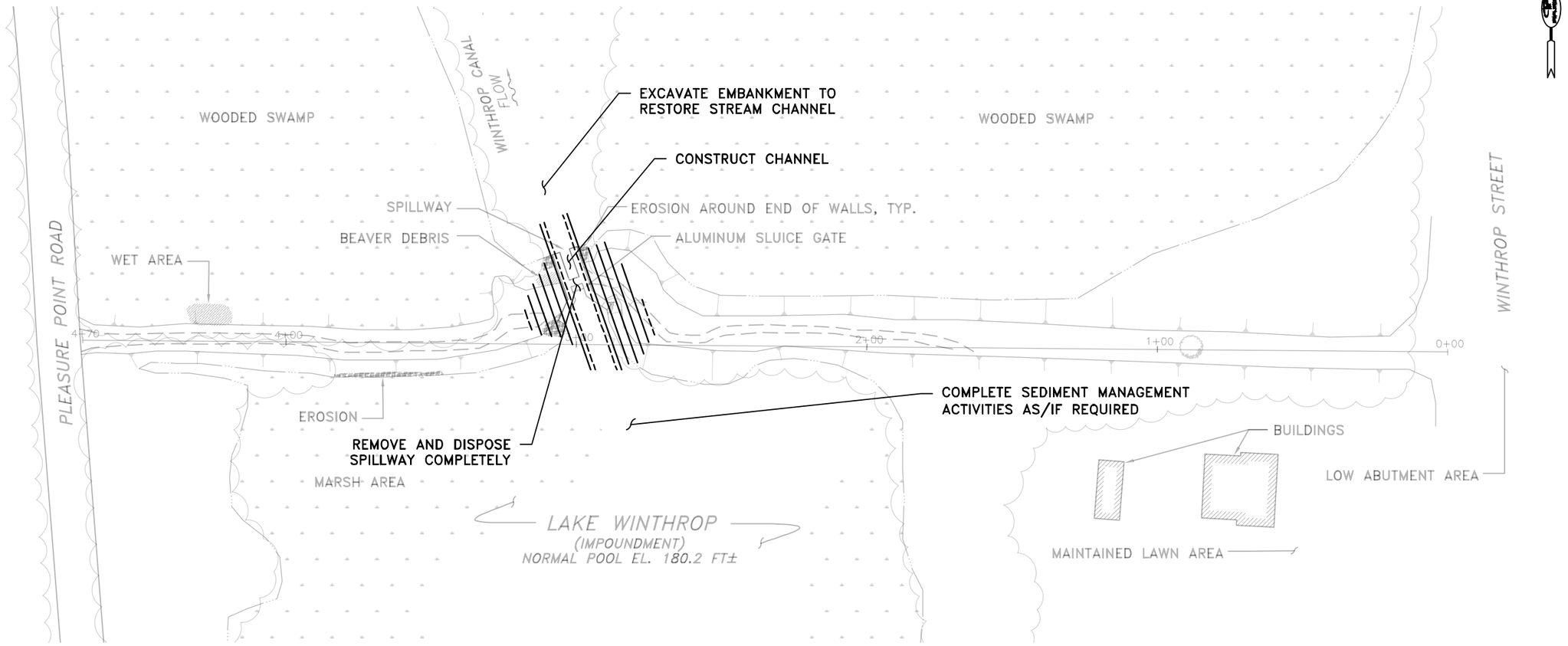
LAKE WINTHROP DAM
MA02949 / 4-9-136-3
HOLLISTON, MASSACHUSETTS
TOWN OF HOLLISTON

REVISIONS:

PROJECT NO.:	21214.00/203
DATE:	JUNE 2022
SCALE:	AS NOTED
DESIGNED BY:	MLP
CHECKED BY:	ARO
DRAWN BY:	LMC
APPROVED BY:	ARO

CONCEPTUAL PLAN DAM REHABILITATION

FIGURE NO.: 4.2

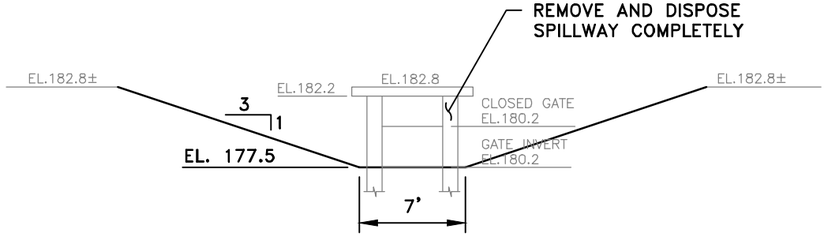


DAM REMOVAL

SCALE: 1"=40'

NOTES AND LEGEND

1. SKETCH DEVELOPED FROM INFORMATION OBTAINED DURING PREVIOUS INSPECTION AND AVAILABLE AERIAL PHOTOGRAPHY. THE INFORMATION INCLUDED ON THE SKETCH IS PROVIDED FOR REFERENCE PURPOSES ONLY.



SECTION

SCALE: 1"=10'

PARE
PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
508-543-1755

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

LAKE WINTHROP DAM

MA02949 / 4-9-136-3

HOLLISTON, MASSACHUSETTS

TOWN OF HOLLISTON

REVISIONS:

PROJECT NO.:	21214.00/203
DATE:	JUNE 2022
SCALE:	AS NOTED
DESIGNED BY:	MLP
CHECKED BY:	ARO
DRAWN BY:	LMC
APPROVED BY:	ARO

CONCEPTUAL PLAN DAM REMOVAL

FIGURE NO.:

4.3

APPENDIX A
Visual Dam Inspection Limitations
Lake Winthrop Dam
Holliston, Massachusetts

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 Holliston for specific application to the reference Lake Winthrop 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.

APPENDIX B
Opinion of Probable Costs
Lake Winthrop Dam
Holliston, Massachusetts

PARE CORPORATION

Project: Lake Winthrop Dam
Subject: Opinions of Probable Costs
Computation By: MLP
Check By: ARO

Project No.: 21214/Task 203
Date: June 2022
Date: June 2022

CONCEPTUAL DESIGN OPINION OF PROBABLE COST

Alternate 1: Dam Repairs

Item	Quantity	Unit	Unit Price	Total	Source	Notes
General Bid Items						
Construction Trailer and Utilities	1	MON	$ 2,700.00	$ 2,700.00	Engineering Judgement	
Project Superintendent	1	MON	$ 8,200.00	$ 8,200.00	Engineering Judgement	
QC Plans	4	HR	$ 75.00	$ 300.00	Engineering Judgement	
Submittals	4	HR	$ 75.00	$ 300.00	Engineering Judgement	
Schedules	4	HR	$ 75.00	$ 300.00	Engineering Judgement	
Meetings	4	EA	$ 150.00	$ 600.00	Engineering Judgement	
Project Sign	1	LS	$ 1,000.00	$ 1,000.00	Engineering Judgement	
Proctor Tests	2	TEST	$ 200.00	$ 400.00	Laboratory Quote plus markup	
Sieve Analyses	4	EA	$ 110.00	$ 440.00	Laboratory Quote plus markup	
Concrete Sampling/Testing	0	EA	$ 500.00	$ -	Recent project bids	
Concrete Compression Tests	0	EA	$ 50.00	$ -	Laboratory Quote plus markup	
Field Density Testing	5	DAY	$ 500.00	$ 2,500.00	Recent project bids	
Chemical Soil Tests	0	EA	$ 1,000.00	$ -	Recent project bids	
Subtotal				**$ 16,740.00**		
Mobilization & Demobilization						
Mobilization	1	LS	$ 15,000.00	$ 15,000.00	Engineering Judgment	
Demobilization	1	LS	$ 10,000.00	$ 10,000.00	Engineering Judgment	
Subtotal				**$ 25,000.00**		
Clear and Grub						
Clear and Grub	0.5	ACRE	$ 5,000.00	$ 2,500.00	RSMEANS 31 11 10.10 0200	
Clear Trees up to 24"	3	EA	$ 500.00	$ 1,500.00	RSMEANS 31 13 13 20 3150	
Engineered Fill Imported	9	TN	$ 25.00	$ 225.00	Recent Project Costs	
Engineered Fill Placed	4.5	CY	$ 40.00	$ 180.00	Recent Project Costs	
Subtotal				**$ 4,405.00**		
Erosion Control						
Straw bales	200	LF	$ 9.00	$ 1,800.00	RSMEANS 31 25 14 16 0600	
Silt Fence	200	LF	$ 10.00	$ 2,000.00	RSMEANS 31 25 14 16 1000 + markup	
Maintenance and Removal	1	LS	$ 2,000.00	$ 2,000.00	Engineer's Judgment	
Turbidity Barrier	0	LF	$ 30.00	$ -	Recent project bids	
Subtotal				**$ 5,800.00**		
Control of Water / Water Diversion						
Implement Drawdown	0	LS	$ 10,000.00	$ -	Engineer's Judgment	Assumed not needed
Small Sand Bag	0	EA	$ 6.00	$ -	Engineer's Judgment	
Large Sand Bag	0	EA	$ 200.00	$ -	Engineer's Judgment	
Install and Remove Sand Bag	0	DAYS	$ 5,000.00	$ -	Engineer's Judgment	
Install and Remove Siphon/Bypass for drawdown	0	LS	$ 10,000.00	$ -	Engineer's Judgment	
Subtotal				**$ -**		
Embankment Work						
Regrade Embankment	580	CY	$ 40.00	$ 23,200.00	Engineering's Judgement	Assumed average 2' of fill
Import EF	870	TN	$ 25.00	$ 21,750.00	Engineering's Judgement	
Upstream Slope Riprap	400	SY	$ 85.00	$ 34,000.00	RSMEANS 31 37 13 10 0200	
Import Riprap	446	TN	$ 40.00	$ 17,840.00	RSMEANS 31 37 13 10 0350	
Geotextile Fabric	400	SY	$ 6.00	$ 2,400.00	RSMEANS 3132 19 16 1550 plus markup	
Loam Crest & DS Slope	940	SY	$ 7.00	$ 6,580.00	RSMEANS 32 91 19 13 0800	
Import Loam	160	CY	$ 70.00	$ 11,200.00	MassDOT Price Bid	
Seed	940	SY	$ 4.00	$ 3,760.00	MassDOt Price Bid	
Subtotal				**$ 120,730.00**		
Spillway work						
Seal and Patch Concrete	1	LS	$ 20,000.00	$ 20,000.00	Engineering's Judgement	
Debris Removal	1	LS	$ 2,000.00	$ 2,000.00	Engineering's Judgement	
Subtotal				**$ 22,000.00**		
			SUBTOTAL	$ 194,675.00		
			Contract Bonds	$ 2,000.00		
			Design Contingency	**$ 68,250.00**	35%	
			OPINION OF PROBABLE CONSTRUCTION COST	**$ 265,000.00**		
			Engineering & Design	$ 30,000.00		
			Permitting	$ 15,000.00		
			Construction Phase Services	$ 15,000.00		
			OPINION OF PROBABLE CONSTRUCTION COST	**$ 325,000.00**		

PARE CORPORATION

Project: Lake Winthrop Dam
Subject: Opinions of Probable Costs
Computation By: MLP
Check By: ARO

Project No.: 21214/Task 203
Date: June 2022
Date: June 2022

CONCEPTUAL DESIGN OPINION OF PROBABLE COST

Alternate 2: Dam Rehabilitation

Item	Quantity	Unit	Unit Price	Total	Source	Notes
General Bid Items						
Construction Trailer and Utilities	1	MON	$ 2,700.00	$ 2,700.00	Engineering Judgement	
Project Superintendent	1	MON	$ 8,200.00	$ 8,200.00	Engineering Judgement	
QC Plans	4	HR	$ 75.00	$ 300.00	Engineering Judgement	
Submittals	4	HR	$ 75.00	$ 300.00	Engineering Judgement	
Schedules	4	HR	$ 75.00	$ 300.00	Engineering Judgement	
Meetings	4	EA	$ 150.00	$ 600.00	Engineering Judgement	
Project Sign	1	LS	$ 1,000.00	$ 1,000.00	Engineering Judgement	
Proctor Tests	2	TEST	$ 200.00	$ 400.00	Laboratory Quote plus markup	
Sieve Analyses	4	EA	$ 110.00	$ 440.00	Laboratory Quote plus markup	
Concrete Sampling/Testing	0	EA	$ 500.00	$ -	Recent project bids	
Concrete Compression Tests	0	EA	$ 50.00	$ -	Laboratory Quote plus markup	
Field Density Testing	5	DAY	$ 500.00	$ 2,500.00	Recent project bids	
Chemical Soil Tests	0	EA	$ 1,000.00	$ -	Recent project bids	
Subtotal				**$ 16,740.00**		
Mobilization & Demobilization						
Mobilization	1	LS	$ 15,000.00	$ 15,000.00	Engineering Judgment	
Demobilization	1	LS	$ 10,000.00	$ 10,000.00	Engineering Judgment	
Subtotal				**$ 25,000.00**		
Clear and Grub						
Clear and Grub	0.5	ACRE	$ 5,000.00	$ 2,500.00	RSMEANS 31 11 10.10 0200	
Clear Trees up to 24"	3	EA	$ 500.00	$ 1,500.00	RSMEANS 31 13 13 20 3150	
Engineered Fill Imported	9	TN	$ 25.00	$ 225.00	Recent Project Costs	
Engineered Fill Placed	4.5	CY	$ 40.00	$ 180.00	Recent Project Costs	
Subtotal				**$ 4,405.00**		
Erosion Control						
Straw bales	200	LF	$ 9.00	$ 1,800.00	RSMEANS 31 25 14 16 0600	
Silt Fence	200	LF	$ 10.00	$ 2,000.00	RSMEANS 31 25 14 16 1000 + markup	
Maintenance and Removal	1	LS	$ 1,500.00	$ 1,500.00	Engineer's Judgment	
Turbidity Barrier	0	LF	$ 30.00	$ -	Recent project bids	
Subtotal				**$ 5,300.00**		
Control of Water / Water Diversion						
Implement Drawdown	0	LS	$ 10,000.00	$ -	Engineer's Judgment	
Small Sand Bag	0	EA	$ 6.00	$ -	Engineer's Judgment	
Large Sand Bag	0	EA	$ 200.00	$ -	Engineer's Judgment	
Install and Remove Sand Bag	0	DAYS	$ 5,000.00	$ -	Engineer's Judgment	
Install and Remove Siphon/Bypass for drawdown	0	LS	$ 10,000.00	$ -	Engineer's Judgment	
Subtotal				**$ -**		
Embankment Work						
Regrade Upstream and Downstream Slope	460	CY	$ 40.00	$ 18,400.00	Engineering's Judgement	Assumed 1.5' of fill for USE
Import EF	690	TN	$ 25.00	$ 17,250.00	Engineering's Judgement	
Upstream & Downstream Slope Riprap	720	SY	$ 85.00	$ 61,200.00	RSMEANS 31 37 13 10 0200	
Import Riprap	810	TN	$ 40.00	$ 32,400.00	RSMEANS 31 37 13 10 0350	
Geotextile Fabric	720	SY	$ 6.00	$ 4,320.00	RSMEANS 3132 19 16 1550 plus markup	
Loam Crest	625	SY	$ 7.00	$ 4,375.00	RSMEANS 32 91 19 13 0800	
Import Loam	110	CY	$ 70.00	$ 7,700.00	MassDOT Price Bid	
Seed	625	SY	$ 4.00	$ 2,500.00	MassDOt Price Bid	
Subtotal				**$ 148,145.00**		
Spillway work						
Seal and Patch Concrete	1	LS	$ 20,000.00	$ 20,000.00	Engineering's Judgement	
Debris Removal	1	LS	$ 2,000.00	$ 2,000.00	Engineering's Judgement	
Subtotal				**$ 22,000.00**		
			SUBTOTAL	$ 221,590.00		
			Contract Bonds	$ 3,000.00		
			Design Contingency	**$ 77,700.00**	35%	
			OPINION OF PROBABLE CONSTRUCTION COST	**$ 303,000.00**		
			Engineering & Design	$ 30,000.00		
			Permitting	$ 15,000.00		
			Construction Phase Services	$ 15,000.00		
			OPINION OF PROBABLE CONSTRUCTION COST	**$ 363,000.00**		

PARE CORPORATION

Project:	Lake Winthrop Dam	**Project No.:**	21214/Task 203
Subject:	Opinions of Probable Costs		
Computation By:	MLP	**Date:**	June 2022
Check By:	ARO	**Date:**	June 2022

CONCEPTUAL DESIGN OPINION OF PROBABLE COST

Alternate 3: Dam Removal

Item	Quantity	Unit	Unit Price	Total	Source	Notes
General Bid Items						
Construction Trailer and Utilities	1.5	MON	$ 2,700.00	$ 4,050.00	Engineering Judgement	
Project Superintendent	1.5	MON	$ 8,200.00	$ 12,300.00	Engineering Judgement	
QC Plans	8	HR	$ 75.00	$ 600.00	Engineering Judgement	
Submittals	8	HR	$ 75.00	$ 600.00	Engineering Judgement	
Schedules	8	HR	$ 75.00	$ 600.00	Engineering Judgement	
Meetings	8	EA	$ 150.00	$ 1,200.00	Engineering Judgement	
Project Sign	1	LS	$ 1,000.00	$ 1,000.00	Engineering Judgement	
Proctor Tests	1	TEST	$ 225.00	$ 200.00	Laboratory Quote plus markup	
Sieve Analyses	1	EA	$ 110.00	$ 110.00	Laboratory Quote plus markup	
Concrete Sampling/Testing	0	EA	$ 500.00	$ -	Recent project bids	
Concrete Compression Tests	0	EA	$ 50.00	$ -	Laboratory Quote plus markup	
Field Density Testing	0	DAY	$ 500.00	$ -	Recent project bids	
Chemical Soil Tests	0	EA	$ 1,000.00	$ -	Recent project bids	
Subtotal				**$ 20,660.00**		
Mobilization & Demobilization						
Mobilization	1	LS	$ 30,000.00	$ 30,000.00	Engineering Judgment	
Demobilization	1	LS	$ 15,000.00	$ 15,000.00	Engineering Judgment	
Subtotal				**$ 45,000.00**		
Clear and Grub						
Clear and Grub	0.5	ACRE	$ 5,000.00	$ 2,500.00	RSMEANS 31 11 10.10 0200	
Clear Trees up to 24"	3	EA	$ 500.00	$ 1,500.00	RSMEANS 31 13 13 20 3150	
Engineered Fill Imported	9	TN	$ 25.00	$ 225.00	Recent Project Costs	
Engineered Fill Placed	4.5	CY	$ 40.00	$ 180.00	Recent Project Costs	
Subtotal				**$ 4,405.00**		
Erosion Control						
Straw bales	200	LF	$ 9.00	$ 1,800.00	RSMEANS 31 25 14 16 0600	
Silt Fence	200	LF	$ 5.00	$ 1,000.00	RSMEANS 31 25 14 16 1000 + markup	
Maintenance and Removal	1	LS	$ 3,000.00	$ 3,000.00	Engineer's Judgment	
Turbidity Barrier	50	LF	$ 30.00	$ 1,500.00	Recent project bids	
Subtotal				**$ 7,300.00**		
Control of Water / Water Diversion						
Implement Drawdown	1	LS	$ 5,000.00	$ 5,000.00	Engineer's Judgment	
Small Sand Bag	30	EA	$ 6.00	$ 180.00	Engineer's Judgment	0.5'x2'x1'
Large Sand Bag	20	EA	$ 200.00	$ 4,000.00	Engineer's Judgment	3'x3'x3'
Install and Remove Sand Bag	1	LS	$ 5,000.00	$ 5,000.00	Engineer's Judgment	
Subtotal				**$ 14,180.00**		
Structures Demolition						
Concrete/Wall Disposal	81	TN	$ 300.00	$ 24,300.00	Engineering's Judgement	
Channel Excavation	150	CY	$ 15.00	$ 2,250.00	Engineering's Judgement	
Dispose Material	150	CY	$ 25.00	$ 3,750.00	Engineering's Judgement	
Subtotal				**$ 30,300.00**		
Sediment Management						
Dredging & Disposal	TBD	-	-	$ -	Sediment Management Reqts Unknown	
Subtotal				**$ -**		

SUBTOTAL	$	121,845.00
Contract Bonds	$	2,000.00
Design Contingency	**$**	**42,700.00**
OPINION OF PROBABLE CONSTRUCTION COST	**$**	**167,000.00**
Engineering & Design	$	35,000.00
Permitting	$	75,000.00
Construction Phase Services	$	20,000.00
OPINION OF PROBABLE CONSTRUCTION COST	**$**	**297,000.00**

35%

APPENDIX C
Previous Reports and References
Lake Winthrop Dam
Holliston, Massachusetts

PREVIOUS REPORTS AND REFERENCES

The following documents were identified within the dam safety database or reference as part of this work:

1. "Lake Winthrop Dam - Change of Hazard Classification of Dam and Release from the February 22, 2008 Certificate of Non-Compliance and Dam Safety Order", Department of Conservation & Recreation, October 31, 2022.
2. "VIF-Jurisdictional Determination for Lake Winthrop Dam", Pare Corporation, December 3, 2021.
3. "Emergency Action Plan for Lake Winthrop Dam", Lenard Engineering. August 25, 2021
4. "Office of Dam Safety Poor and Unsafe Condition Dam Follow-up Inspection Form – Lake Winthrop Dam", Lenard Engineering. Date of Inspection: May 10, 2021
5. "6-Month Follow-up Dam Safety Visual Inspection – Lake Winthrop Dam", Lenard Engineering. Date of Inspection: November 26, 2018
6. "Lake Winthrop Dam Phase I Inspection/Evaluation Report", Lenard Engineering. Date of Inspection: October 13, 2017
7. "6-Month Follow-up Dam Safety Visual Inspection – Lake Winthrop Dam", Lenard Engineering. Date of Inspection: November 10, 2016
8. "6-Month Follow-up Dam Safety Visual Inspection – Lake Winthrop Dam", Lenard Engineering. Date of Inspection: June 13, 2013
9. "Lake Winthrop Dam Phase I Inspection/Evaluation Report", Lenard Engineering. Date of Inspection: June 8, 2012
10. "6-Month Follow-up Dam Safety Visual Inspection – Lake Winthrop Dam", Lenard Engineering, Date of Inspection: May 9, 2011
11. "6-Month Follow-up Dam Safety Visual Inspection – Lake Winthrop Dam", Lenard Engineering. Date of Inspection: November 16, 2010
12. "Follow up Inspection Report – Lake Winthrop Dam", Fuss & O'Neill. Date of Inspection: May 25, 2010
13. "Poor Condition Follow-Up Inspection – Lake Winthrop Dam", Pare. Date of Inspection: May 23, 2008
14. "Lake Winthrop Dam Phase I Inspection/Evaluation Report", Pare. Date of Inspection: February 13, 2007
15. "Municipally Owned Dam Inspection/Evaluation Report, Lake Winthrop Dam", Gifford, D.G. (Haley & Aldrich. Date of Inspection: May 5, 1999
16. "Lake Winthrop Dam Inspection Report", Smith, R.W. (CVP). Date of Inspection October 8, 1987
17. " Inspection Report – Dams and Reservoirs, Lake Winthrop Dam", Pare & Pizan. Date of Inspection: August 16, 1973

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
5. Massachusetts State Building Code Sec. 1612.4.9
6. Massachusetts Wetlands Protection Act Regulations 310 CMR 10.00

APPENDIX D
Common Dam Safety Definitions
Lake Winthrop Dam
Holliston, Massachusetts

COMMON DAM SAFETY DEFINITIONS

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

Orientation

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

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

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

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

Dam Components

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

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

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

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

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

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

Size Classification

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

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

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

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

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

Hazard Classification

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

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

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

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

General

EAP – Emergency Action Plan - Shall mean a predetermined 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, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

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

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

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