Public Facilities Committee Report

City of Newton
In City Council

Wednesday, September 9, 2020

Present: Councilors Leary (Chair), Kelley, Crossley, Norton, Laredo, Danberg, Gentile and Kalis

Also Present: Councilors Humphrey, Malakie, Bowman and Downs

City Staff Present: City Engineer Lou Taverna, Commissioner of Public Works Jim McGonagle, and Chief Operating Officer Jonathan Yeo

#331-20 **National Grid petition for grant of location in Crescent Square**
NATIONAL GRID petition for a grant of location to relay 127' +/- of 4" CI LP (cast-iron low pressure) gas main and 23' +/- of 4" PL LP (plastic low pressure) in Crescent Square with 150'+/- 6" PL LP (plastic low pressure) from Thornton Street to the end of the main. (Ward 1)

Action: **Public Facilities Approved 7-0 (Councilor Gentile not voting)**

Note: Mary Mulroney, a representative from National Grid, presented the request for a grant of location to relay 127' +/- of 4" CI LP (cast-iron low pressure) gas main and 23' +/- of 4" PL LP (plastic low pressure) in Crescent Square with 150'+/- 6" PL LP (plastic low pressure) from Thornton Street to the end of the main. Ms. Mulroney explained that this work is at the request of the Newton Water Department so this work should begin as soon as possible.

Committee members asked the following questions-

Q: Will the abutters be notified before this work begins?

A: Ms. Mulroney noted that the abutters will be notified.

Q: Why is this gas main being replaced?

A: Ms. Mulroney explained that this main needs to be relocated so that it is not in the way of the City's water main.

Q: Are there any capacity changes with the gas upgrades?

A: Ms. Mulroney explained that that there will not be an increase in capacity.

The Public Hearing was opened, with no member of the public wishing to speak the Public Hearing was closed.

Councilor Crossley motioned to approve which passed 7-0, Councilor Gentile not voting.

#133-20 Request for Ordinance Amendments to Chapter 5, Section 7

SOLID WASTE COMMISSION AND COUNCILOR LEARY requesting an ordinance change of Chapter 5 of the Revised Ordinances, Solid Waste Commission, Sections 7-50—7-54. The changes will revise the commission's name to the Sustainable Materials Management Commission to align with the updated name of the Sustainable Materials Management Division of the Department of Public Works. Additionally, requesting to reduce the maximum number of members to eleven from the current fifteen, add organics management and energy recovery to the commission's areas of interest; and define a quorum as a majority of the members then serving on the commission.

Action: Public Facilities Approved 7-0 (Councilor Gentile not voting)

Note: Marian Rambelle, Chair of the Solid Waste Commission, explained that the proposed new name will align with the new name of the Sustainable Materials Management Division, which the commission works with. Ms. Rambelle explained that the commission would also like to investigate organics management and energy recovery which would fall under the purview of Sustainable Materials Management. Additionally, Ms. Rambelle explained that currently the ordinance calls for the commission to have 15 members. Ms. Rambelle explained that the commission has never had 15 members. Currently the commission has 11 members and that has been sufficient. The Commission would also like to define a quorum as a majority of the members serving on the Commission.

Committee members thanked the Solid Waste Commission for the work they have done for the City.

Councilor Crossley motioned to approve which passed 7-0, Councilor Gentile not voting.

Referred to Public Facilities and Finance Committees

#366-20 Appropriate $150,000 for the rehabilitation of the Bullough's Pond Dam

HER HONOR THE MAYOR requesting authorization to appropriate and expend one hundred and fifty thousand ($150,000) from Acct # 6200-3240 Stormwater Management Fund Surplus for the purpose of funding engineering design services and permitting fees for the rehabilitation of the Bullough's Pond Dam.

Action: Public Facilities Approved 8-0

Note: Lou Taverna, City Engineer, presented the request to appropriate and expend $150,000 for the purpose of funding engineering design services and permitting fees for the rehabilitation of the Bullough's Pond Dam. Mr. Taverna explained that they have completed the

Phase 2 dam inspection report in which the City's consulting engineer did a complete evaluation of the dam. Bullough's Pond Dam is an embankment dam which is overtopped by Dexter Road. Mr. Taverna explained that the City had received a notice of noncompliance in 2017/2018 from the State's Office of Dam Safety which stated that the dam was in poor condition. The consulting engineer has created an emergency action plan should an emergency happen. Additionally, the consulting engineer has recommended some routine maintenance items and some major repairs to the dam as a precautionary measure. The major repairs include reinforcing the upstream slope and the downstream slope.

Mr. Taverna explained that the plan is to complete the final design and specifications of the major reinforcement of the upstream and downstream slopes of the dam. Also fix the low level outlet pipes that have old gates that need to be replaced. The minor repairs include tree removal along the embankment and other items that will help stabilize the dam if a storm were to happen. Mr. Taverna explained that these funds will also go towards the permitting process. The design consultant has provided five alternative plans for repairing the dam and the City chose the list invasive and the most cost effective alternative. The department will need to come back to the Council for the constructions funds once the design phase is complete.

<u>Committee members asked the following questions-</u>

Q: What does it mean to design the dam to hurricane standards and what standards is the dam built to now?

A: Mr. Taverna explained for a dam of this size the State requires the City to design the dam to be able to handle "Hurricane Sandy" level storms. Additionally, Mr. Taverna explained that currently there is a hazard downstream if the dam does break. The condition of the dam is characterized as poor and would not withstand a major storm. The repairs will reinforce the upstream and downstream slopes so that that the dam does not break.

Q: Will there be opportunity to have a site visit with abutters and councilors before any design decisions are made?

A: Mr. Taverna explained that they will have site visits and meetings with the Bullough's Pond Dam Association and other members of the public. The preferred alternative can still be changed at this time and these funds are just funding the engineering design and the permitting. Commissioner of the Public Works Department, Jim McGonagle, explained that the starting of the design is more than 30 days out and they can have a public meeting before that.

Q: Has the dam failed?

A: Mr. Taverna explained that there is no record of Dexter Road overtopping. The dam is not in a state of failing at this time.

Q: Will the City be looking for other agencies to finance this project?

A: Mr. Taverna explained that they are looking at grants that would be available for this repair.

Q: What is the schedule and construction cost for this project?

A: Mr. Taverna explained that the engineering consultant did provide an estimated construction cost based on the recommended plan, which would be $800,000 to $1,000,000. The goal is to complete design by June 2021 and start construction by next summer. This may require Dexter Road to be closed for a period time.

Q: What will be the impact on the trees and wildlife in the area?

A: Mr. Taverna explained that he has been in contact with Marc Welch, Superintendent of Urban Forestry and he is aware of this project. The trees on the embankment and within the downstream channel are the ones causing the most concern. The trees that surround Bullough's Pond are not the issue. Mr. Taverna explained that the tree roots of the ones that are on the embankment grow into the embankment and create voids. This can cause water to seep through the dam. The department will continue to investigate the impact to the trees in that area and will have a public meeting on the issue.

Kathleen Kouril Greiser, Vice President of the Bullough's Pond Association, expressed the Bullough's Pond Association's opinion on the current proposed design and explained that they are preparing a letter for the City Council expressing their concerns and explaining some alternatives. Additionally, Ms. Kouril Greiser expressed her approval of this project being looked at by the City because the dam has needed repair for some time. The Bullough's Pond Association does not agree with leveling the slopes around Laundry Brook, clear cutting the trees and covering the area with riprap gravel. Ms. Kouril Greiser explained that the area around Laundry Brook is considered a wildlife corridor by the Planning Department and is also a historic landscape in Newton. The Bullough's Pond Dam was built in 1664 to power Grist Mill and has historical significance to Newton. Ms. Kouril Greiser expressed the need for Bullough's Pond to be dredged before this work is done and would like the City to consider other alternatives. Ms. Kouril Greiser also stated that other communities are pushing back on the guidance from the State that there should not be trees in the embankment.

Commissioner McGonagle emphasized that the department is committed to working with the public on this project and that the department will still need to come back to the committee for the construction funding. Mr. Taverna added that these funds are needed to get the design consultants on board to advance this and be able to discuss the concerns that have been brought up. The department can also come back to the Public Facilities Committee to provide updates before the design has been completed.

Councilor Norton motioned approve which passed unanimously.

Referred to Public Facilities and Finance Committees

#367-20 **Appropriate $900,000 for the rehabilitation of the Waban Hill Covered Reservoir**
HER HONOR THE MAYOR requesting authorization to appropriate and expend nine hundred thousand dollars ($900,000) from Acct #6000-3240 Water Fund Surplus for the purpose of funding the rehabilitation of the Waban Hill Covered Reservoir.

Action: **Public Facilities Approved 8-0**

Note: Commissioner of the Public Works Department, Jim McGonagle, presented the request to appropriate and expend $900,000 for the purpose of funding the rehabilitation of the Waban Hill Covered Reservoir's central core. Commissioner McGonagle explained that the central core houses all of the infrastructure for the ten million gallon underground reservoir. This project is out to bid, and the cost is estimated at just under $900,000. The condition of the central core is shown attached to this report. Commissioner McGonagle explained that this project has been before the committee previously.

Committee members asked the following questions-

Q: When was this project first on the Capital Improvement Plan (CIP)?

A: Commissioner McGonagle explained that this was first on the CIP over five years ago and was first put out to bid approximately 3 years ago. Additionally, Commissioner McGonagle explained that they are confident that this will now lead to a complete project.

Q: What has changed with this project since the last time it went out to bid?

A: Commissioner McGonagle explained that the specs have changed, and the department has asked their consultants to share this project with contractors that normally do this work.

Q: Will this help with locating leaks in the reservoir?

A: Commissioner McGonagle stated that this project will help with leak detection. The core will need to be drained to fix the valves.

Councilor Laredo motioned to approved which passed unanimously.

#359-20 **Authorization to improve intersections on Allen and Beethoven Ave**
HER HONOR THE MAYOR requesting authorization to improve the traffic, pedestrian and bicycle safety at several intersections on Allen and Beethoven Ave near the Zervas Elementary School Pin in addition to slowing the vehicle speeds in the neighborhood around the Zervas School.

Action: **Public Facilities Approved 7-0-1 (Councilor Kalis abstaining)**

Note: Commissioner of the Public Works Department, Jim McGonagle presented the request for authorization to improve the traffic, pedestrian and bicycle safety at several intersections on Allen and Beethoven Avenue near the Zervas Elementary School Pin in addition to slowing the vehicle speeds in the neighborhood around the Zervas School. Commissioner McGonagle explained that DPW and the Public Buildings Department had committed to these improvements during the construction of the Zervas School. This is to improve safety around the school and the design has been coordinated with the Newton Fire Department.

For Beethoven Avenue at Puritan the department will construct a raised table to slow down traffic.

For Allen at Pine Ridge the department will create traffic calming curb bump-outs on both sides, reconstruct the ADA ramps, construct a new crosswalk for better access to Richardson's field and create additional space on the sidewalk for an existing bus stop.

For Allen at Plainfield the department will construct traffic calming bump outs on both sides, construct ADA ramps and create a new crosswalk across Allen for approved access to Richardson's field.

Commissioner McGonagle explained that the construction cost is estimated at $310,000 for all three projects. $200,000 is part of the Zervas School construction fund for off site improvements and the other $110,000 will come from the department's operating budget for traffic calming that is budgeted for every year.

<u>Committee members asked the following questions-</u>

Q: Are their goals for the level of safety in the area?

A: Commissioner McGonagle explained that have all of the data from the traffic study, which measures things like speed and crashes so the department will have a baseline to compare it to after the project is completed.

Q: What is the timing for these projects?

A: Commissioner McGonagle explained that the goal is to start construction in spring/early summer 2021.

Q: Is there a need for two crosswalks on Allen Avenue?

A: Commissioner McGonagle explained that through their investigation it was determined that both crosswalks are necessary.

Q: Who was involved in this project?

A: Commissioner McGonagle explained that the department has been working with Safe Routes to Schools, the Zervas School community and the City's own transportation department conducts the traffic calming evaluation. Mr. Taverna added that this project was reviewed but the Complete Streets Committee.

Q: Is there directed patrols in this area and would this project help with decreasing the police budget in the area?

A: Chief Operating Officer, Jonathan Yeo, explained that directed patrols do not cost the City any additional funds. A directed patrol is what an officer would do while waiting for a call.

Committee members made the following comments-

The addition of two crosswalks at Allen Ave may not be necessary and there are other traffic calming projects in the City that could use those funds.

Regarding the previous comment, Commissioner McGonagle expressed that he agrees that there are other areas in the City that need traffic calming measures taken but this work is necessary at this time.

This is a school safety zone that has a number of problems and as a part of building the Zervas School the City made a commitment to the community to address these safety issues.

Residents do tend to cross at both sides of Allen Avenue coming from Richardson's Field, so both crosswalks are necessary.

This project should have been done before the children entered the school, but it was delayed and needs to be completed now. The City does need to be proactive with this project.

John Rice, former Ward 5 Councilor, expressed his approval for the project. Mr. Rice explained that he worked on this project for a number of years and had many meetings with the community to hear what the safety concerns are in the area.

Jesse Corey, 64 Oak Cliff Road, expressed his approval of the project because with Covid-19 more children may be walking to school this year and will be able to do so safely with the painted crosswalks.

Joseph Sypek and Cynthia Theodof, 101 Allen Ave, expressed their approval of the project. They have lived at the address for many years and have witnessed many near accidents in the area around their home. Ms. Theodof questioned where the bus stop would be after the improvements are completed?

Commissioner McGonagle explained that he can answer this question at a future time.

Councilor Crossley motioned to approve which passed 7-0-1, Councilor Kalis abstaining.

#360-20 Acceptance of an easement on Terrace Avenue
HER HONOR THE MAYOR requesting the acceptance of a 20' wide easement in property known as 47 Terrace Avenue and adjacent City property (Ward 6).
Action: Public Facilities Approved 8-0

Note: City Engineer, Lou Taverna, presented the request for the granting of a 20' wide easement in property known as 47 Terrace Avenue and adjacent City property. This deals with a sewer service pipe that runs across surplus City property into a sewer main. In 2011 the property at 47 Terrace Ave experienced a septic system failure and were directed by the Public Health Department to correct the situation. The simplest solution for them was to run a sewer service in the rear of property, through City property, into a City sewer main. This work was an emergency, so it was done first, and the plan was to receive the easement afterwards. The residents next door to 47 Terrace Ave were having a similar problem and the neighbors were to negotiate a deal to connect to their sewer service pipe but this did not happen. The land is under the control of the Mayor and the City Council must authorize the easement.

Councilor Danberg motioned to approve which passed unanimously.

The Committee adjourned at 8:29 p.m.

Respectfully Submitted,

Alison M. Leary, Chair

366-20

City of Newton, Massachusetts
Office of the Mayor

RUTHANNE FULLER
MAYOR

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August 31, 2020

Honorable City Council
Newton City Hall
1000 Commonwealth Avenue
Newton Centre, MA 02459

Councilors:

I respectfully submit a docket item to your Honorable Council requesting authorization to appropriate and expend the sum of $150,000 from Acct # 6200-3240 Stormwater Management Fund Surplus – Available for Appropriation for the purpose of funding engineering design services and permitting fees for the rehabilitation of the Bullough's Pond Dam, NID No. MA03414, Newton, MA.

Bullough's Pond Dam is an approximately 170-foot long earthen embankment. The top of the embankment is the asphalt-paved Dexter Road. The water level in Bullough's Pond is maintained via an uncontrolled 35-foot-long spillway located toward the middle of the embankment and a gated twin 24-inch diameter low-level outlet, located on the left or west side of the embankment. The upstream and downstream slopes are grassed and heavily vegetated with woody brush and trees. The Massachusetts Office of Dam Safety (OSD) database indicates that Bullough's Pond Dam is a Small size structure with a Significant Hazard Potential.

The project scope and fee are attached. Thank you for your consideration of this matter.

Sincerely,

Ruthanne Fuller

Ruthanne Fuller
Mayor

City of Newton

DEPARTMENT OF PUBLIC WORKS
OFFICE OF THE COMMISSIONER
1000 Commonwealth Avenue
Newton Centre, MA 02459-1449

Ruthanne Fuller
Mayor

Date: August 27, 2020

To: Mayor Ruthanne Fuller

From: James McGonagle, Commissioner

Subject: Request for Docket Item and Funding
Bullough's Pond Dam Rehabilitation Engineering Design Services

I respectfully request an appropriation of $150,000.00 for engineering design services and permitting fees for the rehabilitation of the Bullough's Pond Dam, NID No. MA03414, Newton, MA. See scope and fee attached.

Bullough's Pond Dam is an approximately 170-foot long earthen embankment. The top of embankment is asphalt-paved Dexter Road. The water level in Bullough's Pond is maintained via an uncontrolled 35-foot-long spillway located toward the middle of the embankment and a gated twin 24-inch diameter low-level outlet, located on the left or west side of the embankment. The upstream and downstream slopes are grassed and heavily vegetated with woody brush and trees. The Massachusetts Office of Dam Safety (OSD) database indicates that Bullough's Pond Dam is a Small size structure with a Significant Hazard Potential.

The Phase 2 dam inspection and report has been completed by our consulting engineers, GZA Geo-Environmental, Inc. The report recommends rehabilitation of the dam structure.

Numerous inspections since 2017 found the dam to be in poor condition. Reported deficiencies in the follow-up inspections include:

- Unwanted vegetation in areas of the dam including large trees along the downstream slops;
- Scarping along the upstream slope and bare soils prone to erosion along the downstream slope;
- Areas of displaced stones from the low-level outlet downstream headwall;
- Area of scour along the downstream channel including at the low-level outlet and along the left and right banks. If erosion of the left bank continues, it could encroach on the toe of the downstream slope;
- Mortar missing from some joints of the spillway training walls;
- Additional unspecified maintenance deficiencies and potential dam safety concerns.

The Phase 2 dam inspection report presented some alternatives for repairs to the dam. Alternative 5, substantial reinforcement of the upstream and downstream slopes, among many other recommendations, has been selected as the preferred alternative.

Telephone: 617-796-1009 • Fax: 617-796-1050 • Jmcgonagle@newtonma.gov

Design funds are requested at this time to begin and complete the design of the repair work. Our consulting engineers are GZA Geo-Environmental, Inc. Construction funds will be requested once design is completed. Please docket this item with the honorable City Council for consideration.

Sincerely,

James McGonagle
Commissioner Public Works

Attachments:

Scope and fee dated July 24, 2020

Telephone: 617-796-1009 • Fax: 617-796-1050 • Jmcgonagle@newtonma.gov

Alternative 5: Armor Downstream Slope to Provide Overtopping Protection

This alternative includes armoring of the embankment to allow overtopping during the spillway design flood while mitigating potential erosion and scour failure of the embankment. Under existing and proposed conditions, the dam would be overtopped by approximately 0.2 feet. There are different methods of slope armoring available, all of which have the same goal: to protect the earth from the flow and turbulence of flood water that tends to erode the embankment, thus leading to dam failure. There are three main categories of slope armoring:

1. Pre-cast, Articulated Concrete Blocks (ACB) 2. Stone Riprap 3. Turf Reinforcement Mats (TRM) 4. Gabions
All of these are proven methods for overtopping protection. They are selected based on the depth of overtopping, flow velocities, and duration of overtopping. Each of these armor alternatives comes in different sizes and strengths, depending on individual site constraints. Since upstream slope protection is envisioned under all five alternatives, the upstream and downstream slopes could be designed to use the same armoring and would appear similar.

Placing riprap on the slope is a natural and low-labor solution. Stones would be dumped downslope and chinked into place using smaller stones. The riprap also helps to establish a stable slope; however, public access would be difficult due to irregular footing. In addition, maintenance of the riprap would likely be needed as the stones may be displaced over time or by vandalism, especially in public areas. Gabions could be used to armor the slope in a stepped fashion. During final design, it is likely that the gabions will require concrete facing of horizontal surfaces to resist scour. A filter or drainage layer would likely be needed for either riprap or gabions.

Unlike riprap, ACBs provide a physically flexible option for erosion protection. They are not intended for slope stabilization and slope stability must be established before implementing and ACB system. ACB systems are composed of pre-formed concrete blocks that are interconnected by cables. The blocks conform to changes in the subgrade and provide protective cover. Topsoil can be placed in and over open-cell ACBs to allow vegetation to be established, which can improve aesthetic appeal. In an ACB system, the contact between the ACB's and the subgrade is paramount. A filter or drainage layer is needed in the design of ACB systems. Flow beneath the armor layer can cause uplift pressure and separate the blocks from the subgrade.

Turf Reinforcement Mats (TRMs) are generally not as erosion-resistant as riprap or ACBs, but have been used and approved by ODS in the past as embankment dam overtopping protection. TRMs are a permanent, cost effective and environmentally friendly alternative to hard armor erosion protection solutions. TRMs essentially consist of ultraviolet light and chemical resistant synthetic polyolefins manufactured to create a flexible three-dimensional matrix. Seed and soil are held in place within the matrix. As the vegetation matures, roots and stems inter-twine with the matrix, creating a "Biotechnical Composite" that is permanently anchored to the soil greatly enhancing the turfs' ability to withstand high shear stresses and flow velocities. With adequate care, a visitor to the site would see only a grassed slope within a growing season. At the upstream water level, a different material such as riprap would be necessary to resist scour. This alternative would also require repointing of the spillway training walls.

The conceptual cost estimate for armor using either TRM or ACBs is $700,000 to $800,000. Armoring using riprap would be on the order of $850,000 to $950,000. In GZA's opinion, armoring the downstream slope to allow it to withstand the SDF is the preferred alternative.

Additional Repair Considerations

DCR may reclassify Bulloughs Pond Dam as a High Hazard potential, dam. This reclassification would increase the Spillway Design Flood (SDF) per Massachusetts Dam safety regulations. Hazard Classification and SDF should be re-evaluated during final design. Each of the first four alternatives is not scalable in that if additional storage or outflow capacity is required after construction, significant dam modifications could be required. The preferred (fifth) alternative is scalable in that additional or more robust overtopping protection could be considered in the final design and installed at the present time to accommodate future changes in SDF outflow.

The following additional construction and contractual items may be necessary to support final design, depending on the selected alternative.

- Replacement of the two 24-inch diameter gate valves. The current valves are functional, but they may be nearing the end of their service life.
- A property line survey will be required for final design.
- Traffic impact studies may be necessary, depending on the alternative chosen.
- Temporary or permanent easement agreement(s) with nearby property owners for temporary access to work areas or location of permanent features to be constructed on adjoining properties.

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July 24, 2020
File No. 01.P000330.21

Louis M. Taverna, P.E.
City Engineer
City of Newton Department of Public Works
1000 Commonwealth Avenue
Newton, Massachusetts 02459

RE: Proposal for Final Design and Permitting Services
Bulloughs Pond Dam, NID No. MA03414
Dexter Road, Newton, Massachusetts

Dear Mr. Taverna:

Based on your recent request, GZA GeoEnvironmental, Inc. (GZA) is pleased to provide the City of Newton (City/Client) with this proposal / scope of services for dam safety engineering services at the Bulloughs Pond Dam on Dexter Road in Newton, Massachusetts (Site). The objective of our proposed services for the City is to provide final design, permitting, preparation of bidding documents, and bid administration assistance for rehabilitation of the Bulloughs Pond Dam.

PROJECT UNDERSTANDING

Bulloughs Pond Dam is an approximately 225-foot long, 14.5-foot high earthen embankment. The dam is currently an **Intermediate** size, **Significant Hazard Potential** structure. GZA has provided previous dam safety services for the City, including an Emergency Action Plan[1] (EAP) required by Dam Safety Regulations[2], Follow-up inspections necessitated by a prior Poor Condition rating (by others), and a Phase II investigation, evaluation and Report[3]. The Phase II Report forms the basis of the repair scope of services presented below.

The top of Bulloughs Pond Dam embankment is asphalt-paved Dexter Road with a bridge over the spillway. The upstream and downstream slopes are grassed and heavily vegetated with woody brush and trees. The embankment slopes are inclined at approximately 2 horizontal to 1 vertical (2H:1V) on both the upstream and downstream sides, with locally steeper upstream slopes where scarping has occurred near the normal pool level. There is an apparent roadway drain pipe outlet on the downstream embankment and another apparent drain outlet the right abutment downstream of the spillway. According to historic drawings provided by the City, a concrete core wall is present along the length of the dam embankment. The core wall was probed during the Phase II investigations.

The water level in Bulloughs Pond is maintained via an uncontrolled 35-foot-long spillway located upstream of the Dexter Road bridge. An additional downstream weir is located below

[1] "Bulloughs Pond Dam Emergency Action Plan," prepared by GZA, dated May 22, 2020
[2] 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002
[3] "Phase II Engineering Evaluation & Alternatives Analysis" prepared by GZA, dated May 22, 2020

the bridge. Low flows can be passed via two gated 24-inch diameter cast iron low-level outlet pipes located toward the left (west) end of the embankment. The gates valves are located in a vault in the upstream slope and are reportedly exercised by City personnel on a yearly basis.

Based on prior inspections by others, the dam was judged to be in overall Poor condition. In response to the Poor condition rating, the Massachusetts Department of Conservation and Recreation, Office of Dam Safety (DCR or ODS) issued a Certificate of Non-Compliance and Dam Safety Order dated July 16, 2018. The DCR Order required the City to complete follow-up inspections at six-month intervals, a Phase II Inspection and Investigation (Phase II evaluation), and rehabilitate the dam to bring it into compliance with current dam safety regulations.

Our Phase II evaluation confirmed the condition of the dam and identified the following specific deficiencies, which were generally consistent with previous inspections:

- Inadequate minimum freeboard during the SDF and the potential for embankment overtopping.
- Inadequate calculated factors of safety for embankment seepage stability and slope stability.
- Unwanted vegetation in areas of the dam including large trees along the downstream slope.
- Scarping along the upstream slope and bare soils prone to erosion along the downstream slope.
- Deterioration/potentially unstable headwall at the downstream end of the low-level outlet.
- Areas of scour along the downstream channel including at the low-level outlet headwall and along the left and right banks.
- Mortar missing from some of the spillway training wall joints.

Bulloughs Pond Dam is currently classified by DCR as a Significant Hazard structure. Results of the dam breach analysis completed as part of the EAP suggest that the dam could be reclassified by DCR as a High Hazard Potential structure due to homes located within the inundation area. If DCR re-classifies Bulloughs Pond Dam as a High Hazard structure, the regulatory basis for the Spillway Design Flood (SDF) will increase from a 100-year storm to one-half of the Probable Maximum Flood (½ PMF). Accordingly, the scope of services presented below includes consideration of the SDF consistent with a High Hazard rating. This will require additional hydrologic and hydraulic (H&H) analyses during final design and will likely result in similar, but more robust overtopping protection as described below.

Our Phase II report presented several alternatives to repair the above deficiencies and bring the dam into compliance with current dam safety regulations. The preferred alternative (Alternative 5) included protecting the embankment against overtopping during the SDF while mitigating potential erosion and scour failure of the embankment. Repairs associated with the preferred alternative generally include:

- Removal of trees and vegetation on the upstream and downstream slopes. Removal of all roots/root balls associated with trees and vegetation and backfilling resulting voids with compacted sand/gravel.
- Regrading and armoring of the upstream slope with riprap to increase slope stability and reduce erosion (scarping) along the normal water elevation.
- Flattening and armoring of the downstream slope to increase slope stability and provide erosion protection during an overtopping event. GZA will use the flow depths and velocities predicted by the additional H&H analyses to refine our recommendations regarding armoring methods described in the Phase II Report.

Improvements to the downstream slope will also include a purpose-designed mineral filter and seepage collection (i.e. pipes), if feasible based on elevations and potential drain pipe outfall locations.

- Upward extension of the core wall to help address seepage instability.
- Armoring of the downstream channel to mitigate erosion, including at the right groin, portions of the outlet channel, and along the toe of the downstream slope.
- Lining of the two low-level outlet pipes and replacement of the two existing 24-inch gate valves. It is assumed the two gates will be replaced 'in-kind.'
- Repointing of existing training walls and bridge abutment walls.

Additional engineering investigations and analyses are necessary to confirm and finalize elements of the design such as required grading, hydrology and hydraulics for the appropriate SDF, overtopping protection materials and details, seepage filter materials and configuration, discharge channel armoring, Low-level outlet (LLO) improvements including gate replacement and pipe lining, and repairs to the concrete and stone masonry components of the dam. Final design will include considerations such as construction site access and staging areas at the site. Alteration, evaluation, or replacement of the Dexter Road spillway bridge is not included in our scope of services below. Permitting requirements will be verified and permit applications will be prepared and submitted on behalf of the City as described in the following Scope of Services. Items we will need from the City are noted in ***bold italics***, below.

SCOPE OF SERVICES

GZA proposes the scope of services described below to address the above deficiencies and help bring the dam into better compliance with current dam safety regulations. The proposed scope includes permitting, final design, preparation of bid documents, and bidding assistance. We can provide a proposal (or amendment) for engineering services during construction once the elements of the design are better defined during final design.

TASK 1 – PROJECT KICK OFF MEETING

Upon notice to proceed, GZA will meet with City Engineering staff at a kick-off meeting to discuss various technical and project management issues, including the following:

- Review existing data, dam operations, and site constraints that may impact the proposed design and construction including site access, construction staging, utilities, road closures, adjacent properties, etc.
- Obtain any additional existing information (including design drawings, operational information, subsurface information, observations, etc.) available in the City archives not already provided as part of the Phase II evaluation.
- Review the proposed conceptual design, design objectives, and engineering methodologies.
- Discuss operational issues associated with the current LLO gate operation and potential for gate upgrade or replacement. Discussion of gate vault dewatering and entry protocols and need for Confined Space Entry (CSE) Permits will be included.
- Discuss City's bathymetric survey methods and results and the need for additional sediment probes and sampling on upstream slope and near low-level outlet as discussed in Task 3 below.

- Considerations and approach to dewatering. Discuss desired construction phase pond levels and need for temporary cofferdam. Please note that pond levels during construction will have significant impacts on environmental permitting as discussed below.
- Provide overview of project schedule (i.e. key milestones, timing of deliverables, advertising and construction notice to proceed, etc.).
- Final bid document formats and contents.
- Public outreach efforts (see public outreach subtask in Environmental Permitting section below).
- Project liaison, project administration, invoicing procedures, etc.

As part of this Task, we will make a brief visit to the dam site with City personnel to observe current conditions and discuss the various deficiencies, associated rehabilitation design concepts, and site access and staging areas for construction. ***We assume that the City will provide the location of above- and below-ground utilities, City-owned property boundaries (and easements) at and adjacent to the site to support the final design effort in AutoCAD format.*** This is particularly important for the property boundary at the right abutment where erosion protection will be installed at or near the property boundary.

TASK 2 – RESPONSE TO ODS PHASE II COMMENTS

ODS issued comments to the Phase II Report on July 9, 2020. The comments were characterized by ODS as "minor," however we recommend the comments be addressed prior to proceeding with final design. We will issue email responses to ODS and submit a revised Phase II Report as necessary.

TASK 3 – ADDITIONAL FIELD INVESTIGATIONS AND LABORATORY TESTING

Prior to our field activities, GZA will prepare a site-specific health and safety plan (HASP) for our employees' use in the field. Our HASP will include procedures per the Commonwealth of Massachusetts COVID-19 guidelines and procedures for all construction sites and workers at all public work[4] and a CSE permit, if necessary.

GZA will conduct the following site visits and investigations to support final design efforts:

- One half-day site visit to complete additional (hand-excavated) subsurface investigations to explore the thickness of topsoil in areas to be stripped during construction and to obtain samples to support the downstream slope filter design. Up to three samples will be obtained from proposed filter areas and submitted to a geotechnical testing laboratory for particle gradation (sieve) analyses.
- Probes for soft sediment thickness in upstream areas to support design of upstream slope improvements and evaluation of dewatering options. We anticipate up to five probes at three cross-sections (15 probes total) will be taken by boat access in a one-day site visit. Boat insertion will be at the eastern shore of the pond off Bullough Park. If the boat has been in the water in the 2 weeks prior to usage at Bulloughs Pond, we will power wash to mitigate potential import of Zebra Mussels. To comply with health and safety requirements for in-water work near a potentially active spillway, we require that you lower the pond below the spillway crest prior to our probing.

[4] https://www.mass.gov/covid-19-guidelines-and-procedures-for-all-construction-sites-and-workers-at-all-public-work as of April 16, 2020

- Sediment samples to support soil/sediment management for work on the upstream slope. Three samples will be collected during the sediment probes described above. The sediment will be sampled with a hand auger or by driving a 2-inch inner-diameter clear Lexan tube into the pond bottom until refusal or to the depth practicable.

  The samples will be submitted for sieve/grain size and environmental chemistry analyses. The sieve analyses will result in a graphical representation of the grain size distribution of all material encountered with the sampler that is larger than a No. 200 sieve and smaller than about 2-inch size.

  The sediment samples collected will also be analyzed for quality as required under 314 CMR 9.07 for the submission of a 401 Water Quality Certificate (WQC) permit application. The sediment testing will also include the following analyses:

  - The following metals: Arsenic, Cadmium, Total Chromium, Chromium V, Copper, Lead, Mercury, Nickel, Zinc,
  - Extractable Petroleum Hydrocarbons (EPH),
  - Volatile Organic Compounds (VOCs),
  - Polycyclic Aromatic Hydrocarbons (PAHs),
  - Polychlorinated Biphenyls (PCBs),
  - Pesticides 8081,
  - Total Petroleum Hydrocarbons (TPH) 8100,
  - Total Organic Carbon (TOC),
  - Percent Water.

  Additional testing may be required if the concentrations of metals or organic compounds are equal to or greater than the theoretical concentration at which Toxicity Characteristic Leaching Procedure (TCLP) criteria may be exceeded. Additional TCLP testing, if required, has not been included in the project budget.

- GZA will engage a specialty subcontractor to perform a video inspection of the existing LLO discharge pipes downstream of the gates. Portions of the pipes upstream of the gates will not be inspected. Results of the LLO pipe surveys will be used to develop the relining and valve replacement/rehabilitation designs and to reduce the potential for unanticipated conditions and associated delays and change orders during construction. We assume the video inspection(s) can be completed in one day.
- One site visit to observe the existing condition and configuration of the existing LLO gate valves. ***We will need the City to pump out the valve chambers and access the chambers to document existing conditions and obtain any required measurements under their existing gate vault entry protocols.***

The City completed wetland resource flagging and topographic and bathymetric survey as part of the Phase II evaluation. ***We assume that, if required, the City will reflag wetland resource areas as needed and complete additional topographic and bathymetric survey as required to support final design and permitting. We will also need the City to provide a property line survey for final design as described in Task 1 above. We assume that traffic impact studies and construction zone traffic safety plans are not required for permitting, design, or construction.***

TASK 4 – ADDITIONAL ENGINEERING ANALYSES, DESIGN COMPUTATIONS AND DESIGN REPORT

GZA will complete additional engineering analyses to support final design and preparation of design drawings and specifications for dam rehabilitation as follows:

- Revised Hydrologic and Hydraulic (H&H) analyses will be performed to consider the ½ PMF spillway design flood (SDF) to accommodate potential future reclassification as a High Hazard Potential structure by DCR. This is

intended to allow the final design to accommodate potential hazard reclassification and corresponding increase in SDF overtopping flow depth and velocity. We assume that modifications to Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) will not be required since the hydraulic capacity of the existing spillway will not be altered. Our scope of services does not include FIRM map modifications.

- Slope stability and seepage analyses to confirm the final design geometry and physical requirements of the proposed embankment cross-section including slope inclinations, filter/drain configuration, and core wall extension.
- Final selection and sizing of the selected armoring alternative. As part of this sub-task, we will develop alternatives for the current 100-year SDF and the potential future ½ PMF, along with conceptual premium pricing to help the City select a technically feasible and financially appropriate armoring alternative.
- The above analyses will be documented in a design report that will be submitted with the permit applications as described below.

TASK 5 – FINAL DESIGN AND DEVELOPMENT OF PLANS AND SPECIFICATIONS

GZA will design embankment improvements and repairs to the LLO and training walls including overtopping and slope protection, grading and drainage features for the downstream slope, LLO improvements including relining and gate replacement or rehabilitation, and other civil design elements of the project as generally discussed in the Phase II Report and Task 1 project kickoff. We will prepare draft (approximately 75 percent level) design plans, technical specifications, and an updated opinion of probable construction costs for the proposed dam rehabilitation for review by the City. We have assumed that the City will prepare up-front boilerplate (e.g. bid instructions, agreement, insurance and bonding requirements) and that GZA will provide technical specification sections. We anticipate developing bidder qualification requirements to be integrated with the City's up-front bid instructions. The intent of the bidder qualification requirements will be to solicit bids from Contractors that are experienced, qualified, and have successfully completed similar dam rehabilitation projects.

We anticipate the drawings will include the following sheets:

1. Title/Cover Sheet;
2. General Notes and Legend;
3. Existing Conditions Plan and Resource Area Delineation;
4. Sediment, Erosion, and Water Control Plan;
5. Site Temporary Access and Staging Areas;
6. Final Conditions & Grading Plan;
7. Typical Cross Sections of Embankment Modifications;
8. LLO repairs including pipe lining and gate replacement; and
9. General Details including miscellaneous stone masonry repairs.

Following input from City, GZA will finalize the 75% design plans and technical specifications for permit filing and bidding. The design report included in Task 4, above, and the final drawings and technical specifications prepared under Task 5 will serve as the primary document for submission with the Chapter 253 permit application package.

At the 75 and 100 percent stages, GZA will also provide an engineer's estimates for proposed construction costs. GZA's cost estimates will be based on our quantity take-offs and on unit prices based on recent experience with other dam

rehabilitation projects, published MassDOT Bid tabulations, and general cost estimating guidance. GZA assumes this project will be bid under MGL Ch. 30 § 39M.

GZA will develop specifications suitable for bidding and construction purposes for the rehabilitation of the dam. GZA will prepare technical specifications for the project to describe the work and the basis of measurement and payment for individual pay items. Two (2) hard copies of the final contract plans and technical specifications will be stamped and signed by a Professional Engineer licensed in the Commonwealth of Massachusetts. GZA will provide the City with electronic versions of the final plans and technical specifications for inclusion in the City-prepared contract document package.

Deliverables:

- Design Report (.pdf versions).
- Draft Technical Specifications and Drawings (.pdf version).
- Final Technical Specifications and Drawings (2 hard copies + .pdf version).
- Engineers Cost Estimate at 75 and 100 percent (.pdf versions).

TASK 6 – OPERATIONS AND MAINTENANCE (O&M) PLAN

GZA will prepare an Operation and Maintenance (O&M) plan for future dam operation. The O&M plan will indicate routine maintenance items including measures to control vegetation on the dam, recommended observations for seepage, erosion and other indicators of stability problems with the embankment portions of the dam, recommended instrumentation (if applicable), and LLO operation and maintenance recommendations. An O&M plan will be required as part of the Chapter 253 Dam Safety Permit described below.

TASK 7 – ENVIRONMENTAL PERMITTING ASSISTANCE

GZA will prepare permit applications and supporting documents on behalf of the City for required construction permits for Bullough Pond Dam. ***We anticipate that the City will provide property information (book and page) for the site. We also assume that the City will provide any field assessments (i.e., additional wetland delineation or wildlife assessments) required for permit submission not included in Task 3, above.***

We anticipate the following permits will be required for rehabilitation of Bulloughs Pond Dam:

- Wetland Protection Act (WPA) Notice of Intent (Newton Conservation Commission / MADEP[5]) – GZA will prepare a Notice of Intent (NOI) requesting a full Order of Conditions (OOC) authorizing the rehabilitation of the Dam under the WPA and City Wetland Bylaws.. The NOI will discuss impacts to resource areas. The application will be filed with the City of Newton Conservation Commission. "Limited project status" will be sought. GZA will attend one site visit and up to two virtual public hearings with the Conservation Commission to discuss the permit application. Additional meetings with the Conservation Commission may be required but are outside this scope of services. For budgeting purposes, GZA has assumed that, following submittal of the Draft NOI to the City, GZA will need to respond to one round of comments.

- Chapter 253 Dam Safety Repair Permit (Office of Dam Safety) – GZA will prepare and submit an application for repair of the dam to ODS. The finalized design report, drawings, technical specifications, and O&M plan will be used to support this permit application.

[5] Massachusetts Department of Environmental Protection (MADEP or DEP)

- Project Notification Form (Massachusetts Historical Commission) – Because the project will require a state permit (Chapter 253), a Project Notification Form (PNF) will need to be filed with the Massachusetts Historic Commission (MHC) in accordance with 950 CMR 71.00. GZA will prepare and submit the PNF. We will report any historic information which is available from GZA and City files, but will not do any additional historical research. GZA's role will be to complete the form in the proper format, provide maps, photos, and figures, and reproduce the documentation. We have assumed that no additional historical documentation or mitigation will be necessary.

- Chapter 91 Waterways Office Notification Letter (MassDEP) – GZA has preliminarily reviewed the project in reference to Massachusetts Waterways Regulations. It is our opinion that any proposed activities at the dam do not require a Chapter 91 license or permit, as per the provisions contained 310 CMR 9.05(3)(g)(4) of the Chapter 91 regulations. Rehabilitation of the upstream slope of the dam is anticipated to be generally within the current footprint and will not adversely affect navigation. However, it is noted that this structure is unlikely to have been licensed in the past and the DEP may take this opportunity to request the City obtain a license. At this stage, GZA proposes to only to prepare and submit a notification letter or Chapter 91 Request for Determination of Applicability (RDA) to the DEP Waterways office. For budgeting purposes, GZA has assumed that, following submittal of the Draft Notification Letter or RDA to the City, GZA will need to respond to one round of comments from the City. GZA assumes up to one virtual meeting with Chapter 91 Waterways staff to discuss the project.

- Section 401 Water Quality Certification (MassDEP) – MassDEP may require a Water Quality Certification (WQC) for dredging below the water table or within wetlands. At this time, we anticipate some minor dredging along the upstream face of the dam will be needed to facilitate placement of protective riprap. Additionally, minor dredging activities may be needed along portions of the embankment toe and discharge channel to place protective riprap and/or other armoring materials. We will consult with the MassDEP as to whether a Section 401 permit is required for this work, but we currently believe that the OOC will serve as our WQC. GZA assumes one virtual meeting with MassDEP as part of this effort. In addition, GZA will request a waiver of replacement of bordering vegetative wetlands lost, if any. If not, GZA will prepare and apply for either an Excavate/Fill Permit or a Dredge Permit. Our scope of work and fee do not currently include the preparation of an Excavate/Fill Permit.

- Section 404 Permit (US Army Corps of Engineers) –GZA anticipates that this project will require a Pre-Construction Notice (PCN) under Massachusetts General Permit Nos. 1 and 14. GZA will consult with the US Army Corps of Engineers (USACE) to confirm this opinion. GZA will prepare and submit a PCN Form under the applicable General Permits. For budgeting purposes, GZA has assumed that, following submittal of the Draft PCN to the City, GZA will need to respond to one round of comments. GZA assumes one virtual pre-application meeting with the USACE to discuss project activities and coordinate the application for appropriate Massachusetts General Permits.

- Massachusetts Environmental Policy Act (MEPA) approval – GZA does not currently anticipate that the dam rehabilitation project will exceed any MEPA thresholds for a mandatory Environmental Notification Form (ENF) and/or Environmental Impact Report (EIR). MEPA thresholds are exceeded when a state-level Permit is required for a project. Should a Chapter 91 license or a 401 Water Quality Certification from MassDEP be required, a MEPA ENF may be required. An ENF is likely to be required if the pond is significantly drawn down for construction. We therefore propose to coordinate with the MEPA office to ascertain MEPA jurisdiction of the proposed rehabilitation project. GZA assumes one virtual meeting to support this effort. If the City wishes, we could also request a formal Advisory Opinion from the MEPA office.

GZA's understanding of permitting requirements and scope are based on the following assumptions:

- The existing delineation of Wetlands Protection Act resource areas within the project limits by the Newton Conservation Agent are accepted as jurisdictional boundaries and will be used for impact assessment purposes. Information collected during the delineation, included data sheets, photographs and a written narrative describing each resource area assessed, will be provided to GZA for use in preparation of the NOI and USACE 404 PCN documents. No additional field studies will be required.
- Wetland replication will not be required.
- Field surveys for listed species including fish, turtles, benthos, or submerged aquatic vegetation will not be needed.
- All public hearings and coordination meetings will be conducted by video conferencing and will not require travel.
- A Chapter 91 Waterways License or Permit is not required for the proposed activities.
- An individual 401 Water Quality Certification is not required for the proposed activities.
- A MEPA ENF / EIR is not required for the proposed activities.
- The City will sign the permit applications and pay permitting and advertising fees. These fees have not been included in this budget.
- Permitting services do not include wetland construction monitoring or post-construction monitoring assessment and reporting.

Deliverables:

- Draft Permit applications (.pdf version of each permit).
- Final Permit applications (.pdf version of each permit for submittal to appropriate agencies).

Public Outreach: In our experience, public "buy-in" helps to smooth the permitting process. To help engage the public, we will prepare an informational package with preliminary designs for the City to distribute to local interest groups like the Bulloughs Pond Association (BPA) and to solicit public feedback. We have also budgeted for attendance at one meeting with the BPA (along with city representatives) to present the project.

TASK 8 – BID PHASE ASSISTANCE

GZA will assist the City in the bidding process by (1) attending a pre-bid meeting at the site; (2) considering bid-phase questions and issuing up to two Clarifications or Addendums; (3) tabulating the bids; (4) checking references of the apparent low bidder; (5) issuing an opinion memorandum regarding the responsiveness of the bidders and a recommendation regarding the acceptance of the apparent low bidder.

TASK 9 – PROJECT MANAGEMENT

This task will encompass GZA's efforts to manage the project, coordinate with City staff, and report on project progress to City management, including:

- *Project Management* – Review of schedule, deliverables, and budget.
- *Design Phase Project Meetings* - GZA has budgeted for our attendance at up to three (3) meetings with the City to review plans or discuss project progress, including at the conclusion of the investigatory phase.
- *Budget Management & Reporting* - GZA will regularly provide the City with updates on the project budget as part of monthly progress reports / invoices.

TASK 10 – ADDITIONAL FOLLOW-UP INSPECTIONS

The July 2018 DCR Certificate of Non-Compliance and Dam Safety Order requires Follow-Up Inspections at a 6-month frequency until repairs are complete. The most recent Follow-Up Inspection was performed in April of 2020. Additional Follow-Up Inspections will be required by ODS at 6-month intervals. These inspections will be performed by a registered professional engineer experienced in dam engineering. For budgeting purposes, we have assumed four additional Follow-Up Inspections will be required at 6-month intervals. Please note that depending on the design, permitting and construction durations, additional Follow-Up Inspections may be necessary.

BASIS OF BILLINGS

Billings will be based on actual accrued time and material basis in accordance with the attached **Schedule of Fees.** The Schedule of Fees is based on a 3 percent escalation from the fees contained in our 2018 Agreement. Estimated budgets, by task, for the Scope of Services described above are as follows:

Estimated Budget Summary

TASK #	TASK DESCRIPTION	ESTIMATED BUDGET
1	Project Kick Off Meeting and Review of Existing Information	$2,000
2	Response to ODS Phase II Comments	$500
3	Additional Field Investigations and Laboratory Testing Planning/Health & Safety GZA Equipment/Labor Sediment Probes/Test Pits/LLO Vault (2 days) Low-Level Outlet ROV Inspection (1 Day) Subcontracted ROV Crew/Equipment GZA Oversight Subcontracted Analytical & Geotechnical Laboratory Testing	 $1,000 $2,700 $5,300 $1,000 $4,700
4	Additional Engineering Analyses, Design Computations and Design Report	$17,100
5	Final Design and Development of Plans and Specifications Draft (75%) Plans, Specifications and Cost Estimate Final (100%) Plans, Specifications and Cost Estimate	 $24,800 $7,600
6	Operations and Maintenance (O&M) Plan	$2,900
7	Environmental Permitting Assistance BPA Public Outreach/Info Package/Meeting	$29,800 $6,300
8	Bid Phase Assistance	$4,000
9	Project Management	$8,700
10	Additional Follow-Up Inspections	$6,200
	Total Estimated Budget	**$124,600**

This estimate is based on the anticipated scope of work outlined above which represents our best judgment at this time as to the efforts required to achieve the stated objectives. It must be recognized, however, that unforeseen conditions may become evident during the course of the project which may alter or increase the scope of work required. Permitting scope changes are becoming increasingly common, with variations in how regulators and regulatory agencies interpret regulations and jurisdictions. Should the MEPA office claim jurisdiction, a project ENF may be required. Should the MassDEP Waterways office require a Chapter 91 License or Permit, or if the MassDEP Water Quality section require an individual 401 Water Quality Certificate GZA can complete these applications. We recommend including a budget contingency of $20,000 for additional permit applications, if required.

PROPOSED PROJECT SCHEDULE

We are prepared to work to the following schedule:

Late July 2020	Notice to Proceed
Early August 2020	Kick-off Meeting; Respond to ODS Phase II Comments
September 2020	Additional Field investigations
November 2020	Additional Engineering Analyses and Design Computations
February 2021	75% Design Plans Complete; Permit Applications Submitted
May 2021	Final Plans and Specification Complete
June 2021	Final Permits Applications Submitted

CONDITIONS OF ENGAGEMENT

Our services will be performed in accordance with the Terms of our existing Agreement with the City ("Agreement for Engineering Services by and between the City of Newton, Massachusetts and GZA GeoEnvironmental Inc. for Engineering Services Phase II Dam Safety Engineering Evaluation Bulloughs Pond Dam", Contract L-6463, signed by GZA on November 12, 2018, and approved by the City of Newton December 10, 2018). That agreement, along with this Proposal, form our entire agreement. This proposal is valid for 90 days from issuance.

ACCEPTANCE

This proposal may be accepted by signing in the appropriate spaces below and returning one complete copy (with attachment) to us. The executed agreement must be received prior to the initiation of the services described above. Issuance of a purchase order implicitly acknowledges acceptance of the above-mentioned contract terms.

GZA is submitting this proposal with the belief that we will be able to fulfill the scope and schedule requirements during this COVID-19 Pandemic crisis. If performance is rendered impossible because of the impacts of COVID-19, GZA will notify you of that Force Majeure event.

We look forward to the chance to assist you with this project. Please call us with any questions that you may have.

Sincerely,
GZA GEOENVIRONMENTAL, INC.

Laurie A. Gibeau, P.E.
Project Manager

Chad W. Cox, P.E.
Consultant/Reviewer

Jonathan D. Andrews, P.E.
Principal-in-Charge

Attachment: Schedule of Fees

This Contract for Services and the Terms and Conditions are hereby accepted and executed by a duly authorized signatory, who by execution hereof, warrants that he/she has full authority to act for, in the name, and on behalf of Client.

CITY OF NEWTON

By: _____ Title: _____

Typed Name: _____ Date: _____

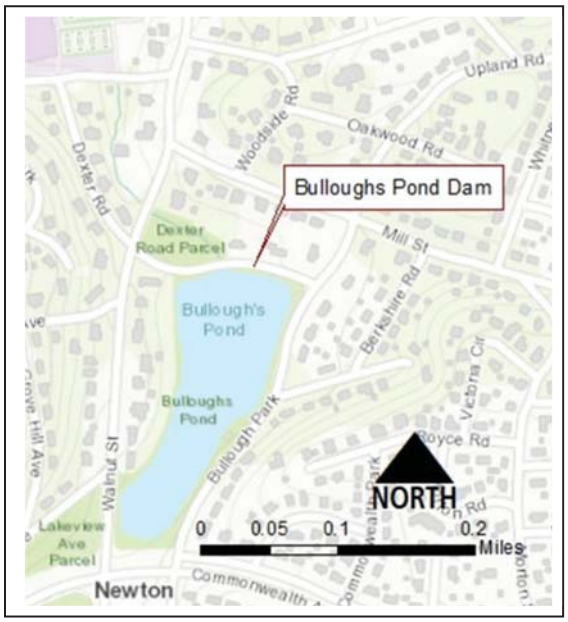
EMERGENCY ACTION PLAN

for

BULLOUGHS POND DAM

Newton, Middlesex County, Massachusetts

National I.D. Number: MA03414
Dam Location: 42.34185º N /71.20524º W



Dam Owner and Caretaker:
City of Newton Department of Public Works
1000 Commonwealth Avenue, Newton Centre, Massachusetts, 02459
Owner Daytime Phone: 617.796.1000
Owner Emergency Phone - Police: 617.796.2100
Owner Emergency Phone - Fire: 617.796.2200

Plan Developed 2020-05 by GZA
Revision Number 0 Date 2020-05

BULLOUGHS POND DAM

EMERGENCY ACTION PLAN
TABLE OF CONTENTS

PREAMBLE

This Emergency Action Plan (EAP) was prepared for the Owner of the Bulloughs Pond Dam in accordance with the Commonwealth of Massachusetts General Laws, M.G.L. 253, Section 44, Chapter 302 C.M.R. 10.00, "Dam Safety, dated February 10, 2017". This EAP establishes a basic plan of action if conditions at the dam indicate the potential for dam failure or if any individual observes and reports that a dangerous condition is developing at the dam. This EAP follows a template developed by the Department of Conservation and Recreation (DCR) Office of Dam Safety (ODS). The development of the template has been primarily based on the Federal Emergency Management Agency (FEMA) "Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners," dated October 1998, the Federal Energy Regulatory Commission (FERC) "Emergency Action Plan Guidelines," dated November 1998, 2006 Natural Resources Conservation Service (NRCS) recommendations for developing EAPs, and other publicly available EAP templates from state dam safety programs.

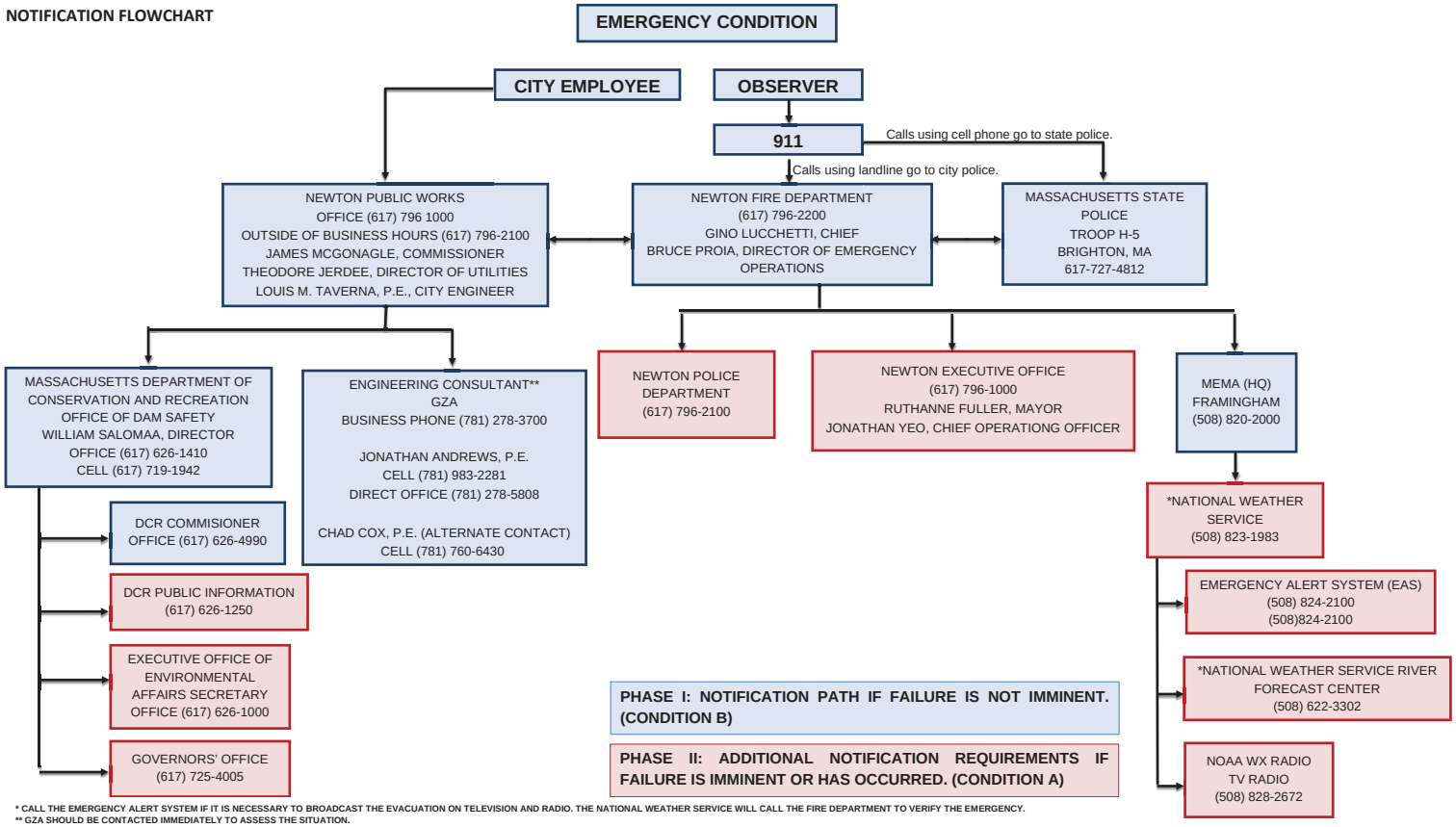
The purpose of this plan is to define responsibilities and provide procedures for identifying unusual and unlikely conditions, which may endanger the Bulloughs Pond Dam and infrastructure downstream of the dam, in time to take mitigated action and to notify the appropriate emergency management officials of possible, impending, or actual failure of the dam in order to reduce property damage and loss of life.

This Emergency Action Plan should not be viewed as a substitute for implementing standard dam maintenance, inspections and repairs in accordance with good dam operations.

It is important to note that the condition of the dam depends on numerous and constantly changing internal conditions and is evolutionary in nature. It would be incorrect to assume that the condition of the dam will remain the same over time. Only through continued care and inspection can there be any chance of detecting unsafe conditions before they result in an emergency condition.

The EAP is housed in a three-ring binder to easily facilitate updates to the plan. The EAP should be updated and exercised annually to ensure that the information is current. Most importantly, the names and telephone numbers of emergency response personnel listed in the Notification Flowchart shall be updated periodically. The general layout for emergency notifications is as follows:

NOTIFICATION FLOWCHART



*** CALL THE EMERGENCY ALERT SYSTEM IF IT IS NECESSARY TO BROADCAST THE EVACUATION ON TELEVISION AND RADIO. THE NATIONAL WEATHER SERVICE WILL CALL THE FIRE DEPARTMENT TO VERIFY THE EMERGENCY.**
**** GZA SHOULD BE CONTACTED IMMEDIATELY TO ASSESS THE SITUATION.**

1.0 NOTIFICATION PROCEDURES

1.1 Notification Flowchart

The Notification Flowchart (located after the Preamble) indicates the chain of communication to be followed in the event of an Emergency. The Notification Flowchart indicates a Phase I and Phase II type of notification to be implemented depending on the emergency classification level (Dam Safety Watch or Dam Failure Warning) as determined necessary based upon the judgment of the personnel monitoring the emergency condition at the dam (see Appendix B for additional descriptions).

- **Dam Safety Watch: "Potential failure is developing":** This is a situation where a failure may eventually occur if left unattended. This situation will require a Phase I response with continuous monitoring of the situation.

- **Dam Failure Warning:** "**Failure is Imminent or has occurred":** This is a situation where a failure either has occurred, is occurring, or is just about to occur. This situation will require Phase I and II responses that will proceed with evacuation procedures.

During the highest emergency level (Dam Failure Warning), procedures are to evacuate the downstream residents using a combination of the telephone (including reverse 911), augmented by police cruising the area broadcasting the evacuation message and going door to door to homes that cannot be reached by telephone. To ease this burden somewhat, the National Weather Service can be alerted at (508) 823-1983 and they will make a general broadcast about the evacuation over the airwaves. ***The National Weather Service will call the Fire Department to verify the emergency. Therefore, the Fire Department should be called before the National Weather Service is contacted. The Massachusetts Emergency Management Agency (MEMA) can also be contacted to activate the Emergency Alert Service.***

The flowchart should be updated yearly to account for local or state personnel changes. Any new personnel should be informed and trained to perform their responsibilities under this plan.

This Notification Flowchart is contained within the opening pages of this report.

1.2 Emergency Notification Template

Once the emergency condition has been identified, and the appropriate response level has been determined, the following template can be used as a guide for notification announcements:

> "This is (your name, title, affiliation)
>
> You are being contacted per the Emergency Action Plan for the Bulloughs Pond Dam.
>
> Please be advised: A Dam Safety Watch / Dam Failure Warning condition has been identified at the Bulloughs Pond Dam.

The observation was made at (time and date)

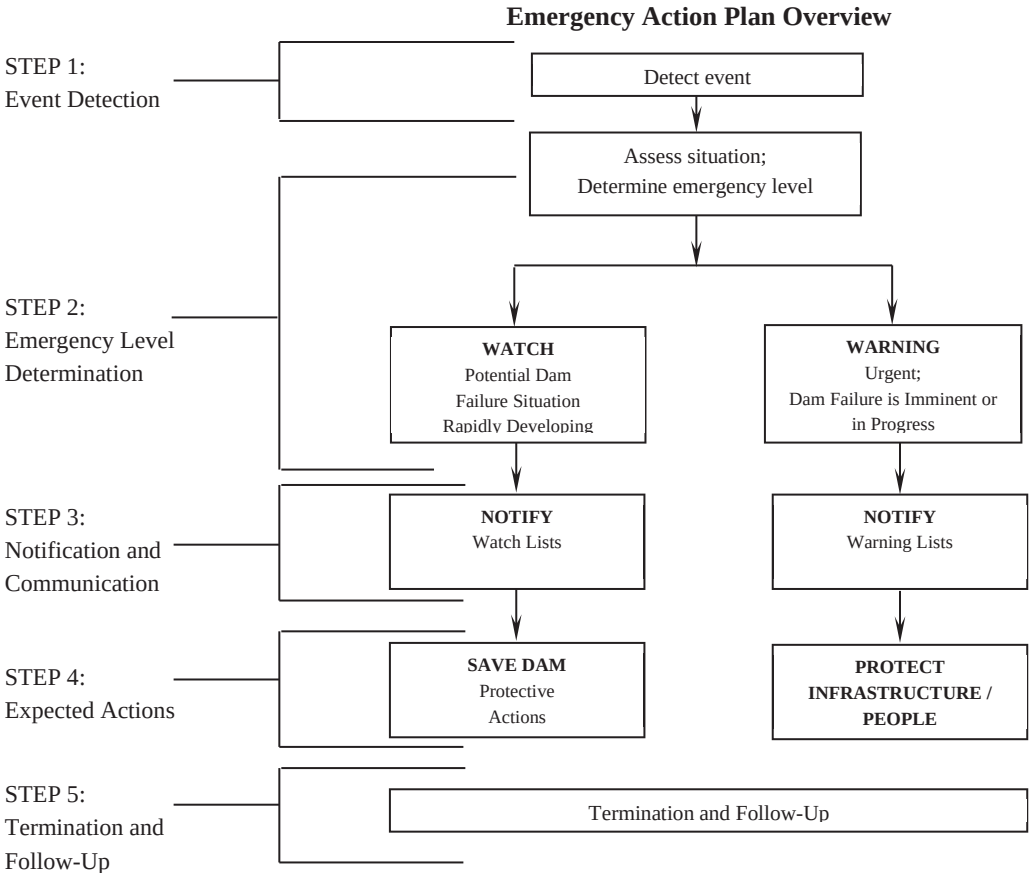
The situation is (provide brief description)

It is recommended that (Remain on alert; Prepare for Evacuation; Evacuate the area and move to higher ground)"

1.3 Impact Summary / Road Closures

The downstream flooding from failure of Bulloughs Pond Dam was estimated by GeoEnvironmental Inc. (GZA) using the HEC-RAS version 5.0.7 software (see Section 4.0). Based on the analysis, the downstream flooding is expected to impact the town of Newton. The estimated peak flow through the dam breach is 1,280 cubic feet per second (cfs). See Section 4.0 for an inundation map as well as more information on roadways and buildings in the downstream inundation zone.

1.4 General Response Flowchart



2.0 PROJECT DESCRIPTION

Dam Name: Bulloughs Pond Dam
Federal ID (NID): MA03414
City/Town: Newton
Hazard Classification: Significant[1]
Size Classification: Intermediate
County: Middlesex

Location: The Bulloughs Pond Dam is located at the north end of Bulloughs Pond. The top of the dam is asphalt-paved Dexter Road, with a bridge over the spillway. Flows through the spillway form Laundry Brook, which flows northeast towards the Charles River.

Access: The dam can be accessed by Dexter Road, which extends across the dam top. The upstream and downstream slopes can be accessed by foot from Dexter Road. Dexter Road has street parking.

Latitude: 42.34185º N Longitude: 71.20524º W
River/Stream/River Basin: Laundry Brook
Drainage Area (sq. mi.): 3.2
Quad Sheet for USGS Topographic Maps: Newton
Dam Type: Earthen Embankment with a Spillway Weir
Hydraulic/Structural Height (ft): 8.4/14.5
Dam Length (ft): 225
Normal Surface Area (ac): 7
Normal Storage (ac-ft): 16
Maximum Storage (ac-ft): 64
Spillway Capacity (cfs): 970
Outlet Type (other than spillway): Two 24-Inch Diameter Low-Level Outlets
Year Built: 1664
Last Rehabilitation: 1926

Purpose/Operation of Dam: The primary use of the dam and pond is recreation.

Instrumentation (if any): None
Downstream Flow Path: Laundry Brook
Upstream Dams: City Hall Pond, Carlisle Street Dam (located in Newton)
Downstream Dams: No downstream dams along Laundry Brook

[1] Bulloughs Pond Dam is currently classified as a Significant Hazard dam. The inundation maps prepared for this EAP suggest the dam may qualify for a High Hazard classification. GZA and the City of Newton will discuss the hazard classification with the Massachusetts Office of Dam Safety. As per 302 CMR 10.06 Hazard Classification is determined by the Commissioner of the Department of Conservation and Recreation.

Description of Downstream Area: Mostly residential with local roads, some schools, some commercial/manufacturing, Interstate 90; Laundry Brook is mostly subterranean (i.e. flows through a series of culverts)
Method of emergency drawdown: Low-Level Outlets (operated by the Utilities Division of DPW)

3.0 GENERAL RESPONSIBILITIES

3.1 Summary of Responsibilities

Entity	Responsibilities
Dam Owner & Caretaker: City of Newton Department of Public Works (DPW) Phone: 617-796-1000 Emergency Phone: 617-796-2100	1. Notify local authorities. Consult with dam engineer. 2. Evaluate the extent/nature/severity of the incident. Update the Incident Commander as to the need to implement the EAP. 3. Monitor the situation at the dam for the duration of the emergency. Update the Incident Commander and other local and state authorities of developing conditions at the dam for the duration of the emergency situation.
Local Fire Department Newton Fire Department Phone Number: 617-796-2210 Emergency Phone: **9-1-1**	1. Contact and warn population in area of potential impacts; Coordinate efforts with other parties involved in the EAP as necessary. 2. The Incident Commander will serve as the contact point for disseminating all updates concerning the condition of the emergency.
Local Police Department: Newton Police Department Phone Number: 617-796-2100 Emergency Phone: **9-1-1**	1. Assist in securing the site and implementing evacuation if necessary (i.e. coordinating barricades, street closures, traffic flow). 2. Utilize appropriate and/or necessary evacuation procedures, which may include but are not limited to, multilingual broadcasts, slow-speed broadcasts, and coordinated efforts with other emergency responders.
Massachusetts Emergency Management Agency (MEMA) **24 hrs: 508-820-2000**	1. Coordinate broadcast notification as requested by the local Fire/Police/EMD. 2. Mobilize necessary equipment as requested by the local Police/Fire/EMD.
Massachusetts State Police Brighton Barracks / Troop H-5 (serves Newton) **24hrs: 617-727-4812**	1. Assist in securing the site, implementing evacuation, and controlling traffic flow in and out of the impacted area as requested by the local Police Department.

3.2 Emergency Response Coordination

During an emergency situation, the **Chief of the Newton Fire Department** will be responsible for the proper organization and operation of the Emergency Action Plan (i.e. Incident Commander). He/she will coordinate all activities with state and local authorities.

4.0 INUNDATION MAPS

4.1 Inundation Map Development

To evaluate the extent of flooding due to a partial dam failure at Bulloughs Pond Dam, GZA performed a simulation of the hypothetical dam break utilizing HEC-RAS 5.0.7 software. HEC-RAS was developed by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center. HEC-RAS performs 1-dimensional and 2-dimensional unsteady flow calculations. For the dam break modeling, GZA used the 2-dimensional routine, which uses a network of grid cells to route flows.

Inputs to the program include storage-elevation data for the impoundment, the terrain and Manning's n (roughness) for the downstream area, grid cell size, and the geometry of downstream culverts. Laundry Brook is mostly subterranean, through culverts, while it flows from Bulloughs Pond Dam to the Charles River. GZA's analysis used the following inputs and assumptions:

- Storage-elevation data: GZA developed storage-elevation data for the impoundment using two sources. For elevations above normal pool, GZA used the LiDAR data. For elevations below normal pool, GZA used a bathymetric map provided in the Bulloughs Pond Dam Diagnostic/Feasibility Study by Camp Dresser & McKee Inc., published August 1990.
- Terrain: LiDAR data captured in 2013 and 2014 and processed into a 1-meter resolution raster (USGS New England Sandy Project).
- Manning's n: Land use was classified as either building, medium density vegetation, open space, parking lot, or roadway. The Manning's n values were assigned 0.5, 0.06, 0.04, 0.025, and 0.025, respectively.
- Grid Cell Size: GZA assigned 50 feet.
- Downstream Culverts: The location, dimensions, and elevations of the downstream culverts were assigned based on LiDAR data, and a GIS shapefile of the City's drainage system (called StormMains.shp). At Walnut Street and Hull Street, GZA also gathered coarse measurements in the field.

See Appendix G for screenshots of the model setup and terrain.

GZA performed one dam failure simulation with the breach parameters listed below. Note that an actual breach may have different characteristics.

- Pool Elevation at Failure (ft, NAVD88): 92 (at top of dam)
- Average Breach Width (ft): 30.3
- Breach Side Slopes (H:V): 0.5
- Time to Failure (hrs): 0.5
- Breach Invert Elevation (ft, NAVD88): 81.9
- Antecedent Flow Through Dam: None
- Antecedent Downstream Flooding: None

Note that the inundation zone from the dam failure may be affected by antecedent flooding (i.e. flooding from rainfall) and blockage in the downstream culverts. GZA's simulation does not

include antecedent flooding in the downstream area. Except for the culvert at Hull Street, GZA modeled the culverts as fully unblocked. GZA modeled the Hull Street culvert as 75% blocked because the City reported the culvert frequently gets blocked.

4.2 Impacted Area Summary

The estimated peak flow through the dam breach is 1,280 cfs. The impacted area is shown on the Inundation Map.

Based on the analysis, the downstream flooding is expected to remain within the City of Newton limits. Walnut Street, the first downstream bridge, is not overtopped. Between Walnut Street and Hull Street, a residential structure is located within the inundation zone. Hull Street is overtopped. The flows overtopping Hull Street travel north over tennis courts and along the Newton North High School grounds. The maximum flood depth at the school building is 2 feet. The flows continue in a northeast direction through a residential neighborhood towards Cabot Park. Over 400 residential addresses are in the inundation zone. The flows continue north of Cabot Park and onto the Massachusetts Turnpike (Interstate 90 / I-90) and adjacent railroad tracks. The railroad tracks service the MBTA Commuter Rail (Worcester/Framingham Line) and Amtrak.

Directly south of the Massachusetts Turnpike, Laundry Brook enters a long culvert that carries the brook to the Charles River. The mapping was terminated at the Laundry Brook's confluence with the Charles River. The flood wave has attenuated to 240 cfs at this location and is expected to dissipate in the Charles River.

Gay Street	
Distance Downstream (mi)	0.6
Leading Edge Arrival Time (hr:min)	0:30
Peak Flood Arrival Time (hr: min)	0:50
Maximum Water Surface Elevation (ft)	52.9
Maximum Flood Depth (ft)	2.4
Peak Discharge Due to Dam Breach (cfs)	880

Newtonville Avenue	
Distance Downstream (mi)	1
Leading Edge Arrival Time (hr:min)	1:55
Peak Flood Arrival Time (hr: min)	2:00
Maximum Water Surface Elevation (ft)	44.5
Maximum Flood Depth (ft)	1.0
Peak Discharge Due to Dam Breach (cfs)	260

Hull Street	
Distance Downstream (mi)	0.2
Leading Edge Arrival Time (hr:min)	0:10
Peak Flood Arrival Time (hr: min)	0:30
Maximum Water Surface Elevation (ft)	73.5
Maximum Flood Depth (ft)	3
Peak Discharge Due to Dam Breach (cfs)	1,090

366-20

NORTH

0 500 1,000 Feet

LEGEND

- AREA FLOODED BY DAM FAILURE
- FLOW DIRECTION
- TOWN BOUNDARY
- SCHOOLS
- HOSPITALS
- RAILROADS
- DAMS

NOTES:
1. AERIAL PHOTO IS BING MAPS AERIAL BASEMAP (DATE OF IMAGERY IS OCTOBER 2019).
2. SCHOOLS LOCATIONS FROM NEWTON GIS.
3. HOSPITALS LOCATIONS FROM MASS GIS.
4. THE INUNDATION AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF BULLOUGHS POND DAM.
5. THE INUNDATION AREA SHOWN IS APPROXIMATE AND SHOULD BE USED AS A GUIDELINE FOR ESTABLISHING EVACUATION ZONES.
6. ACTUAL INUNDATION AREA WILL DEPEND ON ACTUAL FAILURE CONDITIONS AND MAY DIFFER FROM THIS MAP.
7. INUNDATION AREA WAS CALCULATED BY SIMULATING DAM FAILURE WITH THE HEC-RAS 5.0.7 COMPUTER SOFTWARE.
8. DAM FAILURE WAS SIMULATED WITH IMPOUNDMENT AT TOP OF DAM AND WITHOUT ANTECEDANT DOWNSTREAM FLOODING. HULL STREET CULVERT WAS MODELED AS 75% BLOCKED.
9. ELEVATIONS ARE IN VERTICAL DATUM NAVD88.
10. LEADING EDGE ARRIVAL TIME IS TIME FOR WATER SURFACE ELEVATION TO RAISE 1 FOOT.

INUNDATION MAP FOR BULLOUGHS POND DAM (MA03414)

Newton, MA

Page 1 of 1

Prepared For:
City of Newton
Deparmtment of Public Works
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Newton, MA 02459

Prepared By:
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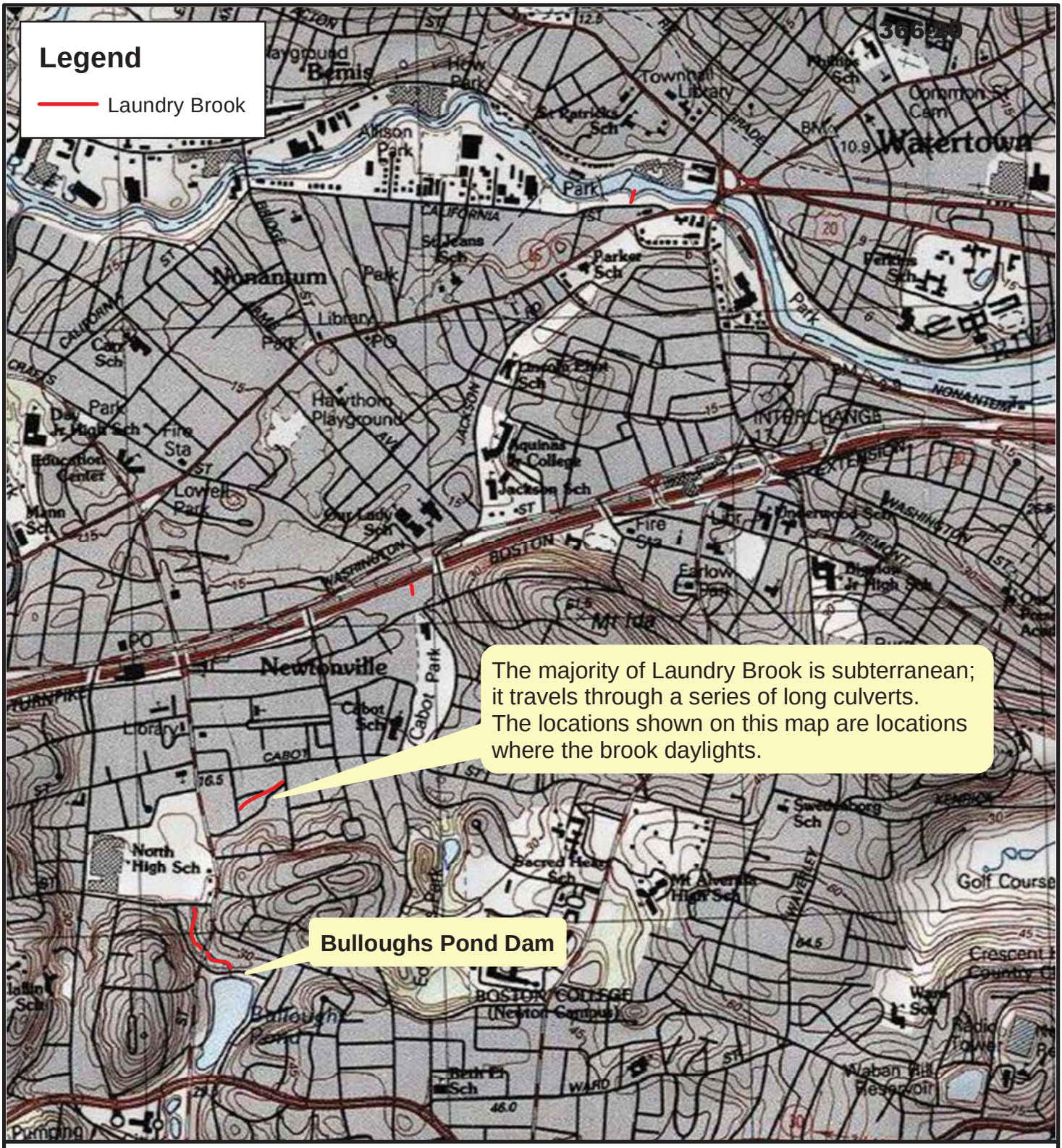
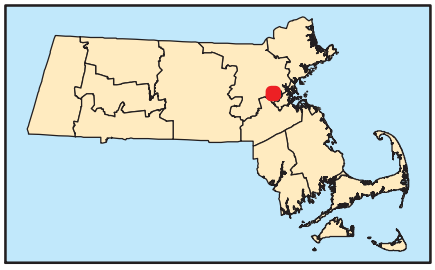
Proj. Mgr.:	CES	Dwg. Date:	5/14/2020
Designed By:	CES		
Reviewed By:	JDA	Job No.:	01.174021.10
Operator:	CES		

Document Path: C:\Users\christine.suhonen\Desktop\Now\Bullough\GIS\InundationMap.mxd

FIGURES





SOURCE : THIS MAP CONTAINS THE ESRI ARCGIS ONLINE USA TOPOGRAPHIC MAP SERVICE, PUBLISHED DECEMBER 12, 2009 BY ESRI ARCIMS SERVICES AND UPDATED AS NEEDED. THIS SERVICE USES UNIFORM NATIONALLY RECOGNIZED DATUM AND CARTOGRAPHY STANDARDS AND A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.

0 500 1,000 2,000 3,000 4,000

SCALE IN FEET

N W E S

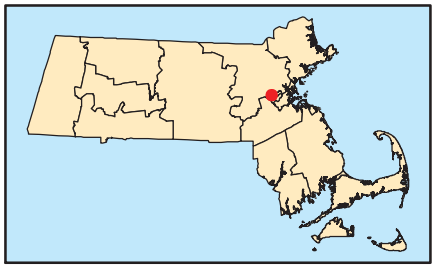
PROJ. MGR.: CES
DESIGNED BY: CES
REVIEWED BY: JDA
OPERATOR: CES
DATE: 04-23-2020

TOPOGRAPHIC LOCUS MAP

BULLOUGHS POND DAM (MA03414)
NEWTON, MASSACHUSETTS

JOB NO. 01.0174021.10

FIGURE NO. 1



SOURCE : BASEMAP PROVIDED BY BING MAPS AERIAL.
DATE OF IMAGERY IS OCTOBER 2019.

0 500 1,000
SCALE IN FEET

N
W E
S

PROJ. MGR.: CES
DESIGNED BY: CES
REVIEWED BY: JDA
OPERATOR: CES
DATE: 04-23-2020

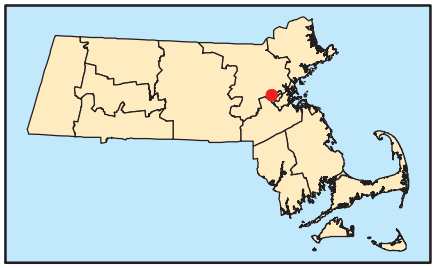
AERIAL PHOTO LOCUS MAP

JOB NO.
01.0174021.10

BULLOUGHS POND DAM (MA03414)
NEWTON, MASSACHUSETTS

FIGURE NO.
2

366-20



SOURCE : THIS MAP CONTAINS THE ESRI ARCGIS ONLINE WORLD STREET MAP SERVICE, PUBLISHED DECEMBER 12, 2009 BY ESRI ARCIMS. SERVICES ARE UPDATED AS NEEDED. THIS SERVICE USES A VARIETY OF AVAILABLE SOURCES FROM SEVERAL DATA PROVIDERS.

0 500 1,000

SCALE IN FEET

N W E S

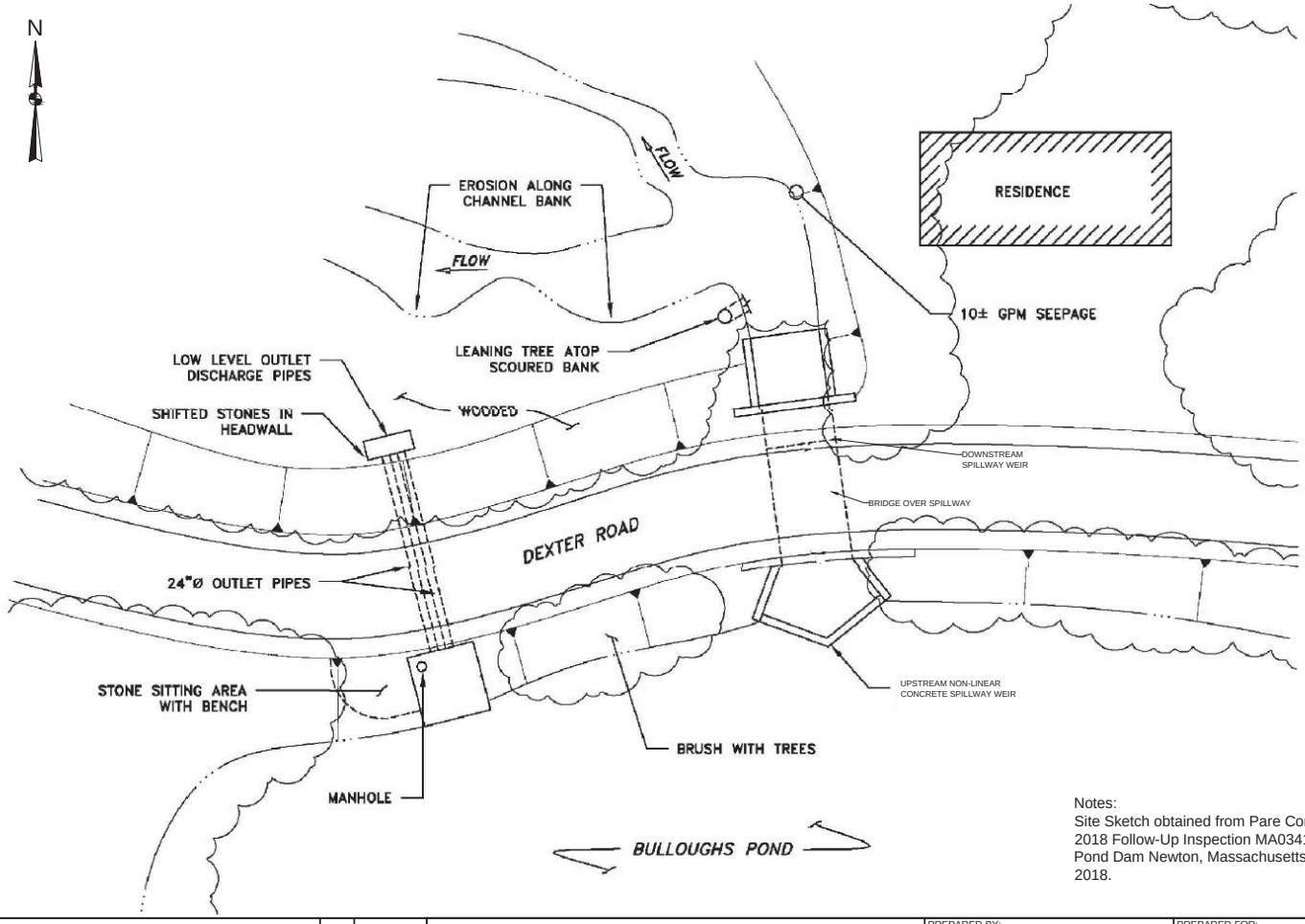
PROJ. MGR.: CES
DESIGNED BY: CES
REVIEWED BY: JDA
OPERATOR: CES
DATE: 04-23-2020

STREET LOCUS MAP

BULLOUGHS POND DAM (MA03414)
NEWTON, MASSACHUSETTS

JOB NO. 01.0174021.10

FIGURE NO. 3



Notes:
Site Sketch obtained from Pare Corporation "June 2018 Follow-Up Inspection MA03414 Bulloughs Pond Dam Newton, Massachusetts" dated June 8, 2018.

NO.	ISSUE/DESCRIPTION	BY	DATE

BULLOUGHS POND DAM
NEWTON, MA

SITE SKETCH

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
CITY OF NEWTON
NEWTON, MASSACHUSETTS

PROJ MGR: LAG	REVIEWED BY: JDA	CHECKED BY: LAG	FIG. NO. 4
DESIGNED BY: CMG	DRAWN BY: DEM	SCALE: NTS	
DATE: 09/202019	PROJECT NO. 174021.10	REVISION NO. -	

APPENDIX A

Preparedness

PREPAREDNESS

Preparedness actions are taken to prevent an emergency situation from developing or to minimize the extent of damage caused from a developed emergency situation. The preparedness actions may be by providing response procedures to emergency situations and/or arranging for equipment, labor, and materials for use in emergency situations.

Surveillance

The most important step to activating an EAP is the identification of a problem at the dam. If a problem is not identified, the plan cannot be implemented. Problem identification will be much easier if knowledgeable personnel regularly monitor the dam closely.

The dam owner and dam operator must continue to monitor the dam on a regular basis. This is especially important during high rainfall events and during spring runoff conditions when large amounts of snow melting occur. Appendix B identifies some potential hazards that could lead to dam failure. The engineering division of Newton DPW will perform routine surveillance of the dam. The utilities division of Newton DPW will take any operations actions, such as opening gates,

It is impossible to predict when an emergency situation will develop, therefore it is important that emergency contact information be posted at the site so that a casual observer can contact emergency personnel if they observe an unusual condition.

Access to Site

The dam can be accessed by Dexter Road, which travels across the dam top. The upstream and downstream slopes can be accessed by foot from Dexter Road. Dexter Road has street parking.

Operations and Maintenance Manual

The City of Newton Department of Public Works (DPW) is currently responsible for implementing operational and maintenance activities for the dam. There is no formal Operation & Maintenance Plan for Bulloughs Pond Dam. However, City personnel perform routine surveillance of the dam. The low-level outlets are exercised on a yearly basis. Prior to forecasted large storm events, the Utilities Division of the DPW will operate the gates at City Hall Pond (directly upstream of Bullough's Pond) and Bulloughs Pond Dam to lower the pond elevations. The gates at Bullough's Pond Dam will be replaced during the dam's upcoming rehabilitation.

Response during Periods of Darkness

There is no lighting equipment at Bulloughs Pond Dam.

The embankment, spillway, low level outlet and any distressed areas of the dam should be illuminated if an emergency condition develops during periods of darkness. This will allow the emergency condition to be monitored, assessed, and help facilitate a response. Lighting (e.g.

portable light towers) is available for use by town and state agencies through MEMA. Emergency power and remote lighting contingencies may be available from local rental companies, such as United Rentals, 361 SW Cutoff, Worcester, MA 508-756-3306.

Response during Evenings, Weekends, and Holidays

The Notification Flowchart can be used for evenings, weekends, and holidays. When practical, redundancies of personnel and alternate telephone contact numbers have been provided.

Response during Periods of Adverse Weather

Personnel from the City of Newton and the local and state emergency management will be in a heightened state of readiness in the event of predicted or actual adverse weather conditions. The dam is easily accessible by the City and other emergency personnel via local roads.

Training and Testing

Training and testing of the EAP is the responsibility of the dam owner. The dam owner should coordinate training and testing with local responders and emergency personnel within the municipalities impacted by a dam failure. Training/orientation seminars should be held for all operators, attendants and other personnel (i.e. police and fire) responsible for the implementation of the plan. After the initial training seminar, it is recommended that a special meeting be held to explain the plan to the downstream residents and elected officials. The meeting with downstream residents will be extremely beneficial at a time of emergency.

It is recommended that EAP or components of the plan be tested periodically. The testing should be conducted through the use of communication drills and table top exercises. Testing should include operators, attendants, police, fire and other personnel responsible for the implementation of the plan. Downstream residents shall not be included in the test.

Below is a list of <u>suggested</u> training exercises, the frequencies they should be conducted, and the topics they should cover:

<u>Seminars with Emergency Personnel</u>

- Frequency: As needed
- Topics:
    - New hires should be briefed on their duties during an emergency response.
    - At a minimum a read-through of the EAP and a brief assessment should be conducted.

<u>Emergency Management Workshop</u>

- Frequency: Annually
- Attendees: City of Newton Department of Public Works, City of Newton Fire Department, MEMA, State Police Troop H-5.
- Topics:

- Authorities responsible for executing the EAP should gather to discuss the EAP.
- Review and updating of the Notification Flowchart, Emergency Contracts, and Emergency Warning systems should be conducted at this time.
- Parties should discuss the response effort (specifically the Notification Flowchart) and the corrective actions to be taken at the dam during various scenarios.
- Lines of communication should be streamlined such that a developing condition at the dam can be assessed and handled.

Public Meetings

- Frequency: Every 2 Years
- Topics:
  - The public should be educated on the EAP and how they can facilitate the rapid and safe execution of the EAP during an emergency.
  - Evacuation routes should be discussed.
  - Emergency Warning systems for alerting the public (i.e. Connect-CTY, CodeRED) should be discussed and updated.
  - Preparation and situational awareness techniques during an emergency situation should be discussed. (i.e. Areas of high ground within the town, keeping a cell phone charged, supplies needed for an extended evacuation, navigation of flooded roads, etc.)

Table Top Exercise

- Frequency: Every 3 to 4 Years
- Topics:
  - Emergency management personnel should gather and discuss different emergency scenarios to assess plans, policies, and procedures.

Functional Exercise

- Frequency: Every 5 Years
- Topics:
  - A functional exercise is conducted to test and validate the coordination, command, and control between the DCR, EMD, and all agencies involved with carrying out the EAP.
  - This type of exercise does not include any “boots on the ground”.

After each of the tests mentioned above, a “lessons learned” discussion and evaluation should be conducted. The discussions should highlight procedures that work well and those that did not; as well as inaccurate information (within the flowchart, inundation maps, resident contacts, assigned responsibilities, equipment, etc.). Results should be written down and distributed to the associated parties and any corrections and updates should be made.

The training and testing activities should be fully documented.

Updating and Posting

All aspects of the EAP should be reviewed and updated once per year. The City of Newton Department of Public Works is responsible for coordinating the review and updates for this EAP.

During the review, a determination of any new developments or other changes downstream or elsewhere should be made to determine whether any revisions to the current EAP are necessary. It is imperative that all other holders of the EAP receive updates to the EAP immediately upon becoming aware of necessary changes to keep the EAP workable. This includes revisions when phone numbers and/or names change for Notification Flowchart personnel and downstream residents.

An up-to-date copy of the flowchart and notification list should be maintained in prominent locations in the offices of the personnel responsible for the EAP implementation.

A copy of the complete up-to-date EAP should also be available to all operators and personnel responsible for the implementation of the EAP. At a minimum, a full copy of the EAP should be located at the following locations:

- Owner: City of Newton Department of Public Works, 1000 Commonwealth Avenue, Newton Centre, MA 02459
- Local Emergency Management Agency: Newton Fire Department, 1164 Centre Street, Newton Centre, MA 02459
- Massachusetts Emergency Management Agency (MEMA): Ben Hiltunen, 400 Worcester Road, Framingham, MA 01702
- Massachusetts Department of Conservation and Recreation, Office of Dam Safety: William Salomaa, Director, 251 Causeway Street, Boston, MA 02114

Emergency Response Coordination

During an emergency situation, the **Incident Commander** will likely be the Chief of the Newton Fire Department. He/she will be responsible for the proper organization and operation of the Emergency Action Plan. He/she will coordinate all activities with state and local authorities.

Emergency Evacuation Routes

Emergency evacuation routes will be established by City of Newton Police and Fire personnel, in consult with the **Incident Commander**. Revisions to emergency evacuation routes will be made based on workshop, exercise, and public meeting input, and included in EAP updates as appropriate.

Contact Lists

Contact lists should be maintained for facilities, structures, and other properties that may be impacted by a flood wave. Dependent upon the nature of the inundated area, the contact lists

may include residents to be evacuated due to shallow flooding, facilities requiring special considerations, and other facilities. Contact lists should also consider special needs in the impacted area such as multilingual communications.

Hard copies of the list should be kept at within each EAP binder. At a minimum, annual reviews and updating of the contact list should be completed to keep the list current.

A list of addresses in the inundation area presented on the Inundation Map is included as Table A.1.

Alternative Systems of Communication

If there is an interruption in telephone service during an emergency condition, emergency response personnel should broadcast over their radio communications system and cellular phones as necessary. Cell phone/telephone numbers for the emergency responders should be maintained and updated in the notification flowchart on a regular basis. Notifying the public can be accomplished with Reverse 911 systems (such as Connect-CTY or CodeRED), patrol cars, door to door, social media (Facebook, Twitter), and roadside message boards.

Emergency Labor, Supplies and Equipment

Once an emergency condition has been identified, mobilization of the appropriate equipment is key to addressing the situation. The following list indicates some equipment that may be used for the conditions described above. This list should be modified as required to address actual conditions at the time of the emergency. Additional equipment, not listed below, may be necessary. The actual condition and estimated response time versus the rate of deterioration of the dam may preclude the repair of the structure and necessitate full evacuation. The primary goal is to protect human life and minimize property damage.

- Emergency lights and generators for dam work or evacuation.
- Construction equipment if the dam is repairable:
- Loaders
- Excavators
- Gravel hauling trucks
- High wheel trucks
- Sandbags
- Shovels
- Tree removal equipment
- Barriers, barricades and personnel transportation to facilitate evacuation

The provision of labor, equipment and materials is the responsibility of the dam owner. As such the following sections provide recommendations for establishing relationships and agreements with local contractors, vendors, and suppliers. Refer to Appendix D for additional information.

<u>Contractors</u>

The dam owner should develop/maintain open-ended contracts with a number of general contractors and/or suppliers. These contracts allow the dam owner to hire equipment as needed at a set hourly rate. Materials could be purchased from the contractors.

Potential Borrow Areas Around the Town

Potential borrow areas should be identified that could be used as sources of fill material in the event of an emergency condition at the dam that requires soil fill material. The owners of these and any other gravel pits that may be used during an emergency should be contacted.

TABLE A.1: List of Addresses in the Inundation Zone[1]

1 Albany St	16 Bonwood St	55 Bridges Ave
2 Albany St	17 Bonwood St	3 Cabot Ct
3 Albany St	18 Bonwood St	4 Cabot Ct
4 Albany St	19 Bonwood St	201 Cabot St
5 Albany St	21 Bonwood St	203 Cabot St
6 Albany St	4 Bowers St	223 Cabot St
7 Albany St	6 Bowers St	229 Cabot St
8 Albany St	10 Bowers St	253 Cabot St
9 Albany St	12 Bowers St	257 Cabot St
10 Albany St	4 Briar Ln	260 Cabot St
11 Albany St	4 Bridges Ave	261 Cabot St
12 Albany St	7 Bridges Ave	262 Cabot St
13 Albany St	9 Bridges Ave	266 Cabot St
14 Albany St	11 Bridges Ave	270 Cabot St
15 Albany St	12 Bridges Ave	273 Cabot St
16 Albany St	14 Bridges Ave	276 Cabot St
17 Albany St	15 Bridges Ave	278 Cabot St
19 Albany St	17 Bridges Ave	279 Cabot St
20 Albany St	18 Bridges Ave	282 Cabot St
21 Albany St	19 Bridges Ave	284 Cabot St
22 Albany St	20 Bridges Ave	286 Cabot St
24 Albany St	21 Bridges Ave	288 Cabot St
16 Blithedale St	23 Bridges Ave	293 Cabot St
20 Blithedale St	25 Bridges Ave	294 Cabot St
26 Blithedale St	27 Bridges Ave	297 Cabot St
5 Bonwood St	31 Bridges Ave	300 Cabot St
6 Bonwood St	33 Bridges Ave	301 Cabot St
7 Bonwood St	41 Bridges Ave	303 Cabot St
8 Bonwood St	43 Bridges Ave	305 Cabot St
9 Bonwood St	45 Bridges Ave	307 Cabot St
10 Bonwood St	47 Bridges Ave	308 Cabot St
12 Bonwood St	49 Bridges Ave	309 Cabot St
14 Bonwood St	51 Bridges Ave	313 Cabot St
15 Bonwood St	53 Bridges Ave	318 Cabot St

[1] This list was created using the computed dam failure inundation area, parcel data from Mass GIS, and address data from the City of Newton GIS.

319 Cabot St
320 Cabot St
321 Cabot St
322 Cabot St
324 Cabot St
326 Cabot St
327 Cabot St
328 Cabot St
331 Cabot St
332 Cabot St
333 Cabot St
336 Cabot St
340 Cabot St
344 Cabot St
346 Cabot St
350 Cabot St
352 Cabot St
364 Cabot St
365 Cabot St
369 Cabot St
372 Cabot St
375 Cabot St
380 Cabot St
383 Cabot St
15 Carter St
18 Carter St
19 Carter St
20 Carter St
21 Carter St
22 Carter St
3 Claflin Pl
5 Claflin Pl
7 Claflin Pl
4 Clarendon St
5 Clarendon St
6 Clarendon St
8 Clarendon St
9 Clarendon St
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34 Clarendon St
35 Clarendon St
37 Clarendon St
38 Clarendon St
39 Clarendon St
40 Clarendon St
41 Clarendon St
42 Clarendon St
46 Clarendon St
12 Cloelia Ter
14 Cloelia Ter
20 Cloelia Ter
10 Clyde St
14 Clyde St
20 Clyde St
28 Clyde St
31 Clyde St
34 Clyde St
37 Clyde St
40 Clyde St
43 Clyde St
45 Clyde St
49 Clyde St
60 Clyde St
66 Clyde St
67 Clyde St
70 Clyde St
72 Clyde St
74 Clyde St
12 Dale St
15 Dale St
20 Dale St
21 Dale St
23 Dale St
24 Dale St
26 Dale St
27 Dale St
10 Dexter Rd
12 Dexter Rd
20 Dexter Rd
26 Dexter Rd
36 Dexter Rd
101 East Side Pkwy
57 Elm Rd
9 Frederick St
11 Frederick St
15 Frederick St
22 Frederick St
24 Frederick St
25 Frederick St
26 Frederick St
27 Frederick St
28 Frederick St
29 Frederick St
30 Frederick St
33 Frederick St
36 Frederick St
37 Frederick St
38 Frederick St
44 Frederick St
45 Frederick St
47 Frederick St
3 Gay St
4 Gay St
9 Gay St
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47 Harvard St
48 Harvard St
50 Harvard St
51 Harvard St
52 Harvard St
58 Harvard St
60 Harvard St
62 Harvard St
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APPENDIX B

Emergency Detection, Evaluation, & Classification

EMERGENCY DETECTION, EVALUATION & CLASSIFICATION

The detection, evaluation and classification of a potential emergency situation are crucial in determining the level of response and notification required in order to minimize the response time.

The following emergency classification system is proposed for this site:

- **Dam Safety WATCH: "Potential failure is developing":** This is a situation where a failure may eventually occur if left unattended. This situation will require a Phase I response with continuous monitoring of the situation. This emergency classification level was formerly titled "Condition I".

- **Dam Failure WARNING:** "**Failure is Imminent or has occurred":** This is a situation where a failure either has occurred, is occurring, or is just about to occur. This situation will require Phase I and II responses that will proceed with evacuation procedures. This emergency classification level was formerly titled "Condition II".

Examples of the preplanned procedures and notification that should be followed based on the various conditions observed during either storm or fair weather conditions are outlined below. These are examples and are not intended to describe all possible conditions, nor are they intended to limit the actions taken during a given event.

B.1 Dam Safety WATCH Examples

Notify: Dam Owner, Local EMD, Engineer, MA DCR ODS, MEMA, Massachusetts State Police

- Earthquake resulting in visible damage to the dam or appurtenances
- Other situations which may lead to damage at the structure
  - Evidence of vandalism
  - Bomb threat
  - A civil disorder near the reservoir
  - Any aircraft accident near the reservoir
- Water level of the impoundment is at an unsafe level and is rising, threatening to overtop the dam
- Discharges resulting in significant erosion and/or scour
- Any developing erosion, settlement, or upheaval occurring on the downstream slope or at the toe of the dam that is considered to be controllable
- Any undocumented leakage through any dam structure considered to be controllable

B.2 Dam Safety WARNING Examples

Notify: ALL PARTIES LISTED ON THE NOTIFICATION FLOWCHART

- Water has overtopped or will overtop the dam

- Uncontrollable erosion, settlement, or upheaval occurring on the downstream slope or at the toe of the dam
- Uncontrollable leakage through any dam structure resulting in degradation to the structural integrity of the dam
- A dislocation or failure of any structure which allows for an expanding, uncontrollable discharge of water through the spillway or dam, indicating a breach is occurring
- Dam is failing, is about to fail, or has failed

A Dam Safety Watch may be declared initially with gradual transition into a Dam Failure Warning or a Dam Failure Warning may be declared immediately, depending on the actual conditions.

While these actions attempt to generalize responses to the observed conditions, the judgment of the primary observer and/or knowledgeable person(s) must be utilized. Some conditions such as breaching, overtopping and severe piping can dictate an immediate evacuation, while others will require the observer to determine the extent of the concern and the probability of the concern being addressed within a timely fashion.

B.3 Additional Guidance for Determining the Emergency Level[1]

TABLE B.1: Possible Failure Modes

Event	Situation	Emergency Level
Structural Cracking	New cracking in the concrete structure with radial, transverse, or vertical displacement	- -
	New cracks in the concrete with seepage	Watch
	New cracks/old cracks with actively progressing displacements	Warning
Foundation Weakness	New cracks at the abutment greater than ¼-inch wide without seepage	Watch
	Cracks in the abutment with seepage	Watch
	Visual movement/slippage of the embankment slope	Warning
Construction Joint Cracking	Cracking at a construction joint	- -
	Cracked construction joint with displacement and seepage	Watch
Sinkholes	Rapidly enlarging sinkhole	Warning
Embankment Cracking	New cracks in the embankment greater than ¼-inch wide without seepage	- -
	Cracks in the embankment with seepage	Watch / Warning
Earthquake	Earthquake felt within 50 miles of the dam	- -
	Earthquake resulting in visible damage to the dam or appurtenances	Watch
	Earthquake resulting in uncontrolled release of water from the dam	Warning
Security Threat	Verified bomb threat that, if carried out, could result in damage to the dam	Warning
	Detonated bomb that has resulted in damage to the dam or appurtenances	Warning
Sabotage/ Vandalism	Damage to dam or appurtenances with no impacts to the functioning of the dam	- -
	Damage to dam or appurtenances that has resulted in seepage flow	Watch
	Damage to dam or appurtenances that has resulted in uncontrolled water release	Warning

* "- -" signifies a non-emergency situation; an unusual event is slowly developing.
* "Watch / Warning" signifies that site-specific visual inspection is warranted and engineering judgement is required to classify the emergency level.

[1] Based upon the NRCS Recommendations for Developing EAPs, 2006.

B.4 Potential Hazards That Can Lead to Dam Failure

The purpose of the section is to educate the user of the EAP as to some of the common causes of dam instability and possible failure. A short definition of each hazard is listed along with typical causes. This is not intended to be an exhaustive list of all failure mechanisms as each dam has a unique set of conditions which will influence the development of conditions and concerns.

1. Flow Erosion

    - Wash out of spillways, embankment sections.

    - Causes: poor compaction of silt backfill; lack of riprap or concrete protection at interface between soil embankment and concrete structure; erosion by flow over embankment, spillway, or through outlet.

2. Embankment Leakage, Piping

    - Excessive seepage resulting in internal erosion followed by formation of a "pipe" through the embankment, which once formed, causes rapid flow erosion and wash out of the embankment.

    - Causes: poor compaction of soil along interface with concrete structures; lack of seepage control collars around pipe; tree root and rodent holes; inadequate or nonexistent filters between fine and coarse soils; cracks or voids within the concrete structure.

3. Foundation Leakage, Piping

    - Wash-out of foundation material below dam causing undermining.

    - Causes: poor interface with bedrock and concrete structures; excessive seepage at dam toe carrying soil with it.

4. Sliding

    - Serious movement in foundation or concrete structure which either result in dam failure or significantly weaken the dam structure.

    - Causes: foundation material weak; excessive water pressure in structure or foundation.

5. Deformation

    - Gross deformation of dam or outlet structures resulting in immediate failure or cracking of the dam, and subsequent washouts.

- Causes: excessive settlement in foundation, ice jacking (pressure exerted by expending/contracting ice structures).

6. Blowing of Trees from Embankment

- Blowing of trees on and near the embankment could result in substantial cracks and scour of the embankment and subsequent washout of the embankments.

- Causes: heavy rain associated with gusty winds and natural aging and poor root system of the trees on and near the embankments.[1]

7. Reduction of Crest Elevation

- Deterioration or washout of dam crest.

- Causes: poor concrete condition; heavy rain runoff.

8. Dam Overtopping

- Water flows over the crest of the dam causing erosion and subsequently reducing dam height with time. If overtopping continues for any length of time it may lead to a total failure of the dam.

- Causes: heavy rain; blocked or inadequately sized spillway.

9. Cracking

- Longitudinal cracking can be due to movements and/or settlements of the dam and can allow water to infiltrate the concrete.

- Transverse cracking can be due to horizontal and/or vertical movement and can result in a flow path across the concrete structure.

- Thin cracks can be very deep and intersect the phreatic surface.

[1] For more information, see FEMA 534 "Technical Manual for Dam Owners – Impacts of Plants on Earthen Dams", September 2005, published by Flood Emergency Management Agency (FEMA).

APPENDIX C

Termination & Recovery

APPENDIX C
TERMINATION & RECOVERY

If the EAP has been placed into action and the event has been deemed to not be an emergency, or the threat has been mitigated, termination of the emergency response under the EAP will be the sole responsibility of the incident commander. Termination process should include, but not be limited to, the following steps:

- Notify all agencies and parties contacted during the response of the situation termination
- Issue public notification
- Complete post-situation dam inspection
- Implement post-situation recovery, including restoring impacted areas such that they are safe for public use and repairing or otherwise addressing damaged infrastructure

APPENDIX D

Materials & Equipment

APPENDIX D
MATERIALS & EQUIPMENT

The City of Newton should maintain a current list of contractors under contract or prequalified to complete work for the City along with contact names, addresses, telephone numbers, and capabilities (i.e. material and equipment). Copies of the contracts as well as a schedule for contract renewals should be maintained in this section of the EAP.

The City should maintain an updated list of available equipment within this section. This list should include the location at which this equipment is stored as well as the status of the equipment (working, damaged, etc.).

For informational purposes, GZA has prepared an abbreviated list of contractors who have completed dam projects within Massachusetts:

Contractor	Phone Number	Locations
T Ford Company, Inc.	978-352-5606	Georgetown, MA
J. H. Lynch & Sons, Inc.	401-333-4300	Millbury, MA; other locations in CT & RI
New England Infrastructure Inc.	978-293-3535	Hudson, MA
WES Construction Corp.	781-294-1080	Halifax, MA
NEL Corporation	978-777-2085	Middleton, MA
R. Zoppo Corp.	781-344-8822	Stoughton, MA
S&R Corporation	978-441-2000	Lowell, MA
James A Gross Contractors	781-862-7307	Lexington, MA
Northern Construction LLC	413-289-1230	Weymouth, MA; Palmer, MA
Maxymillian Technologies	413-499-3050	Pittsfield, MA
E.T. & L. Corp.	978-897-4353	Stow, MA
Charter Contracting Company LLC	857-246-6800	Boston, MA
Mark Santora PE Inc.	508-839-5113	North Grafton, MA

APPENDIX E

Signoff Sheets

APPENDIX E
SIGNOFF SHEETS

RECORD OF REVISIONS

Date of Revision	Revision #	Sections Reviewed and Revisions Made	By Whom
May 2020	0	Original EAP Developed	GZA Newton DPW

RECORD OF TRAINING

Date of Training	Description	Attendees

APPENDIX F

Common Dam Safety Definitions

APPENDIX F
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. On 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.

APPENDIX G

HEC-RAS Screenshots

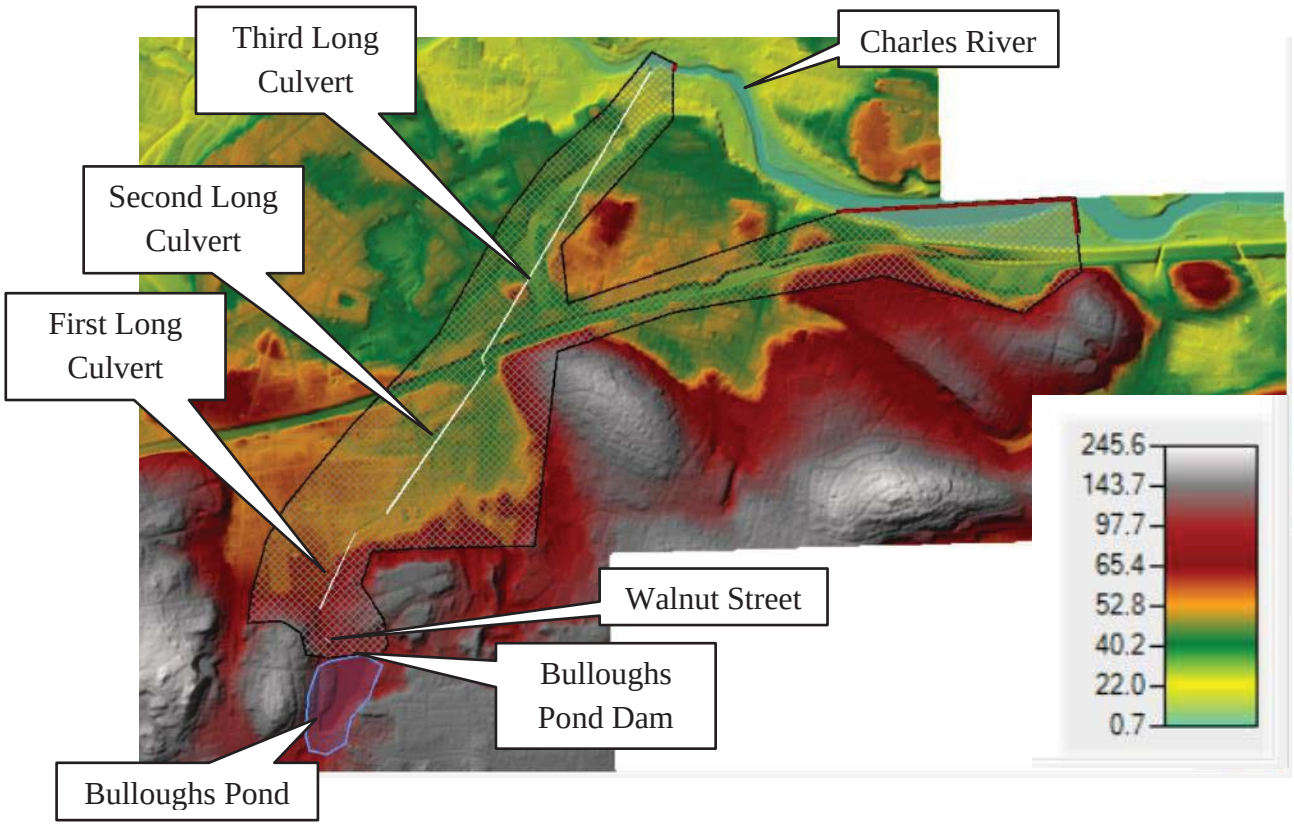

Figure G1: Model Setup with Terrain (Feet, NAVD88)

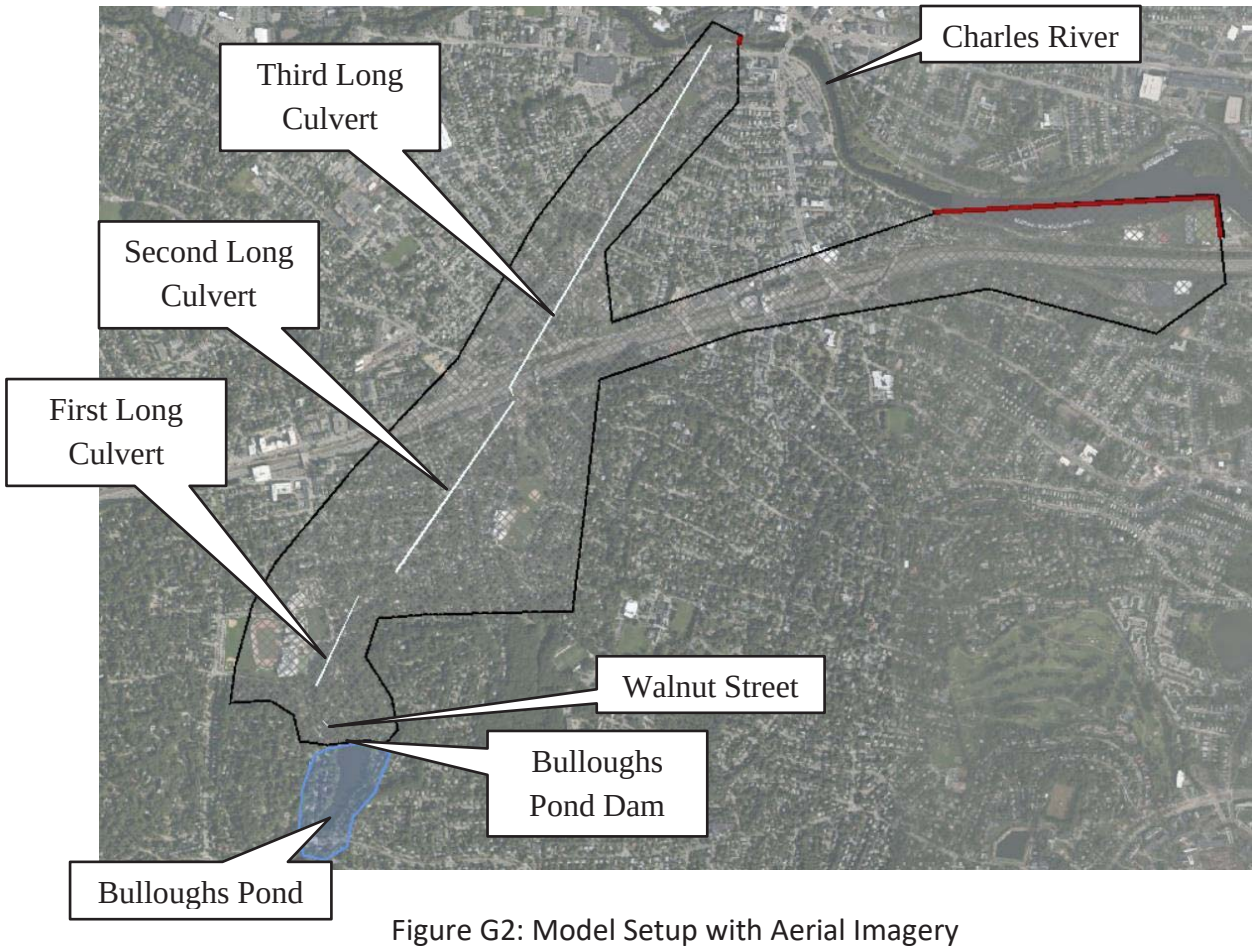

Figure G2: Model Setup with Aerial Imagery

APPENDIX H

Limitations

APPENDIX H
LIMITATIONS

Use of Report

1. GeoEnvironmental, Inc. (GZA) prepared this report on behalf of the City of Newton Department of Public Works (Client) for the stated purpose(s) and location(s) identified in the Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

Standard of Care

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. Our services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

General

4. The observations described in this report were made under the conditions stated therein. The conclusions presented were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of described services or the time and budgetary constraints imposed by the Client.

5. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein available to GZA at the time of the evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

6. Observations were made of the site and of structures on the site as indicated within the report. Where access to portions of the structure or site, or to structures on the site was unavailable or limited, GZA renders no opinion as to the condition of that portion of the site or structure. In particular, it is noted that water levels in the impoundment and elsewhere and/or flow over the spillway may have limited GZA's ability to make observations of underwater portions of the structure. Excessive vegetation, when present, also inhibits observations.

7. In reviewing this Report, it should be realized that the reported condition of the dam is based on observations of field conditions during the course of this study along with data made available to GZA. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued inspection and care can there be any chance that unsafe conditions be detected.

8. It should be noted that the overall contents of this Report, including recommendations describing organization and duties, are not intended for the dam owner to usurp the responsibility of other state and local governmental entities responsible for the evacuation of people and protection of life and property.

9. It should be understood that this plan is intended for use in dam emergency conditions only and does not address any other emergency operation. This plan should be used at all times in conjunction with established policies and procedures from other agencies.

10. Any GZA hydrologic analysis presented herein is for the rainfall volumes and distributions stated herein. For storm conditions other than those analyzed, the response of the site's spillway, impoundment, and drainage network has not been evaluated.

11. The dam breach analysis and inundated areas shown on the Inundation Maps included in this document reflect events of an extremely remote nature. They are not in any way intended to reflect upon the integrity of the dam.

12. The analysis presented is for the breach scenarios stated herein. For conditions other than those analyzed, the estimated flood wave and resulting inundation area has not been analyzed.

<u>Additional Services</u>

13. It is recommended that GZA be retained to provide services during any future: site observations, explorations, evaluations, design, implementation activities, construction and/or implementation of remedial measures recommended in this Report. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

14. These various guidelines and references are presented for informational purposes only. The procedures presented may not cover all potential damage and repair scenario. It is important that the City engage a qualified Massachusetts Registered Professional Engineer, with experience in dam evaluations, design and construction.

REFERENCES

REFERENCES

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. Commonwealth of Massachusetts General Laws, M.G.L. 253, Section 44, Chapter 302 CMR 10.00, Dam Safety, February 10, 2017.

5. "Draft Phase II Report for Bulloughs Pond Dam," GZA, May 2020.

6. "Bullough's Pond Diagnostic/Feasibility Study, City of Newton, MA", Camp Dresser & McKee, August, 1990.

7. "The History of Bulloughs Pond", Bulloughs Pond Association, http://www.bulloughspond.org/the-history-of-bulloughs-pond.html, accessed 4-22-2020.

Known for excellence.
Built on trust.

PHASE II REPORT FOR BULLOUGHS POND DAM

Newton, MA

May 22, 2020
File No. 01.0174021.00

PREPARED FOR:
City of Newton

GZA GeoEnvironmental, Inc.
249 Vanderbilt Avenue | Norwood, MA 02062
781-278-3700

30 Offices Nationwide
www.gza.com

Bulloughs Pond Dam MA03414
City of Newton
Newton, Massachusetts

Phase II Engineering Evaluation and Alternatives Analysis

TABLES:

FIGURES:

APPENDICES:

1.0 INTRODUCTION

1.1 Authority

GZA GeoEnvironmental, Inc. (GZA) of Norwood, Massachusetts, was contracted by the City of Newton (City) to perform a Phase II dam safety evaluation involving a number of engineering tasks preliminary to the design of repairs and rehabilitations to the Bulloughs Pond Dam. GZA was authorized to proceed by the City on December 10, 2018. This report is subject to the Limitations contained in **Appendix A**.

1.2 Purpose

The overall purpose of our services was to perform Phase II inspections and Investigations as required by the Massachusetts Department of Conservation and Recreation, Office of Dam Safety (DCR or ODS) Certificate of Non-Compliance and Dam Safety Order dated July 16, 2018. The Dam Safety Order was issued as a result of Pare Corporation inspections that determined the dam to be **STRUCTURALLY DEFICIENT** and in **POOR** condition.

GZA's approach for this Phase II assessment was to design and execute a limited exploratory field program and to conduct engineering analyses to address the following technical issues:

- Characterize the embankment and foundation soils and estimate the seepage (phreatic) surface and stability of the earthen portion of the dam embankment;
- Conduct a detailed hydrologic and hydraulic (H&H) analysis to evaluate whether the dam can pass the Spillway Design Flood (SDF) for the dam, which is the 100-year storm; and
- Develop alternatives to mitigate identified deficiencies.

Unless otherwise noted, elevations used in this report are referenced to the North American Vertical Datum of 1988 (NAVD88).

1.3 Scope of Services

As part of our Phase II efforts, GZA performed the following scope of services:

- Compiled available information. As part of this initial task, GZA visited the dam site and conducted a Follow-up inspection as required by the Dam Safety Order. GZA referenced inspection guidelines and standard document formats presented on the ODS website. GZA compiled and reviewed original engineering design drawings and available on-line resources;
- Planned, coordinated and observed a subsurface exploration program consisting of four test borings to obtain information that was used in seepage and stability analyses. Observation wells were installed in two of the four completed borings;
- Performed five laboratory gradation analyses on representative embankment and foundation soil samples;
- Performed seepage and stability analyses to evaluate performance of the dam with respect to embankment safety;

- Conducted preliminary geotechnical design evaluations of proposed embankment modifications to address seepage and stability performance;
- Conducted follow-up inspections on January 15, 2019, July 19, 2019, and April 6, 2020;
- Performed a detailed hydrologic and hydraulic (H&H) analysis of the existing dam and reservoir system in accordance with Massachusetts Dam Safety Regulations and current engineering practice.
- Conducted preliminary evaluations of proposed dam and spillway modifications to safely pass the SDF;
- Based on the above-performed tasks and to assist Client in decision making, developed recommendations and preliminary cost estimates for selected remedial repair alternatives to address deficiencies identified during our investigation and analyses specifically with respect to safely passing the SDF, replacing the existing low-level outlet gates, repairing the spillway and training walls, regrading and protecting the embankment; and
- Prepared this report summarizing our investigations and engineering analyses, conclusions and recommendations.

Subsequent to GZA's initiation of Phase II efforts, the City of Newton engaged GZA to develop an Emergency Action Plan (EAP) for Bulloughs Pond Dam. The EAP is being submitted under separate cover. The results of the EAP suggest that the dam may be reclassified by DCR as a ***High Hazard Potential (Class I)*** dam. In addition, our Phase II evaluations indicate that the Bulloughs Pond Dam is an ***Intermediate-size*** structure. ***Dam Size and Hazard classification should be considered during final design of the selected alternative, particularly with respect to hydrology and hydraulics analyses, stability evaluations, and the selected repair alternative.*** Refer to Sections 2.3, 2.4, and 9.3.6 for additional discussion.

2.0 SITE DESCRIPTION

2.1 File Review

Based on GZA's review of existing files, some type of dam/impoundment structure has been present at the site since about 1664. The Bulloughs Pond Association's research[1] indicates that the structure was replaced sometime around 1926 with the configuration present today.

Pertinent information on the dam's construction was garnered from our review of drawings prepared between 1897 and 1922 (Historic Drawings) when the dam underwent a major reconstruction to its present configuration. These drawings were provided by the City of Newton Engineering Department and are included in Appendix B.

2.2 Description of Dam and Appurtenances

Bulloughs Pond Dam is an approximately 225-foot long, 14.5-foot high earthen embankment. The top of embankment (at approximately elevation 92) is asphalt-paved Dexter Road with a bridge over the spillway. The

[1] The History of Bullough's Pond" webpage, researched and prepared by the Bullough's Pond Association, http://www.bulloughspond.org/the-history-of-bulloughs-pond.html

paved roadway is flanked by a stone dust walkway on the upstream side and grassy shoulder on the downstream side. The upstream and downstream slopes are grassed and heavily vegetated with woody brush and trees. The embankment side slopes are approximately 2 horizontal to 1 vertical (2H:1V) on both the upstream and downstream sides, with locally steeper upstream slopes where scarping has occurred near the normal pool level.

The water level in Bulloughs Pond (historically also referred to as Spring's Pond or Pearl Lake) is maintained via an uncontrolled 35-foot-long spillway located upstream of the Dexter Road bridge, with an additional downstream weir located below the bridge. The vee-shaped upstream weir elevation is 85.94 feet, and the downstream weir elevation is 84.95 feet with a central lower throat at elevation 81.9 feet. The downstream weir appears to follow the contours of the bedrock beneath the bridge.

Low flows can be passed via two gated 24-inch diameter low-level outlets, located toward the left (west) end of the embankment. The outlet pipes are cast iron, with downstream inverts around elevation 77 feet. The gates valves are located in a vault in the upstream slope and reportedly exercised on a yearly basis.

According to the historic drawings (see **Appendix B**) made available to GZA, a concrete core wall is present along the length of the dam embankment. The top of core wall is shown on historic drawings approximately 3½ to 5½ feet below proposed 1897 grades. It is likely that roadway work has modified grades over the past century. As described below, the core wall was encountered during the subsurface exploration program about 5 feet below current grade. The core wall alignment varies from upstream to downstream along the length of the embankment. The core wall is reportedly 2.5 feet wide at the top tapering to 3.5 feet wide at the base.

2.3 Dam Size Classification

The dam is currently classified by DCR as a **Small** size structure, likely due to information contained in the National Inventory of Dams (NID) database[2]. According to the NID database, Bulloughs Pond Dam has a maximum height of approximately 9 feet and an estimated maximum storage capacity of about 30.8 acre-feet.

The dam height surveyed by the City of Newton (refer to **Appendix C**) indicates that maximum embankment height of Bulloughs Pond Dam is about 14.5 feet. The results of the hydrology and hydraulics evaluations described in Section 6 indicate that the dam has a maximum storage of about 63 acre-ft. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts Dam Safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Bulloughs Pond Dam is an **Intermediate** size structure (due to a height exceeding 6-feet, but less than 15-feet and a maximum storage capacity exceeding 50 acre-feet, but less than 100 acre-feet).

2.4 Dam Hazard Classification

The dam is currently classified by DCR as having a **Significant Hazard** (Class II) potential. Significant Hazard is defined as: "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 interruption of use or service of relatively important facilities."

[2] https://nid.sec.usace.army.mil/ords/f?p=105:113:10544599320348::NO:113,2:P113_RECORDID:31354

Massachusetts Dam Safety Regulations now require an Emergency Action Plan (EAP) for all Significant Hazard dams in Massachusetts. GZA is currently developing an Emergency Action Plan for this dam, which will be submitted to ODS under separate cover. The results of this evaluation suggest that DCR may consider reclassification of Bulloughs Pond Dam as a High Hazard Potential (Class I) structure.

3.0 DAM SAFETY INSPECTIONS

3.1 Summary of Previous Inspections by Others

Pare Corporation personnel visited the site in May 2017, December 2017, and June 2018 to conduct Follow-up dam inspections. Based on these inspections, Pare recommended a **POOR** condition for Bulloughs Pond Dam, as defined in 302 CMR 10.03.

3.2 Summary of GZA Inspections

Follow-up inspections were performed by GZA on January 15, 2019, July 19, 2019, and April 6, 2020. Based on our inspections, we observed that the dam condition was generally unchanged from the prior inspections by others.

3.3 Summary of Previously Identified Deficiencies

The following is a brief summary of deficiencies/issues identified during previous inspections/evaluations:

1. Unwanted vegetation in areas of the dam including large trees along the downstream slope;
2. Scarping along the upstream slope and bare soils prone to erosion along the downstream slope;
3. Deterioration/potentially unstable headwall at the downstream end of the low-level outlet with observed scour/displaced riprap within the channel;
4. Areas of scour along the downstream channel including at the low-level outlet and along the left and right banks. If erosion of the left bank continues, it could encroach on the toe of the downstream slope;
5. Mortar missing from some joints of the spillway training walls; and,
6. Additional maintenance deficiencies and dam safety concerns. *{Unspecified in 2018 Pare Follow-up}*

GZA did not observe significant changes to the above-noted deficiencies during our follow-up inspections. During the April 2020 inspection, GZA observed eroded footpaths on the upstream and downstream slopes.

3.4 Summary of Dam Safety Orders

Based on the reported Poor condition of the dam, ODS issued a Certificate of Non-Compliance and Dam Safety Order dated July 16, 2018. The order requires that the City:

- Conduct follow-up inspections at six-month intervals (Follow-up Inspection reports were submitted to ODS as referenced in **Appendix D**);
- Conduct a Phase II Inspection and Investigation; and,
- Bring the dam into compliance and complete repair work.

ODS also issued Orders related to preparation of an Emergency Action Plan (EAP) as follows:

- An Order to Prepare an Emergency Action Plan for Significant Hazard Potential Dams, Bulloughs Pond Dam, Newton, MA03414, Significant Hazard, dated December 10, 2018 (with December 17, 2018 Correction to Recent Emergency Action Plan Order); and
- A request for status update concerning December 10, 2018 Order to Prepare an Emergency Action Plan for Significant Hazard Potential Dams, Bulloughs Pond Dam, Newton, MA03414, Significant Hazard, dated march 3, 2020.

On behalf of the City, GZA requested and received extensions to the deadlines in these Dam Safety Orders. Refer to **Appendix E** for Dam Safety Orders and extension correspondence.

4.0 PHASE II INVESTIGATIONS

A subsurface exploration program including lab testing for select samples was developed and performed by GZA. Topographic and bathymetric surveys and natural resource delineations were performed by the City to support the Phase II investigations.

4.1 Test Borings

Four test borings (GZ-1 through GZ-4) were completed on February 25 and 26, 2019 by New England Boring Contractors, Inc. of Brockton, Massachusetts. Test boring locations were chosen to provide information about the dam embankment to support our seepage and stability evaluations and to help confirm presence of a core wall. The borings were located near the dam maximum section between the spillway and low-level outlet. The test borings were performed at the locations shown in Appendix F as located in the field by City topographic survey subsequent to the explorations.

Borings were advanced via drive-and-wash methods using flush-jointed HW (4-inch-diameter) casing to depths ranging from about 11.5 to 23 feet below the existing ground surface. Split spoon sampling was generally performed on a continuous basis, with larger spacing for two of the sample intervals to help increase production. Split spoon sampling and Standard Penetration Tests (SPTs) were performed in general accordance with ASTM D1586 wherein a 2-inch-outside diameter split spoon is driven up to 24 inches with a 140-pound safety hammer falling 30 inches. The number of blows required to drive the sampler for each 6-inch increment was recorded and the Standard Penetration Resistance (N-value) was computed as the sum of the blows over the middle 12 inches of penetration. Representative soil samples were collected and stored in jars for later review and laboratory testing.

Upon completion, borings GZ-2 and GZ-3 were each completed as an observation well (OW). OW GZ-2 was screened in embankment soils from 6 to 11 feet below existing ground surface (GZ-2-OW) and OW GZ-3 was screened in in the embankment soils from 6.5 to 11.5 feet below the existing ground surface (GZ-3-OW). The wells were backfilled with filter sand extending to about one foot above the screened interval. Up to 1 foot of bentonite chips was installed above the screen sections. Close to the ground surface, a thin layer of sand was placed to provide bedding for the concrete collar for flush-mounted roadboxes, which were installed at each well. Each road box was grouted in place. Borings GZ-1 and GZ-4 were backfilled with a cement/bentonite grout.

A GZA representative observed the explorations, visually classified the soil samples using the modified Burmister Classification system, and prepared the logs included in **Appendix F**.

4.2 Geotechnical Laboratory Testing

Geotechnical laboratory gradation (sieve) tests were performed on two of the embankment soil samples and three of the foundation soil samples obtained from the test boring program. The tests were performed in accordance with American Society of Testing and Materials (ASTM D-422) by Thielsch Engineering in Cranston, Rhode Island. The testing was performed to help confirm visual field classifications and assign engineering parameters to the soils for use in the seepage and stability modeling. Laboratory results are attached as **Appendix G**.

4.3 Natural Resource Delineation

The City flagged bordering vegetated wetlands (BVW) and bank location. The resource flagging was performed by Jennifer Steel, Senior Environmental Planner for the City of Newton. Wetland flag locations were surveyed by City personnel as described below and are shown in **Appendix C**.

4.4 Topographic and Bathymetric Survey

The City conducted a topographic and bathymetric survey of Bulloughs Pond Dam and the immediately surrounding areas[3]. The topographic survey included abutments, low-level outlet intake and outlet structures, pipe inverts, spillway crest and downstream apron, upstream and downstream slope angles, bridge deck and abutments, roadway drainage structures, manholes, upstream edge of water and top/bottom of bank for outlet channel, boring locations, property lines, natural resource boundaries, spot elevations of key site features and one-foot contours. The topographic survey was referenced to the Massachusetts State Plane Coordinate System horizontal datum, and North American Vertical Datum of 1988 (NAVD88) vertical datum. Refer to **Appendix C** for the topographic and bathymetric survey plan.

5.0 INTERPRETATION OF SUBSURFACE CONDITIONS

5.1 Soil Strata

Subsurface conditions as interpreted from GZA's test borings generally consist of embankment fill over natural soil or bedrock. A summary of the subsurface conditions encountered at each test boring is presented below:

- Topsoil: An approximately 2-foot thick surficial layer of topsoil was encountered in the grassed area near the downstream edge of the top of embankment (crest) in boring GZ-3. This strata was not encountered in borings GZ-1, GZ-2, or GZ-3 which were performed in paved areas. The topsoil was loose and generally consisted of a dark brown, fine to coarse sand with between 20 and 35 percent silt, up to 10 percent gravel, and up to 5 percent roots.
- Asphalt and Road Base: An approximately 6-inch thick surficial layer of asphalt was encountered in borings GZ-1, GZ-2, and GZ-4. An approximately 1½-foot thick layer of road base soil was encountered below the asphalt paving in boring GZ-1. Samples of roadway base soils were not attempted in borings GZ-2 and GZ-4. Where

[3] "Existing Conditions Topographic Plan of Bulloughs Pond Dam Spillway Culvert in Newton, MA" Prepared for City of Newton, MA by the City of Newton Engineering Department, dated October 7, 2019.

sampled, the road base material generally consisted of brown, fine to coarse sand, with between 20 and 35 percent gravel and 10 to 20 percent silt.

- Embankment Fill: Embankment fill was encountered in each boring below the road base or topsoil. The embankment fill generally consisted of a brown to reddish brown mixture of gravel, sand, silt, and clayey silt with consistencies varying from loose to medium dense or stiff. Where fully penetrated, the embankment fill extended to depths below ground surface (bgs) of about 10.5 feet in GZ-3 to 14 feet in GZ-2.
- Core Wall: According to the typical cross-section depicted on historical drawings provided from the City of Newton, the dam was reportedly constructed in a zoned fashion with a soil shell and a concrete core. The top of core wall is shown on historic drawings approximately 3½ to 5½ feet below proposed 1897 grades. It is likely that roadway work has modified grades over the past century. Evidence of a core wall was encountered in boring GZ-1, where reddish-brown concrete was encountered and cored from about 5- to 12 feet bgs, or below approximate elevation 87 feet. The concrete was fresh to slightly weathered with moderately spaced to close fractures.
- Fine-Grained Foundation Soils: A fine grained natural foundation soil layer was encountered immediately below the embankment fill layer in borings GZ-3 and GZ-4. Where encountered, the fine-grained foundation soil generally consisted of a loose, gray to grayish brown fine to medium sand with about 10 to 35 percent gravel.
- Bedrock: Sound bedrock was encountered at approximately 14-feet bgs in boring GZ-2 and inferred from casing and roller bit refusals at depths of at 11.5 and 13-feet below ground surface at GZ-3 and GZ-4, respectively. These depths correspond to approximate top of bedrock elevations of 78 to 81 feet. The bedrock cored in boring GZ-2 generally consisted of hard, slightly weathered, amorphous to medium-grained, greenish gray Argillite with very thin, moderately dipping foliation, and smooth, planar, and close to moderately close sub-horizontal joints. Core recovery ranged from 80 to 92 percent with Rock Quality Designation[4] (RQD) ranging from 77 to 83 percent. This lithology is consistent with published regional bedrock geologic mapping[5].

5.2 Groundwater

Groundwater was encountered during drilling in borings GZ-2, GZ-3, and GZ-4 at depths between 6 and 7 feet bgs, corresponding to approximate elevation 85 to 86 feet. The reservoir water elevation during drilling was approximately 1 to 2-inches over the spillway crest (corresponding to approximate elevation 86 feet). Due to drilling disturbance and the use of drilling fluids, these measurements are not considered stabilized readings.

Monitoring wells were installed in borings GZ-2 and GZ-3 (GZ-2OW and GZ-3OW) to allow stabilized groundwater level measurements. After six weeks of stabilization time, the measured water levels were 9.86 feet bgs (approximate elevation 82.0) in GZ-2OW, and 10.9 feet bgs (approximate elevation 81.3 feet) in GZ-3OW. The reservoir level was at approximately normal pool (elevation 86 feet) when the stabilized groundwater levels were measured. The core wall is located between GZ-1/GZ-4 and GZ-3OW, indicating an approximate 4 to 5 foot head drop across the core wall.

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[4] RQD is defined as the sum of the lengths of rock core pieces measuring >4-inches divided by the length of core run, expressed in percent

[5] "Bedrock Geologic Maps of the Boston North, Boston South, and Newtown Quadrangles, Massachusetts Sheet 1 of 2" by Clifford A. Kaye dated 1980

Please note that fluctuations in groundwater levels will occur due to variations in season, rainfall, site features, and other factors different from those existing at the time of the explorations and measurements.

6.0 HYDROLOGIC AND HYDRAULIC (H&H) ANALYSES

6.1 Objectives

GZA conducted hydrologic and hydraulic (H&H) analyses of the Bulloughs Pond Dam. The initial objective of the analysis was to assess the spillway capacity and embankment overtopping potential. The dam's spillway adequacy was evaluated for the spillway design flood (SDF). Per DCR Dam Safety Regulation 302 CMR 10.14, the SDF for the Bulloughs Pond Intermediate-sized, Significant Hazard dam is a 100-year recurrence interval design storm. Future design should consider the higher SDF associated with a High Hazard structure, if so designated by DCR. The results of our H&H analyses were subsequently used to evaluate spillway adequacy for the alternatives analysis. Computer model input/output for the hydrology and hydraulics analyses are contained in **Appendix H**.

GZA used the US Army Corps of Engineers Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) computer program to estimate the flow generated by the 100-year flood SDF. This flow was routed through the dam/reservoir system. Inflow and outflow hydrographs were generated for the current spillway configuration, and then the model was used to study potential design alternatives for passing the SDF.

6.2 Methodology and Inputs

GZA used the Spillway Design Flood (SDF) criteria specified in the Massachusetts Dam Safety Regulations (302 CMR 10.14(6)) for an existing Intermediate-sized, Significant Hazard dam. Refer to Sections 2.3 and 2.4 for discussion of size and hazard classification. Hazard re-classification will increase the SDF per Massachusetts Dam Safety regulations. For this Phase II evaluation, per the current Significant Hazard classification and Intermediate size, the SDF for Bulloughs Pond Dam is the 100-year flood.

GZA simulated the rainfall/runoff process using the HEC-HMS computer program. Inflow hydrographs were generated for the 100-year storm event using a 24-hour, nested rainfall distribution and Dimensionless Unit Hydrograph methodology.

Precipitation

GZA developed the rainfall distributions for the 100-year storm using a nested approach based on the Natural Resources Conservation Service (NRCS) National Engineering Handbook, Part 630: Hydrology, Chapter 4: Storm Rainfall Depth and Distribution guidance document (NRCS, 2015). GZA used the nested method to develop the 24-hour rainfall distribution, which includes nested storms of smaller duration from 5-minutes through 24-hours in a single rainfall hyetograph (i.e., time series). GZA developed the distribution from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation depths for New England and New York. The precipitation depth estimates are provided below.

Table 6.1: Precipitation Depth Estimates

Event	Precipitation Total (in)
2-Year, 24-Hour	3.3
5-Year, 24-Hour	4.3
10-Year, 24-Hour	5.1
25-Year, 24-Hour	6.3
50-Year, 24-Hour	7.2
100-Year, 24-Hour	8.1

According to published rainfall data for the Northeast Regional Climate Center Bedford Station[6], the largest regional rainfall intensity between 1957 and 2008 was 7.83 inches over 24 hours, on October 20, 1998. No other storms during that time period exceeded 6 inches of precipitation. We understand from the City of Newton that the embankment has not overtopped since they started keeping records in 1992.

Watershed Characteristics

GZA delineated the total contributing drainage area of approximately 3.15 square miles using the USGS StreamStats web application and 2013-2014 USGS Sandy LiDAR data published by Massachusetts Geographic Information System (MassGIS). The LiDAR data had a resolution of 1 meter. GZA subdivided the watershed into six sub-watersheds which are shown in **Figure 3**. The watershed is characterized by a varying range of runoff potential soils as well as commercial, residential, and recreational (parks) land uses. The City of Newton is densely populated with a large amount of impervious area and the impervious areas are considered connected as its runoff flows directly into a drainage system, as defined in Chapter 9 of the NRCS National Engineering Handbook (NEH) Part 630 Hydrology (NRCS, 2004). The characterization of soil types within the drainage area is shown in **Figure 4**.

The Curve Number (CN) Method was used to model infiltration. The CN is assigned based on hydrologic soil group (A, B, C or D, from lowest to highest runoff potential) and land cover type based on guidance in Chapter 9 of the NRCS NEH Part 630 Hydrology (NRCS, 2004). The hydrologic soil group classification was obtained from the 2017 Norfolk and Suffolk Counties Soil Data GIS shapefile available from the NRCS Web Soil Survey. The land cover data was obtained from the 2005 Massachusetts Land Use GIS shapefile available on the MassGIS website. The resultant CN for the subwatersheds are provided in **Table 6.2** below. The land use categories within the watershed are shown in **Figure 5**. Curve number computations are included in **Appendix H**.

The watershed time of concentration (Tc) and lag time were calculated for each of the subwatersheds based on guidelines included in Chapter 15 of the NRCS Part 630 Hydrology NEH (NRCS, 2010). The estimated watershed lag times are provided in **Table 6.2**. The alignment of the flow paths identified for the time of concentration calculations are shown in **Figure 6**. The input and outputs of the time of concentration calculations are included in **Appendix H**. Note that the curve number and time of concentration were ultimately revised using calibration, which is discussed below.

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[6] "Partial Duration Series (by Station), Station ID #190535 – BEDFORD", period of record 1957 through 2008, http://precip.eas.cornell.edu/

Table 6.2: Watershed Characteristics

Watershed	Area (sq. mi)	Curve Number	Lag Time (min)	Calibrated Curve Number	Calibrated Lag Time (min)
A – Newton Cemetery	1.22	66	66	56	76
B – Newton Centre Playground	0.22	76	33	65	38
C – Commonwealth Avenue	0.33	80	33	68	38
D – Below Hammond Pond	0.8	72	54	61	62
E – Hammond Pond	0.4	76	38	76	62
G – Bulloughs Pond	0.18	73	16	62	18

Reservoir Stage Area Curve

GZA developed a stage surface area relationship for Bulloughs Pond and the upstream pond adjacent to Newton City Hall using 2014 LiDAR data. GZA computed stage-area relationships in Bulloughs Pond at 1-foot intervals with a minimum elevation of 85 feet, which is below the spillway weir and the approximate lowest elevation included in the LiDAR Digital Elevation Model in Bulloughs Pond. GZA computed stage-area relationships in the City Hall Pond at 1-foot intervals with a minimum elevation of 89 feet.

Stage-area information for both impoundments below the normal pool was estimated based on the assumed depth of the impoundment based on the structural height of Bulloughs Pond Dam and the elevation of the weir at the upstream City Hall Pond. The city indicated that prior to large storm events they typically lower the pool level at City Hall Pond, however, it is unlikely that the pond has sufficient storage to attenuate the peak flow of the design storm. Thus, City Hall Pond was not included in the final HMS model used by GZA. The stage-area relationship for Bulloughs Pond computed using ArcGIS tools and the 2014 LiDAR is provided in the table below. Elevations over 92.5-ft (top of dam) are included in the table as these values were required to run the model in HEC-HMS.

Table 6.3: Stage-Area Relationships

Bulloughs Pond	
Elevation (ft-NAVD88)	Area (acres)
85	6.9
86	7.2
87	7.4
88	7.7
89	7.8
90	8.0
91	8.4
92	9.0
93	9.4
94	9.7
95	10.0

Outflow Hydraulics

Spillway and dam geometry (i.e. length) were based on survey data from September 2019, supplied by the City of Newton. Terrain in the vicinity of the dam were estimated and available LiDAR data from MassGIS (USGS,2014).

In GZA's opinion, the hydraulics of Bulloughs Pond Dam are influenced in a domino fashion by 1) culvert capacity of the culvert under Walnut St (315 feet downstream of Bulloughs Pond Dam), 2) resulting headwater upstream of the culvert under Walnut St, 3) culvert capacity of the secondary weir under Dexter Rd (20 feet downstream of the v-shaped spillway weir), 4) resulting headwater upstream of the secondary weir, immediately downstream of the v-shaped spillway weir (noted as the "Plunge Pool", and 5) spillway capacity.

GZA developed a hydraulic model of the dam, spillway, and downstream culverts using HY-8 version 7.5 to estimate tailwater conditions for use in developing a rating curve for Bulloughs Pond Dam. To incorporate the limiting factors in order, the rating curve developed for each structure was used as the tailwater rating curve for the structure upstream of it. For example, the rating curve developed for the culvert under Walnut Street was used as a tailwater rating curve in developing the rating curve for the secondary spillway under Dexter Road.

The tailwater data entered for the culvert under Walnut Street was based on available LiDAR data, and on photographs from a site visit. The tailwater flows in a rectangular channel that was approximate 4 feet wide, with a slope of 0.006 ft/ft and an invert at 68.6 feet. The culvert was modeled as a 138-inch wide and 87-inch-high concrete pipe arch with a slope of 0.004ft/ft, an inlet elevation of 68.7 feet, and a crest elevation of 87 feet.

The tailwater data entered for the secondary spillway under Dexter Road was the rating curve developed for the culvert under Walnut Street. The secondary spillway was modeled as a concrete box culvert, with a span of 19.5 feet and a height of 5.5 feet. The elevation of a small weir within the culvert was set as the culvert channel bottom. The inlet elevation set at 85 feet and the crest elevation was set at 91.5 feet (lowest elevation of roadway along top of dam). The manning's n was set to 0.012 and the slope of the culvert was 0.005 ft/ft.

The rating curve developed for the secondary spillway culvert under Dexter Road was brought into the HEC-HMS model to create a rating curve for the Bulloughs Pond Dam vee-shaped spillway. The HEC-HMS software computes spillway submergence if the user specifies tailwater conditions. The spillway and top of dam geometry were input in the HMS "Outflow Structures" subroutine. The dam top was set at elevation 92.5 feet (based on topographic survey data supplied by the City of Newton) with a length of 225 feet and a weir coefficient of 3.0. The spillway crest was set at elevation 85.9 feet, with a length of 35 feet and a weir coefficient of 3.0. Weir coefficients were estimated by GZA using a broad-crested weir coefficient look up table, based on weir crest breadth and head, developed by Brater and King (1976). Using a "Source" node, GZA passed flows varying from 100 cubic feet per second (cfs) to 5,500 cfs and extracted the computed reservoir elevation to develop a rating curve to be used in the Bulloughs Pond Dam HMS model.

For all modeling, the low-level outlet was assumed to be closed. The USGS StreamStats application estimated a 100-year peak inflow to the dam of 564 cfs (approximately 182 cfs per square mile of drainage area). The HMS model created by GZA estimated a 100-year peak inflow of 2500 cfs (806 cfs per square mile of drainage area).

The City of Newton indicated that the dam has not overtopped in the past 28 years. In order to calibrate the model based on this observation, GZA acquired maximum rainfall totals at in the Greater Boston area for durations between 1-hour to 24-hours. According to published U.S Hourly Precipitation Data available from the Blue Hill Weather

Station, the largest regional rainfall intensity over the past 28 years was 5.96 inches over 6 hours, on June 13, 1996. GZA used the available hourly rainfall data as the precipitation input for the existing model. the time of concentration and curve numbers from this were calibrated such that the resulting inflow (1,500 cfs) was at the top of the dam.

The computed outflow rating curve for Bulloughs Pond Dam used in the model is shown below in the following table**.**

Table 6.4: Outflow Rating Curve

Reservoir Elevation (feet-NAVD88)	Discharge (cfs)
85.94 (spillway crest)	0.0
87.0	100
89.2	500
91.9	968
92.5	1000
93.3	1500
93.9	2000
94.9	2500

Note: Considers weir tailwater submergence. See text above.

6.3 Results

GZA used HEC-HMS to model and route the 100-year peak inflows to Bulloughs Pond Dam and evaluate the spillway capacity and embankment overtopping potential.

The top of dam is approximately elevation 92.5 based on topographic survey. The HEC-HMS results for the 100-year flood are provided in **Table 6.5.** Outputs from HEC-HMS are included in **Appendix H**.

Table 6.5: HEC-HMS Results for 100-Year Spillway Design Flood

Peak Inflow	Peak Outflow	Peak Water Surface Elevation	Overtopping Depth	Overtopping Duration	Percent of SDF Passed Without Overtopping
1,630 cfs	1,570 cfs	92.7 feet	0.2 feet	0.6 hours	91%

Note: Initial water surface in Bulloughs Pond modelled as normal pool elevation 85.9 feet.

The results of the HEC-HMS flood analysis indicate that the current configuration of Bulloughs Pond Dam is not able to pass the 100-year SDF without overtopping. Overtopping of the embankment in its current configuration could lead to erosion, embankment failure, and resulting release of the impoundment. The analyses indicate remedial measures are required to safely pass the SDF.

Please note that the calculated peak water surface elevation will inundate areas to the right of the dam along Dexter Road and Bullough Park Road. These inundated areas will convey floodwater to the right groin and spillway outlet channel along the right downstream side of the dam. In this area, there is a relatively steep slope upward from the outlet channel to the adjoining 96 Dexter Road property. We understand the property line is approximately 22 feet from the outlet channel. The floodwater conveyed from these areas to the right of the dam will concentrate on

these steep slopes with the possibility of erosion and loss of the spillway right abutment. In addition to remedial measures to safely pass the SDF, remedial measures will be required to prevent erosion at the right groin and right side of the downstream channel.

7.0 SEEPAGE ANALYSES

GZA evaluated the seepage of the embankment portion of the Bulloughs Pond Dam. The evaluation considered the maximum section of the embankment in the vicinity of the low-level outlet pipe on the left side of the embankment approximately 75 feet left of the spillway. Calculations along with the seepage analysis assumptions and loading conditions are presented in **Appendix I**.

7.1 Seepage Model

GZA used GEO-SLOPE International, Ltd.'s computer program, SEEP/W 2019 R2 (a two-dimensional, finite element seepage analysis package), to simulate the pore pressures at finite element nodes, exit gradients, and seepage quantity (flux) for the existing conditions at the dam. Seepage through and under the dam was evaluated through a typical section near the low-level outlet using SEEP/W. Representative headwater and tailwater conditions were modelled based on the H&H analyses.

For the purpose of a steady-state seepage analysis, the model was first calibrated using the impoundment elevation (normal pool) and measured groundwater elevations. During GZA's subsurface investigations, the groundwater profile dropped in elevation from the upstream-most to the downstream-most borings. The core wall was possibly encountered and cored at GZ-1. Based on the groundwater measurements, the apparent core wall causes a drop of approximately 3 feet in head. These conditions were taken as representative of average seepage conditions over the full length of the embankment. GZA then used the SEEP/W computer model to estimate seepage gradients and flux through and under a unit width of the embankment.

7.2 Soil Characteristics

Permeability (i.e. hydraulic conductivity) coefficients for the various materials modeled in the seepage analysis were estimated based on published correlations to the gradation analysis of the tested samples and on engineering judgment. Permeability, as well as soil strengths values were assigned according to the table below.

Table 7.1: Assumed Soil Material Properties for Seepage and Stability Analyses

Soil	Saturated Unit Weight[1]	Cohesion	Friction Angle[2]	Permeability (Saturated) [1]
Embankment Fill	125 pcf	0 ksf	31°	6.0×10^{-5} cm/sec
Fine-Grained Foundation Soil	130 pcf	0 ksf	29°	7.0×10^{-4} cm/sec
Core Wall	140 pcf	288 ksf	0°	2.6×10^{-4} cm/sec
Bedrock	Impenetrable			3.0×10^{-10} cm/sec

1. Unit weight approximated based on Table 2-1 in *An Introduction to Geotechnical Engineering* by Roberts D. Holtz and William D. Kovacs.
2. Permeability approximated based Federal Highway Administration[7] and Justin-Hinds[8] methodologies.
3. Friction angle approximated based on Table 35.12 in the *Civil Engineering Reference Manual* by Michael R. Lindeburg.

7.3 Seepage Analyses Results

The SEEP/W seepage analyses indicate that under maximum pool conditions with the upstream water surface level at elevation 92.6 feet and the downstream water surface at 87.5 feet, the maximum exit gradient of water in the embankment is about 0.59 (foot/foot), just above the tailwater elevation. Taking the critical gradient (which is the gradient slope at which soil transport and thus potential piping failure is assumed to begin) as 1.0, as is typically done for these analyses, the computed exit gradient is lower than the critical gradient, indicating that soil transport is likely not a concern at the dam, in GZA's opinion.

Due to the significant uncertainties inherent in such calculations, the recommended factor of safety against seepage failure ranges from 2.5 to 3.0 (Cedergran 1977). The factor of safety equation against seepage (piping) failure through the embankment is:

$$F.S. = i_c/i$$

The calculated factor of safety against seepage instability for the Bulloughs Pond Dam embankment is approximately **1.8** at maximum pool. This factor of safety against seepage instability is considered insufficient and remedial measures are considered necessary.

The seepage model is only applicable to general conditions at the dam. It should be noted that isolated anomalies in the embankment are not captured by this analysis.

8.0 STABILITY ANALYSES

8.1 Liquefaction

Liquefaction potential susceptibility was evaluated per the Massachusetts State Building Code (MSBC)[9] Section 1806.4.1. Using the SPT results measured during drilling, Seismic Site Class was established following IBC[10] Section

[7] FHWA IF-02-034, Originally published by GeoSyntec Consultants, Inc. (1991). Geotextile Filter Design Manual.
[8] Justin, Hinds and Creager, "Engineering for Dams"; Vol. III; John Wiley & Sons.
[9] Ninth Edition of the MA State Building Code 780 CMR Amendments to the 2015 IBC International Codes published by the International Code Council (IBC).

1613.5.5. Liquefaction potential screening using MSBC Figure 1804.6.b, indicated the site is not considered susceptible to liquefaction. A more rigorous evaluation using the "Seed and Idriss" demand-capacity approach[11] was used to confirm the MSBC screening and estimate vertical settlements during a seismic event. The demand-capacity evaluations estimated seismically-induced vertical settlements of less than about ¼-inch and confirmed the MSBC liquefaction potential screening results.

8.2 Slope Stability

GZA performed a two-dimensional stability analysis at the maximum section of the Bulloughs Pond Dam embankment. The analyses were performed in general accordance with Massachusetts Dam Safety Regulations (302 CMR 10.14(9)) as well as other industry standards from the United States Bureau of Reclamation, United States Army Corp of Engineers, and Federal Energy Regulatory Commission.

Slope stability for an embankment dam is an important factor in the overall safety of the structure. Both the upstream and downstream slopes of an embankment must have sufficient capacity to resist sliding under a variety of loading conditions. The slope stability safety factors are a measure of an earthfill dam's capacity to meet the stability requirements mandated by Massachusetts Dam Safety Regulations (302 CMR 10.14(9(c)) and sound engineering practice. The safety factors are a function of several different parameters including soil type, slope height and angle, soil density, phreatic surface location, and loading condition.

A limit equilibrium-based computer code, GEO-SLOPE International, Ltd.'s SLOPE/W 2019 R2, was used for the slope stability assessment. The general representative cross section was the seepage analysis cross section. Pore water pressure values obtained from the seepage analysis were incorporated in the SLOPE/W simulation. Input parameters for the stability analyses are shown in **Table 7.1** above. Using the SLOPE/W program to assist the analyses, factors of safety against slope failure were estimated for various loading conditions. Estimated and recommended minimum factors of safety for existing conditions are shown below. Output from the SLOPE/W program is contained in **Appendix I**.

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[10] 2015 International Codes published by the International Code Council (IBC)

[11] Idriss, I.M. and Boulanger, R.W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute. Oakland, California. EERI Publication No. MNO-12.

Table 8.2: Slope Stability Results – Existing Conditions

Loading Condition	Dam Face	Slope Stability Factor of Safety	
		Minimum (302 CMR 10.14)	Existing Conditions – Slope Stability
Rapid Drawdown from Normal Pool (85.94 feet)	Upstream	1.2	1.2
Rapid Drawdown from Flood Pool (92.6 feet)	Upstream	>1.1	1.3
Steady Seepage at Normal Pool (Elev. 85.94 feet)	Upstream	1.5	1.5
	Downstream	1.5	1.5
Steady Seepage at Flood Pool (Elev. 92.6 feet)	Upstream	1.4	1.7
	Downstream	1.4	***1.0***
Earthquake (pseudo-static, 0.218g)	Upstream	>1.0	***0.9***
	Downstream	>1.0	***0.9***

The analyses indicated unacceptable factors of safety on the downstream slope under flood pool, and both slopes during earthquake loading. Based on the overall results of the stability assessment, stability-related corrective actions are required.

9.0 ALTERNATIVES ANALYSIS

Based on our Phase II analyses we have developed a suite of alternative approaches to address the identified deficiencies related to inadequate spillway capacity, embankment slope and seepage instability, presence of trees and related heavy vegetation on the embankment, scour in the downstream channel, and missing mortar in spillway training wall joints.

As discussed in Sections 1.3 and 2.4, DCR may reclassify Bulloughs Pond Dam as a High Hazard potential, dam. This reclassification would increase the Spillway Design Flood (SDF) per Massachusetts Dam safety regulations. ***Hazard Classification and SDF should be re-evaluated during final design.***

As a part of our Phase II engineering investigations, GZA performed preliminary analysis of possible alternatives for correcting the deficiencies identified during the Phase I visual inspection and confirmed by the engineering assessments performed as part of our Phase II services. Advantages and disadvantages of the various alternatives are presented as necessary.

9.1 No Action

The "No Action" alternative is not considered a viable option due to the observed safety deficiencies at the dam. Failure to address the identified deficiencies would be a violation of Massachusetts Law (G.L c. 253, § 44-49 as amended by Chapter 330 of the Acts of 2002) and Massachusetts Dam Safety Regulations (302 CMR 10.00) which require an Owner to properly maintain their dam such that it meets minimum dam safety standards. Failure to correct the dam safety deficiencies identified at the Bulloughs Pond Dam could endanger downstream public safety and property.

9.2 Dam Breach/Removal

The option to breach or fully remove the Bulloughs Pond Dam was considered. However, Bulloughs Pond serves as an important recreational asset for the City of Newton. Thus breaching the dam is not considered a viable alternative.

9.3 Repair the Dam

As the Bulloughs Pond Dam is very likely to remain, it will need to be repaired to bring it into compliance with the latest Massachusetts Dam Safety Regulations. Repairs are necessary to remediate the following deficiencies:

- Inadequate minimum freeboard during the SDF and the potential for embankment overtopping.
- Inadequate calculated factors of safety for embankment seepage stability and slope stability.
- Unwanted vegetation in areas of the dam including large trees along the downstream slope.
- Scarping along the upstream slope and bare soils prone to erosion along the downstream slope.
- Deterioration/potentially unstable headwall at the downstream end of the low-level outlet.
- Areas of scour along the downstream channel including at the low-level outlet and along the left and right banks. If erosion of the left bank continues, it could encroach on the toe of the downstream slope.
- Mortar missing from some of the spillway training wall joints.

GZA evaluated alternatives for remedying each of these deficiencies and provides the following conceptual recommendations. A conceptual design sketch depicting pertinent features of the each of the alternatives is included as **Figures 7A** through **7E**.

There are several repair scope items that are common to all repair alternatives, including

- Protection and/or flattening of slopes to help address slope instability. Conceptually, the upstream slope would be protected against seismic loading by placement of several feet of riprap at the toe and up the slope;
- Upward extension of the core wall to help address seepage instability. Note that the location of the most critical exit gradient is just above the tailwater during the SDF. We infer that the location of the critical exit gradient will change for lesser storms when the tailwater is lower. Toe drains were therefore not considered as part of the alternatives analysis and the slope flattening should include a drainage feature such as a blanket to properly filter and collect seepage;
- Armoring of the downstream channel, including the right groin and right downstream outlet channel to mitigate off-dam floodwater erosion;
- Lining (or replacement) of the two outlet pipes. Since lining is economically desirable and technically feasible, it is preferred over pipe replacement;
- Regrading upstream slope and placement of riprap on the upstream slope to mitigate scarping;
- Repointing of existing training walls; and
- Removal of trees and vegetation on the upstream and downstream slopes.

It is acknowledged by the dam safety engineering community that trees and woody plants that are allowed to grow on and immediately along and downstream of the toe of earthen dams can hinder safety inspections, interfere with safe operations, or can even cause dam failure via piping or blow-down. Therefore remedial repairs should include removal of trees, brush and associated woody vegetation from the crest, embankment slopes, and in the area immediately downstream of the embankment toe along the entire downstream length of the dam per the latest DCR-ODS policy of "Trees on Dams". Concurrent with tree/brush removal, remove all roots/root balls associated with trees and vegetation and backfill resulting voids with compacted sand/gravel. Thereafter establish a uniform, healthy grass cover within the cleared areas.

Note that in addition to final engineering and design, each alternative will require additional studies to facilitate permitting. Additionally, local conservation commission, state, and federal ecological requirements would need to be adhered to for each alternative.

9.3.1 - Alternative 1: Raise the Dam Embankment and Dexter Road to Provide Additional Storage

Raising the top of the dam and Dexter Road to approximate elevation 95 feet would allow the dam to store and safely retain the 100-year SDF. The length of the raising would extend from Walnut Street eastward across dam to either:

1) Across Bullough Park Road onto private property where natural grades are above the peak water surface elevation, or

2) Along Dexter Road on the right side of the dam. This would not fully contain the SDF and would allow flow around the right side of the raised embankment.

As part of this work, the roadway, bridge, and training walls would have to be raised or replaced at a higher elevation. Slopes would need to be extended upstream and downstream, with areas of retaining walls to reduce encroachment on adjoining private properties. Driveway ramps to between one and three residences along Dexter Road would be required to maintain vehicular access, depending on the length of Dexter Road raised. We estimate that two to six nearby residences would be severely impacted by the embankment raising.

The estimated cost of this alternative ranges from around $900,000 to $1,000,000, excluding bridge modifications. Based on the Federal Highway Administration[12] information, bridge modifications would be on the order of $600,000 to $800,000 depending on the level needed.

9.3.2 -Alternative 2: Parapet Walls to Provide Additional Storage

Similar to the Alternative 1, construction of one- to four-foot-high parapet walls to elevation 95 feet would be used to provide additional storage and help retain the 100-year flood. The length of these walls would also extend from Walnut Street to the west and to Bullough Park on the right.

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[12] "Bridge Replacement Unit Costs 2017" United States Department of Transportation Federal Highway Administration. http://www.fhwa.dot.gov/bridge/nbi/sd2017.cfm

This alternative would allow bypass flow around the right side of the parapet wall near Bullough Park Road. This bypass flow would require armoring of the right downstream groin and outlet channel to mitigate erosion. A gap in the wall would be required at the 69 Dexter Road driveway to allow vehicular access. The approximately 1.5-foot high gap in the wall would need to be closed by sandbags or flood barriers prior to overtopping events. The roadway grading and bridge elevations would not be affected by the parapet walls. However, the bridge would have to be evaluated by a structural engineer and modified to tie in with the parapet wall and withstand the additional loading. Views of the pond will be impacted, which could degrade recreational usage.

The estimated cost of this alternative is around $850,000 to $950,000, exclusive of bridge modifications. Based on the Federal Highway Administration information, bridge modifications would be on the order of $400,000 to $600,000 depending on the level needed.

9.3.3 -Alternative 3: Lower Impoundment and Construct Parapet Wall to Augment Spillway Outflow and Provide Additional Storage

A third option is to permanently lower the spillway weir and construct a relatively lower parapet wall. These actions will increase storage while providing additional outlet capacity. The spillway weir would be lowered by about 6 feet to approximate elevation 80 feet, with a parapet wall up to about 1.5-feet high. This alternative would lower the normal pool by about 6 feet, which would impact recreational usage of the pond. The lowering of the weir would require demolition and training wall repairs or rebuilding. The bridge would need to be evaluated for modifications or replacement. Similar to alternative 2, bypass flow would occur around the right side of the parapet wall near Bullough Park Road. This bypass flow would require armoring of the right downstream groin and outlet channel to mitigate erosion.

The estimated cost of this alternative is around $850,000 to $950,000, exclusive of bridge modifications. Based on the Federal Highway Administration information, bridge modifications would be on the order of $400,000 to $600,000 depending on the level needed.

GZA understands from discussions with the City that lowering the impoundment would not be a preferred alternative due to the scenic and recreational benefits that the pond provides.

9.3.4 -Alternative 4: Widen Spillway to Augment Spillway Outflow

The fourth option involves widening the spillway to approximately 60 feet to safely pass the SDF through the spillway. The spillway weir would remain at the same elevation and the normal pool elevation would be retained. Roadway grade modifications would not be required, however the bridge and training walls would have to be rebuilt. Since the full SDF outflow would be passed through the spillway, bypass flow to the right of the dam would be mitigated. The estimated cost of this alternative is over $1.4 million excluding bridge costs. Based on the Federal Highway Administration information, bridge modifications would be above $1.5 million.

9.3.5 - Alternative 5: Armor Downstream Slope to Provide Overtopping Protection

This alternative includes armoring of the embankment to allow overtopping during the SDF while mitigating potential erosion and scour failure of the embankment. Under existing and proposed conditions, the dam would be overtopped by approximately 0.2 feet. There are different methods of slope armoring available, all of which have the

same goal: to protect the earth from the flow and turbulence of flood water that tends to erode the embankment, thus leading to dam failure. There are three main categories of slope armoring:

1. Pre-cast, Articulated Concrete Blocks (ACB)
2. Stone Riprap
3. Turf Reinforcement Mats (TRM)
4. Gabions

All of these are proven methods for overtopping protection. They are selected based on the depth of overtopping, flow velocities, and duration of overtopping. Each of these armor alternatives comes in different sizes and strengths, depending on individual site constraints. Since upstream slope protection is envisioned under all five alternatives, the upstream and downstream slopes could be designed to use the same armoring and would appear similar.

Placing riprap on the slope is a natural and low-labor solution. Stones would be dumped downslope and chinked into place using smaller stones. The riprap also helps to establish a stable slope; however, public access would be difficult due to irregular footing. In addition, maintenance of the riprap would likely be needed as the stones may be displaced over time or by vandalism, especially in public areas. Gabions could be used to armor the slope in a stepped fashion. During final design, it is likely that the gabions will require concrete facing of horizontal surfaces to resist scour. A filter or drainage layer would likely be needed for either riprap or gabions.

Unlike riprap, ACBs provide a physically flexible option for erosion protection. They are not intended for slope stabilization and slope stability must be established before implementing and ACB system. ACB systems are composed of pre-formed concrete blocks that are interconnected by cables. The blocks conform to changes in the subgrade and provide protective cover. Topsoil can be placed in and over open-cell ACBs to allow vegetation to be established, which can improve aesthetic appeal. In an ACB system, the contact between the ACB's and the subgrade is paramount. A filter or drainage layer is needed in the design of ACB systems. Flow beneath the armor layer can cause uplift pressure and separate the blocks from the subgrade.

Turf Reinforcement Mats (TRMs) are generally not as erosion-resistant as riprap or ACBs, but have been used and approved by ODS in the past as embankment dam overtopping protection. TRMs are a permanent, cost effective and environmentally friendly alternative to hard armor erosion protection solutions. TRMs essentially consist of ultraviolet light and chemical resistant synthetic polyolefins manufactured to create a flexible three-dimensional matrix. Seed and soil are held in place within the matrix. As the vegetation matures, roots and stems inter-twine with the matrix, creating a "Biotechnical Composite" that is permanently anchored to the soil greatly enhancing the turfs' ability to withstand high shear stresses and flow velocities. With adequate care, a visitor to the site would see only a grassed slope within a growing season. At the upstream water level, a different material such as riprap would be necessary to resist scour. This alternative would also require repointing of the spillway training walls.

The conceptual cost estimate for armor using either TRM or ACBs is $700,000 to $800,000. Armoring using riprap would be on the order of $850,000 to $950,000. In GZA's opinion, armoring the downstream slope to allow it to withstand the SDF is the preferred alternative.

9.3.6 Additional Repair Considerations

As discussed in Sections 1.3 and 2.4, DCR may reclassify Bulloughs Pond Dam as a High Hazard potential, dam. This reclassification would increase the Spillway Design Flood (SDF) per Massachusetts Dam safety regulations. ***Hazard Classification and SDF should be re-evaluated during final design.*** Each of the first four alternatives is not scalable in that if additional storage or outflow capacity is required after construction, significant dam modifications could be required. The preferred (fifth) alternative is scalable in that additional or more robust overtopping protection could be considered in the final design and installed at the present time to accommodate future changes in SDF outflow.

The following additional construction and contractual items may be necessary to support final design, depending on the selected alternative.

- Replacement of the two 24-inch diameter gate valves. The current valves are functional, but may be nearing the end of their service life.
- A property line survey will be required for final design.
- Traffic impact studies may be necessary, depending on the alternative chosen.
- Temporary or permanent easement agreement(s) with nearby property owners for temporary access to work areas or location of permanent features to be constructed on adjoining properties.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

Bulloughs Pond Dam has been found by others to be in "Poor" condition, it exhibits deficiencies that directly impact the long term performance of the structure. Our studies also indicate that the size classification should be changed from Small to Intermediate size. Parallel development of an EAP indicates that Bulloughs Pond Dam may be re-classified as High Hazard. GZA has undertaken preliminary engineering analyses with respect to evaluating and mitigating the following deficiencies:

- Inadequate minimum freeboard during the SDF and the potential for embankment overtopping.
- Inadequate calculated factors of safety for embankment seepage stability and slope stability.
- Unwanted vegetation in areas of the dam including large trees along the downstream slope.
- Scarping along the upstream slope and bare soils prone to erosion along the downstream slope.
- Deterioration/potentially unstable headwall at the downstream end of the low-level outlet.
- Areas of scour along the downstream channel including at the low-level outlet and along the left and right banks. If erosion of the left bank continues, it could encroach on the toe of the downstream slope.
- Mortar missing from some of the spillway training wall joints.

10.2 Recommendations

To bring the structure into compliance with Massachusetts Dam Safety Regulations and current engineering practice, GZA recommends the following:

- Resurface the upstream embankment with stone rip-rap protection.
- Re-grade the downstream embankment to a uniform and stable slope by extending the toe five to ten feet. Place armor over the downstream slope to address potential for crest overtopping and erosion of the downstream slope. The downstream slope should be designed to incorporate an appropriate filter blanket to collect and filter seepage and confine locations of maximum seepage gradients under flood conditions.
- Clear vegetation, trees and woody vegetation from the embankments, crest and downstream toe area. Additionally, remove all roots/root balls associated with trees and vegetation and backfill resulting voids with compacted sand/gravel
- Repoint training walls.
- Slipline the low level outlet pipes and construct new headwall at extended toe of slope.
- Armor the downstream channel.

These recommendations should be confirmed during final design, especially if DCR increases the Hazard classification for the dam.

10.3 Permitting

We anticipate the following permits will be required for the repairs:

- Order of Conditions under the Massachusetts Wetlands Protection Act (Newton Conservation Commission).
- Chapter 253 Dam Safety Permit (DCR-ODS).
- Section 106 Historical Notification (Mass. Heritage Commission).
- Chapter 91 license review by the Massachusetts Department of Environmental Protection (MADEP).
- Water Quality Certification by MADEP under Section 401.
- Review by the U.S. Army Corps of Engineers under Section 404.
- Environmental Notification Form for Massachusetts Environmental Policy Act Office.

Permitting requirements should be confirmed during final design

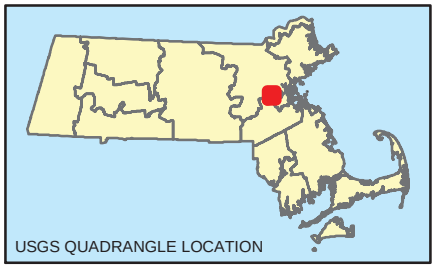
10.4 Preliminary Conceptual Cost Estimates

The preliminary conceptual cost estimate for the concept design developed for the preferred remedial repairs discussed herein is between $700,000 and $950,000, depending on the selected slope armoring material. A detailed breakdown of the estimate is presented in **Appendix K.** This estimate was generated based on prices for similar projects updated to reflect 2020 construction prices. Actual construction and other costs will vary based on final design and other circumstances.

It must be noted that the recent climate for construction in Massachusetts has seen significant increases in the cost of fuel, concrete, steel, and other construction materials. This has led to very high bids on a number of recent projects. Recent discussions with contractors who are engaged in dam repair work indicate that higher than average cost inflation may continue. We also believe that economic uncertainty related the COVID-19 pandemic may have large impacts on bid prices depending on the timing of procurement and construction. This could lead to actual bid costs above those estimated by GZA. Accordingly, we recommend that a larger than usual contingency be applied. In GZA's experience, bids for water control at dam repair project sites have recently been higher than expected, which appears to reflect contractor concern about the risk involved with this item. It is also important to recognize that costs for environmental mitigations may exceed the estimate above depending upon the extent of work required under permit conditions.

We estimate that the engineering costs for construction oversight services by an engineering consultant will range between approximately $80,000 and $120,000.

Figures



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Data Supplied by : USGS

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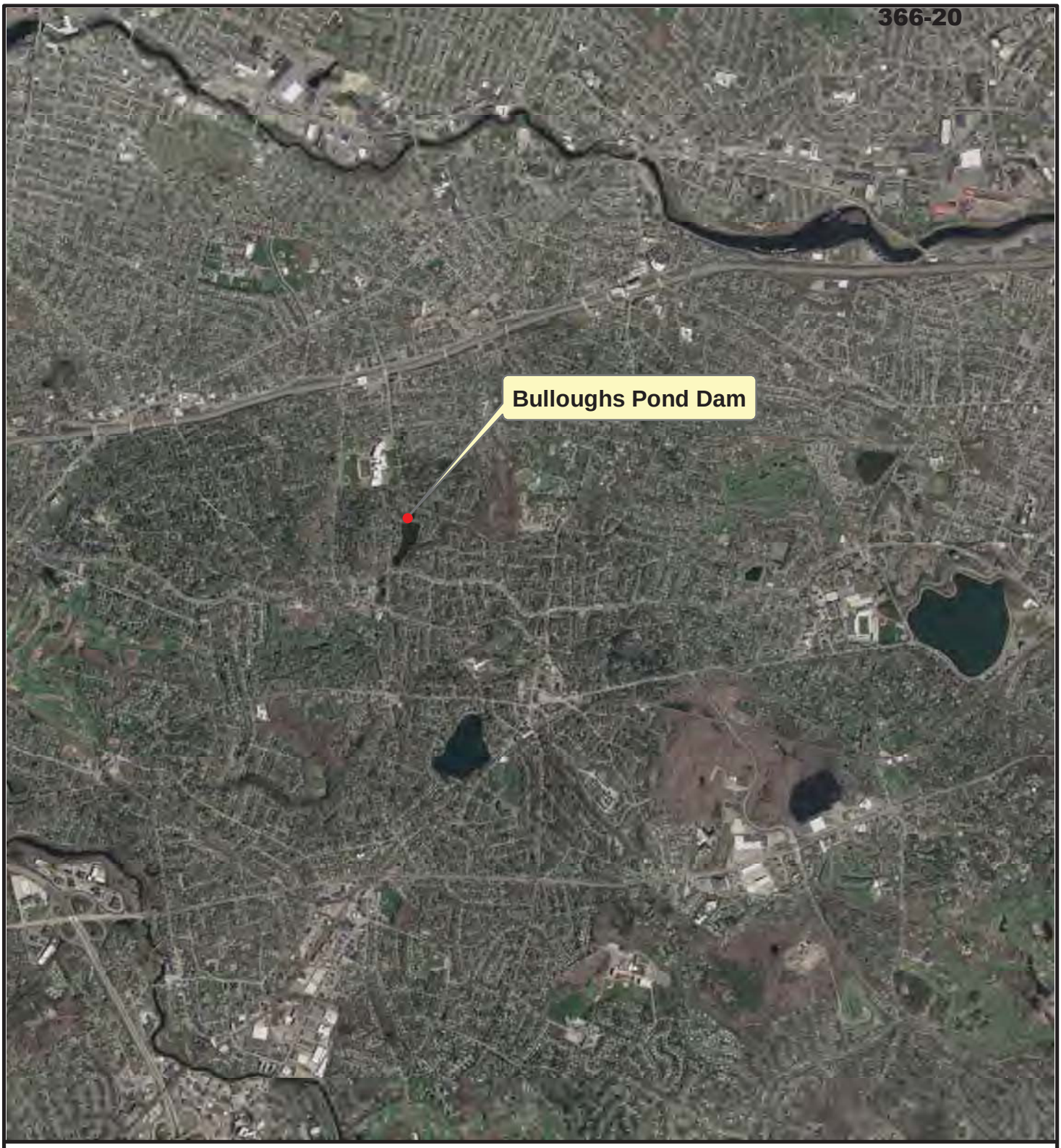
PROJ. MGR.: LAG
DESIGNED BY: DEM
REVIEWED BY: CWC
OPERATOR: DEM
DATE: 3/11/2020

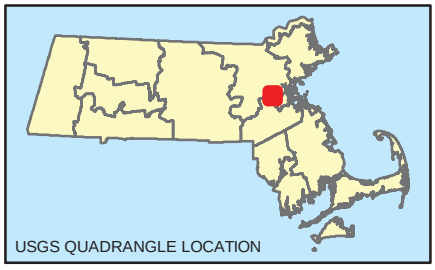
LOCUS PLAN

BULLOUGHS POND DAM
NEWTON, MASSACHUSETTS

JOB NO. 01.174021.00

FIGURE NO. 1





SOURCE : THIS MAP CONTAINS AERIAL PHOTOGRAPHY OBTAINED FROM MASS GIS. STATEWIDE AERIAL PHOTOGRAPHY FROM 2013-2014, PUBLISHED IN 2014.

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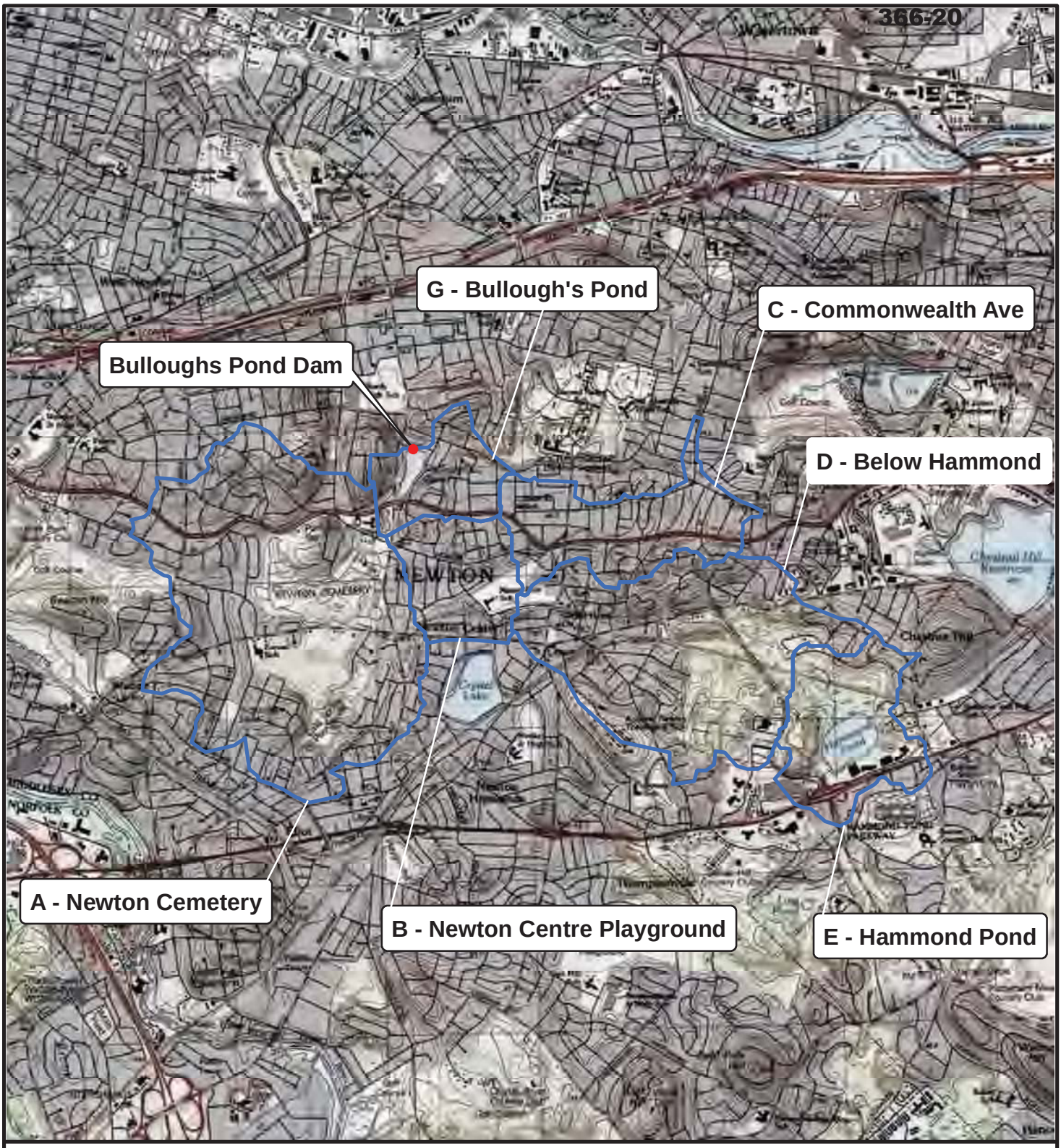
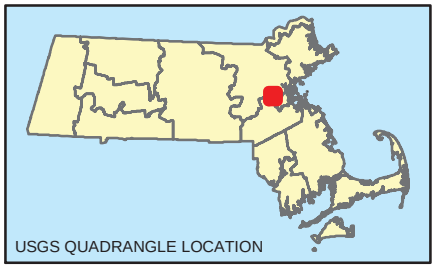
AERIAL LOCUS PLAN

BULLOUGHS POND DAM
NEWTON, MASSACHUSETTS

JOB NO.
01.174021.00

FIGURE NO.
2





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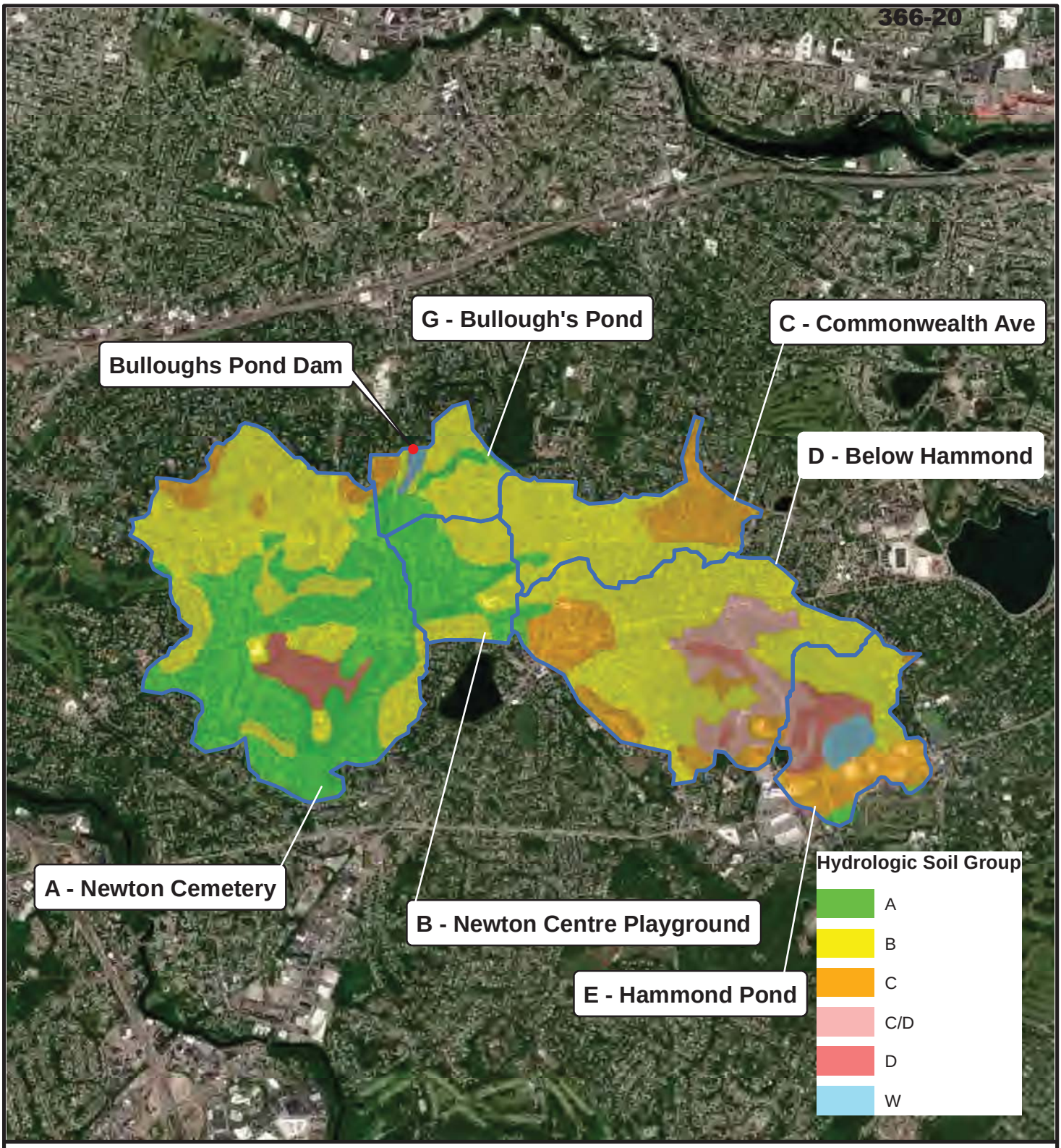
PROJ. MGR.: LAG
DESIGNED BY: DEM
REVIEWED BY: CWC
OPERATOR: DEM
DATE: 3/11/2020

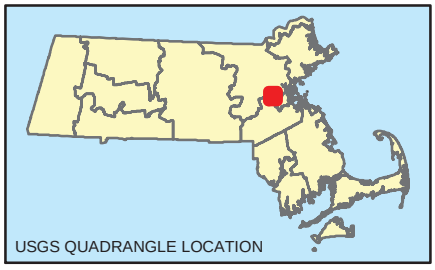
WATERSHED PLAN

BULLOUGHS POND DAM
NEWTON, MASSACHUSETTS

JOB NO. 01.174021.00

FIGURE NO. 3





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Data Supplied by : USGS

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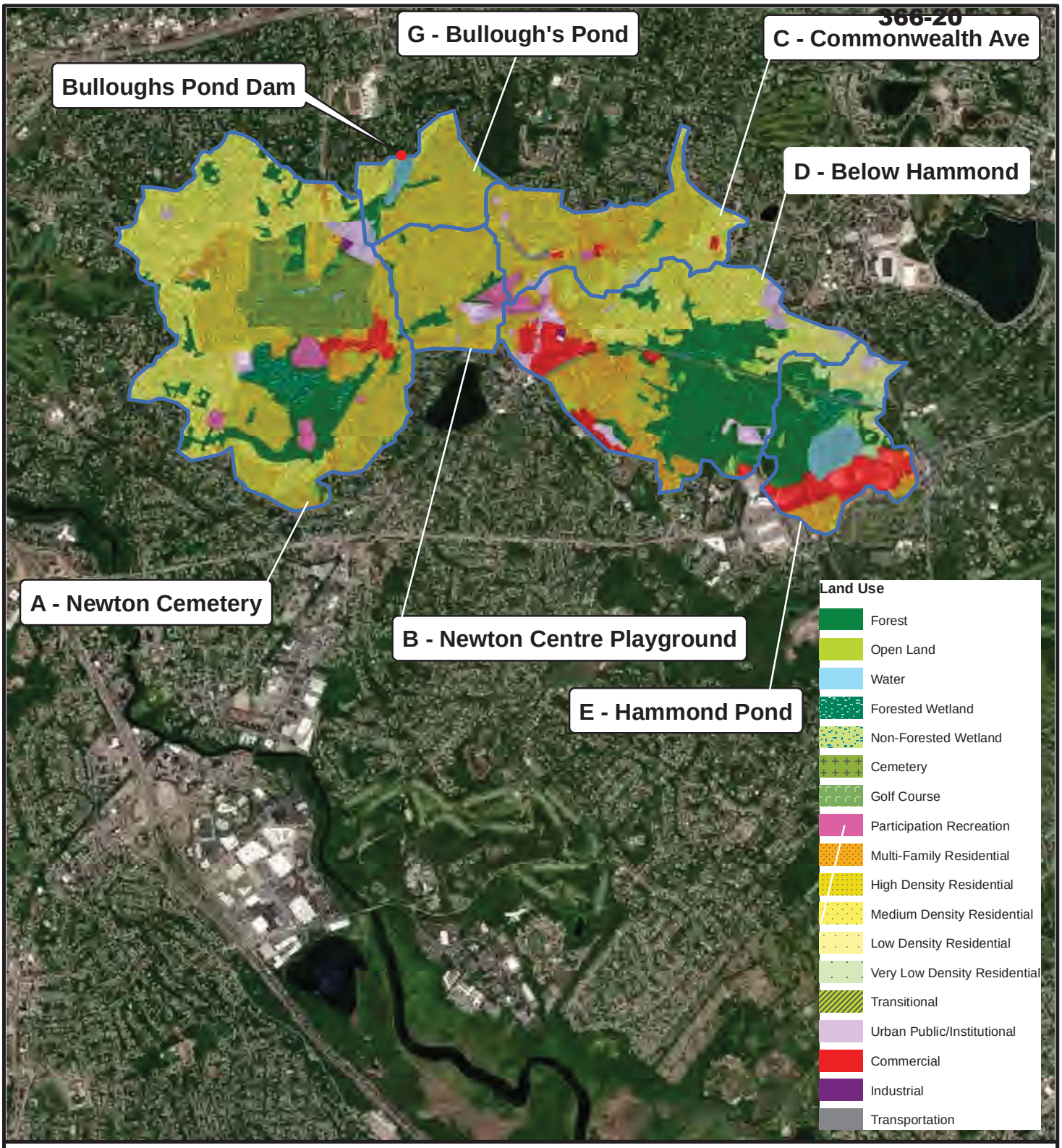
PROJ. MGR.: LAG
DESIGNED BY: DEM
REVIEWED BY: CWC
OPERATOR: DEM
DATE: 3/11/2020

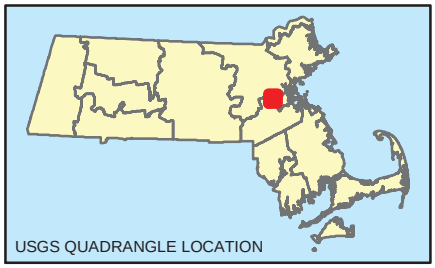
SOILS MAP

BULLOUGHS POND DAM
NEWTON, MASSACHUSETTS

JOB NO.
01.174021.00

FIGURE NO.
4





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LAND USE DATA WASA RETRIEVED FROM MASS GIS, PUBLISHED IN 2005

Data Supplied by : USGS

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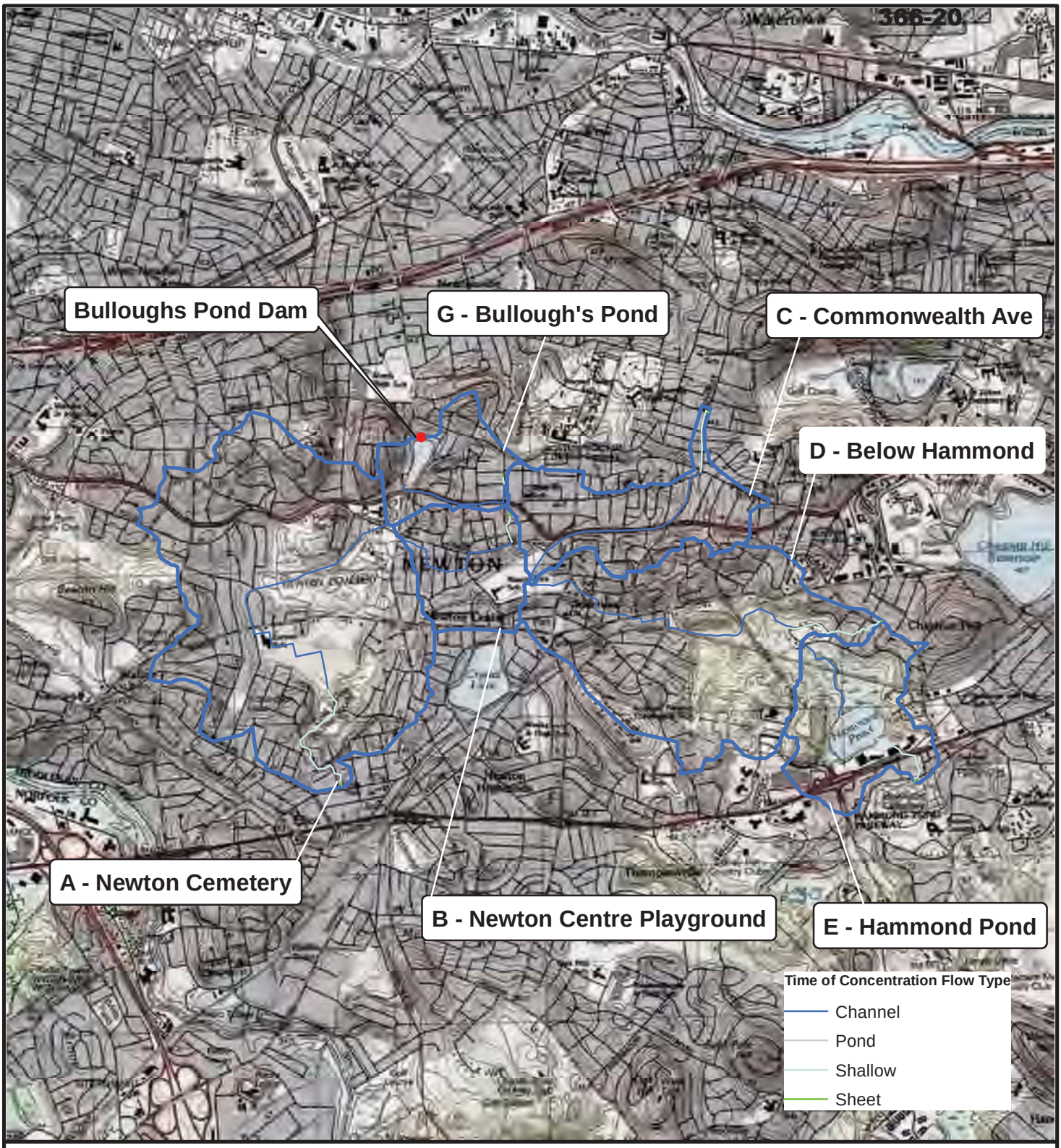
PROJ. MGR.: LAG
DESIGNED BY: DEM
REVIEWED BY: CWC
OPERATOR: DEM
DATE: 3/11/2020

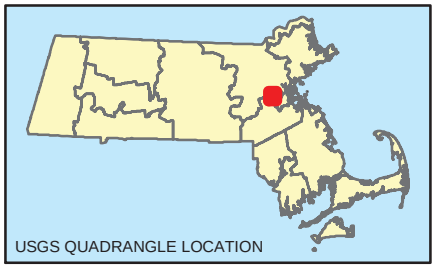
LAND USE MAP

BULLOUGHS POND DAM
NEWTON, MASSACHUSETTS

JOB NO. 01.174021.00

FIGURE NO. 5





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Data Supplied by : USGS

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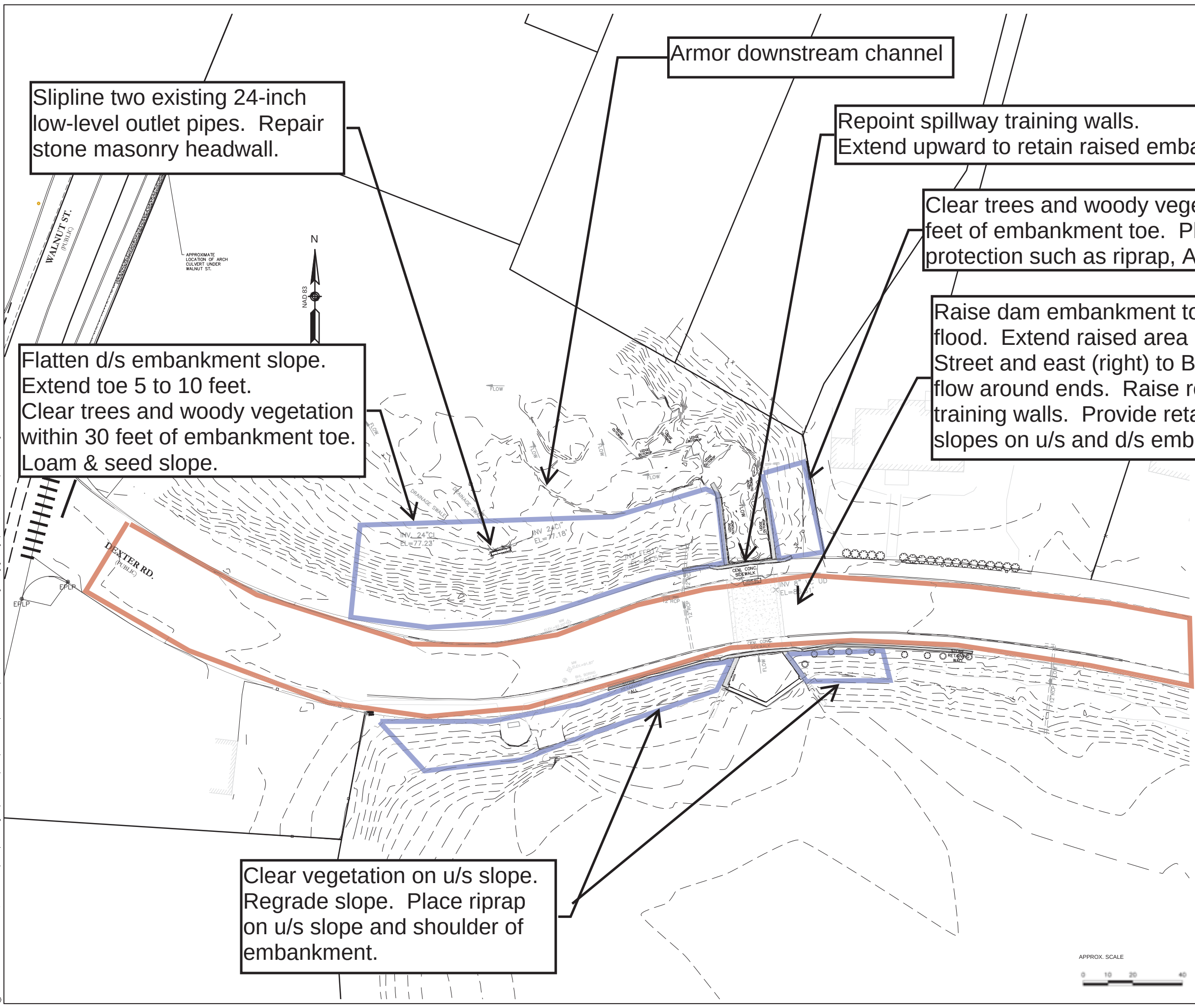
DESIGNED BY: DEM
REVIEWED BY: CWC
OPERATOR: DEM
DATE: 3/11/2020

FLOW PATH MAP

BULLOUGHS POND DAM
NEWTON, MASSACHUSETTS

JOB NO.
01.174021.00

FIGURE NO.
6



NO.	ISSUE/DESCRIPTION	BY	DATE

BULLOUGH'S POND DAM

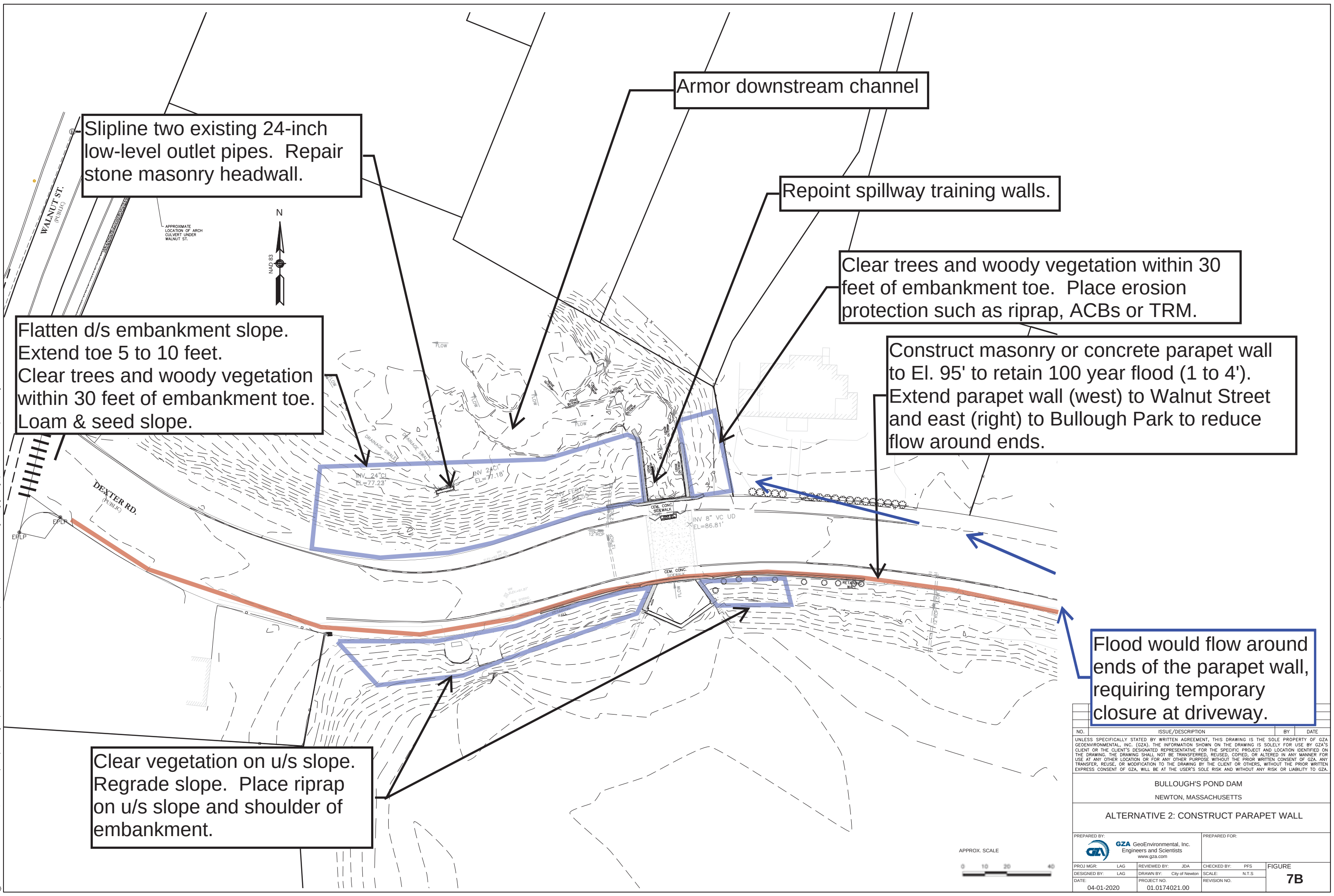
NEWTON, MASSACHUSETTS

ALTERNATIVE 1: RAISE DAM EMBANKMENT

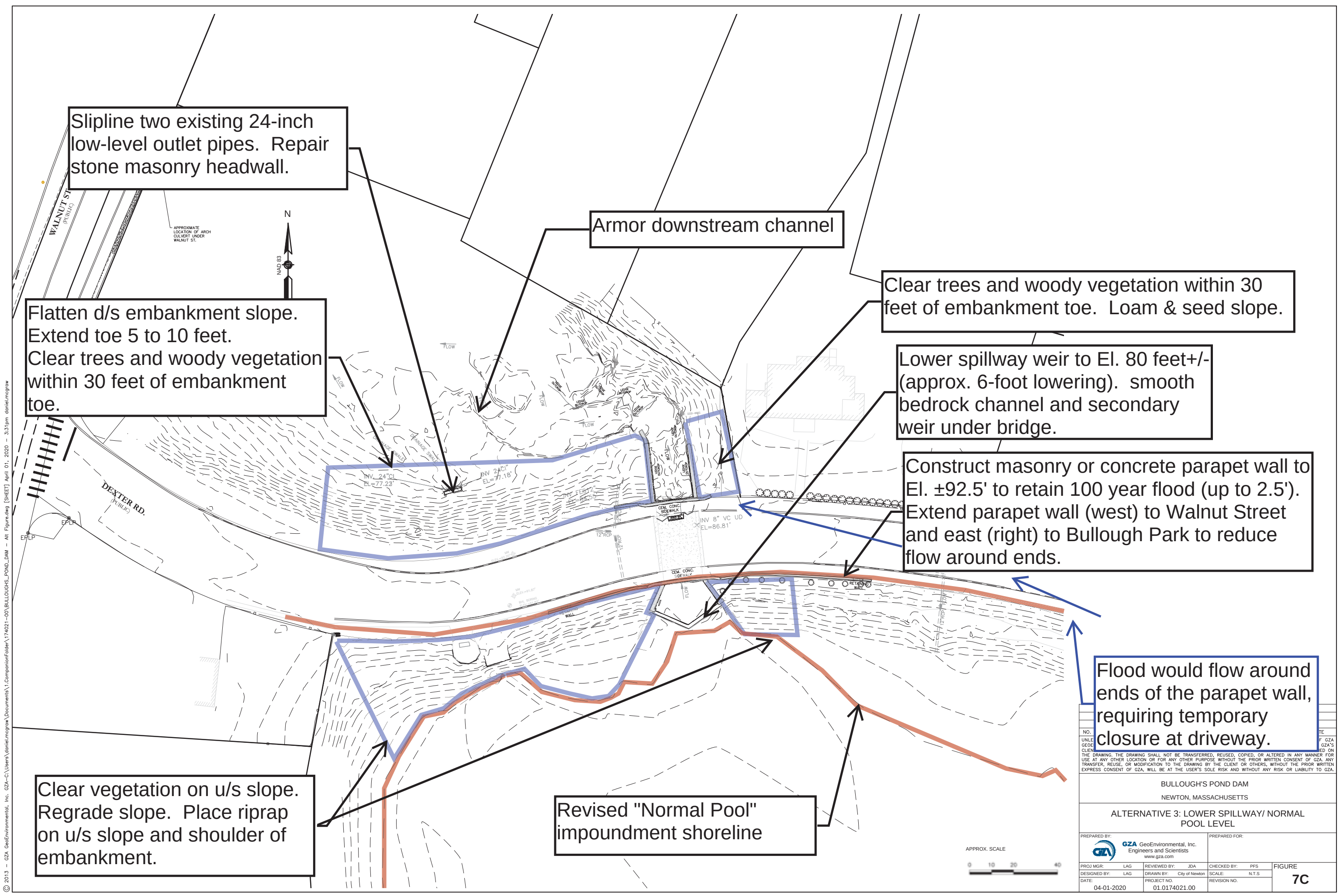
PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com

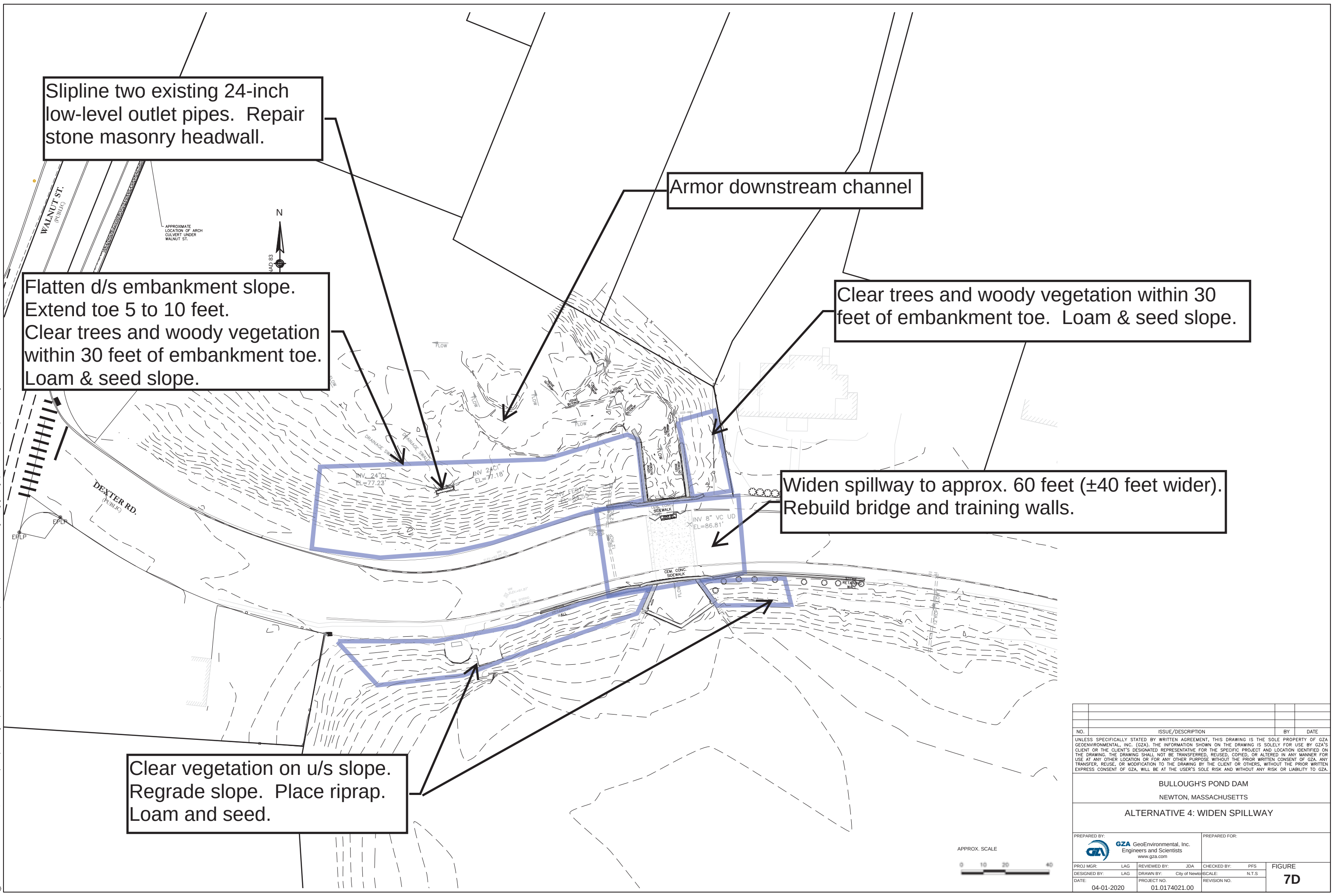
PREPARED FOR:

PROJ MGR: LAG	REVIEWED BY: JDA	CHECKED BY: PFS	FIGURE
DESIGNED BY: LAG	DRAWN BY: City of Newton	SCALE: N.T.S	7A
DATE: 04-01-2020	PROJECT NO. 01.0174021.00	REVISION NO.	


Armor downstream channel
Slipline two existing 24-inch low-level outlet pipes. Repair stone masonry headwall.
Repoint spillway training walls.
Clear trees and woody vegetation within 30 feet of embankment toe. Place erosion protection such as riprap, ACBs or TRM.
Flatten d/s embankment slope. Extend toe 5 to 10 feet. Clear trees and woody vegetation within 30 feet of embankment toe. Loam & seed slope.
Construct masonry or concrete parapet wall to El. 95' to retain 100 year flood (1 to 4'). Extend parapet wall (west) to Walnut Street and east (right) to Bullough Park to reduce flow around ends.
Flood would flow around ends of the parapet wall, requiring temporary closure at driveway.
Clear vegetation on u/s slope. Regrade slope. Place riprap on u/s slope and shoulder of embankment.
WALNUT ST.
DEXTER RD.
N
NAD 83
APPROX. SCALE
0 10 20 40
BULLOUGH'S POND DAM
NEWTON, MASSACHUSETTS
ALTERNATIVE 2: CONSTRUCT PARAPET WALL
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com
FIGURE
7B
DATE:
04-01-2020
PROJECT NO.
01.0174021.00

366-20


Slipline two existing 24-inch low-level outlet pipes. Repair stone masonry headwall.
Armor downstream channel
Clear trees and woody vegetation within 30 feet of embankment toe. Loam & seed slope.
Flatten d/s embankment slope. Extend toe 5 to 10 feet. Clear trees and woody vegetation within 30 feet of embankment toe.
Lower spillway weir to El. 80 feet+/- (approx. 6-foot lowering). smooth bedrock channel and secondary weir under bridge.
Construct masonry or concrete parapet wall to El. ±92.5' to retain 100 year flood (up to 2.5'). Extend parapet wall (west) to Walnut Street and east (right) to Bullough Park to reduce flow around ends.
Flood would flow around ends of the parapet wall, requiring temporary closure at driveway.
Clear vegetation on u/s slope. Regrade slope. Place riprap on u/s slope and shoulder of embankment.
Revised "Normal Pool" impoundment shoreline
WALNUT ST. (PUBLIC)
DEXTER RD. (PUBLIC)
N
NAD 83
APPROXIMATE LOCATION OF ARCH CULVERT UNDER WALNUT ST.
INV. 24"CI EL=77.23'
INV. 24"CI EL=77.18'
INV. 8" VC UD EL=86.81'
APPROX. SCALE
0 10 20 40
BULLOUGH'S POND DAM
NEWTON, MASSACHUSETTS
ALTERNATIVE 3: LOWER SPILLWAY/ NORMAL POOL LEVEL
PREPARED BY:
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com
PREPARED FOR:
PROJ MGR: LAG
REVIEWED BY: JDA
CHECKED BY: PFS
DESIGNED BY: LAG
DRAWN BY: City of Newton
SCALE: N.T.S
DATE: 04-01-2020
PROJECT NO. 01.0174021.00
REVISION NO.
FIGURE 7C



NO.	ISSUE/DESCRIPTION	BY	DATE

BULLOUGH'S POND DAM

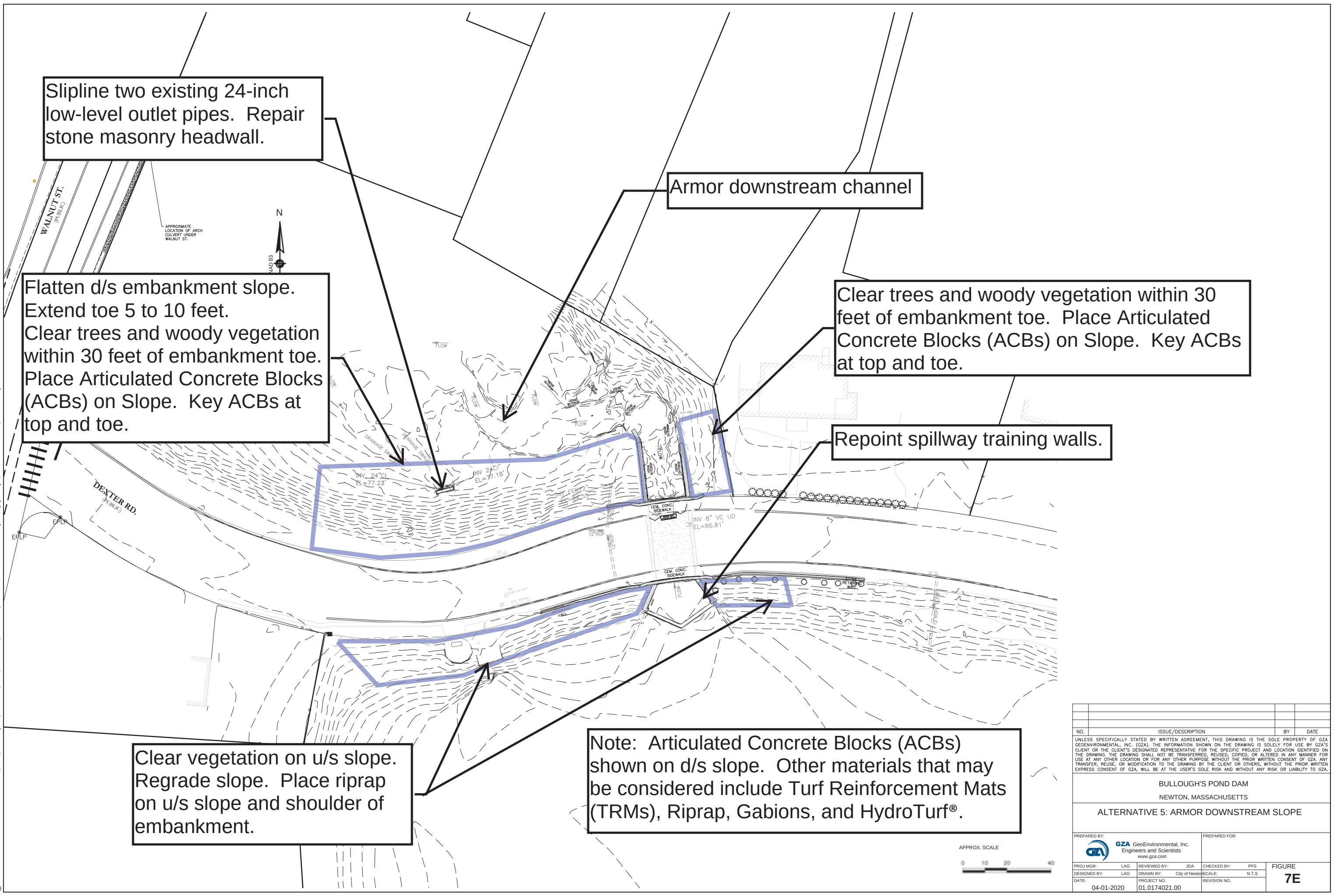
NEWTON, MASSACHUSETTS

ALTERNATIVE 4: WIDEN SPILLWAY

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com

PREPARED FOR:

PROJ MGR: LAG	REVIEWED BY: JDA	CHECKED BY: PFS	FIGURE 7D
DESIGNED BY: LAG	DRAWN BY: City of Newton	SCALE: N.T.S	
DATE: 04-01-2020	PROJECT NO. 01.0174021.00	REVISION NO.	


Slipline two existing 24-inch low-level outlet pipes. Repair stone masonry headwall.
Armor downstream channel
Flatten d/s embankment slope. Extend toe 5 to 10 feet. Clear trees and woody vegetation within 30 feet of embankment toe. Place Articulated Concrete Blocks (ACBs) on Slope. Key ACBs at top and toe.
Clear trees and woody vegetation within 30 feet of embankment toe. Place Articulated Concrete Blocks (ACBs) on Slope. Key ACBs at top and toe.
Repoint spillway training walls.
Clear vegetation on u/s slope. Regrade slope. Place riprap on u/s slope and shoulder of embankment.
Note: Articulated Concrete Blocks (ACBs) shown on d/s slope. Other materials that may be considered include Turf Reinforcement Mats (TRMs), Riprap, Gabions, and HydroTurf®.
WALNUT ST. (PUBLIC)
DEXTER RD. (PUBLIC)
N
APPROX. SCALE
0 10 20 40
NO. ISSUE/DESCRIPTION BY DATE
UNLESS SPECIFICALLY STATED BY WRITTEN AGREEMENT, THIS DRAWING IS THE SOLE PROPERTY OF GZA GEOENVIRONMENTAL, INC. (GZA). THE INFORMATION SHOWN ON THE DRAWING IS SOLELY FOR USE BY GZA'S CLIENT OR THE CLIENT'S DESIGNATED REPRESENTATIVE FOR THE SPECIFIC PROJECT AND LOCATION IDENTIFIED ON THE DRAWING. THE DRAWING SHALL NOT BE TRANSFERRED, REUSED, COPIED, OR ALTERED IN ANY MANNER FOR USE AT ANY OTHER LOCATION OR FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF GZA. ANY TRANSFER, REUSE, OR MODIFICATION TO THE DRAWING BY THE CLIENT OR OTHERS, WITHOUT THE PRIOR WRITTEN EXPRESS CONSENT OF GZA, WILL BE AT THE USER'S SOLE RISK AND WITHOUT ANY RISK OR LIABILITY TO GZA.
BULLOUGH'S POND DAM
NEWTON, MASSACHUSETTS
ALTERNATIVE 5: ARMOR DOWNSTREAM SLOPE
PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com
PREPARED FOR:
PROJ MGR: LAG
REVIEWED BY: JDA
CHECKED BY: PFS
DESIGNED BY: LAG
DRAWN BY: City of Newton
SCALE: N.T.S
DATE: 04-01-2020
PROJECT NO. 01.0174021.00
REVISION NO.
FIGURE 7E

Appendix A
Limitations

DAM ENGINEERING REPORT LIMITATIONS

Use of Report

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of City of Newton (Client) for the stated purpose(s) and location(s) identified in the Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

Standard of Care

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. Our services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

Subsurface Conditions

4. If presented, the generalized soil profile(s) and description, along with the conclusions and recommendations provided in our Report, are based in part on widely-spaced subsurface explorations by GZA and/or others, with a limited number of soil and/or rock samples and groundwater /piezometers data and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

5. Water level readings have been made in test holes (as described in the Report), monitoring wells and piezometers, at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the groundwater and piezometer levels, however, occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, reservoir and tailwater levels, the presence of subsurface utilities, and/or natural or artificially induced perturbations.

General

6. The observations described in this report were made under the conditions stated therein. The conclusions presented were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of described services or the time and budgetary constraints imposed by the Client.

7. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein available to GZA at the time of the evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

8. Any GZA hydrologic analysis presented herein is for the rainfall volumes and distributions stated herein. For storm conditions other than those analyzed, the response of the site's spillway, impoundment, and drainage network has not been evaluated. This analysis also relies on anecdotal data on overtopping frequency provided by the Client.

9. Observations were made of the site and of structures on the site as indicated within the report. Where access to portions of the structure or site, or to structures on the site was unavailable or limited, GZA renders no opinion as to the condition of that portion of the site or structure. In particular, it is noted that water levels in the impoundment and elsewhere and/or flow over the spillway may have limited GZA's ability to make observations of underwater portions of the structure. Excessive vegetation, when present, also inhibits observations.

10. In reviewing this Report, it should be realized that the reported condition of the dam is based on observations of field conditions during the course of this study along with data made available to GZA. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued inspection and care can there be any chance that unsafe conditions be detected.

Compliance with Codes and Regulations

11. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

12. This scope of work does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

Cost Estimates

13. Unless otherwise stated, our cost estimates are for comparative, or general planning purposes. These estimates may involve approximate quantity evaluations and may not be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over the labor and material costs required to plan and execute the anticipated work, our estimates were made using our experience and readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

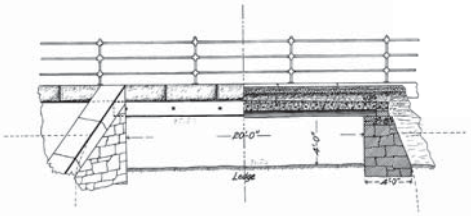
Additional Services

14. It is recommended that GZA be retained to provide services during any future: site observations, explorations, evaluations, design, implementation activities, construction and/or implementation of remedial measures recommended in this Report. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

Appendix B
Historic Drawings

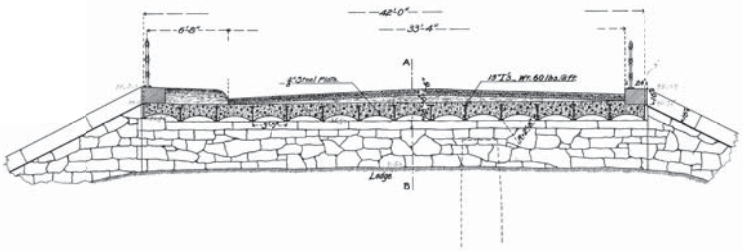
7587

END ELEVATION OF CULVERT.

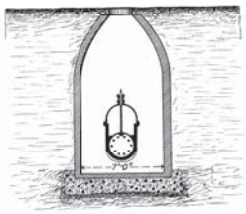


HALF SECTION ON A-B.

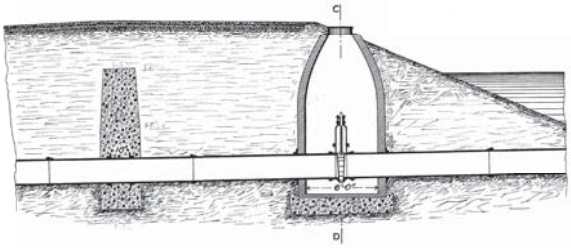
SECTION THROUGH OVERFLOW CULVERT.



SECTION ON C-D.



SECTION THROUGH WASTE PIPE AND GATE CHAMBER.



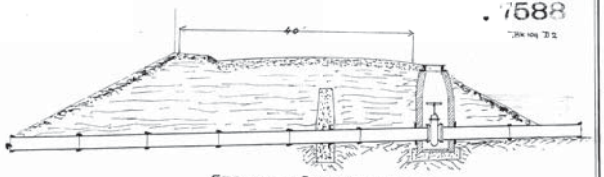
DETAILS OF
CULVERT AND WASTE PIPE
BULLOUGHS POND IMPROVEMENTS

SCALE 4 FT. = 1 IN.

NEWTON, MASS.
SEPT. 1897.

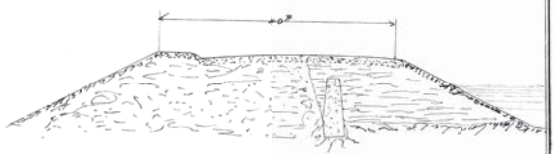
H.D.WOODS,
CITY ENGINEER.

SECTION OF BROOKWAY.

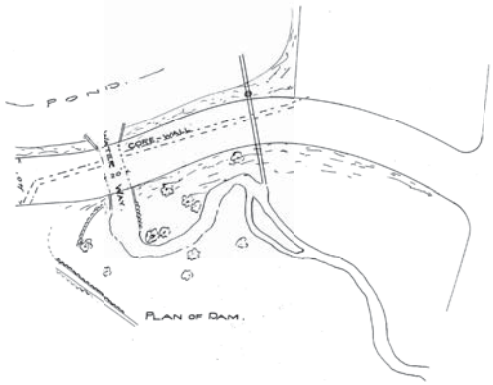


SECTION OF DAM AND WASTE-PIPE.

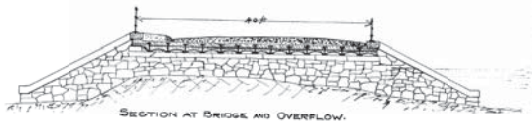
SECTION OF DRIVEWAY.



GENERAL SECTION OF DAM.



PLAN OF DAM.



SECTION AT BRIDGE AND OVERFLOW.

PLAN OF

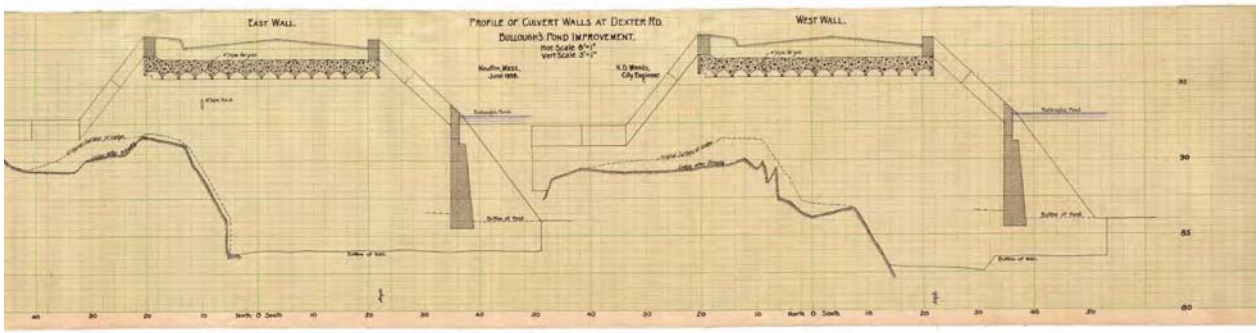
PROPOSED SECTIONS OF ROADWAYS AND DAM.

BULLOUGHS POND IMPROVEMENTS.

SCALE 8 FEET = 1 INCH.

NEWTON, MASS., AUG. 1897.

H. D. WOODS, CITY ENGR.


East Wall.
Profile of Culvert Walls at Dexter Rd.
Billough's Pond Improvement.
Hor. Scale 8"=1'
Vert. Scale 3"=1'
Newton, Mass.
June 1898.
H.D. Woods,
City Engineer
West Wall.
North
South
90
85
80

PLAN AND PROFILE OF DRAIN IN

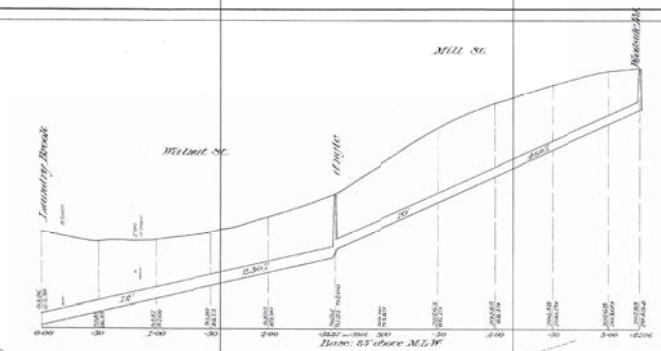
WALNUT ST.

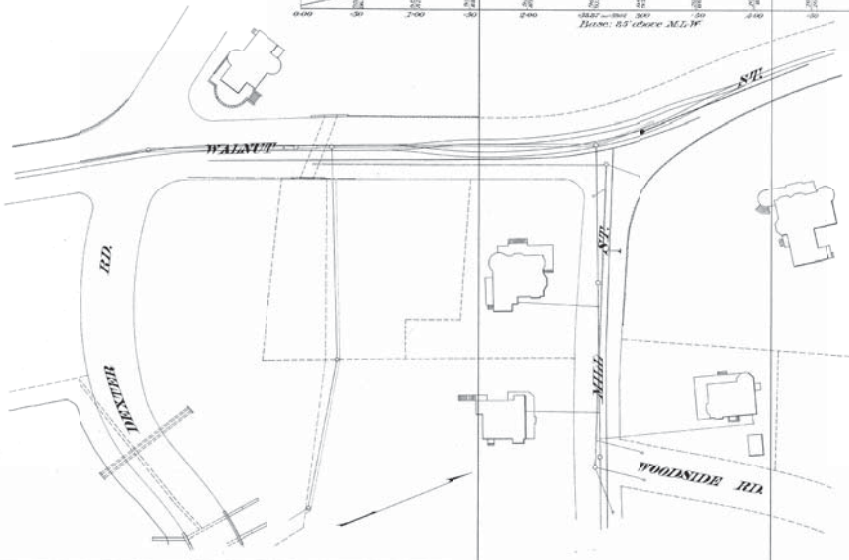
LAUNDRY BROOK TO MILL ST.

MILL ST.

WALNUT ST. WOODSIDE RD.

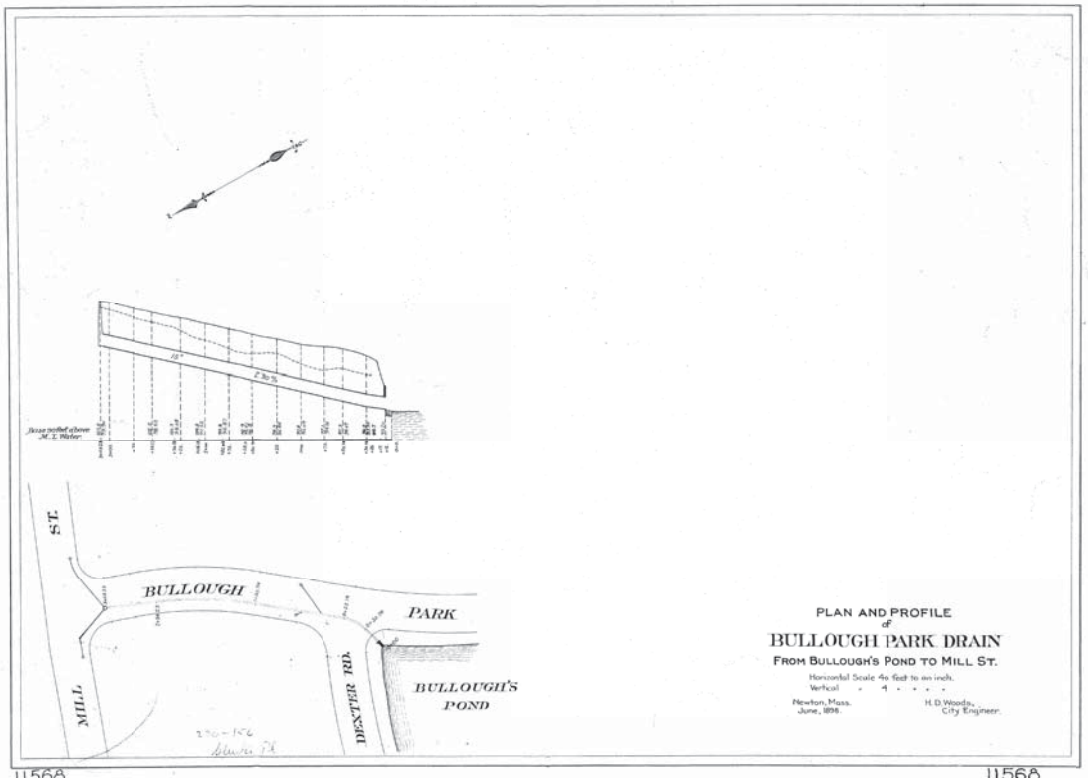
Horizontal Scale 40'=1'
Vertical " 4'=1'
Newton Mass. December 1904.
Irving T. Farnham City Eng'r.





10648
P-16

10648
P-16



11568
P-19

11568
P-19

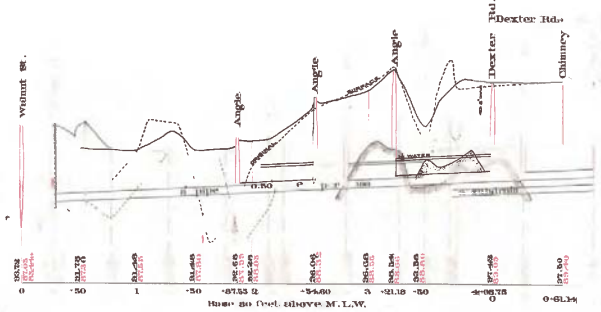
PLAN AND PROFILE OF PRIVATE LAND AND DEXTER RD. SEWER WALNUT ST. TOWARD BULLOUGH PK.

SHOWING ASSESSMENT

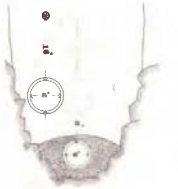
Horizontal scale: 1in. to 40 ft.
Vertical " " " 4 "

Newton, Mass., Dec. 15, 1898.

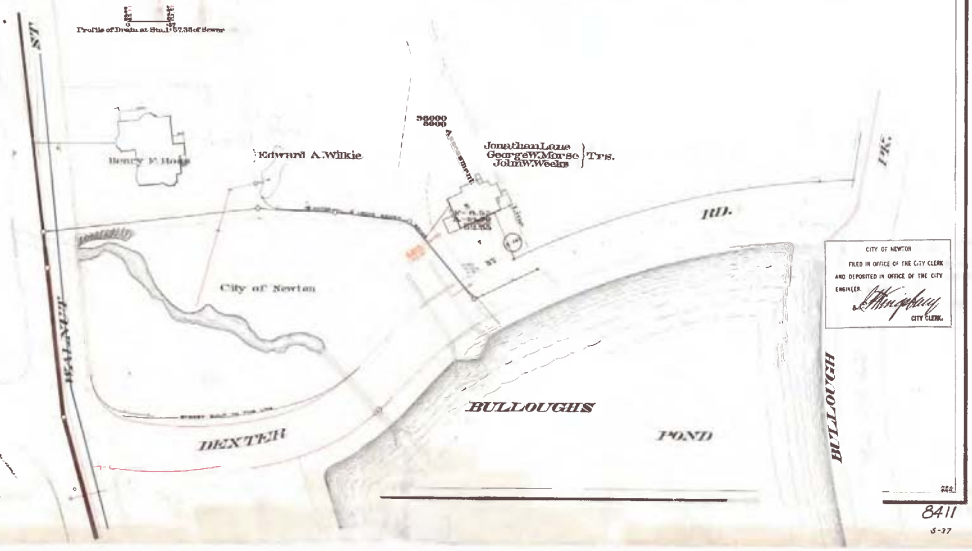
H.D. Woods, City Engineer.



Profile of Drain at Bush 57.58 of Sewer



Scale: 1in. to 1ft.



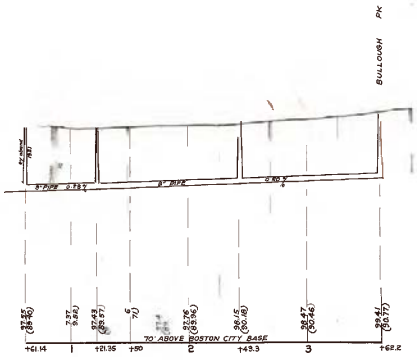
CITY OF NEWTON
FILED IN OFFICE OF THE CITY CLERK
AND DEPOSITED IN OFFICE OF THE CITY ENGINEER.
CITY CLERK.

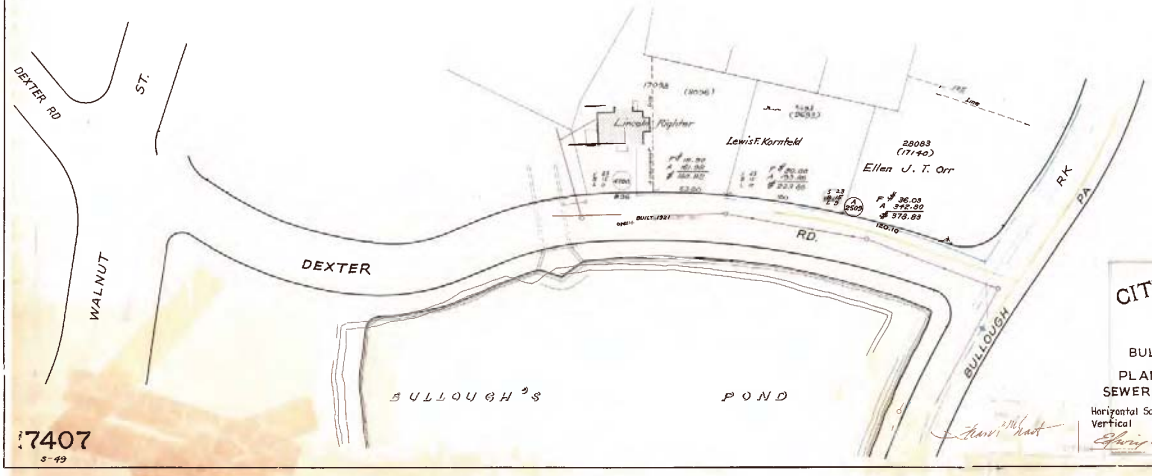
8411
5-27

8411
5-27

17407

17407





17407

CITY OF NEWTON

MASSACHUSETTS

DEXTER ROAD

BULLOUGH PK. WESTERLY

PLAN AND PROFILE SHOWING
SEWER AND SEWER ASSESSMENT

Horizontal Scale: 40' to an inch
Vertical " 6' " "

February 6, 1922.

CITY ENGINEER.

17407

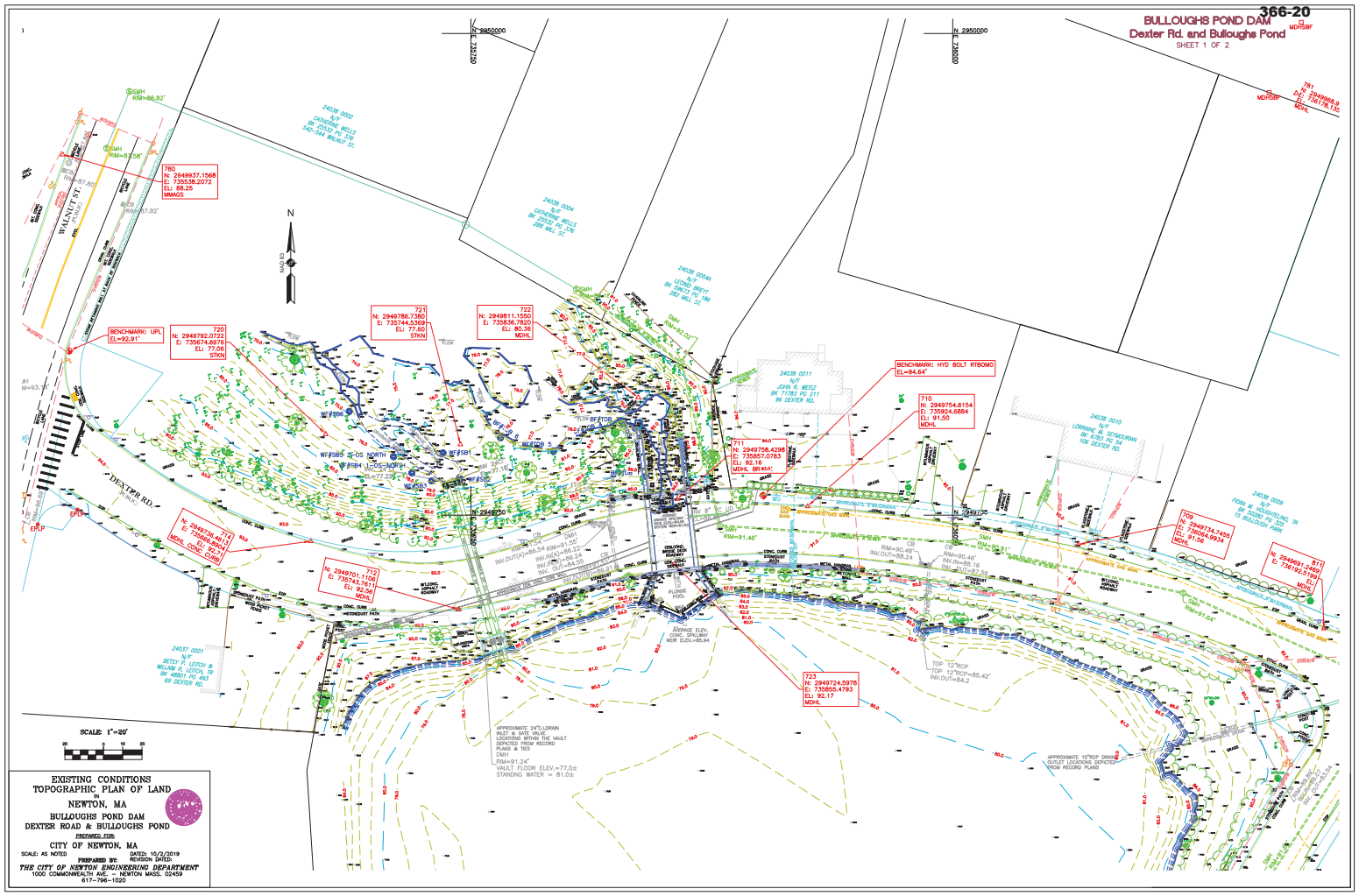
S-49

17407
S-49

Appendix C
Topographic Survey

366-20

BULLOUGHS POND DAM
Dexter Rd. and Bulloughs Pond
SHEET 1 OF 2



366-20

BULLOUGHS POND DAM

Dexter Rd. and Bullroughs Pond

SHEET 2 OF 2

NOTES:

1. LOCATIONS OF UTILITIES SHOWN WERE PLOTTED FROM (1) RECORD DATA PROVIDED BY THE CITY OF NEWTON, MA OR THE RESPECTIVE UTILITY OR (2) BY LOCATION IN THE FIELD. LOCATIONS AND ELEVATIONS OF ALL UTILITIES ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL NOTIFY DIG SAFE AND DETERMINE THE EXACT LOCATIONS IN THE FIELD PRIOR TO ANY WORK PER MASSACHUSETTS GENERAL LAW CHAPTER 82 SECTIONS 40A - 40E, AS AMENDED. THIS PLAN DOES NOT WARRANTY NOR GUARANTEE THE LOCATION OF ALL UTILITIES EITHER DEPICTED OR NOT DEPICTED, THIS PLAN MAY OR MAY NOT SHOW ALL THE UTILITIES SERVICING OR EXISTING AT THIS SITE; ABOVE GROUND OR BELOW, IN SERVICE OR ABANDONED, UNRECORDED OR OF RECORD. ANY LABEL IDENTIFYING A UTILITY STRUCTURE IS BASED ON FIELD INSPECTION AND/OR FROM AVAILABLE PLANS AND SHOULD NOT BE CONSIDERED AS A DEFINITIVE DESCRIPTION OF EITHER THE UTILITY OR USAGE OF THE STRUCTURE.

2. THIS PLAN IS NOT A CERTIFICATION TO TITLE OR OWNERSHIP OF PROPERTY SHOWN, OWNERS OF ADJOINING PROPERTIES ARE ACCORDING TO CURRENT ASSESSOR'S RECORDS.

3. THIS PLAN DOES NOT SHOW ANY RECORDED, UNRECORDED OR UNWRITTEN EASEMENTS WHICH MAY EXIST.

4. THIS PLAN WAS PREPARED FOR THE CITY OF NEWTON ENGINEERING DIVISION FOR THE FOLLOWING PURPPOSES: EXISTING CONDITIONS TOPOGRAPHIC PLAN OF A PORTION OF BULLOUGHS POND, BULLOUGH PARK, DEXTER RD. & BULLOUGHS POND DAM, TO BE USED FOR INSPECTION, EVALUATION AND DESIGN IMPROVEMENT & REPAIRS. THIS PLAN IS THE RESULT OF TOPOGRAPHIC DETAIL SURVEY AND RIGHT OF WAY RETRACEMENT SURVEY PERFORMED BY THE CITY OF NEWTON ENGINEERING DIVISION.

5. THE HORIZONTAL SURVEY CONTROL WAS BASED ON SURVEY CONTROL ESTABLISHED ON THE GROUND BY THE CITY OF NEWTON ENGINEERING DIVISION, SURVEY SECTION BY PERFORMING A CLOSED LOOP TRAVERSE AND TRAVERSE ADJUSTMENT, CONTROL WAS FURTHER EXTENDED BY MEANS OF TRAVERSING RADIALLY FROM CLOSED LOOP TRAVERSE OUTWARD TO LOCATE STREET MONUMENTS (RADIAL TRAVERSE INCORPORATED CLOSING THE HORIZON ANGULARLY ALONG ANY EXTENSIONS FROM CLOSED TRAVERSE LOOP). THE COORDINATES OF THIS PROJECT ARE DERIVED FROM GEODETIC POSITIONING USING REAL TIME KINEMATIC (RTK) GLOBAL POSITIONING SYSTEM (GPS) NETWORK ROVER THAT RECEIVED ON THE FLY POSITIONAL CORRECTIONS FROM THE MAINE TECHNICAL SOURCE COOPERATIVE NATIONAL GEODETIC SURVEY (NGS) CONTINUALLY OPERATING REFERENCE SYSTEM (CORS) BASED ON THE NORTH AMERICAN DATUM OF 1983 (2011) (NAD83) (CORS2011) (EPOCH 2010) HORIZONTAL DATUM (MASSACHUSETTS MAINLAND STATE PLANE COORDINATE SYSTEM ZONE 2001). COORDINATE VALUES OBTAINED WERE AVERAGED FROM MULTIPLE OBSERVATIONS TAKEN AT DIFFERENT TIMES ON DIFFERENT DAYS. (SEPTEMBER 22 & 23, 2017) AT FOUR OF THE HORIZONTAL CONTROL TRAVERSE LOCATIONS. RTK GPS DERIVED NAD83 STATE PLANE COORDINATE SYSTEM ZONE 2001 MASSACHUSETTS MAINLAND, THE AVERAGE COMBINED SCALE FACTOR FOR THIS PROJECT SITE IS 0.9999673, AND THE UNITS OF THE COORDINATES, DISTANCES AND MEASURE DEPICTED HEREON ARE U.S. SURVEY FEET.

6. LOCATIONS AND OTHER UNDERGROUND UTILITIES I.E.: WATER MAINS, GAS MAINS, SEWER LINES, DRAIN LINES, ELECTRIC LINES, COMMUNICATION LINES LOCATIONS DEPICTED HEREON ARE TAKEN FROM A COMBINATION OF PLANS OF RECORD, FIELD LOCATIONS FROM DIG SAFE MARKINGS & STRUCTURE LOCATIONS, AND FROM DIGITIZING THE LOCATIONS FROM SCANNED PLANS THAT CONTAIN GRAPHICAL REPRESENTATIONS OF THE LOCATION WITHOUT DIMENSIONAL INFORMATION. AS SUCH THE LOCATION OF UNDERGROUND UTILITIES AND THE DAM CORE WALL LOCATIONS DEPICTED HEREON ARE APPROXIMATE IN NATURE AS RECREATING THE EXACT LOCATIONS IS BEYOND THE SCOPE OR NECESSITY OF THIS PROJECT, THEY ARE FOR ILLUSTRATIVE PURPOSES ONLY.

7. THE VERTICAL CONTROL ELEVATIONS DEPICTED HEREON ARE BASED ON THE ELEVATIONS OF THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29) THAT WERE CONVERTED FROM NGVD29 TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 1988) REFERENCING THE MASS HIGHWAY SURVEY MANUAL DATUM PLANE RELATIONS TABLE. VERTICAL CONTROL AT THIS SITE WAS OBTAINED BY PERFORMING CLOSED LOOP DIFFERENTIAL LEVELING THROUGH THE PUBLISHED BENCHMARK AND THE LOCAL SITE BENCHMARKS AND TRAVERSE POINTS DEPICTED HEREON FROM PUBLISHED BENCH MARK MassDOT ID:4421, STATION #10033, A MASS. GEODETIC SURVEY DISK ON CONC. PEDESTAL ON GROUNDS OF NEWTON CITY HALL, CITY OF NEWTON ENGINEERING DIVISION FIELD BOOK 988 & 993.

NOTES (CONTINUED):

8. THIS PLAN IS THE ORIGINAL WORK OF THE CITY OF NEWTON ENGINEERING DEPARTMENT. IT IS A VIOLATION OF LAW FOR ANYONE TO REPRESENT THIS PLAN AS THEIR OWN ORIGINAL WORK, WITH OR WITHOUT EDITING. IT IS A VIOLATION OF LAW TO EDIT THIS PLAN AND CONTINUE TO REPRESENT IT AS THE ORIGINAL WORK OF THE CITY OF NEWTON ENGINEERING DEPARTMENT.

9. BY VISUAL REVEIW AND SCALE, DEXTER RD AND BULLOUGHS POND IS NOT LOCATED WITHIN FLOOD ZONE X (AREAS OUTSIDE TH E0.03% ANNUAL CHANCE FLOODPLAIN) NOR FLOOD ZONE X (AREAS OF 0.2% ANNUAK CHANCE FLOOD) AS SHOWN ON NATIONAL FLOOD INSURANCE PROGRAM (NFIP) FLOOD INSURANCE RATE MAP (FIRM) NUMBER 25017C0554E WITH AN EFFECTIVE DATE OF JUNE 4, 2010.

10. THE BORDERING VEGETATIVE WETLANDS (BVW) & BANK LOCATION FLAGS SHOWN HEREON WERE LOCATED IN THE FIELD. THE WETLAND FLAGS WERE HUNG BY JENNIFER STEELE, THE SENIOR ENVIRONMENTAL PLANNER FOR THE CITY OF NEWTON, TO DELINEATE THE EDGE OF BORDERING VEGETATED WETLANDS AND THE BANK.

11. THE COLD SPRING BROOK, COLEMAN BROOK, HAMMOND BROOK DRAINAGE CULVERTS AND ROADWAY DRAINAGE ARE THE SOURCE FOR THE WATER PASSING THROUGH BULLOUGHS POND AND THE BULLOUGHS POND SPILLWAY.

12. THE RIGHT OF WAY LINES DEPICTED HEREON REPRESENT A RETRACEMENT OF THE DEXTER ROAD AND BULLOUGH PARK THE RIGHTS OF WAY.

13. THIS PLAN DOES NOT SHOW ANY RECORDED, UNRECORDED OR UNWRITTEN EASEMENTS WHICH MAY EXIST. A REASONABLE AND DILIGENT ATTEMPT HAS BEEN MADE TO OBSERVE ANY APPARENT VISIBLE USES OF THE LAND; HOWEVER, THIS DOES NOT CONSTITUTE A GUARANTEE THAT NO SUCH EASEMENTS EXIST.

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
⊠ DH/SB	DRILL HOLE/ STONE BOUND	▦ C.B.	CATCH BASIN		BENCHMARK
⊕ D.H.	DRILL HOLE	Ⓓ D.M.H.	DRAIN MANHOLE	CTRL.CAB.	CONTROL CABINET (TRAFFIC)
○ I.R	IRON ROD	Ⓢ S.M.H.	SEWER MANHOLE	P.B	PULL BOX
○ I.P.	IRON PIPE	Ⓦ	WATERMAIN MANHOLE	VAR.	VARIABLE
▦ C.B.	CONCRETE BOUND	M.W.R.A.	MA WATER RESOURCES AUTHORITY	X 100.00	EXISTING SPOT GRADE
⊠CTR./S.B.	CENTER/ STONE BOUND	Ⓣ	TELEPHONE MANHOLE	APPR.	APPROXIMATE
⊠CRNR./S.B.	CORNER/ STONE BOUND	Ⓔ	ELECTRIC MANHOLE	UGU	UNDERGROUND UTILITIES
⊡E.P./L.P.	ESCUTCHEON PIN/LEAD PLUG	Ⓜ	MANHOLE OTHER	PKWY.	PARKWAY
▣I.P./C.B.	IRON PIPE/CONCRETE BOUND	—•—	SIGN	BK.	BOOK
BIT.	BITUMINOUS	⋈	WATER GATE	PG.	PAGE
CONC.	CONCRETE	O WG	WATER GATE	S.D.	SOUTH DISTRICT
B.G.	BELOW GRADE	—○— ULT	UTILITY POLE W/ LIGHT	M.C.R.D.	MIDDLESEX COUNTY REGISTRY OF DEEDS
GRAN.	GRANITE	○	UTILITY POLE	SPCS	STATE PLANAR COORDINATE SYSTEM
S.	SET	—O— UPL	UTILITY POLE	BLDG.	BUILDING
F.	FOUND	⊕OW	GUY	PL.BK.	PLAN BOOK
N/F	NOW OR FORMERLY	⋈	HYDRANT	EOP	EDGE OF PAVEMENT
CLF	CHAIN LINK FENCE	☼	LIGHT	DYCL	DOUBLE YELLOW CENTER LINE
OGG	GAS GATE	OVRHDW	OVERHEAD WIRES	CEM.	CEMENT
PS	PARKING SPACE	UGE	UNDERGROUND ELECTRIC WIRES	CONC.	CONCRETE

SCALE 1"=20'

20 0 10 20

EXISTING CONDITIONS
TOPOGRAPHIC PLAN OF LAND
IN
NEWTON, MA
BULLOUGHS POND DAM
DEXTER ROAD & BULLOUGHS POND

PREPARED FOR:
CITY OF NEWTON, MA

SCALE: AS NOTED DATED: 10/3/2019
REVISION DATED:

PREPARED BY:
THE CITY OF NEWTON ENGINEERING DEPARTMENT
1000 COMMONWEALTH AVE. – NEWTON MASS. 02459
617-796-1020

Appendix D
References

PREVIOUS REPORTS AND REFERENCES

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

1. GZA GeoEnvironmental, Inc., Follow Up Inspection/Evaluation Report, April 2020.
2. "Existing Conditions Topographic Plan of Bulloughs Pond Dam Spillway Culvert in Newton, MA" Prepared for City of Newton, MA by the City of Newton Engineering Department, dated October 7, 2019.
3. GZA GeoEnvironmental, Inc., Follow Up Inspection/Evaluation Report, July 2019.
4. GZA GeoEnvironmental, Inc., Follow Up Inspection/Evaluation Report, January 2019.
5. Pare Corporation., Follow Up Inspection/Evaluation Report, June 2018.
6. Ninth Edition of the MA State Building Code 780 CMR Amendments to the 2015 IBC International Codes published by the International Code Council (IBC).
7. 2015 International Codes published by the International Code Council (IBC)
8. The History of Bullough's Pond" webpage, researched and prepared by the Bullough's Pond Association, http://www.bulloughspond.org/the-history-of-bulloughs-pond.html
9. National Inventory of Dams (NID) database, https://nid.sec.usace.army.mil/ords/f?p=105:113:10544599320348::NO:113,2:P113_RECORDID:31354
10. "Partial Duration Series (by Station), Station ID #190535 – BEDFORD", period of record 1957 through 2008, http://precip.eas.cornell.edu/
11. Idriss, I.M. and Boulanger, R.W. (2008). Soil Liquefaction During Earthquakes. Earthquake Engineering Research Institute. Oakland, California. EERI Publication No. MNO-12.
12. "Bridge Replacement Unit Costs 2017" United States Department of Transportation Federal Highway Administration. http://www.fhwa.dot.gov/bridge/nbi/sd2017.cfm
13. Department of Conservation and Recreation Dam Detail Sheet, September 2006.
14. FHWA IF-02-034, Originally published by GeoSyntec Consultants, Inc. Geotextile Filter Design Manual, 1991.
15. "Bedrock Geologic Maps of the Boston North, Boston South, and Newtown Quadrangles, Massachusetts Sheet 1 of 2" by Clifford A. Kaye dated 1980
16. Cedergren, H.R., Seepage, Drainage and Flow Nets, 1977.

17. Justin, Hinds and Creager, "Engineering for Dams"; Vol. III; John Wiley & Sons. 1961.

18. “Plan and Profile Showing Sewer and Showing Assessment”, City of Newton, February 6, 1922.

19. “Plan and Profile of Drain in Walnut Street, Laundry Brook to Mill Street, Mill Street, Walnut Street, Woodside Road”, City of Newton., December 1904.

20. “Plan and Profile of Private Land and Dexter Road Sewer, Walnut Street Toward Bullough Park, Showing Assessment”, City of Newton, December 15, 1898.

21. “Profile of Culvert Walls at Dexter Road, Bulloughs Pond Improvements”, City of Newton, June 1898.

22. “Plan and Profile of Bullough Park Drain from Bullough’s Pond to Mill St.”, Bulloughs Pond Improvements”, City of Newton, June 1898.

23. “Details of Culvert and Waste Pipe, Bulloughs Pond Improvements”, City of Newton, September 1897.

24. “Plan of Proposed Sections of Roadways and Dam, Bulloughs Pond Improvements”, City of Newton, August 1897.

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

25. Commonwealth of Massachusetts Regulations, 302 CMR 10.00 – Dam Safety, Effective 10/30/2017.

Appendix E
Dam Safety Orders

dcr
Massachusetts

July 16, 2018
Certified Mail No. 7017 2620 0000 7578 6800
Return Receipt Requested

City of Newton
c/o the Honorable Ruthanne Fuller
1000 Commonwealth Ave
Newton, MA 02459

Subject: **CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER**

Dam Name:	Bulloughs Pond Dam
Location:	Newton
National ID No:	MA03414
Known Condition:	Poor
Hazard Potential:	Significant
Middlesex Registry of Deeds:	Book 2618, Page 2

Dear Mayor Fuller:

In accordance with 302 CMR 10.08, the Department of Conservation and Recreation (DCR), Office of Dam Safety (ODS) has determined that Bulloughs Pond Dam does not meet accepted dam safety standards and is a potential threat to public safety. Therefore, DCR hereby issues a **CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER**.

ODS records indicate that the City of Newton is the Owner of the Bulloughs Pond Dam, National Inventory of Dams No. MA03414. ODS classifies the dam as a **Small Size, Significant Hazard Potential** Structure. Significant Hazard Potential Dams are dams that may cause the loss of life and property damage in the event of dam failure.

On May 2, 2017, and more recently on June 7, 2018, inspections of the Bulloughs Pond Dam were performed by engineering consultants PARE Corp., at the expense of the ODS. As a result of these inspections, the dam was determined to be **STRUCTURALLY DEFICIENT** and in **POOR** condition. The dam has been found to be in need of repair, breaching or removal to bring the dam into compliance with dam safety regulations.

The CERTIFICATE OF NON-COMPLIANCE is based on the above-referenced inspection report results which listed the observance of many deficiencies, including but not limited to:

- Unwanted vegetation in areas of the dam including large trees along the downstream slope;
- Scarping along the upstream slope and bare soils prone to erosion along the downstream slope;
- Deterioration/potential unstable headwall at the downstream end of the low-level outlet with observed scour/displaced riprap within the channel;
- Areas of scour along the downstream channel including at the low-level outlet and along the left and right banks. If erosion of the left bank continues, it could encroach on the toe of the downstream slope;
- Mortar is missing from some joints of the spillway training walls; and
- Additional maintenance deficiencies and dam safety concerns.

These foregoing deficiencies compromise the structural integrity of the dam and present a potential threat to public safety. ODS has determined that the dam needs to be repaired, breached or removed in order to bring the dam into compliance with dam safety regulations.

G.L. c. 253, Sections 44-48 and 302 CMR 10.00 set forth the jurisdiction for ODS and its authority to take action and order actions to be taken. For your information a copy of the Dam Safety Regulations, 302 CMR 10.00 Dam Safety, can be found on the ODS website.

DAM SAFETY ORDER:

In accordance with the authority of G.L. c. 253, Section 47, 302 CMR 10.07 and 10.08 you are hereby **ORDERED** to comply with the following:

1) **Conduct Follow-up Inspections:** You shall complete follow-up visual inspections at six (6)-month intervals, conducted by a registered professional civil engineer qualified to conduct dam inspections, at your cost, until adequate repairs are made or the dam is adequately breached. You shall submit the first Follow-up inspection to ODS no later than **December 7, 2018**.

   Follow-up inspections are to be summary in format and shall provide a written description, including photographs, of any changes in condition. Your engineer is to use the attached ODS Poor Condition Dam Follow-up Inspection Form to report follow-up inspection findings. The form is also available electronically on the ODS web site. Your engineer shall include a cover letter on engineering firm letterhead that briefly summarizes the current follow-up inspection and findings.

You shall submit one (1) hard copy printed double-sided and one (1) electronic pdf copy of all completed follow-up visual inspection reports to ODS within thirty (30) days of the date of follow-up inspection field work.

2) **Conduct Phase II Inspection and Investigations**. You shall hire at your cost, a qualified registered professional engineer with dam engineering experience (engineer) to conduct a Phase II Inspection and Investigation of the dam to evaluate the structural integrity and spillway hydraulic adequacy of your dam and to develop/implement a plan to bring the dam into compliance with dam safety regulations by adequately repairing, breaching or removing the dam (see attached Phase II Investigation Outline).

   a. You shall commence the Phase II Inspection and Investigation no later than **October 16, 2018**. The Phase II Inspection and Investigation is to conform to the attached Phase II Investigation Outline. You are to, in a letter to ODS, no later than **October 2, 2018,** identify your selected engineer and inform ODS of the start date of the Phase II work.

   b. The Phase II Inspection and Investigation is to be completed, signed and stamped by your engineer and copies of the Phase II final report are to be delivered to ODS no later than **January 16, 2019**.

      You shall include a cover letter with the submitted Phase II report which describes your selected alternative to bring the dam into compliance with dam safety regulations. The owner shall submit a statement of your intent to implement inspection report recommendations to address structural and operational deficiencies to ODS upon submission of the required Phase II Inspection and Investigation completed by your engineer.

3) **Bring the dam into compliance and complete all repair, breach or removal work no later than January 16, 2020.** With your Phase II submittal, you must also provide a proposed timeline to design, permit and construct the selected alternative to repair, breach or remove the dam. The selected alternative must be completed, and the dam brought into compliance with Dam Safety regulations, by January 16, 2020.

4) **Additional Requirements:**
   a. You shall furnish copies of all required submittals listed above via certified mail.

   b. In order to maintain compliance with the Commonwealth's Wetlands Protection Laws you may have to seek requisite approval from your local Conservation Commission in accordance with G.L. c. 131, §40. You are obligated to contact and maintain communication with the Newton Conservation Commission and any other local, state or federal permitting agency the ensure compliance with the Wetlands Protection Act and any other regulatory requirements.

c. You must inform the following parties about the condition of the dam and your developing plans to bring the dam into compliance with dam safety regulations: all abutters of the impoundment upstream; property owners within one-half mile downstream of the Bulloughs Pond Dam; Northeast District, Division of Fisheries & Wildlife, 85 Fitchburg Rd, Ayer, MA 01432; Regional Director, Department of Environmental Protection, Northeast Region, 205B Lowell St, Wilmington, MA 01887; Conservation Commission, 1000 Commonwealth Ave, Newton, MA 02459; Emergency Management Director, 1164 Centre St, Newton, MA 02459.

Please be advised that in accordance with G.L. c. 253, § 47, "any person who fails to comply with the provisions of this chapter or of any order, regulation or requirement of the department relative to dam safety, shall be fined an amount not to exceed $5,000 for each offense, to be fixed by the court." Furthermore, each violation shall be regarded as a separate and distinct offense and, in case of a continuing violation, each day's continuance thereof shall be deemed to be a separate and distinct offense.

Nothing in this order releases the owner from the requirements of any prior Dam Safety Order issued for this dam.

In accordance with 302 CMR 10.08, this CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER will be recorded by the DCR at the Registry of Deeds in the county where the dam lies. Issuance of a Certificate of Compliance following adequate repair or breaching of the dam will be required to discharge the CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER.

Please direct any technical questions, correspondence, or submittals to Emily Caruso, Department of Conservation and Recreation, Office of Dam Safety, 180 Beaman Street, West Boylston, MA 01583 or Emily.Caruso@state.ma.us. Other questions regarding process and administration of Dam Safety regulations should be directed to Bill Salomaa, Director of Office of Dam Safety, at William.Salomaa@state.ma.us. Additional dam safety information can be found at the DCR-ODS website: http://www.mass.gov/eea/agencies/dcr/conservation/dam-safety/.

Thank you for your cooperation.

Sincerely,

Leo Roy
Commissioner, DCR

Enclosure: June 2018 Follow-Up Inspection

CC: Senator Cynthia Stone Creem
Representative Kay Khan
Newton Emergency Management Director
Newton Conservation Commission
Barbara Newman, U.S. Army Corps
Northeast Region, DEP
Deirdre Buckley, MEPA
Northeast District, DFW
Rob Lowell, DCR
William Salomaa, DCR
Ariana Johnson, Esq., DCR
Nick Wildman, DER

Department of Conservation and Recreation
Office of Dam Safety
Phase II Inspection and Investigation Outline

I.	Review of existing information.....
II.	Updated Detailed Phase I surface inspection in compliance with Office of Dam Safety Phase I Inspection format.....
III.	Subsurface Investigations – borings, sampling, analysis.....
IV.	Topographic Survey, wetlands flagging/delineation, of sufficient detail to support not only the Phase II effort, but sufficient for the future implementation of design phase.....
V.	Stability and seepage analyses – Seismic and static stability evaluation of dam (upstream and downstream slopes, internal materials), seepage potential, internal erosion potential, piping potential.....
VI.	Hydrologic/Hydraulic Analysis and spillway inadequacy resolution.....
VII.	Alternatives analysis and presentation of conceptual designs and associated estimated design, permitting and construction costs to bring the dam structure into compliance with Chapter 253 Section 44-48 and 302 CMR 10.00 Dam Safety Regulations by either executing selected repair plan or breach plan.....
VIII.	Final Report Presented to the Office of Dam Safety.....

Commonwealth of Massachusetts
Department of Conservation and Recreation
Office of Dam Safety Poor Condition Dam Follow-up Inspection Form

(Complete this inspection form and provide a cover letter on consulting firm letterhead that briefly summarizes the current follow-up inspection and findings. The cover letter shall be signed and stamped by the Registered Professional Engineer in charge of the inspection)

Dam Name:
Dam Owner:
Nat. ID Number:
Hazard Potential:
Location of Dam (town):
Coordinate location (lat, long):
Date of Inspection:
Weather:

Consultant Inspector(s): **firm name and name of Registered Professional Engineer in charge of inspection.**

Others in Attendance at Field Inspection: **include list of names, affiliation and phone numbers.**

Attachments: **Updated site sketch with photo locations, Updated photos, and copy of locus map from Phase I report and other applicable attachments.**

I. **Previous Inspection date/Overall Condition:**
- Date of most recent formal Phase I Inspection Report:
- List the overall condition reported in most recent Phase I Inspection Report:

II. **Previous Inspection Deficiencies:**
- List identified deficiencies in the most recent Phase I Inspection Report:

III. **Overall Condition of Dam at the Time of the Current Follow-up Inspection:**
   a. **State the current condition**
   b. **Have conditions changed since the previous inspection? Yes or no.**

IV. **Comparison of Current Conditions to Condition Listed in Previous Phase I Inspection Report:**
   a. **Have any of the deficiencies listed in the previous Phase I Inspection Report worsened?**
   b. **If yes, list the changes.**
   c. **Are there any additional deficiencies that have been identified in the current inspection?**

d. If yes, list the deficiencies and describe.

V. Dam Safety Orders:

- **List dam safety orders that have been issued to the dam owner pertaining to this dam.**

VI. Maintenance:

1. Indicate if there exists an operation and maintenance plan for the dam.
2. Indicate if it appears the dam is being maintained.

VII. Recommendations:

VIII. Other Comments or Observations:

IX. Updated Site Sketch with Photo Locations:

X. Updated Photos:

XI. Copy of Locus Map from Phase I Report:

XII. Other applicable attachment:

Laurie Gibeau

From: Caruso, Emily (DCR) <emily.caruso@state.ma.us>
Sent: Tuesday, March 3, 2020 10:12 AM
To: Laurie Gibeau
Cc: Jonathan Andrews; Louis M. Taverna
Subject: RE: Bulloughs Pond Dam, Newton

Hi Laurie.

That extension is no problem at all. Please let us know if you need anything else.

Emily

Emily Caruso
DAM SAFETY ENGINEER
OFFICE OF DAM SAFETY

dcr MASSACHUSETTS DEPARTMENT OF CONSERVATION AND RECREATION

180 BEAMAN STREET | WEST BOYLSTON, MA | 01583
PH: (508) 792-7716 EXT. 41827

Email: Emily.Caruso@mass.gov
Website: www.mass.gov/dcr

From: Laurie Gibeau [mailto:Laurie.Gibeau@gza.com]
Sent: Tuesday, March 03, 2020 10:01 AM
To: Caruso, Emily (DCR)
Cc: Jonathan Andrews; Louis M. Taverna
Subject: Bulloughs Pond Dam, Newton

Hi, Emily-

Thanks for taking the time to chat with me on the phone. I appreciate that you will be giving the City of Newton an extension to complete the Phase II for Bulloughs Pond Dam. Based on discussions with the City and preliminary results of our evaluations, we should be able to get the Phase II to you by the beginning of May.

Please let me know if you have any questions.

Laurie A. Gibeau, P.E. (MA, CT, NY)
Project Manager | Dams Engineering
GZA | 249 Vanderbilt Avenue | Norwood, MA 02062
o: 781.278.5848 | c: 413.530.7540 | laurie.gibeau@gza.com | www.gza.com | LinkedIn

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For information about GZA GeoEnvironmental, Inc. and its services, please visit our website at www.gza.com.

Appendix F
Soil Boring Logs

LEGEND

SOIL BORING BY NEW ENGLAND BORING CONTRACTORS AND OBSERVED BY GZA ON FEBRUARY 25 AND 26, 2020. GZA-1, GZ-2, AND GZ-3 SURVEYED BY CITY OF NEWTON. GZ-4 WAS LOCATED BASED ON LINE OF SIGHT TO EXISTING SITE FEATURES.

NO.	ISSUE/DESCRIPTION	BY	DATE

BULLOUGH'S POND DAM

NEWTON, MASSACHUSETTS

BORING LOCATION PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com

PREPARED FOR:

PROJ MGR: LAG	REVIEWED BY: JDA	CHECKED BY: PFS	FIGURE
DESIGNED BY: LAG	DRAWN BY: City of Newton	SCALE: N.T.S	F1
DATE: 04-01-2020	PROJECT NO. 01.0174021.00	REVISION NO.	

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

City of Newton DPW
Bulloughs Pond Dam Phase II
Dexter Road
Newton, Massachusetts

BORING NO.: GZ-1
SHEET: 1 of 1
PROJECT NO: 01.0174021.00
REVIEWED BY:

Drilling Co.: New England Boring Contractors
Foreman: Gary Twombley
Logged By: Cody Gibb

Type of Rig: Truck
Rig Model: CME 75
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 91.82
Final Boring Depth (ft.): 12
Date Start - Finish: 2/25/2019 - 2/25/2019

H. Datum: See Plan
V. Datum: NAVD88

Auger/Casing Type: HW
I.D/O.D.(in): 4"/4.5"
Hammer Weight (lb.): 300
Hammer Fall (in.): 24
Other: Safety Hammer

Sampler Type: Split Spoon
I.D./O.D. (in.): 1.375"/2"
Sampler Hmr Wt (lb): 140
Sampler Hmr Fall (in): 30
Other: Auto Hammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
Not	encountered.			

Depth (ft)	Casing Blows (ft/min)	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
									1		0.5	ASPHALT	91.3'
		S-1	1-3	24	12	21 10 9 7	19	S-1: (Top 6") Medium dense, brown to dark gray, fine to coarse SAND, some Gravel, little Silt.			2	ROAD SUBBASE	89.8'
		S-2	3-5	21	3	8 10 9 100/3"	19	S-1: (Bottom 6") Medium dense, brown, fine to coarse SAND, some Silt, little Gravel. S-2: Medium dense, reddish brown, GRAVEL, some fine to coarse Sand, little Silt.				EMBANKMENT FILL	
5									2		5		86.8'
	14.25 9.5 11.75 8.5 10.25	C-1	7-12	60	56			C-1: Reddish brown CONCRETE, fresh to slightly weathered, moderately spaced to close fractures	3			CONCRETE STRUCTURE [POSSIBLE CORE WALL]	
10											12		79.8'
								Bottom of boring at 12 feet.	4				
15													
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from topographic survey by the City of Newton dated October 2, 2019.
2. Casing refusal encountered at 5 feet below ground surface (bgs).
3. Rollerbit refusal encountered at 7 feet bgs.
4. Boring backfilled with grout and bentonite to 0.25 feet bgs. Backfilled with cement to ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-1

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

City of Newton DPW
Bulloughs Pond Dam Phase II
Dexter Road
Newton, Massachusetts

BORING NO.: GZ-2
SHEET: 1 of 1
PROJECT NO: 01.0174021.00
REVIEWED BY:

Drilling Co.: New England Boring Contractors
Foreman: Gary Twombley
Logged By: Cody Gibb

Type of Rig: Truck
Rig Model: CME 75
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 91.87
Final Boring Depth (ft.): 23
Date Start - Finish: 2/25/2019 - 2/25/2019

H. Datum: See Plan
V. Datum: NAVD88

Auger/Casing Type: HW
I.D/O.D.(in): 4"/4.5"
Hammer Weight (lb.): 300
Hammer Fall (in.): 24
Other: Safety Hammer

Sampler Type: Split Spoon
I.D./O.D. (in.): 1.375"/2"
Sampler Hmr Wt (lb): 140
Sampler Hmr Fall (in): 30
Other: Auto Hammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
2/25/19	0300	7		
2/26/19	0710	7.5		
2/26/19	1420	6.5		

Depth (ft)	Casing Blows (ft/min)	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
									1		0.5	ASPHALT	91.4'
									2				
5		S-1	5-7	24	6	5 4 6 5	10	S-1: Stiff, brown, fine to medium SAND and SILT & CLAY, little fine Gravel.					
		S-2	7-9	24	5	4 6 5 8	11	S-2: Stiff, brown, Clayey SILT, some fine to coarse Sand, little Gravel.				EMBANKMENT FILL	
10		S-3	9-11	24	0	7 4 2 2	6	S-3: No recovery.					
		S-4	11-13	24	0	3 3 6 3	9	S-4: No recovery. Gravel in split spoon.					
		S-5	13-14	14	4	1 4	R				14		77.9'
15	13.5 11.5 13.5 27.5	C-1	14-18	48	44	100/2"		C-1: Hard, slightly weathered, amorphous to medium grained, greenish gray, ARGILLITE, with very thin, moderately dipping foliation and smooth, planar, close to moderately close, subhorizontal jointing.	3				
20	12 9.25 10.75 11 9.5	C-2	18-23	60	48			C-2: Hard, slightly weathered, amorphous to medium grained, greenish gray, ARGILLITE, with very thin, moderately dipping foliation and smooth, planar, close to moderately close, subhorizontal jointing.	4			BEDROCK	
											23		68.9'
25								Bottom of boring at 23 feet.	5				
30													

REMARKS

1. Ground surface elevation estimated from topographic survey by the City of Newton dated October 2, 2019.
2. Blind drill from 0 to 5 feet below ground surface (bgs).
3. Casing refusal at 14 feet bgs. Rollerbit refusal encountered at 14 feet bgs.
4. Core barrel jammed at 18 feet bgs. Terminated core.
5. Boring converted to observation well at completion of drilling.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-2

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

City of Newton DPW
Bulloughs Pond Dam Phase II
Dexter Road
Newton, Massachusetts

BORING NO.: GZ-3
SHEET: 1 of 1
PROJECT NO: 01.0174021.00
REVIEWED BY:

Drilling Co.: New England Boring Contractors
Foreman: Gary Twombley
Logged By: Cody Gibb

Type of Rig: Truck
Rig Model: CME 75
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 92.2
Final Boring Depth (ft.): 11.5
Date Start - Finish: 2/26/2019 - 2/28/2019

H. Datum: See Plan
V. Datum: NAVD88

Auger/Casing Type: HW
I.D/O.D.(in): 4"/4.5"
Hammer Weight (lb.): 300
Hammer Fall (in.): 24
Other: Safety Hammer

Sampler Type: Split Spoon
I.D./O.D. (in.): 1.375"/2"
Sampler Hmr Wt (lb): 140
Sampler Hmr Fall (in): 30
Other: Auto Hammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
2/26/19	1420	7		

Depth (ft)	Casing Blows (ft/min)	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	11	3 2 6 6	8	S-1: Loose, dark brown, fine to coarse SAND, some Silt, little Gravel, moist.	1			TOPSOIL	
											2		90.2'
		S-2	2-4	24	12	10 4 3 3	7	S-2: Medium stiff, brown, fine to medium SAND and SILT, little fine Gravel, moist.	2				
5		S-3	4-6	24	12	7 4 3 3	7	S-3: Medium stiff, brown, fine to medium SAND and SILT, little fine Gravel.					
		S-4	6-8	24	10	6 6 13 11	19	S-4: Very stiff, brown, fine to medium SAND and SILT, little fine Gravel.				EMBANKMENT FILL	
		S-5	8-10	24	5	15 7 3 2	10	S-5: Stiff, brown, fine to medium SAND and SILT, some fine to coarse Gravel.					
10		S-6	10-11.5	11	8	24 100/5"	R	S-6: (Top 5") Brown, fine to medium SAND, some Silt, little coarse Gravel.	3		10.5		81.7'
											11.5	FINE GRAINED FOUNDATION SOIL	80.7'
								S-6: (Bottom 3") Gray, SILT, little fine Sand, trace Gravel.	4				
								Bottom of boring at 11.5 feet.	5				
15													
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from topographic survey by the City of Newton dated October 2, 2019.
2. Color change from dark brown to brown was observed in wash return at 2 feet below ground surface (bgs).
3. Casing encountered refusal at 10.5 feet bgs.
4. Rollerbit encountered refusal at 11.5 feet bgs.
5. Boring was converted to observation well at completion of drilling.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-3

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

City of Newton DPW
Bulloughs Pond Dam Phase II
Dexter Road
Newton, Massachusetts

BORING NO.: GZ-4
SHEET: 1 of 1
PROJECT NO: 01.0174021.00
REVIEWED BY:

Drilling Co.: New England Boring Contractors
Foreman: Gary Twombley
Logged By: Cody Gibb

Type of Rig: Truck
Rig Model: CME 75
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 91.8
Final Boring Depth (ft.): 13
Date Start - Finish: 2/26/2019 - 2/26/2019

H. Datum: See Plan
V. Datum: NAVD88

Auger/Casing Type: HW
I.D/O.D.(in): 4"/4.5"
Hammer Weight (lb.): 300
Hammer Fall (in.): 24
Other: Safety Hammer

Sampler Type: Split Spoon
I.D./O.D. (in.): 1.375"/2"
Sampler Hmr Wt (lb): 140
Sampler Hmr Fall (in): 30
Other: Auto Hammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
2/26/19	1330	6		

Depth (ft)	Casing Blows (ft/min)	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
									1		0.5	ASPHALT	91.3'
									2				
									3				
5												EMBANKMENT FILL	
		S-1	7-9	24	3	23 16 12 19	28	S-1: Very stiff, brown, SILT, some fine to coarse Sand, little Gravel.					
		S-2	9-11	24	3	45 22 8 9	30	S-2: Medium dense, brown, fine to coarse SAND, some Gravel, trace Silt. (Gravel stuck in spoon tip.)					
10											11		80.8'
		S-3	11-13	24	6	10 6 3 2	9	S-3: Loose, brown, fine to medium SAND, some fine to coarse Gravel, little Sand.				FINE GRAINED FOUNDATION SOIL	
											13		78.8'
								Bottom of boring at 13 feet.	4 5				
15													
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from topographic survey by the City of Newton dated October 2, 2019.
2. Probe from 0 to 6 feet below ground surface (bgs).
3. Blind drill from 0 to 7 feet bgs.
4. Casing and rollerbit encountered refusal at 13 feet bgs.
5. Boring backfilled with bentonite grout to 0.25 feet bgs. Backfilled with cement to ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-4

Appendix G
Geotechnical Laboratory Test Results

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

Client Information:
GZA GeoEnvironmental
Norwood, MA
PM: Lauries Gibeau
Assigned By: Cody Gibb
Collected By: Cody Gibb

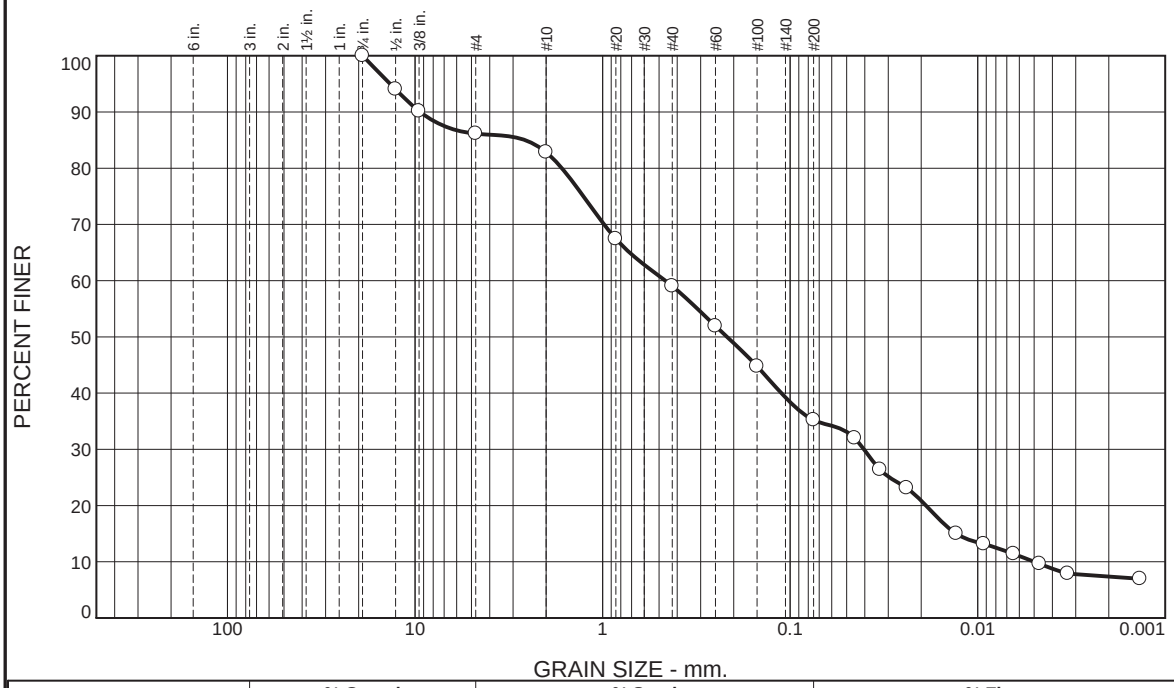
Project Information:
Bulloughs Pond Dam Phase II
Newton, Massachusetts
GZA Project Number: 01.0174021.00
Summary Page: 1 of 1
Report Date: 03.13.19

LABORATORY TESTING DATA SHEET

Boring	Sample No.	Depth (ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	Thermal Resistivity @ 1.5% Moisture (°C*cm/W)	Thermal Resistivity @ Optimum Moisture (°C*cm/W)	Thermal Resistivity Oven Dried (°C*cm/W)	
				D2216	D4318		D6913			D2874	D854			D1557			D5334			
GZ-2	S-1	5-7	S-1				13.9	50.9	35.2											Brown f-m SAND and SILT & CLAY, little fine Gravel
GZ-3	S-3	4-6	S-2				12.0	54.8	33.2											Brown f-m SAND and SILT, little fine Gravel
GZ-3	S-5	8-10	S-3				25.0	42.5	32.5											Brown f-m SAND and SILT, some f-c Gravel
GZ-3	S-6A	10-11	S-4				12.3	58.3	29.4											Brown f-m SAND, some Silt, little coarse Gravel
GZ-4	S-3	11-13	S-5				34.8	50.8	14.4											Brown f-m SAND, some f-c Gravel, little Silt

Date Received *03.06.19* Reviewed By: Date Reviewed: *03.13.2019*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	13.9	3.2	23.9	23.8	27.8	7.4

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	94.0		
0.375"	90.2		
#4	86.1		
#10	82.9		
#20	67.4		
#40	59.0		
#60	51.9		
#100	44.8		
#200	35.2		
0.0453 mm.	32.0		
0.0332 mm.	26.4		
0.0239 mm.	23.1		
0.0130 mm.	15.0		
0.0093 mm.	13.2		
0.0064 mm.	11.4		
0.0047 mm.	9.6		
0.0033 mm.	7.9		
0.0014 mm.	7.0		

* (no specification provided)

Material Description

Brown f-m SAND and SILT & CLAY, little fine Gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= SC **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 9.3954 D_{85}= 2.5904 D_{60}= 0.4628
D_{50}= 0.2169 D_{30}= 0.0404 D_{15}= 0.0130
D_{10}= 0.0050 C_u= 92.65 C_c= 0.71

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 03.06.19 **Date Tested:** 03.13.19

Tested By: RR / MN

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Borings **Depth:** 5-7' **Date Sampled:**
Sample Number: GZ-2 / S-1

Thielsch Engineering Inc.

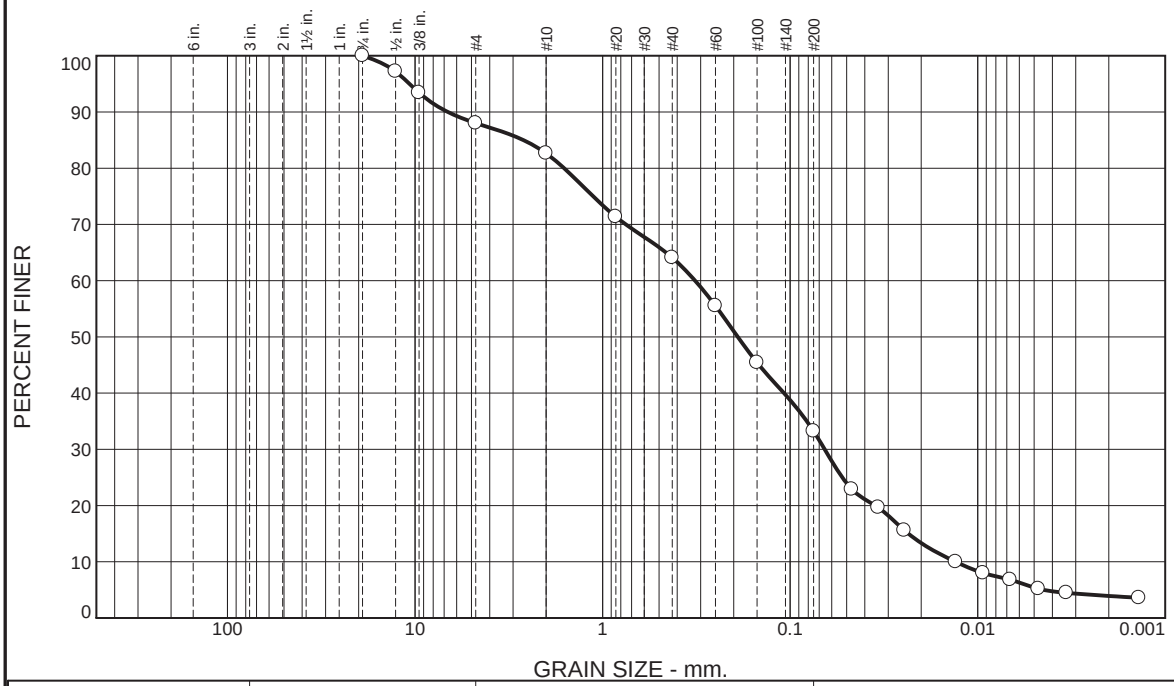
Cranston, RI

Client: GZA GeoEnvironmental

Project: Bulloughs Pond Dam Phase II
Newton, Massachusetts

Project No: 01.0174021.00 **Figure** S-1

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	12.0	5.4	18.5	30.9	29.3	3.9

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	97.2		
0.375"	93.4		
#4	88.0		
#10	82.6		
#20	71.4		
#40	64.1		
#60	55.5		
#100	45.4		
#200	33.2		
0.0469 mm.	22.9		
0.0339 mm.	19.6		
0.0246 mm.	15.6		
0.0131 mm.	10.0		
0.0094 mm.	8.0		
0.0067 mm.	6.8		
0.0047 mm.	5.2		
0.0034 mm.	4.5		
0.0014 mm.	3.6		

* (no specification provided)

Material Description

Brown f-m SAND and SILT, little fine Gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 6.6874 D_{85}= 2.6419 D_{60}= 0.3210
D_{50}= 0.1901 D_{30}= 0.0654 D_{15}= 0.0234
D_{10}= 0.0131 C_u= 24.52 C_c= 1.02

Remarks

Sample visually classified as non-plastic.

Date Received: 3.06.19 **Date Tested:** 3.13.19

Tested By: RR / MN

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Borings **Depth:** 4-6' **Date Sampled:**
Sample Number: GZ-3 / S-3

Thielsch Engineering Inc.

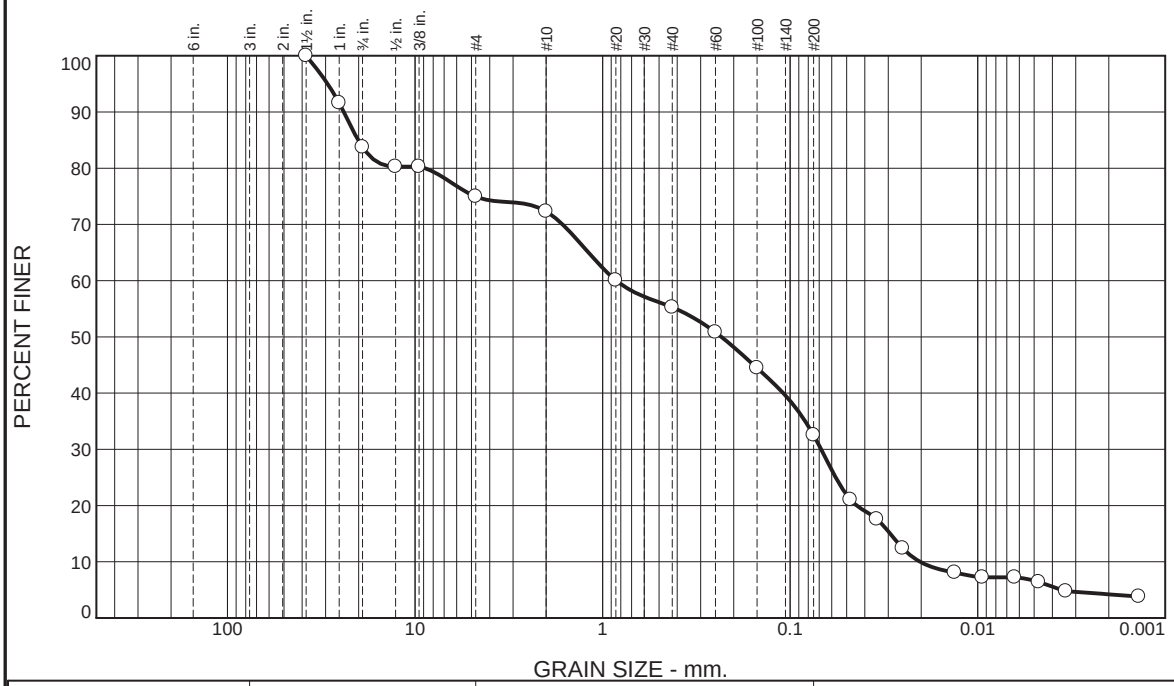
Cranston, RI

Client: GZA GeoEnvironmental

Project: Bulloughs Pond Dam Phase II
Newton, Massachusetts

Project No: 01.0174021.00 **Figure** S-2

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.3	8.7	2.7	17.0	22.8	28.3	4.2

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	91.6		
3/4"	83.7		
1/2"	80.3		
3/8"	80.3		
#4	75.0		
#10	72.3		
#20	60.1		
#40	55.3		
#60	50.8		
#100	44.5		
#200	32.5		
0.0478 mm.	21.0		
0.0345 mm.	17.6		
0.0251 mm.	12.4		
0.0133 mm.	8.1		
0.0094 mm.	7.2		
0.0064 mm.	7.2		
0.0047 mm.	6.4		
0.0034 mm.	4.8		
0.0014 mm.	3.8		

* (no specification provided)

Material Description

Brown f-m SAND and SILT & CLAY, some f-c Gravel

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= SC **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 23.9757 D_{85}= 20.1028 D_{60}= 0.8450
D_{50}= 0.2325 D_{30}= 0.0683 D_{15}= 0.0293
D_{10}= 0.0203 C_u= 41.58 C_c= 0.27

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 03.06.19 **Date Tested:** 3.13.19

Tested By: RR / MN

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Borings **Depth:** 8-10' **Date Sampled:**
Sample Number: GZ-3 / S-5

Thielsch Engineering Inc.

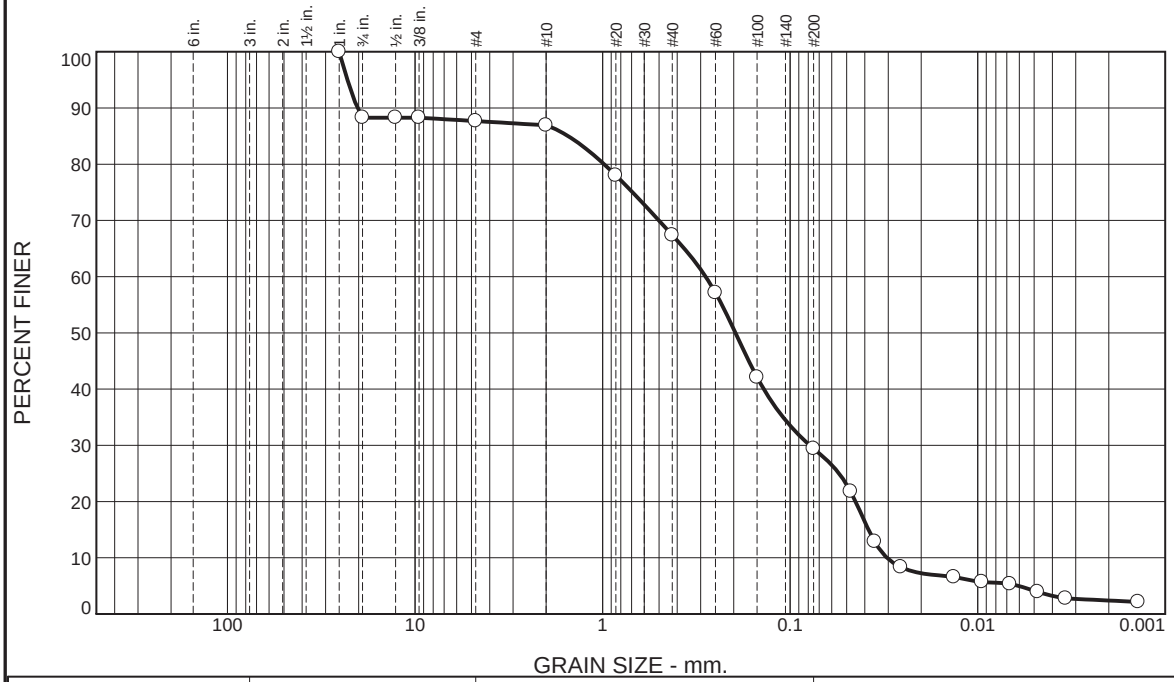
Cranston, RI

Client: GZA GeoEnvironmental

Project: Bulloughs Pond Dam Phase II
Newton, Massachusetts

Project No: 01.0174021.00 **Figure** S-3

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.7	0.6	0.8	19.5	38.0	27.0	2.4

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
0.75"	88.3		
0.5"	88.3		
0.375"	88.3		
#4	87.7		
#10	86.9		
#20	78.0		
#40	67.4		
#60	57.1		
#100	42.1		
#200	29.4		
0.0476 mm.	21.8		
0.0354 mm.	12.9		
0.0257 mm.	8.4		
0.0134 mm.	6.6		
0.0095 mm.	5.7		
0.0067 mm.	5.3		
0.0048 mm.	3.9		
0.0034 mm.	2.8		
0.0014 mm.	2.2		

* (no specification provided)

Material Description

Brown f-m SAND, some Silt, little coarse Gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 20.2671 D_{85}= 1.5249 D_{60}= 0.2819
D_{50}= 0.1956 D_{30}= 0.0786 D_{15}= 0.0383
D_{10}= 0.0305 C_u= 9.25 C_c= 0.72

Remarks

Sample visually classified as non-plastic.

Date Received: 3.06.19 **Date Tested:** 03.13.19

Tested By: RR / MN

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Borings **Depth:** 10-11' **Date Sampled:**
Sample Number: GZ-3 / S-6A

Thielsch Engineering Inc.

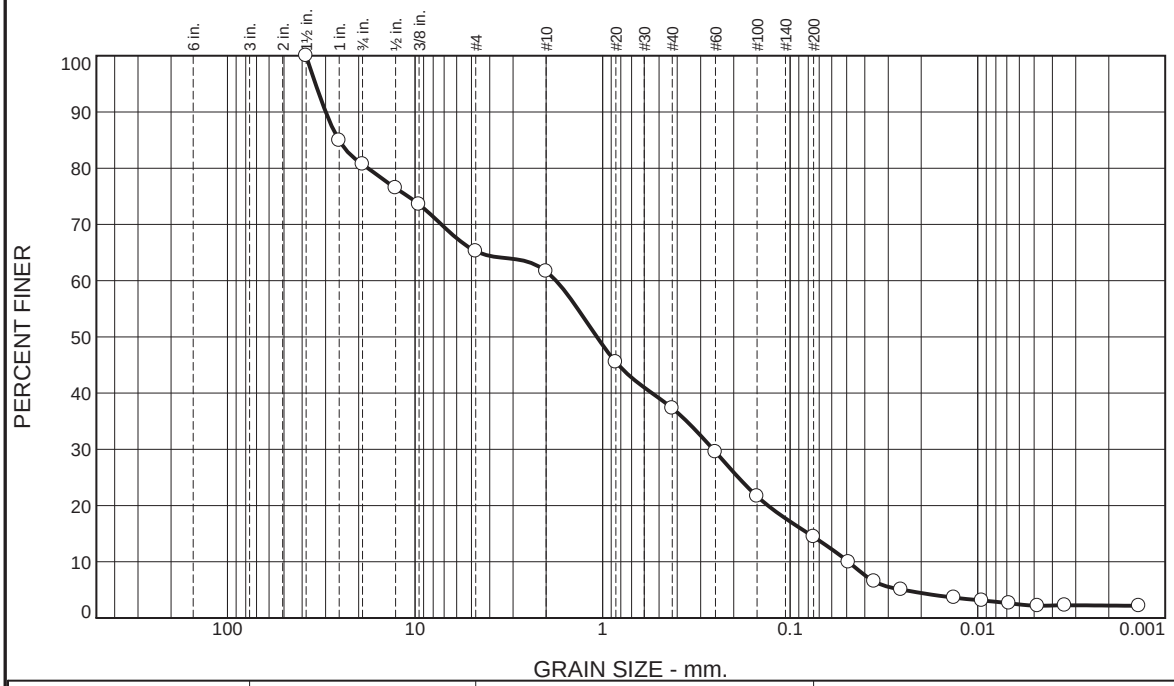
Cranston, RI

Client: GZA GeoEnvironmental

Project: Bulloughs Pond Dam Phase II
Newton, Massachusetts

Project No: 01.0174021.00 **Figure** S-4

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.3	15.5	3.5	24.4	22.9	12.2	2.2

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	84.9		
3/4"	80.7		
1/2"	76.5		
3/8"	73.6		
#4	65.2		
#10	61.7		
#20	45.5		
#40	37.3		
#60	29.5		
#100	21.6		
#200	14.4		
0.0488 mm.	9.9		
0.0357 mm.	6.5		
0.0256 mm.	5.1		
0.0134 mm.	3.6		
0.0095 mm.	3.1		
0.0068 mm.	2.6		
0.0048 mm.	2.2		
0.0034 mm.	2.3		
0.0014 mm.	2.2		

* (no specification provided)

Material Description

Brown f-m SAND, some f-c Gravel, little Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 29.9246 D_{85}= 25.4671 D_{60}= 1.7706
D_{50}= 1.0736 D_{30}= 0.2572 D_{15}= 0.0796
D_{10}= 0.0490 C_u= 36.14 C_c= 0.76

Remarks

Date Received: 3.06.19 **Date Tested:** 3.13.19

Tested By: RR / MN

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Borings **Depth:** 11-13' **Date Sampled:**
Sample Number: GZ-4 / S-3

Thielsch Engineering Inc.

Cranston, RI

Client: GZA GeoEnvironmental

Project: Bulloughs Pond Dam Phase II
Newton, Massachusetts

Project No: 01.0174021.00 **Figure** S-5

Appendix H
Hydrologic & Hydraulic Analyses – Existing Conditions

Project Name: Bullough's Pond Dam Phase II H&H Analysis

Project Number: 01.0174021.00

File Name: HMS_Tc_CN_Calculations

Data Source: Tc lines drawn using USGS topo maps (1:24k scale), elevation data (contours and LiDAR) from MassGIS, and aerial photography downloaded form MassGIS

Date: 3/10/2020

Purpose: To calculate Tc and lag times for subbasins within the study area, as well as curve numbers for subbasins within study area

Notes:

Performed By: Daniel McGraw, E.I.T

Reviewed By: Christine E. Suhonen, P.E.

Review Date: 1/14/2020

Updates:

Date	Action/Comment	Performed by?	Check required?	Checked by	Checked date
4/2/2020	Original calculations	DEM			
11/15/2019	Updates to calculations	DEM	X	CES	1/14/2020
1/14/2020	Checked by Christine Suhonen				
1/15/2020	Updates to Christine Suhonen's comments	DEM			

Time of Concentration/Lag Time Calculations[1]

	Sheet flow (Eq. 15-8):								Shallow concentrated flow (Table 15-3)[5]:								Open Channel / Piped / Open Water Flow (Eq. 15-10 or Eq. 15-11)[6,6b]												TC	
Subwatershed	Len.[2] ft	Elev. Up ft	Elev. Down ft	Slope ft/ft	Surface Description	'n'[3]	P2[4] in	Travel Time hrs	Len. ft	Elev. Up ft	Elev. Down ft	Slope ft/ft	Surface Description	'n'	Vel. ft/s	Travel Time hrs	Len. ft	Elev. Up ft	Elev. Down ft	Slope ft/ft	Flow Type	Description	'n'	Dep. ft	Width ft	Vel. ft/s	Travel Time hrs	hrs	min
Bulloughs Dam	52.9	159.3	159.2	0.003	Smooth Surfaces	0.011	3.30	0.026	190	159.2	158.2	0.005	Paved	0.025	1.46	0.036	722	158.2	150.3	0.011	Piped Flow	Corrugated Metal Pipe	0.024	1	1	2.00	0.10	0.16	9.8
																	211	150.3	148.3	0.009	Piped Flow	Corrugated Metal Pipe	0.024	2	2	2.00	0.03	0.03	1.8
																	736	148.3	142.6	0.008	Piped Flow	Corrugated Metal Pipe	0.024	2	2	2.00	0.10	0.10	6.1
																	1029	142.6	85.8	0.055	Piped Flow	Corrugated Metal Pipe	0.024	2	2	2.00	0.14	0.14	8.6
Newton Centre Playground	74.6	166.4	164.8	0.021	Woods Light Underbrush	0.400	3.30	0.273	650	164.8	143.5	0.033	Short grass	0.073	1.26	0.143	1352	143.5	113.7	0.022	Piped Flow	Corrugated Metal Pipe	0.024	2	2	2.00	0.19	0.60	36.2
																	2162	113.7	88.9	0.011	Open Channel	Main Channel Straight Some Stones	0.035	5	11	2.00	0.30	0.30	18.0
Below Hammond	62.5	211.3	207.6	0.059	Prairie Grass Short	0.150	3.30	0.071	1345	207.6	173.8	0.025	Short grass	0.073	1.10	0.339	6064	165.8	120.6	0.007	Open Channel	Main Channel Straight Some Stones	0.035	4	8	2.00	0.84	1.25	75.1
									864	173.8	165.8	0.009	Paved	0.025	1.96	0.123	900	120.6	115.1	0.006	Open Channel	Main Channel Straight Some Stones	0.035	2	6	2.00	0.13	0.25	14.9
Commonwealth	74.8	220.4	217.0	0.045	Prairie Grass Short	0.150	3.30	0.092	1365	217.0	192.6	0.018	Paved	0.025	2.72	0.140	1524	192.6	154.9	0.025	Piped Flow	Corrugated Metal Pipe	0.024	2	2	2.00	0.21	0.44	26.6
																	1104	154.9	140.4	0.013	Piped Flow	Corrugated Metal Pipe	0.024	3	3	2.00	0.15	0.15	9.2
																	1655	140.4	124.8	0.009	Open Channel	Main Channel Straight Some Stones	0.035	3	6	2.00	0.23	0.23	13.8
																	721	124.8	114.3	0.015	Open Channel	Main Channel Straight Some Stones	0.035	3	6	2.00	0.10	0.10	6.0
Newton Cemetery	56.8	153.2	152.8	0.007	Prairie Grass Short	0.150	3.30	0.155	1611.6	152.8	134.0	0.012	Paved	0.025	2.20	0.204	2435.0	101.6	99.4	0.001	Open Channel	Main Channel Weeds/Stones	0.050	5	12	1.75	0.39	0.75	44.7
									1556.2	134.0	101.6	0.021	Short grass	0.073	1.00	0.430	2341.1	106.8	102.8	0.002	Open Channel	Main Channel Straight Some Stones	0.035	5	7	2.00	0.33	0.76	45.3
																	891.47	102.8	97.11	0.005	Open Channel	Main Channel Straight Some Stones	0.035	5	7	2.00	0.12	0.12	7.4
																	1451.4	97.1	89.1	0.006	Open Channel	Main Channel Straight Some Stones	0.035	5	7	2.00	0.20	0.20	12.1
Hammond Pond	76.2	188.6	184.6	0.053	Prairie Grass Short	0.150	3.30	0.087	1530.7	184.6	164.5	0.013	Paved	0.025	2.33	0.183	929.4	164.5	164.5	0.000	Body of Water	Main Channel Straight Some Stones	0.035	2	4	2.00	0.13	0.40	24.0
																	2175.0	164.5	163.4	0.001	Open Channel	Main Channel Sluggish Reach	0.070	4	15	0.91	0.67	0.67	40.0
HammondPond to Park1																	3378	163.4	137.4	0.008	Open Channel	Main Channel Sluggish Reach	0.070	2	10	2.00	0.47	0.47	28.2
HammondPond to Park2																	3469	137.4	114.5	0.007	Open Channel	Main Channel Straight Some Stones	0.035	2	8	2.00	0.48	0.48	28.9
Combined Park to City Hall																	3587	114.5	88.8	0.007	Open Channel	Main Channel Straight Some Stones	0.035	4	10	2.00	0.50	0.50	29.9
City Hall to Bullough's																	373	88.5	87.9	0.002	Open Channel	Main Channel Straight Some Stones	0.035	2	6	2.00	0.05	0.05	3.1

	TC		Lag
Subwatershed	hrs	min	min
Bulloughs Dam	0.44	26	16
Newton Centre Playground	0.90	54	33
Below Hammond	1.50	90	54
Commonwealth	0.93	56	33
Newton Cemetery	1.83	110	66
Hammond Pond	1.07	64	38

[1] Travel time was determined using the Nation Engineering Handbook (NEH) Section 630.1502 Methods for estimating time of concentration l(b) Velocity Method
[2] Maximum sheet flow length guidance outlined in Eq. 15-9 and in Table 15-2
[3] Manning's roughness from Table 15-1 - Manning's roughness coefficients for sheet flow (flow depth generally ≤ 0.1 ft)
[4] P2 is the 2-year, 24-hour rainfall in inches obtained using the NOAA Atlas 14.
[5] Travel time for shallow concentrated flow calculated using Figure 15-4 / Table 15-3 from NEH-630.1502 (USDA NRCS, May 2010).
[6] Travel time for open channel flow was calculated assuming rectangular channel shape and assumed channel dimensions
[6-b] Channel depth and width estimated based on bankful dimensions as estimated using Stream Stats (or regression estimates)

				Unconnected Impervious Areas CN					Connected Impervious Areas CN	
Row Labels	Sum of CN*Area	Sum of Area_ac	Sum of Imperv Area	% Imperv	Pervious	Composite[1]	R	tial Abstract[2]	Composite[1]	Initial Abstract[2]
NewtonCentrePark	10655.5	140.91	78.1	55.4%	76	85	0.5	0.353	88	0.273
Below Hammond	36948.1	512.24	170.4	33.3%	72	78	0.5	0.564	81	0.469
Bulloughs Pond Dam	8519.8	116.25	57.1	49.1%	73	82	0.5	0.439	85	0.353
Commonwealth Ave	17036.7	213.44	123.3	57.8%	80	88	0.5	0.273	90	0.222
Newton Cemetery/Cold Spring Park	51529.5	780.48	266.7	34.2%	66	74	0.5	0.703	77	0.597
Hammond Pond	15566.1	204.42	68.1	33.3%	76	81	0.5	0.469	83	0.410
(blank)				#DIV/0!	#DIV/0!	#DIV/0!	0.5	#DIV/0!	#DIV/0!	#DIV/0!
Grand Total	**140255.8**	**1967.75**	**763.6**							

Row Labels	Sum of Area_ac
Below Hammond	512.24
Bulloughs Pond Dam	116.25
Commonwealth Ave	213.44
Hammond Pond	204.42
Newton Cemetery/Cold Spring Park	780.48
NewtonCentrePark	140.91
(blank)	
Grand Total	**1967.75**

Row Labels	Sum of Area_ac
3	309.42
4	10.17
6	4.36
7	37.12
11	585.07
12	440.34
13	53.02
15	98.18
16	1.87
17	0.13
20	33.16
31	67.62
37	57.87
38	13.37
10	146.18
18	14.01
34	95.66
26	0.20
(blank)	
Grand Total	**1967.75**

(2) Unconnected impervious areas

If runoff from impervious areas occurs over a pervious area as sheet flow prior to entering the drainage system, the impervious area is unconnected. To determine CN when all or part of the impervious area is not directly connected to the drainage system:

- use equation 9–2 or figure 9–4 if the total impervious area is less than 30 percent of the total area or
- use equation 9–2 or figure 9–3 if the total impervious area is equal to or greater than 30 percent of the total area, because the absorptive capacity of the remaining pervious areas will not significantly affect runoff.

$$CN_c = CN_p + \left(\frac{P_{imp}}{100}\right)(98 - CN_p)(1 - .5R) \quad (9\text{–}2)$$

where:

CN_c = composite runoff curve number
CN_p = pervious runoff curve number
P_{imp} = percent imperviousness
R = ratio of unconnected impervious area to total impervious area

When impervious area is less than 30 percent, obtain the composite CN by entering the right half of figure 9–4 with the percentage of total impervious area and the ratio of total unconnected impervious area to total impervious area. Then move left to the appropriate pervious CN and read down to find the composite CN.

Note: The equation incorrectly indicates 0.05R, whereas it should be 0.5R (see example problem and chart)

(1) Connected impervious areas

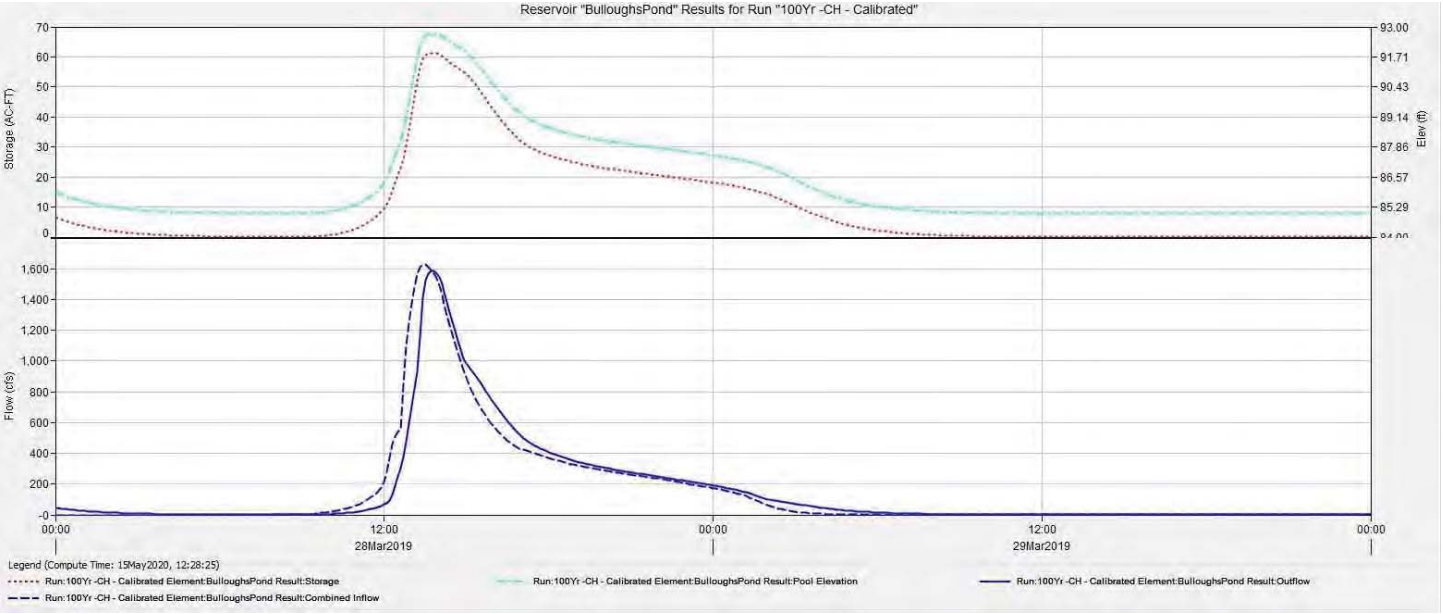
An impervious area is considered connected if runoff from it flows directly into the drainage system. It is also considered connected if runoff from it occurs as shallow concentrated flow that runs over a pervious area and then into a drainage system.

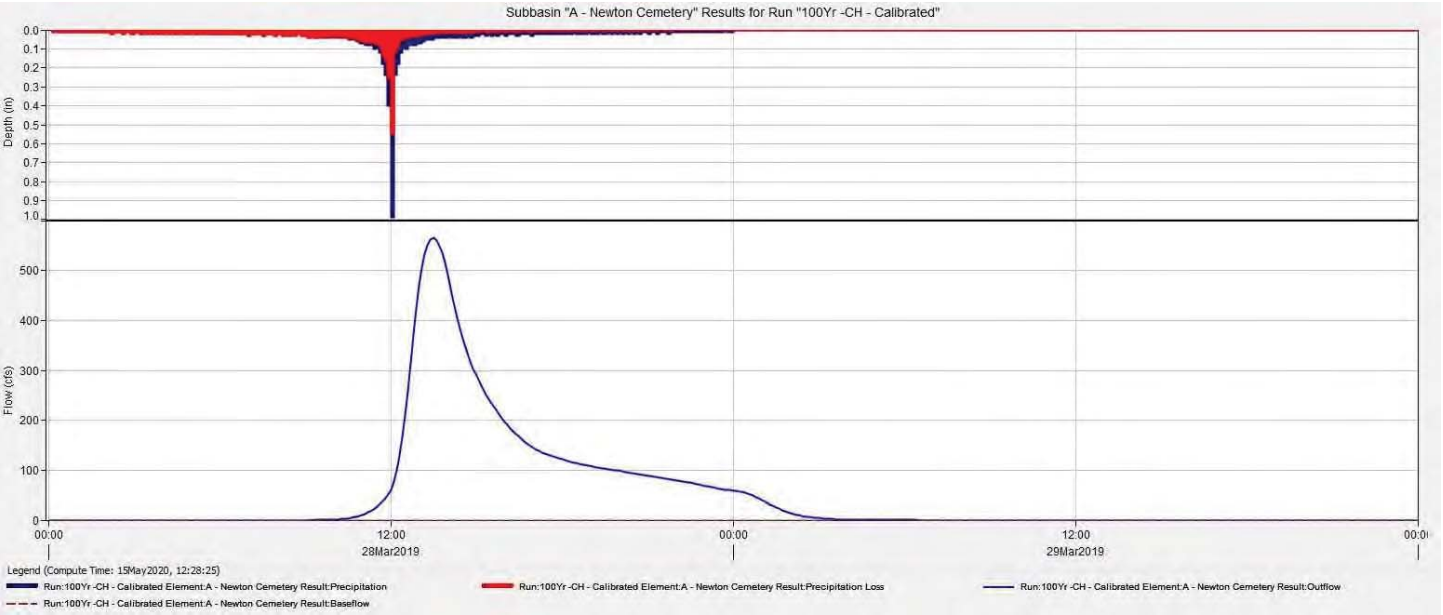
If all of the impervious area is directly connected to the drainage system, but the impervious area percentages in table 9–5 or the pervious land use assumptions are not applicable, use equation 9–1 or figure 9–3 to compute a composite CN.

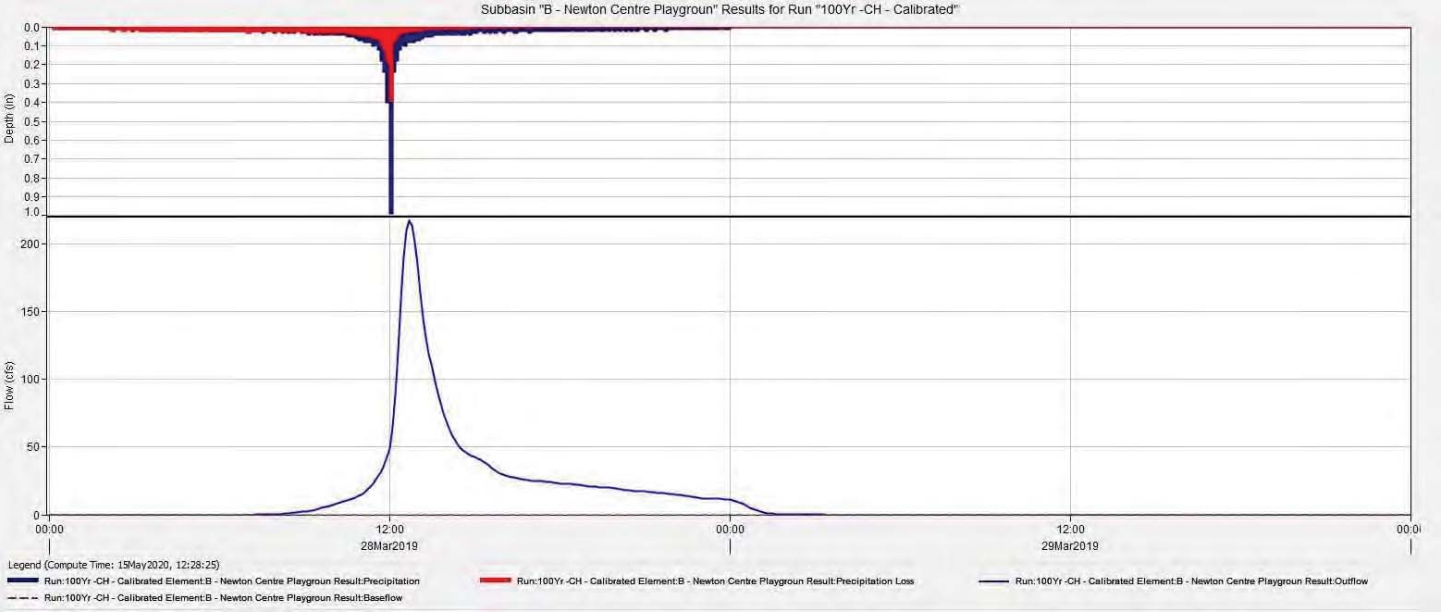
$$CN_c = CN_p + \left(\frac{P_{imp}}{100}\right)(98 - CN_p) \quad (9\text{–}1)$$

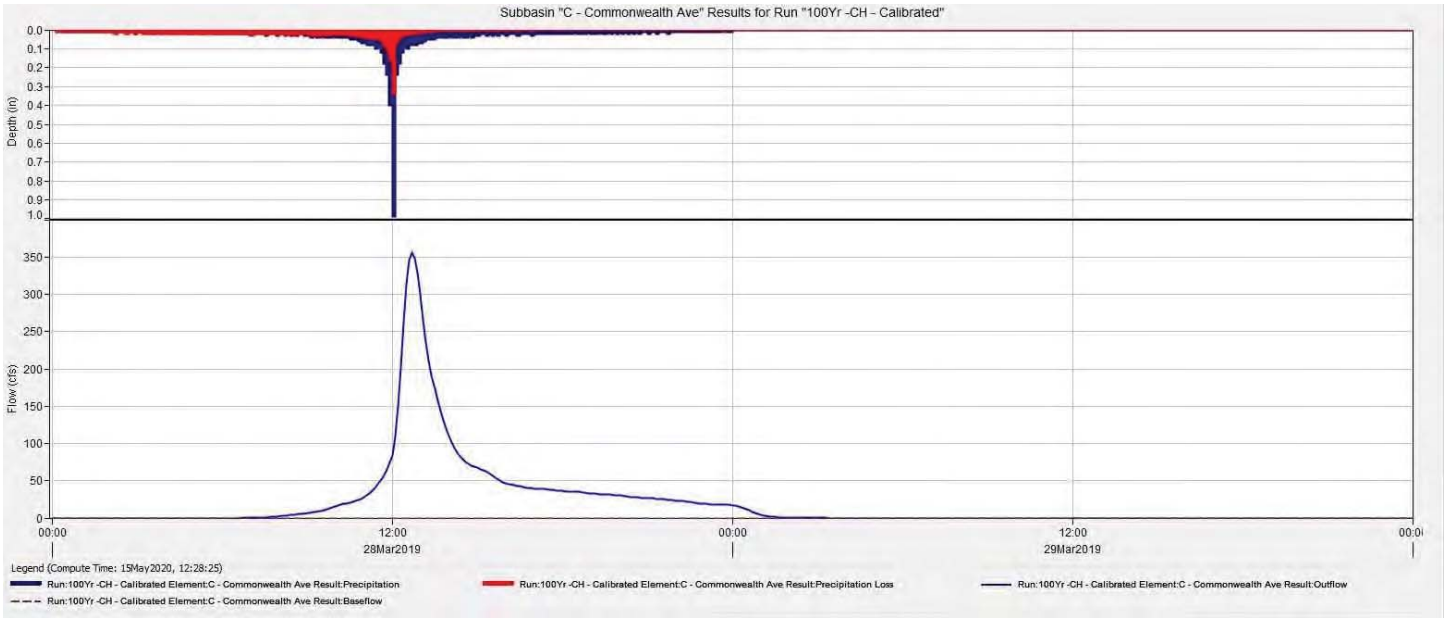
where:

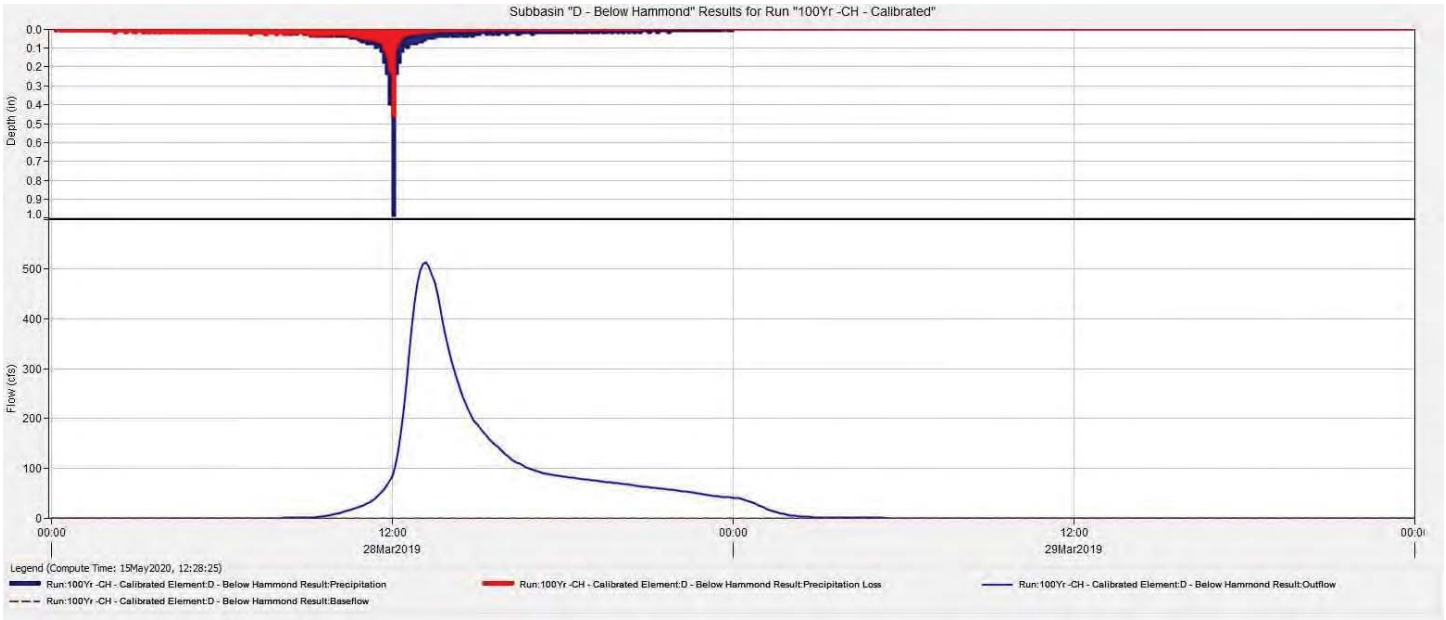
CN_c = composite runoff curve number
CN_p = pervious runoff curve number
P_{imp} = percent imperviousness

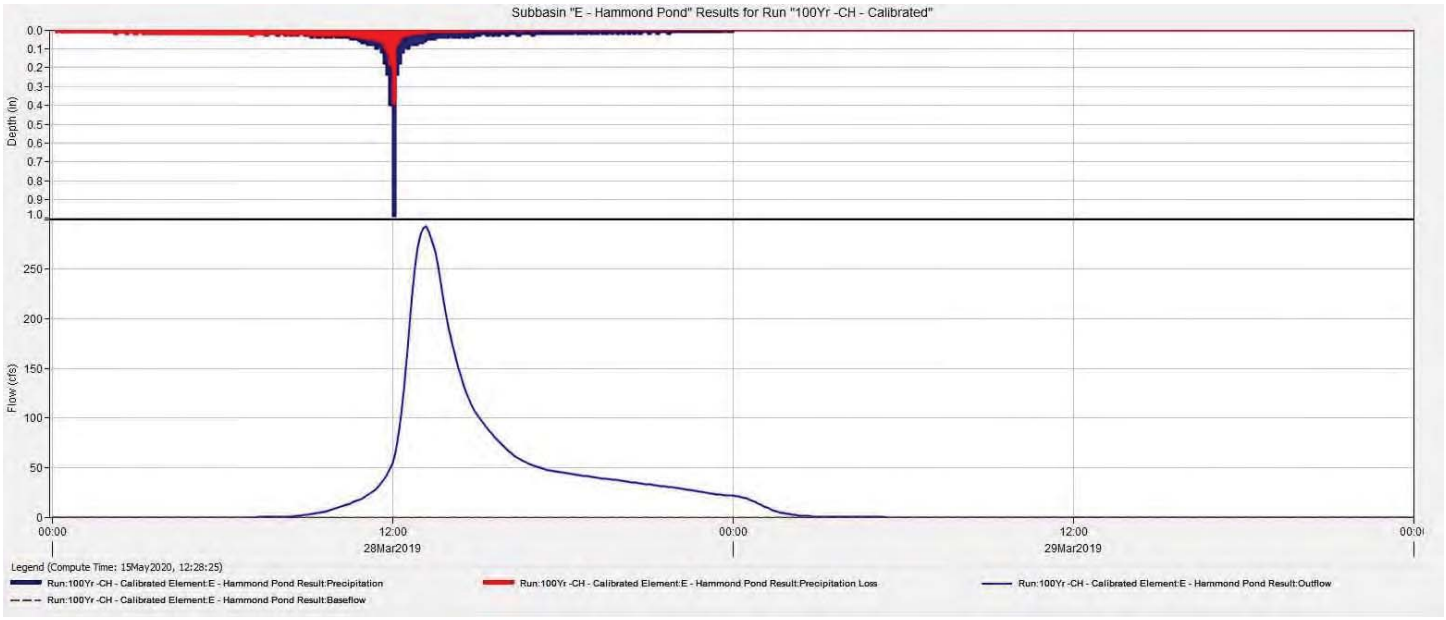

Reservoir "BulloughsPond" Results for Run "100Yr -CH - Calibrated"
Storage (AC-FT)
Elev (ft)
Flow (cfs)
28Mar2019
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:BulloughsPond Result:Storage
Run:100Yr -CH - Calibrated Element:BulloughsPond Result:Pool Elevation
Run:100Yr -CH - Calibrated Element:BulloughsPond Result:Outflow
Run:100Yr -CH - Calibrated Element:BulloughsPond Result:Combined Inflow

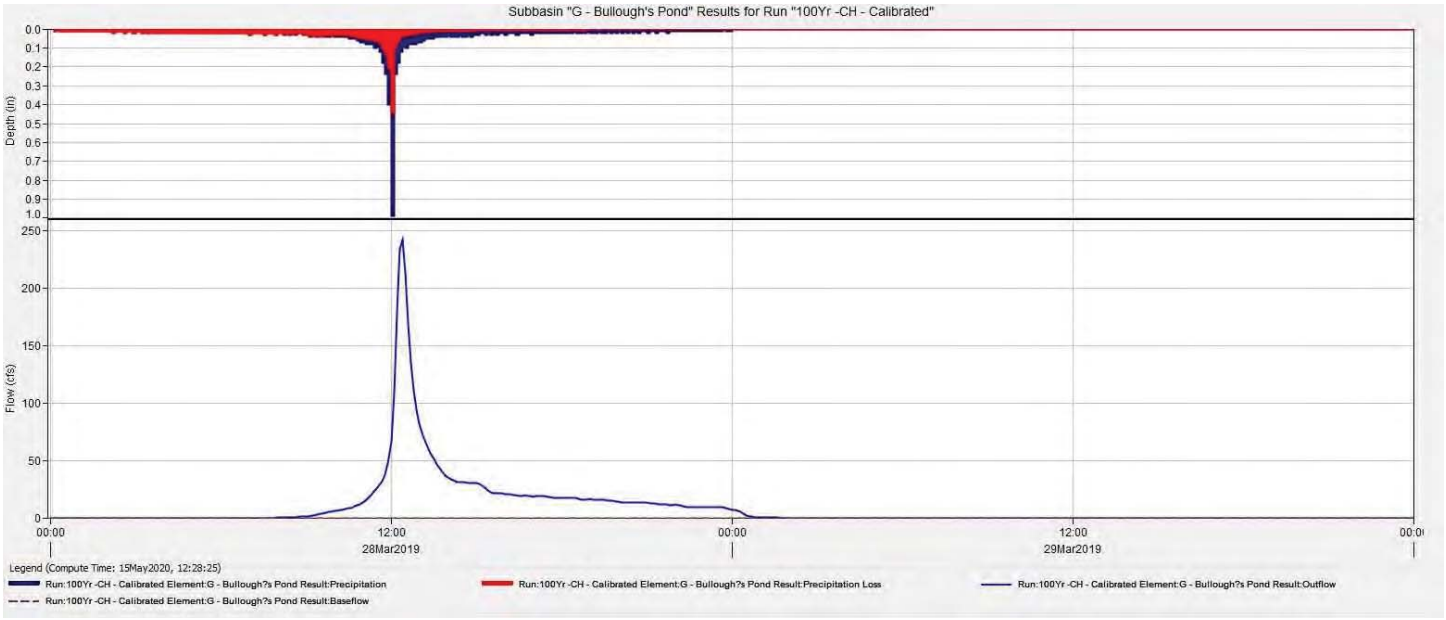

Subbasin "A - Newton Cemetery" Results for Run "100Yr -CH - Calibrated"
Depth (in)
Flow (cfs)
28Mar2019
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:A - Newton Cemetery Result:Precipitation
Run:100Yr -CH - Calibrated Element:A - Newton Cemetery Result:Precipitation Loss
Run:100Yr -CH - Calibrated Element:A - Newton Cemetery Result:Outflow
Run:100Yr -CH - Calibrated Element:A - Newton Cemetery Result:Baseflow


Subbasin "B - Newton Centre Playgroun" Results for Run "100Yr -CH - Calibrated"
Depth (in)
Flow (cfs)
28Mar2019
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:B - Newton Centre Playgroun Result:Precipitation
Run:100Yr -CH - Calibrated Element:B - Newton Centre Playgroun Result:Precipitation Loss
Run:100Yr -CH - Calibrated Element:B - Newton Centre Playgroun Result:Outflow
Run:100Yr -CH - Calibrated Element:B - Newton Centre Playgroun Result:Baseflow


Subbasin "C - Commonwealth Ave" Results for Run "100Yr -CH - Calibrated"
Depth (in)
Flow (cfs)
00:00
12:00
28Mar2019
00:00
12:00
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:C - Commonwealth Ave Result:Precipitation
Run:100Yr -CH - Calibrated Element:C - Commonwealth Ave Result:Precipitation Loss
Run:100Yr -CH - Calibrated Element:C - Commonwealth Ave Result:Outflow
Run:100Yr -CH - Calibrated Element:C - Commonwealth Ave Result:Baseflow


Subbasin "D - Below Hammond" Results for Run "100Yr -CH - Calibrated"
Depth (in)
Flow (cfs)
00:00
12:00
28Mar2019
00:00
12:00
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:D - Below Hammond Result:Precipitation
Run:100Yr -CH - Calibrated Element:D - Below Hammond Result:Precipitation Loss
Run:100Yr -CH - Calibrated Element:D - Below Hammond Result:Outflow
Run:100Yr -CH - Calibrated Element:D - Below Hammond Result:Baseflow


Subbasin "E - Hammond Pond" Results for Run "100Yr -CH - Calibrated"
Depth (in)
Flow (cfs)
00:00
12:00
28Mar2019
00:00
12:00
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:E - Hammond Pond Result:Precipitation
Run:100Yr -CH - Calibrated Element:E - Hammond Pond Result:Precipitation Loss
Run:100Yr -CH - Calibrated Element:E - Hammond Pond Result:Outflow
Run:100Yr -CH - Calibrated Element:E - Hammond Pond Result:Baseflow


Subbasin "G - Bullough's Pond" Results for Run "100Yr -CH - Calibrated"
Depth (in)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Flow (cfs)
250
200
150
100
50
0
00:00
12:00
28Mar2019
00:00
12:00
29Mar2019
Legend (Compute Time: 15May2020, 12:28:25)
Run:100Yr -CH - Calibrated Element:G - Bullough?s Pond Result:Precipitation
Run:100Yr -CH - Calibrated Element:G - Bullough?s Pond Result:Precipitation Loss
Run:100Yr -CH - Calibrated Element:G - Bullough?s Pond Result:Outflow
Run:100Yr -CH - Calibrated Element:G - Bullough?s Pond Result:Baseflow

Appendix I
Seepage and Stability Analyses

GZA
GeoEnvironmental, Inc.
249 Vanderbilt Ave
Norwood, MA 02062
781-278-3700
FAX 781-278-5701
http://www.gza.com

Engineers and Scientists

JOB	01.0174021.00 Bulloughs Pond Dam		
SHEET NO.	1	**OF**	2
CALCULATED BY	CMG/MFJ	**DATE**	9/1/2019- 4/22/2020
CHECKED BY	LAG	**DATE**	4/22/2020
SCALE		N/A	

Objective: To assess stability of the Bulloughs Pond Dam in Newton, MA

Method:

1) Develop typical cross section of dam at approximate maximum section (See attached figure).
2) Determine material parameters from test borings, laboratory testing, and typical values of similar materials.
3) Calculate location of phreatic surface within dam for normal and flood conditions, using SEEP/W. Calculate factor of safety against piping failure. Evaluate effect of rapid drawndown on phreatic surface within dam.
4) Using pore water data from SEEP/W, calculate factors of safety against slope failure for the following load cases defined by requirements of 302 CMR 10.14 (9(c)). Factors of safety calculated for both upstream and downstream slopes using Spencer method.

Case #2 - Rapid drawdown from flood pool to low level outlet
Case #3 - Rapid drawdown from normal pool to low level outlet
Case #4 - Steady seepage at normal pool
Case #5 - Steady seepage with maximum (flood) pool
Case #6 - Earthquake (pseudo-static) at normal pool

Subsurface Information:

- Test borings GZ-1 through GZ-4 by GZA (Feb 2019)
- Observation wells installed in GZ-2 and GZ-3 by GZA (Feb 2019)
- Grain size distributions from samples collected by GZA
- Water levels based on piezometer readings taken on 7/19/19 and groundwater levels measured within boreholes at time of drilling

Assumptions:

- Horizontal acceleration for pseudo-static seismic analysis is **0.216g**, per ASCE7-16 (Modified peak acceleration with 2% probability of exceedance in 50 years)
- Configuration of embankment based on interpretation of strata from test borings, actual configuration may vary from that used in calculations

Material Properties:

Strata	Total Unit Weight, γ_t (pcf)	Cohesion, c (psf)	Friction Angle, $\phi°$	Effective Cohesion, c' (psf)	Effective Friction Angle, $\phi'°$	Saturated Permeability, k_{sat}	Notes
Embankment Fill	125	0	31	0	31	2.0E-06 ft/s, 6.0E-05 cm/s	(1),(2)
Fine Sand	130	0	29	0	29	2.3E-05 ft/s, 7.0E-04 cm/s	(1),(2)
Core Wall	140	288000	0	288000	0	8.5E-06 ft/s, 2.6E-04 cm/s	(3)
Bedrock	Impenetrable					1.0E-11 ft/s, 3.0E-10 cm/s	(3)

(1) - Permeabilities for granular materials encountered in borings estimated from Hazen equation.
(2) - Phi value of granular soils determined by analysis of SPT-N values from the test borings (Attachment D)
(3) - Assumed parameters based on similar material

Analysis Results:

SEEPAGE ANALYSIS RESULTS - EXISTING CONDITIONS

Case	Pool Elevation	Unit Flowrate, Q (2) (through dam face)	Exit Gradient, i_e (2)	Critical Gradient, i_{cr} (3)	FS, i_{cr}/i_e	Required FS (4)
1	Normal (El. 85.94)	0 $ft^3/s/ft$	No Exit	1.0	N/A	2.5-3.0
2	100-year Flood(El. 92.6)	3.2E-05 $ft^3/s/ft$	0.59	1.0	***1.7***	2.5-3.0

- Note: Factor of safety values less than recommended values are shown in italics
(1) - Elevations for Normal and 1/2 PMF pools from GZA's detailed H&H Analysis
(2) - Flow and exit gradient obtained from results of SEEP/W analysis using the maximum section of the dam
(3) - i_{cr}: critical gradient, typical value for sand = 1.0
(4) - Cedergren, 1977

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JOB	01.0174021.00 Bulloughs Pond Dam		
SHEET NO.	2	OF	2
CALCULATED BY	CMG/MFJ	DATE	9/1/2019- 4/22/2020
CHECKED BY	LAG	DATE	4/22/2020
SCALE		N/A	

SLOPE STABILITY ANALYSIS RESULTS

Load Case	Loading Condition	Dam Face	Factor of Safety		Comments / Notes
			Minimum	Existing	
1	End of Construction	Upstream	1.3	Not Applicable	
		Downstream			
2	Sudden drawdown from maximum pool (Flood)	Upstream	1.1	1.2	Figure G-1
3	Sudden drawdown from spillway/top of gates (Normal)	Upstream	1.2	1.3	Figure G-2
4	Steady-state seepage at maximum storage pool (Normal)	Upstream	1.5	1.5	Figure G-3
		Downstream		1.5	Figure G-4
5	Steady-state seepage at surcharge pool (Flood)	Upstream	1.4	1.7	Figure G-5
		Downstream		***1.0***	Figure G-6
6	Earthquake(2) (Steady-state seepage at normal pool)	Upstream	1.0	***0.9***	Figure G-7
		Downstream		***0.9***	Figure G-8

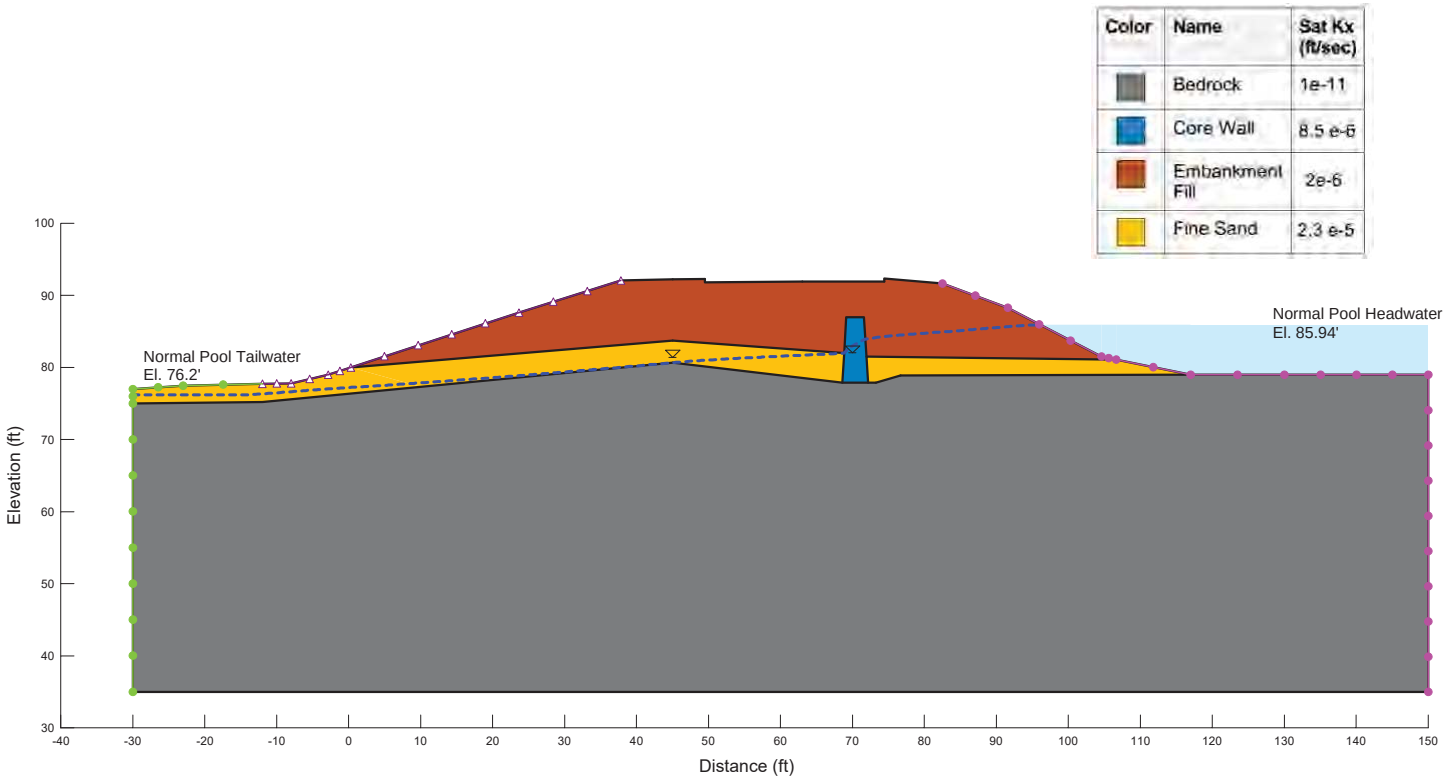
- Note: Factor of safety values less than recommended values are shown in bold and italics
(1) - Low level outlet invert is at elevation 58.9, per H&H analysis
(2) - Earthquake loading applied as a lateral load using seismic coefficient

- Refer to Attachment A for SLOPE/W slope stability analysis graphical results

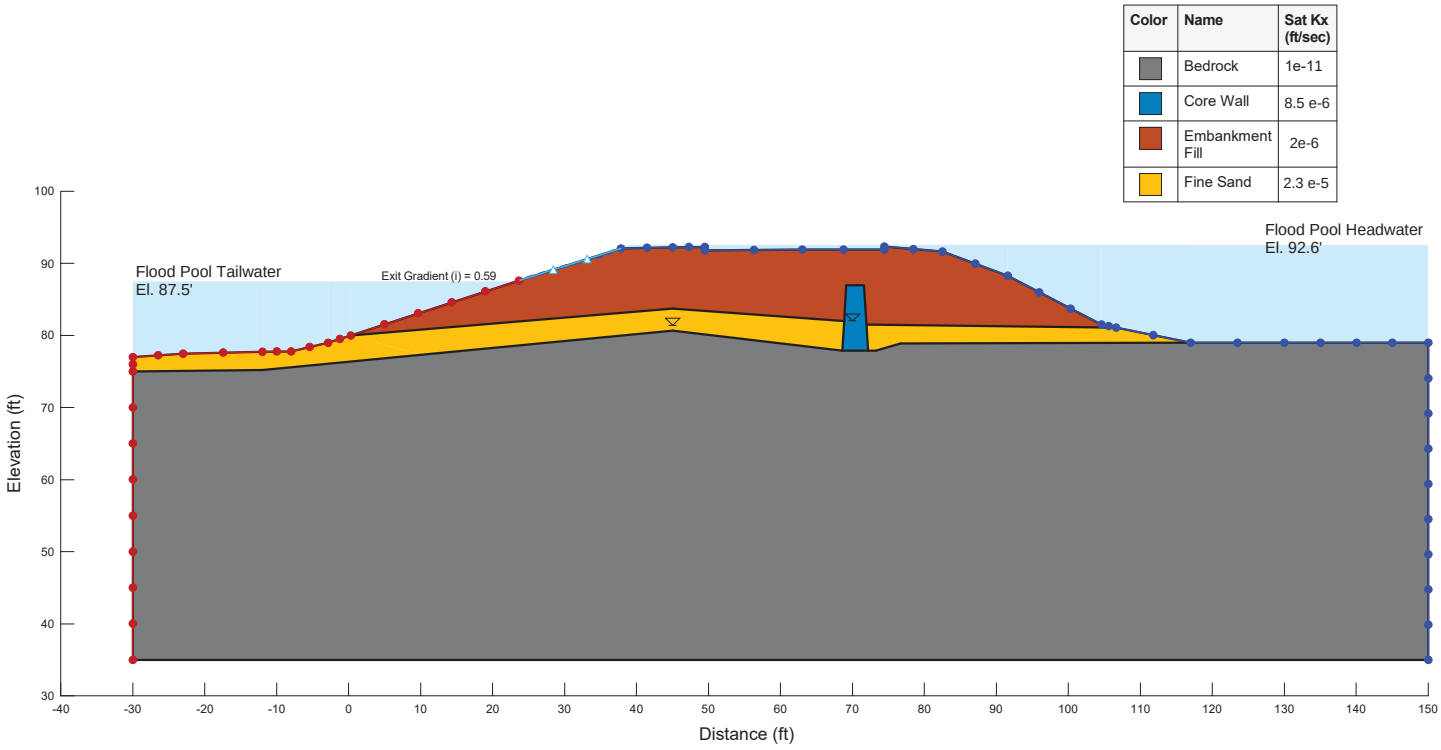
- Refer to Attachment B for Liquefaction Analysis

ATTACHMENT A

SLOPE W GRAPHICAL RESULTS



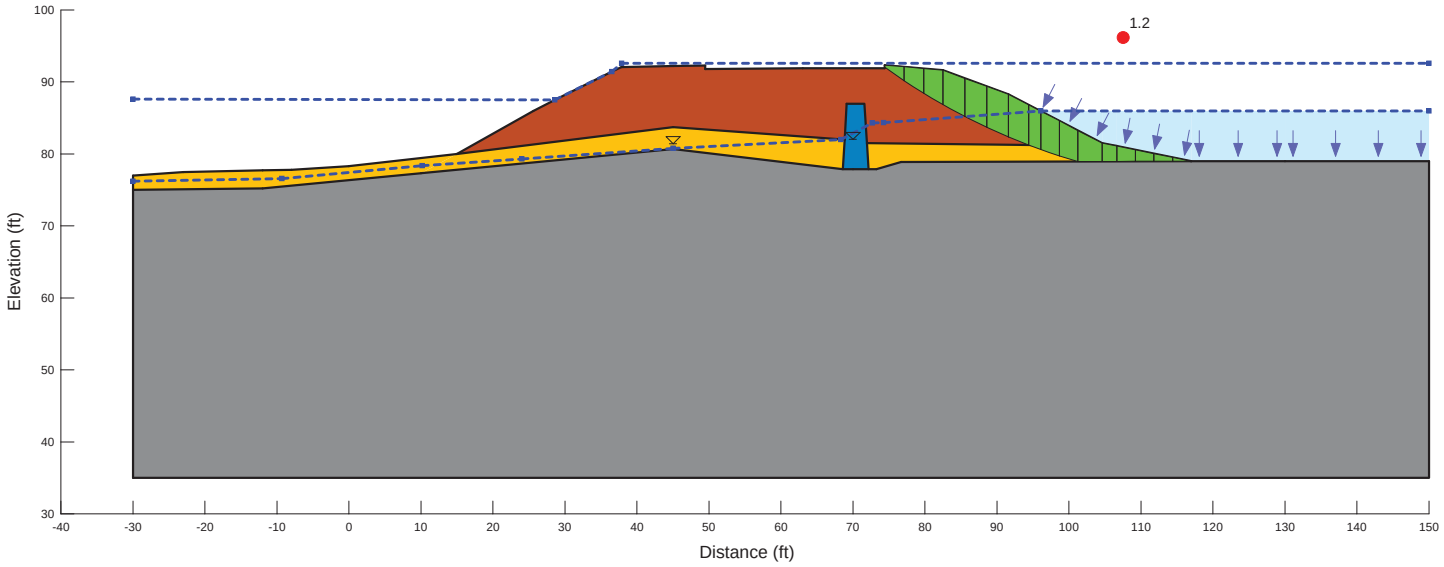
05/19/2020	**Phase II For Bulloughs Pond Dam** **Newton, MA**	**FIGURE**
	Seepage Analysis - Normal Pool	



05/19/2020	**Phase II For Bulloughs Pond Dam** **Newton, MA**	**FIGURE**
	Seepage Analysis - Flood Pool	

366-20

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



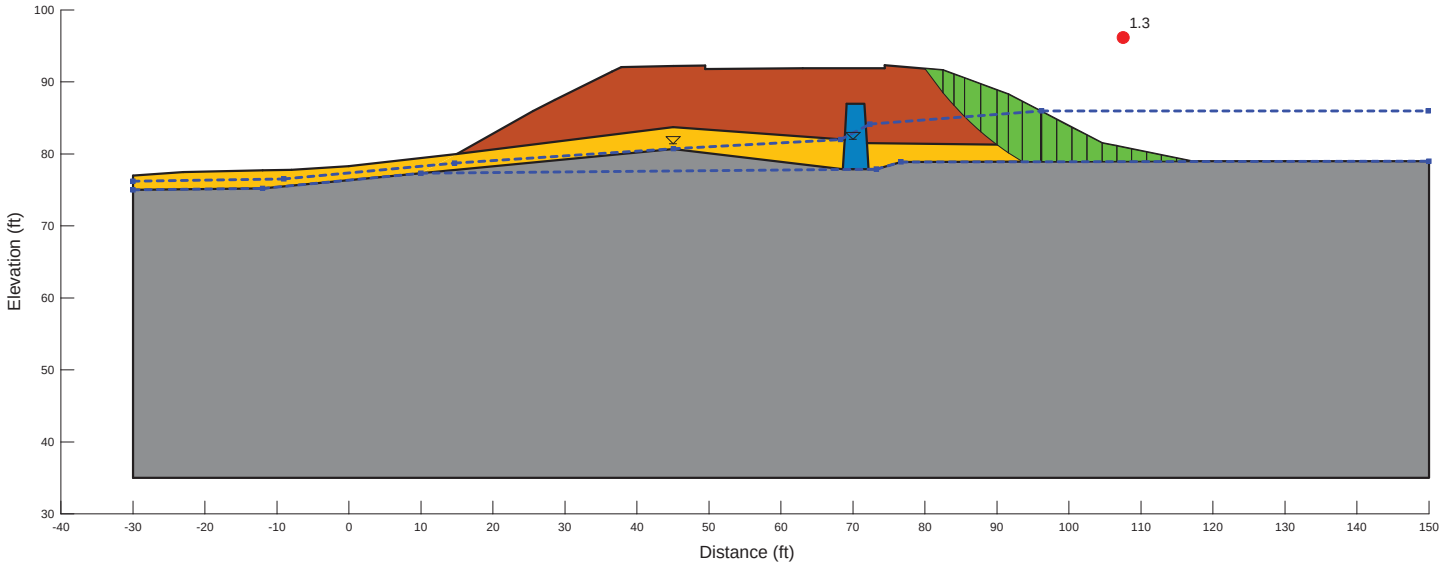
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Upstream Stability - Rapid Drawdown from Flood Pool

FIGURE G-1

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



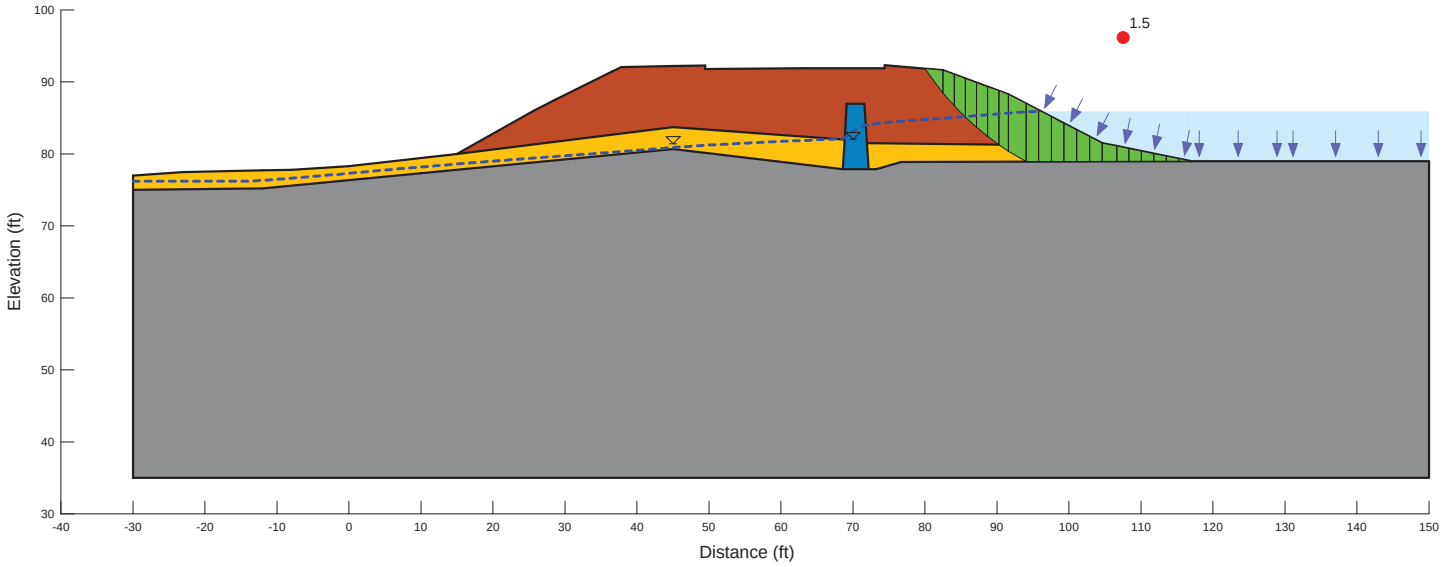
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Upstream Stability - Rapid Drawdown from Normal Pool

FIGURE G-2

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



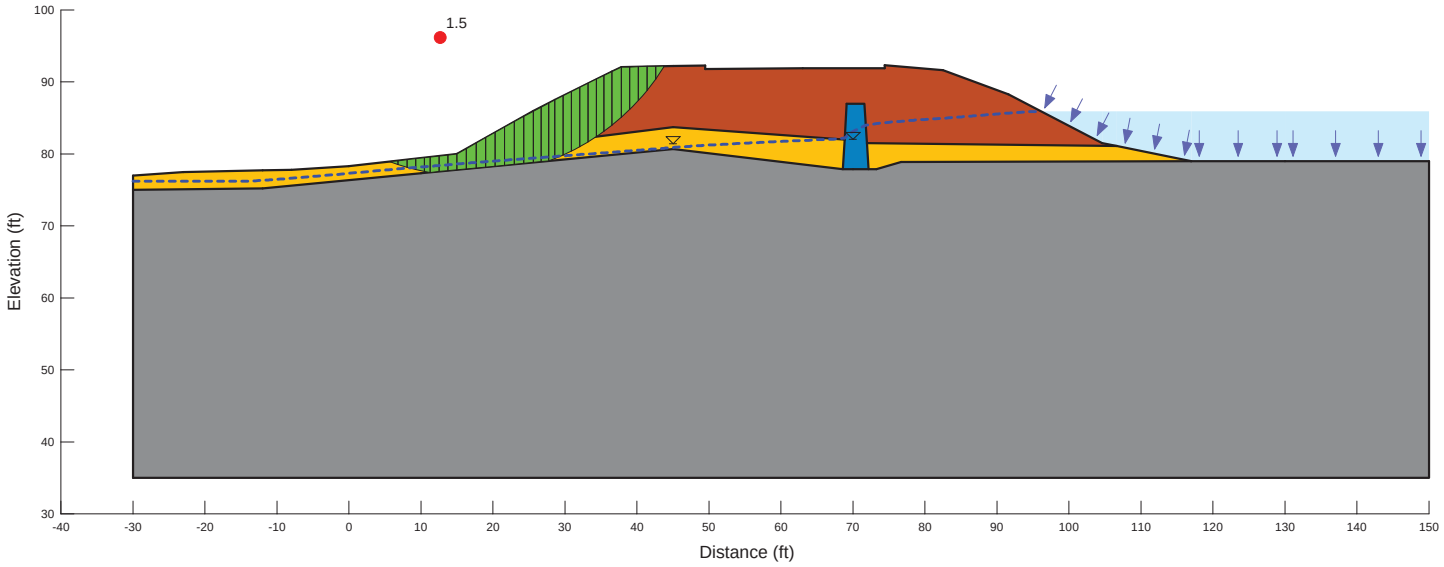
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Upstream Stability - Normal Pool

FIGURE G-3

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



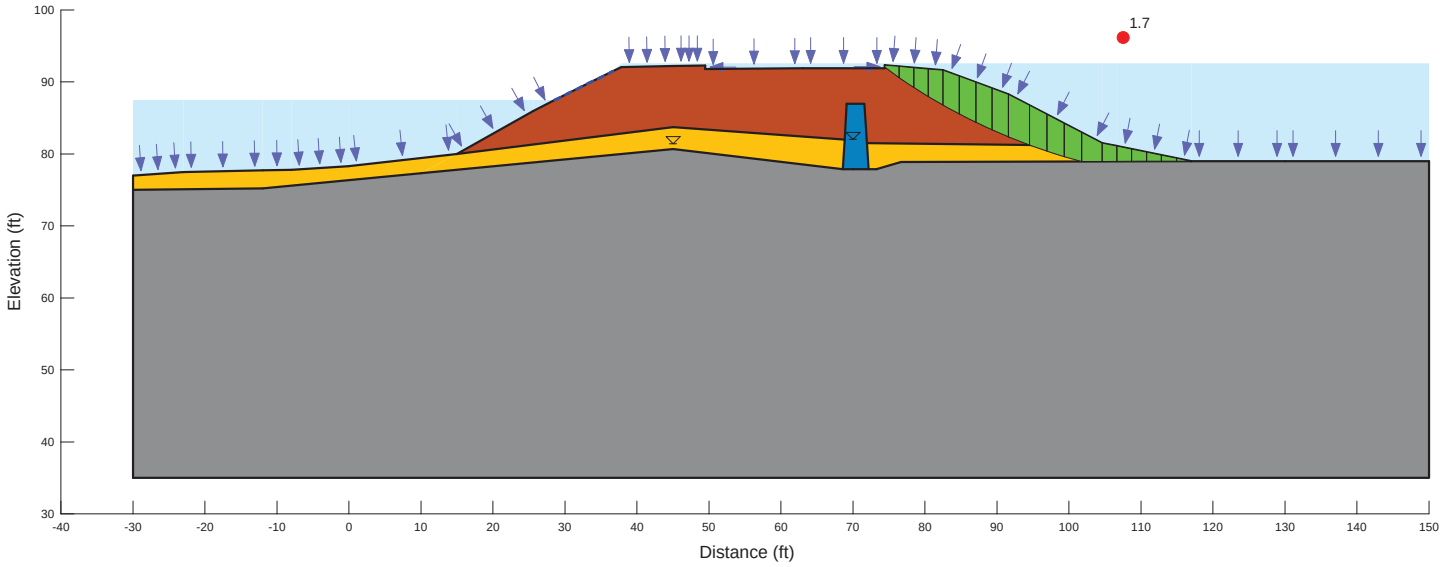
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Downstream Stability - Normal Pool

FIGURE G-4

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



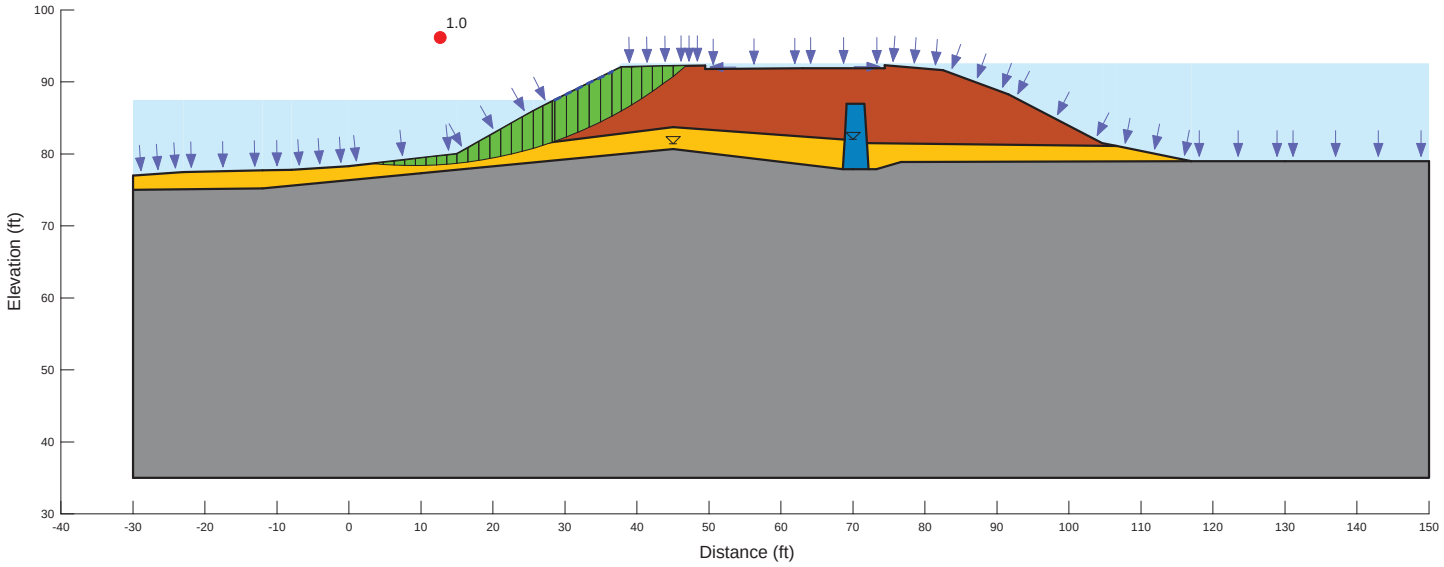
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Upstream Stability - Flood Pool

FIGURE G-5

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



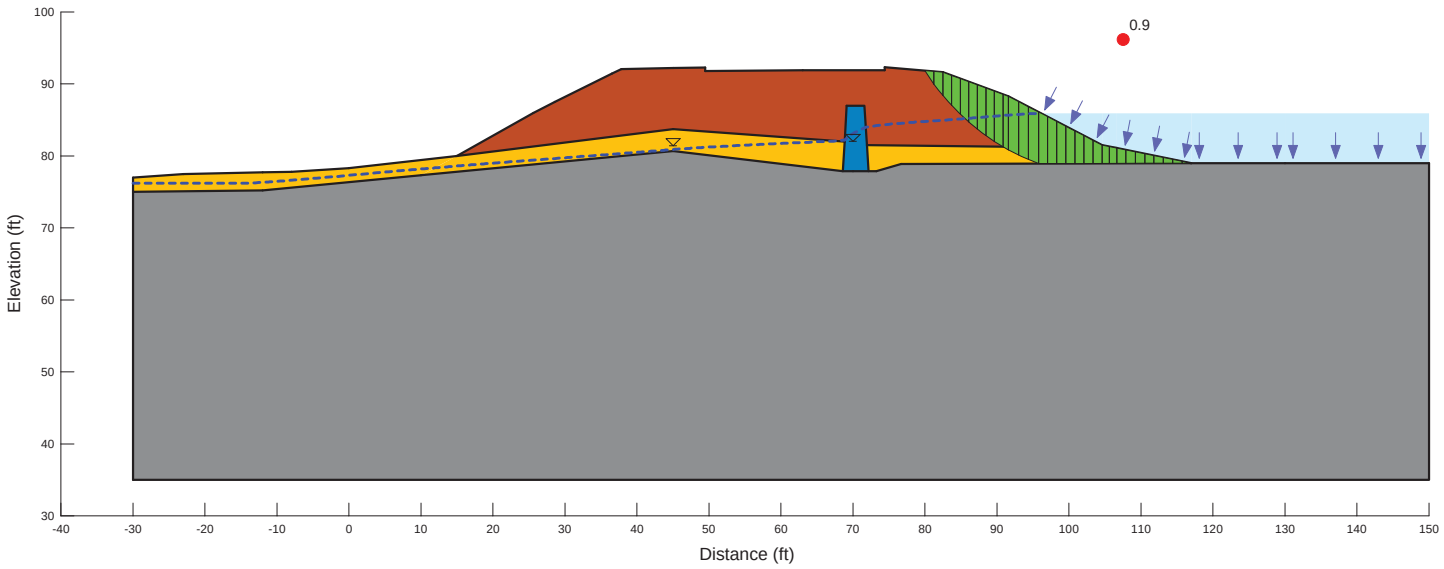
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Downstream Stability - Flood Pool

FIGURE G-6

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



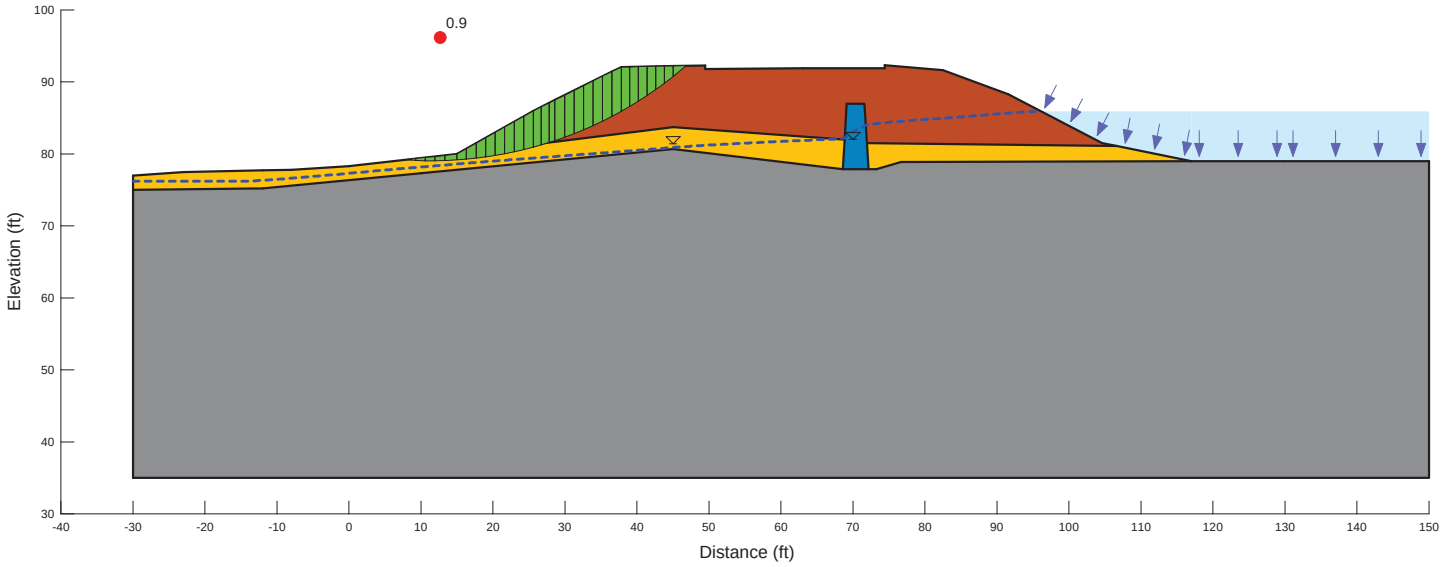
04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Upstream Stability - Flood Pool (Psuedo-static Ag = 0.216)

FIGURE G-7

Color	Name	Unit Weight	Cohesion'	Phi'
	Bedrock			
	Core Wall	140	288,000	0
	Embankment Fill	125	0	31
	Fine Sand	120	0	29



04/22/2020

Phase II For Bulloughs Pond Dam
Newton, MA

Downstream Stability - Normal Pool (Psuedo-static Ag = 0.216)

FIGURE G-8

ATTACHMENT B

LIQUEFACTION ANALYSIS

SPT-Based Liquefaction Susceptibility Evaluation

Project: Bulloughs Pond Dam Phase II **Project No.:** 01.0174021.00
Location: Newton, Massachusetts
Evaluated By: CMG **Date:** 2/27/2019
Checked By: **Date:**

Purpose: Estimate exploration-specific factor of safety against liquefaction and liquefaction induced settlement.

Reference:
1) Idriss, I.M. and Boulanger, R.W. (2008). Soil *Liquefaction During Earthquakes.* Earthquake Engineering Research Institute. Oakland, California. EERI Publication No. MNO-12.
2) Idriss, I.M. and Boulanger, R.W. (2004). *Semi-Empirical Procedures for Evaluating Liquefaction Potential During Earthquakes*. Proceedings of the Joint International Conference on Soil Dynamics & Earthquake Engineering and International Conference on Earthquake Geotechnical Engineering. Berkeley, California. January, 2004. pp.32-56

Approach:
1) Boring GZ-2, GZ-3, and GZ-4 analyzed
2) Create and modify evaluation and plot worksheet tabs to accommodate depths within Boring GZ-2, GZ-3, and G
3) Enter input parameters for boring GZ-2, GZ-3, and GZ-4.
4) Input data from boring (depths, N, estimated fines content, and interpreted soil strata).
5) Check plots for accuracy and update as necessary.
6) If required, spot-check approximations using the MathCAD calculation verification form.
7) Add summary of results below.

Summary of Results: Based on the boring data provided, samples were screened for liquefaction susceptibility using the following criteria:

- Samples whose fines conent (% silt- and clay-sized particles) exceeded 35% were assumed not suscpetible to liquefaction
- Samples whose corrected blow count, $(N_1)_{60\text{-}cs}$, was greater than 30 were assumed not susceptible to liquefaction

Boring ID:	GZ-2	GZ-3	GZ-4
Minimum Factor of Safety:	1.69	2.05	1.54
Elevation of Minimum Factor of Safety (ft, MDC):	90	91	88

Recommendations: Based on the factors of safety against liquefaction presented above, we recommend the site not be considered susceptible to liquefaction.

SPT-Based Liquefaction Susceptibility & Induced Settlement Evaluation

[redacted]oughs Pond Dam Pha Newton, Massachusetts

01.0174021.00

Reference: Idriss & Boulanger (2008)

Exploration ID: GZ-2

Calculated By: CMG Date: 2/27/2019

Checked By: 0.00 Date: 1/0/1900

Input

Elevation Data:
- Ground Surface Elevation: 100.0 ft
- Water Elevation: 93.5 ft

SPT Correction Factors:
- Split Spoon Type: I.D.=1-3/8 in - Standard Sampler
- Hammer Type: Auto Hammer
- Typical rod stickup during SPT: 3 ft
- Borehole Diameter: ≤4.5 in

Material Properties:
- Assumed Soil Unit Weight Above Water Table, γ = 120 pcf
- Assumed Soil Unit Weight Below Water Table, γ_{sat} = 120 pcf
- Atmospheric Pressure, P_a = 2088 psf

Seismic Assumptions
- Maximum Acceleration at Ground Surface, a_{max} = 0.184
- Design Earthquake Magnitude, M = 5.55
- (see attached USGS Deaggregation for more information)

Equations

Overburden and Hammer Energy Corrected Blow Count, $(N_1)_{60} = N_m C_N C_E C_B C_S C_R$

where:

N_m = Field Blow Count

Overburden Correction Factor, $C_N = (P_a/\sigma'_v)^{0.784 - 0.0768\sqrt{(N_1)_{60}}} \le 1.7$

Borehole Diameter Correction Factor,

C_B = 1.0 (2.5"-4.5" diameter), 1.05 (6" diam.), 1.10 (8" diam.)

Sampling Method Correction Factor, C_S

= 1.0 (Standard Sampler or Sampler with liners)

OR, when sampler with room for liners is used without liners;

= 1.1 for $(N_1)_{60} \le 10$

$= 1.0 + \frac{(N_1)_{60}}{100}$ for $10 < (N_1)_{60} \le 30$

= 1.3 for $(N_1)_{60} \ge 30$

Rod Length Correction Factor,

C_R = 0.75 (0 - 3m), 0.80 (3 - 4m), 0.85 (4 - 6m), 0.95 (6 - 10m), 1.0 (> 10m)

Hammer Energy Correction Factor, C_E:

C_E = 0.75 (Donut Hammer), 1.0 (Safety Hammer), 1.2 (Auto Hammer)

Factor of Safety, $F_s = \frac{CRR_{corr}}{CSR}$

Cyclic Stress Ratio, $CSR = 0.65 a_{max} \left(\frac{\sigma_v}{\sigma'_v}\right) r_d$

where:

Depth Reduction Factor, $r_d = \exp[\alpha(z) + M * \beta(z)]$

$\alpha(z) = -1.012 - 1.126 \sin\left(\frac{z}{11.73} + 5.133\right)$ (z = depth in meters)

$\beta(z) = 0.106 + 0.118 \sin\left(\frac{z}{11.28} + 5.142\right)$ (z = depth in meters)

Clean – Sand Corrected Blow Count, $(N_1)_{60\text{-}CS} = (N_1)_{60} + \Delta(N_1)_{60}$

where: $\Delta(N_1)_{60} = e^{\left[1.63 + \frac{9.7}{FC+0.01}\right]\left[\frac{15.7}{FC+0.01}\right]^2}$

FC = Fines Content (%)

For use in liquefaction - induced strain estimates: $N_1 = (N_1)_{60} \cdot 0.833$

Cyclic Resistance Ratio, $CRR =$

$$\exp\left[\frac{(N_1)_{60\text{-}CS}}{14.1} + \left(\frac{(N_1)_{60\text{-}CS}}{126}\right)^2 - \left(\frac{(N_1)_{60\text{-}CS}}{23.6}\right)^3 + \left(\frac{(N_1)_{60\text{-}CS}}{25.4}\right)^4 - 2.8\right]$$

Corrected Cyclic Resistance Ratio, $CRR_{corr} = CRR \cdot MSF \cdot K_\sigma$

where:

Magnitude Scaling Factor, $MSF = 6.9 \exp\left(\frac{-M}{4}\right) - 0.058 \le 1.8$

Overburden Correction Factor, $K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \le 1.1$

$C_\sigma = \frac{1}{18.9 - 2.55\sqrt{(N_1)_{60}}} \le 0.3$

Limiting Shear Strain, $\gamma_{lim} = 1.859\left(1.1 - \sqrt{\frac{(N_1)_{60\text{-}CS}}{46}}\right)^3 \ge 0.0$

Maximum Shear Strain, γ_{max}:

$\gamma_{max} = 0$ when $F_s \ge 2.0$

$\gamma_{max} = \gamma_{lim}$ when $F_s \le F_\alpha$

$\gamma_{max} = \min\left[\gamma_{lim},\ 0.035(2 - F_s)\left(\frac{1 - F_\alpha}{F_s - F_\alpha}\right)\right]$ when $2.0 > F_s > F_\alpha$

where $F_\alpha = 0.032 + 0.69\sqrt{(N_1)_{60cs}} - 0.13(N_1)_{60cs}$

Vertical Strain, $\varepsilon_v = 1.5e^{-0.369\sqrt{(N_1)_{60cs}}} \cdot \min(0.08,\ \gamma_{max})$

$LDI = \Delta H \cdot \gamma_{max}$

Vertical Settlement, $s = \Delta H \cdot \varepsilon_v$

Legend

Liquefaction Likely (Fs < 1.1)

Possible Flow Liquefaction Or Cyclic Strain Softening (1.1 ≤ Fs < 1.4)

Approximation

Depth bgs (mid-SPT interval)	Elevation	Depth	Total Stress, σ_v	Effective Stress, σ'_v	N (field)	C_R	C_N	C_E	$(N_1)_{60}$	Fines Content	$(N_1)_{60CS}$	CRR	MSF	C_σ	K_σ	CRR_{corr}	r_d	CSR	F_s	Limiting Shear Strain, γ_{lim}	Parameter F_α	Max Shear Strain, γ_{max}	Layer Thickness, ΔH	LDI (layer)	LDI (cumulative)	Vertical Strain, ε_v	Vertical Settlement (Layer)	Vertical Settlement (Cumulative)	Interpreted Soil Strata	Comments
ft	ft	m	psf	psf						%													ft	ft	ft		in	in		
6.0	94.0	1.83	720	720	10	0.75	1.68	1.00	15	30	20	0.21	1.66	0.11	1.10	0.39	0.98	0.12	3.32	0.15	0.49	0.000	6	0	0.00	0.000	0.000	0.019	Fill	
8.0	92.0	2.44	960	866	11	0.80	1.52	1.00	16	30	21	0.22	1.66	0.12	1.10	0.41	0.96	0.13	3.22	0.14	0.44	0.000	2	0	0.00	0.000	0.000	0.019		
10.0	90.0	3.05	1200	982	6	0.80	1.52	1.00	9	15	12	0.13	1.66	0.09	1.07	0.24	0.95	0.14	1.69	0.38	0.86	0.002	2	0.003585	0.00	0.001	0.018	0.019	Fine Sand	
12.0	88.0	3.66	1440	1097	9	0.85	1.39	1.00	13	15	16	0.16	1.66	0.10	1.07	0.29	0.94	0.15	1.99	0.25	0.71	0.000	2	0.000231	0.00	0.000	0.001	0.001		
14.0	86.0	4.27	1680	1212	100	0.85	1.00	1.00	102	*Not considered susceptible to liquefaction (N-value > 30 bpf)*																				

Bedrock observed below 14 feet bgs. Not considered susceptible to liquefaction.

SPT-Based Liquefaction Susceptibility & Induced Settlement Evaluation

oughs Pond Dam Pha Newton, Massachusetts
01.0174021.00
Reference: Idriss & Boulanger (2008)

Exploration ID: GZ-3

Calculated By: CMG Date: 2/27/2019
Checked By: 0.00 Date: 1/0/1900

Input

Elevation Data:
Mudline Elevation 100.0 ft
Water Elevation 93.0 ft

SPT Correction Factors:
Split Spoon Type: I.D.=1-3/8 in - Standard Sampler
Hammer Type: Donut Hammer
Typical rod stickup during SPT: 3 ft
Borehole Diameter: ≤4.5 in

Material Properties:
Assumed Soil Unit Weight Above Water Table, γ = 120 pcf
Assumed Soil Unit Weight Below Water Table, γ_{sat} = 120 pcf
Atmospheric Pressure, P_a = 2088 psf

Seismic Assumptions
Maximum Acceleration at Ground Surface, a_{max} = 0.184
Design Earthquake Magnitude, M = 5.55
(see attached USGS Deaggregation for more information)

Equations

Overburden and Hammer Energy Corrected Blow Count, $(N_1)_{60} = N_m C_N C_E C_B C_S C_R$

where:

N_m = Field Blow Count

Overburden Correction Factor, $C_N = (P_a/\sigma'_v)^{0.784 - 0.0768\sqrt{(N_1)_{60}}} \le 1.7$

Borehole Diameter Correction Factor,
C_B = 1.0 (2.5"-4.5" diameter), 1.05 (6" diam.), 1.10 (8" diam.)

Sampling Method Correction Factor, C_S
= 1.0 (Standard Sampler or Sampler with liners)
OR, when sampler with room for liners is used without liners;
= 1.1 for $(N_1)_{60} \le 10$
$= 1.0 + \frac{(N_1)_{60}}{100}$ for $10 < (N_1)_{60} \le 30$
= 1.3 for $(N_1)_{60} \ge 30$

Rod Length Correction Factor,
C_R = 0.75 (0 - 3m), 0.80 (3 - 4m), 0.85 (4 - 6m), 0.95 (6 - 10m), 1.0 (> 10m)

Hammer Energy Correction Factor, C_E :
C_E = 0.75 (Donut Hammer), 1.0 (Safety Hammer), 1.2 (Auto Hammer)

Factor of Safety, $F_s = \frac{CRR_{corr}}{CSR}$

Cyclic Stress Ratio, $CSR = 0.65 a_{max} \left(\frac{\sigma_v}{\sigma'_v}\right) r_d$

where:

Depth Reduction Factor, $r_d = \exp[\alpha(z) + M * \beta(z)]$

$\alpha(z) = -1.012 - 1.126 \sin\left(\frac{z}{11.73} + 5.133\right)$ (z = depth in meters)

$\beta(z) = 0.106 + 0.118 \sin\left(\frac{z}{11.28} + 5.142\right)$ (z = depth in meters)

Clean – Sand Corrected Blow Count, $(N_1)_{60\text{-}CS} = (N_1)_{60} + \Delta(N_1)_{60}$

where: $\Delta(N_1)_{60} = e^{\left[1.63 + \frac{9.7}{FC+0.01}\right]\left[\frac{15.7}{FC+0.01}\right]^2}$

FC = Fines Content (%)

For use in liquefaction - induced strain estimates : $N_1 = (N_1)_{60} \cdot 0.833$

Cyclic Resistance Ratio, $CRR =$
$\exp\left[\frac{(N_1)_{60\text{-}CS}}{14.1} + \left(\frac{(N_1)_{60\text{-}CS}}{126}\right)^2 - \left(\frac{(N_1)_{60\text{-}CS}}{23.6}\right)^3 + \left(\frac{(N_1)_{60\text{-}CS}}{25.4}\right)^4 - 2.8\right]$

Corrected Cyclic Resistance Ratio, $CRR_{corr} = CRR \cdot MSF \cdot K_\sigma$

where:

Magnitude Scaling Factor, $MSF = 6.9 \exp\left(\frac{-M}{4}\right) - 0.058 \le 1.8$

Overburden Correction Factor, $K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \le 1.1$

$C_\sigma = \frac{1}{18.9 - 2.55\sqrt{(N_1)_{60}}} \le 0.3$

Limiting Shear Strain, $\gamma_{lim} = 1.859\left(1.1 - \sqrt{\frac{(N_1)_{60cs}}{46}}\right)^3 \ge 0.0$

Maximum Shear Strain, γ_{max} :
$\gamma_{max} = 0$ when $F_s \ge 2.0$
$\gamma_{max} = \gamma_{lim}$ when $F_s \le F_d$
$\gamma_{max} = \min\left[\gamma_{lim},\ 0.035(2 - F_s)\left(\frac{1 - F_d}{F_s - F_d}\right)\right]$ when $2.0 > F_s > F_d$
where $F_d = 0.032 + 0.69\sqrt{(N_1)_{60cs}} - 0.13(N_1)_{60cs}$

Vertical Strain, $\varepsilon_v = 1.5e^{-0.369\sqrt{(N_1)_{60cs}}} \cdot \min(0.08,\ \gamma_{max})$

$LDI = \Delta H \cdot \gamma_{max}$

Vertical Settlement, $s = \Delta H \cdot \varepsilon_v$

Legend
Liquefaction Likely (Fs < 1.1)
Possible Flow Liquefaction Or Cyclic Strain Softening (1.1 ≤ Fs < 1.4)

Approximation

Depth below mudline (mid-SPT interval)	Elevation	Depth	Total Stress, σ_v	Effective Stress, σ'_v	N (field)	C_B	C_N	C_S	$(N_1)_{60}$	Fines Content	$(N_1)_{60CS}$	CRR	MSF	C_σ	K_σ	CRR_{corr}	r_d	CSR	F_s	Limiting Shear Strain, γ_{lim}	Parameter F_d	Max Shear Strain, γ_{max}	Layer Thickness, ΔH	LDI (layer)	LDI (cumulative)	Vertical Strain, ε_v	Vertical Settlement (Layer)	Vertical Settlement (Cumulative)	Interpreted Soil Strata	Comments
ft	ft	m	psf	psf						%													ft	ft	ft		in	in		
1.0	99.0	0.30	120	120	8	0.75	1.70	1.00	8	30	13	0.14	1.66	0.08	1.10	0.26	1.00	0.12	2.14	0.34	0.83	0.000	2	0	0.00	0.000	0.000	0.000	Topsoil	
3.0	97.0	0.91	360	360	7	0.75	1.70	1.00	7	30	12	0.13	1.66	0.08	1.10	0.24	0.99	0.12	2.05	0.38	0.86	0.000	2	0	0.00	0.000	0.000	0.000		
5.0	95.0	1.52	600	600	7	0.75	1.70	1.00	7	30	12	0.13	1.66	0.08	1.10	0.24	0.98	0.12	2.07	0.38	0.86	0.000	2	0	0.00	0.000	0.000	0.000	Fill	
7.0	93.0	2.13	840	840	19	0.80	1.53	1.00	17	30	23	0.25	1.66	0.12	1.10	0.45	0.97	0.12	3.87	0.12	0.37	0.000	2	0	0.00	0.000	0.000	0.000		
9.0	91.0	2.74	1080	955	10	0.80	1.54	1.00	9	30	15	0.15	1.66	0.09	1.07	0.27	0.96	0.13	2.10	0.29	0.77	0.000	1.75	0	0.00	0.000	0.000	0.000	Fine Sand	
10.5	89.5	3.20	1260	1042	100	0.85	1.10	1.00	70	*Not considered susceptible to liquefaction (N-value > 30 bpf)*																				

Bedrock observed below 10.5 feet bgs. Not considered susceptible to liquefaction.

SPT-Based Liquefaction Susceptibility & Induced Settlement Evaluation

oughs Pond Dam Pha Newton, Massachusetts
01.0174021.00
Reference: Idriss & Boulanger (2008)

Exploration ID: GZ-4

Calculated By: CMG Date: 2/27/2019
Checked By: 0.00 Date: 1/0/1900

Input

Elevation Data:
Mudline Elevation 100.0 ft
Water Elevation 93.5 ft

SPT Correction Factors:
Split Spoon Type: I.D.=1-3/8 in - Standard Sampler
Hammer Type: Donut Hammer
Typical rod stickup during SPT: 3 ft
Borehole Diameter: ≤4.5 in

Material Properties:
Assumed Soil Unit Weight Above Water Table, γ = 120 pcf
Assumed Soil Unit Weight Below Water Table, γ_{sat} = 120 pcf
Atmospheric Pressure, P_a = 2088 psf

Seismic Assumptions
Maximum Acceleration at Ground Surface, a_{max} = 0.184
Design Earthquake Magnitude, M = 5.55
(see attached USGS Deaggregation for more information)

Equations

Overburden and Hammer Energy Corrected Blow Count, $(N_1)_{60} = N_m C_N C_E C_B C_S C_R$

where:

N_m = Field Blow Count

Overburden Correction Factor, $C_N = (P_a/\sigma'_v)^{0.784 - 0.0768\sqrt{(N_1)_{60}}} \le 1.7$

Borehole Diameter Correction Factor,
C_B = 1.0 (2.5"-4.5" diameter), 1.05 (6" diam.), 1.10 (8" diam.)

Sampling Method Correction Factor, C_S
= 1.0 (Standard Sampler or Sampler with liners)
OR, when sampler with room for liners is used without liners;
= 1.1 for $(N_1)_{60} \le 10$
$= 1.0 + \frac{(N_1)_{60}}{100}$ for $10 < (N_1)_{60} \le 30$
= 1.3 for $(N_1)_{60} \ge 30$

Rod Length Correction Factor,
C_R = 0.75 (0 - 3m), 0.80 (3 - 4m), 0.85 (4 - 6m), 0.95 (6 - 10m), 1.0 (> 10m)

Hammer Energy Correction Factor, C_E :
C_E = 0.75 (Donut Hammer), 1.0 (Safety Hammer), 1.2 (Auto Hammer)

Factor of Safety, $F_s = \frac{CRR_{corr}}{CSR}$

Cyclic Stress Ratio, $CSR = 0.65 a_{max} \left(\frac{\sigma_v}{\sigma'_v}\right) r_d$

where:

Depth Reduction Factor, $r_d = \exp[\alpha(z) + M * \beta(z)]$

$\alpha(z) = -1.012 - 1.126 \sin\left(\frac{z}{11.73} + 5.133\right)$ (z = depth in meters)

$\beta(z) = 0.106 + 0.118 \sin\left(\frac{z}{11.28} + 5.142\right)$ (z = depth in meters)

Clean – Sand Corrected Blow Count, $(N_1)_{60\text{-}CS} = (N_1)_{60} + \Delta(N_1)_{60}$

where: $\Delta(N_1)_{60} = e^{\left[1.63 + \frac{9.7}{FC+0.01}\right]\left[\frac{14.7}{FC+0.01}\right]^2}$

FC = Fines Content (%)

For use in liquefaction - induced strain estimates : $N_1 = (N_1)_{60} \cdot 0.833$

Cyclic Resistance Ratio, $CRR =$
$\exp\left[\frac{(N_1)_{60\text{-}CS}}{14.1} + \left(\frac{(N_1)_{60\text{-}CS}}{126}\right)^2 - \left(\frac{(N_1)_{60\text{-}CS}}{23.6}\right)^3 + \left(\frac{(N_1)_{60\text{-}CS}}{25.4}\right)^4 - 2.8\right]$

Corrected Cyclic Resistance Ratio, $CRR_{corr} = CRR \cdot MSF \cdot K_\sigma$

where:

Magnitude Scaling Factor, $MSF = 6.9 \exp\left(\frac{-M}{4}\right) - 0.058 \le 1.8$

Overburden Correction Factor, $K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \le 1.1$

$C_\sigma = \frac{1}{18.9 - 2.55\sqrt{(N_1)_{60}}} \le 0.3$

Limiting Shear Strain, $\gamma_{lim} = 1.859\left(1.1 - \sqrt{\frac{(N_1)_{60cs}}{46}}\right)^3 \ge 0.0$

Maximum Shear Strain, γ_{max} :
$\gamma_{max} = 0$ when $F_s \ge 2.0$
$\gamma_{max} = \gamma_{lim}$ when $F_s \le F_a$
$\gamma_{max} = \min\left[\gamma_{lim},\ 0.035(2 - F_s)\left(\frac{1 - F_a}{F_s - F_a}\right)\right]$ when $2.0 > F_s > F_a$

where $F_a = 0.032 + 0.69\sqrt{(N_1)_{60cs}} - 0.13(N_1)_{60cs}$

Vertical Strain, $\varepsilon_v = 1.5e^{-0.369\sqrt{(N_1)_{60cs}}} \cdot \min(0.08,\ \gamma_{max})$

$LDI = \Delta H \cdot \gamma_{max}$

Vertical Settlement, $s = \Delta H \cdot \varepsilon_v$

Legend
Liquefaction Likely (Fs < 1.1)
Possible Flow Liquefaction Or Cyclic Strain Softening (1.1 ≤ Fs < 1.4)

Approximation

Depth below mudline (mid-SPT interval)	Elevation	Depth	Total Stress, σ_v	Effective Stress, σ'_v	N (field)	C_B	C_N	C_S	$(N_1)_{60}$	Fines Content	$(N_1)_{60CS}$	CRR	MSF	C_σ	K_σ	CRR_{corr}	r_d	CSR	F_s	Limiting Shear Strain, γ_{lim}	Parameter F_a	Max Shear Strain, γ_{max}	Layer Thickness, ΔH	LDI (layer)	LDI (cumulative)	Vertical Strain, ε_v	Vertical Settlement (Layer)	Vertical Settlement (Cumulative)	Interpreted Soil Strata	Comments
ft	ft	m	psf	psf						%													ft	ft	ft		in	in		
8.0	92.0	2.44	960	866	28	0.80	1.43	1.00	24	20	29	0.41	1.66	0.16	1.10	0.74	0.96	0.13	5.82	0.06	0.01	0.000	8	0	0.01	0.000	0.000	0.031	Fill	
10.0	90.0	3.05	1200	982	30	0.80	1.36	1.00	24	20	29	0.42	1.66	0.16	1.10	0.78	0.95	0.14	5.58	0.05	-0.02	0.000	2	0	0.01	0.000	0.000	0.031	Fill	
12.0	88.0	3.66	1440	1097	9	0.85	1.44	1.00	8	15	12	0.13	1.66	0.09	1.06	0.23	0.94	0.15	1.54	0.40	0.88	0.003	2	0.006052	0.01	0.001	0.031	0.031	Sand	

Bedrock observed below 10.5 feet bgs. Not considered susceptible to liquefaction.

Appendix J
Cost Estimate for Preferred Alternatives

BULLOUGH'S POND DAM REHABILITATION PROJECT
NEWTON, MA
GZA GeoEnvironmental, Inc.
File No. 174021
CONCEPTUAL COST ESTIMATE - Alternative 5 (Riprap)

ITEM #	DESCRIPTION	ESTIMATED QUANITY	UNIT	GZA UNIT PRICE	GZA TOTAL PRICE
	ONE TIME COST				
01740.01	Site Restoration	1	LS	$10,000.00	$10,000.00
01900.01	Mobilization and Demobilization	1	LS	$25,000.00	$25,000.00
02065.03	Removal and Legal Disposal of Miscellaneous Debris and Items	1	LS	$5,000.00	$5,000.00
	Slipeline 24-inch Outlet Pipes	1	LS	$225,000.00	$225,000.00
	Repair Stone Masonry Headwall				
11010.02	Repoint Spillway Training Walls	210	LF	$25.00	$5,250.00
	Grout Pump	3	day	$70.00	$210.00
	UPSTREAM SLOPE				
	Clearing, Grubbing , Stripping - Upstream Slope Face	470	SY	$10.00	$4,700.00
	Tree Clearing - Upstream Slope	10	Ea.	$160.00	$1,600.00
02270.01	Furnishing and Placement of Crushed Stone Material Riprap Bedding	423	ton	$60.00	$25,380.00
02270.02	Furnishing and Placement of Upstream Slope Stone Riprap	1410	CY	$100.00	$141,000.00
	DOWNSTREAM SLOPE				
	Clearing, Grubbing , Stripping - Downstream Slope Face	222	SY	$10.00	$2,222.22
	Tree Clearing - Downstream Slope	9	Ea.	$160.00	$1,440.00
02200.01	Common Excavation for Slope Repairs	266.7	CY	$25.00	$6,666.67
02270.01	Furnishing and Placement of Crushed Stone Material Riprap Bedding	804	ton	$60.00	$48,240.00
02270.02	Furnishing and Placement of Downstream Slope Stone Riprap	893	CY	$90.00	$80,400.00
	DOWNSTREAM CHANNEL				
02270.02	Furnishing and Placement Riprap at Downstream Channel	122	SY	$10.00	$1,222.22
				Sub-Total Cost:	**$583,300.00**
				50% Contingency:	**$291,700.00**
				Total Cost:	**$875,000.00**

BULLOUGH'S POND DAM REHABILITATION PROJECT
NEWTON, MA
GZA GeoEnvironmental, Inc.
File No. 174021
CONCEPTUAL COST ESTIMATE - Alternative 5 (TRM)

ITEM #	DESCRIPTION	ESTIMATED QUANITY	UNIT	GZA UNIT PRICE	GZA TOTAL PRICE
	ONE TIME COST				
01740.01	Site Restoration	1	LS	$10,000.00	$10,000.00
01900.01	Mobilization and Demobilization	1	LS	$25,000.00	$25,000.00
02065.03	Removal and Legal Disposal of Miscellaneous Debris and Items	1	LS	$5,000.00	$5,000.00
	Slipeline 24-inch Outlet Pipes	1	LS	$225,000.00	$225,000.00
	Repair Stone Masonry Headwall				
11010.02	Repoint Spillway Training Walls	210	LF	$25.00	$5,250.00
	Grout Pump	3	day	$70.00	$210.00
	UPSTREAM SLOPE				
	Clearing, Grubbing , Stripping - Upstream Slope Face	470	SY	$9.00	$4,230.00
	Tree Clearing - Upstream Slope	10	Ea.	$160.00	$1,600.00
02270.01	Furnishing and Placement of Crushed Stone Material Riprap Bedding	423	ton	$60.00	$25,380.00
02270.02	Furnishing and Placement of Upstream Slope Stone Riprap	1410	CY	$90.00	$126,900.00
	DOWNSTREAM SLOPE				
	Clearing, Grubbing , Stripping - Downstream Slope Face	222	SY	$10.00	$2,222.22
	Tree Clearing - Downstream Slope	9	Ea.	$160.00	$1,440.00
02200.01	Common Excavation for Slope Repairs	266.7	CY	$25.00	$6,666.67
	Furnishing and Placement of Turf Reinforcement Mat	893.3	SY	$11.00	$9,830.00
02930.02	Furnishing and Placement of Loam from Off-Site Sources	148.9	CY	$50.00	$7,444.44
02930.03	Seeding	893.3	SY	$5.00	$4,466.67
	DOWNSTREAM CHANNEL				
02270.02	Furnishing and Placement Riprap at Downstream Channel	122	SY	$10.00	$1,222.22
				Sub-Total Cost:	**$461,900.00**
				50% Contingency:	**$231,000.00**
				Total Cost:	**$692,900.00**

BULLOUGH'S POND DAM REHABILITATION PROJECT
NEWTON, MA
GZA GeoEnvironmental, Inc.
File No. 174021
CONCEPTUAL COST ESTIMATE - Alternative 5 (ACB)

ITEM #	DESCRIPTION	ESTIMATED QUANITY	UNIT	GZA UNIT PRICE	GZA TOTAL PRICE
	ONE TIME COST				
01740.01	Site Restoration	1	LS	$10,000.00	$10,000.00
01900.01	Mobilization and Demobilization	1	LS	$25,000.00	$25,000.00
02065.03	Removal and Legal Disposal of Miscellaneous Debris and Items	1	LS	$5,000.00	$5,000.00
	Slipeline 24-inch Outlet Pipes	1	LS	$225,000.00	$225,000.00
	Repair Stone Masonry Headwall				
11010.02	Repoint Spillway Training Walls	210	LF	$25.00	$5,250.00
	Grout Pump	3	day	$70.00	$210.00
	UPSTREAM SLOPE				
	Clearing, Grubbing , Stripping - Upstream Slope Face	470	SY	$9.00	$4,230.00
	Tree Clearing - Upstream Slope	10	Ea.	$200.00	$2,000.00
02270.01	Furnishing and Placement of Crushed Stone Material Riprap Bedding	423	ton	$60.00	$25,380.00
02270.02	Furnishing and Placement of Upstream Slope Stone Riprap	1410	CY	$90.00	$126,900.00
	DOWNSTREAM SLOPE				
	Clearing, Grubbing , Stripping - Downstream Slope Face	222	SY	$10.00	$2,222.22
	Tree Clearing - Downstream Slope	9	Ea.	$200.00	$1,800.00
02200.01	Common Excavation for Slope Repairs	266.7	CY	$25.00	$6,666.67
	Place ACBs downstream Slope	2000.0	SF	$11.00	$22,000.00
	DOWNSTREAM CHANNEL				
02270.02	Furnishing and Placement Riprap at Downstream Channel	122	SY	$10.00	$1,222.22
				Sub-Total Cost:	**$462,900.00**
				50% Contingency:	**$231,500.00**
				Total Cost:	**$694,400.00**

GZA GeoEnvironmental, Inc.

dcr
Massachusetts

July 10, 2019

City of Newton
c/o Ruthanne Fuller, Mayor
1000 Commonwealth Ave
Newton, MA 02459

Subject: **Notice of Recording**

Dam Name:	Bulloughs Pond Dam
Location:	Newton
National ID No:	MA03414
Hazard Potential:	Significant
Known Condition:	Poor

Dear City of Newton,

This notice is to inform you that on June 26, 2019, the Certificate of Non-Compliance and Dam Safety Order issued to you on July 16, 2018 was recorded at the Middlesex South County Registry of Deeds. A copy of the recorded certificate is enclosed. In accordance with 302 CMR 10.08, a Certificate of Compliance will be issued when the dam is brought into compliance with dam safety regulations. Please contact Emily Caruso of ODS at 508-792-7716 ext. 41827 or Emily.Caruso@mass.gov with any questions. Thank you for your time and anticipated cooperation.

Sincerely,

William C. Salomaa, Director
Office of Dam Safety

Enclosure: Recorded Certificate of Non-Compliance and Dam Safety Order

Middlesex South Registry of Deeds

Electronically Recorded Document

This is the first page of the document - Do not remove

Recording Information

Document Number	: 88670
Document Type	: ORD
Recorded Date	: June 26, 2019
Recorded Time	: 09:40:02 AM
Recorded Book and Page	: 72825 / 544
Number of Pages(including cover sheet)	: 9
Receipt Number	: 2337560
Recording Fee	: $75.00

Middlesex South Registry of Deeds
Maria C. Curtatone, Register
208 Cambridge Street
Cambridge, MA 02141
617-679-6300
www.middlesexsouthregistry.com

dcr
Massachusetts

July 16, 2018
Certified Mail No. 7017 2620 0000 7578 6800
Return Receipt Requested

City of Newton
c/o the Honorable Ruthanne Fuller
1000 Commonwealth Ave
Newton, MA 02459

Subject: **CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER**

Dam Name:	Bulloughs Pond Dam
Location:	Newton
National ID No:	MA03414
Known Condition:	Poor
Hazard Potential:	Significant
Middlesex Registry of Deeds:	Book 2618, Page 2

Dear Mayor Fuller:

In accordance with 302 CMR 10.08, the Department of Conservation and Recreation (DCR), Office of Dam Safety (ODS) has determined that Bulloughs Pond Dam does not meet accepted dam safety standards and is a potential threat to public safety. Therefore, DCR hereby issues a **CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER.**

ODS records indicate that the City of Newton is the Owner of the Bulloughs Pond Dam, National Inventory of Dams No. MA03414. ODS classifies the dam as a **Small Size, Significant Hazard Potential** Structure. Significant Hazard Potential Dams are dams that may cause the loss of life and property damage in the event of dam failure.

On May 2, 2017, and more recently on June 7, 2018, inspections of the Bulloughs Pond Dam were performed by engineering consultants PARE Corp., at the expense of the ODS. As a result of these inspections, the dam was determined to be **STRUCTURALLY DEFICIENT** and in **POOR** condition. The dam has been found to be in need of repair, breaching or removal to bring the dam into compliance with dam safety regulations.

The CERTIFICATE OF NON-COMPLIANCE is based on the above-referenced inspection report results which listed the observance of many deficiencies, including but not limited to:

- Unwanted vegetation in areas of the dam including large trees along the downstream slope;
- Scarping along the upstream slope and bare soils prone to erosion along the downstream slope;
- Deterioration/potential unstable headwall at the downstream end of the low-level outlet with observed scour/displaced riprap within the channel;
- Areas of scour along the downstream channel including at the low-level outlet and along the left and right banks. If erosion of the left bank continues, it could encroach on the toe of the downstream slope;
- Mortar is missing from some joints of the spillway training walls; and
- Additional maintenance deficiencies and dam safety concerns.

These foregoing deficiencies compromise the structural integrity of the dam and present a potential threat to public safety. ODS has determined that the dam needs to be repaired, breached or removed in order to bring the dam into compliance with dam safety regulations.

G.L. c. 253, Sections 44-48 and 302 CMR 10.00 set forth the jurisdiction for ODS and its authority to take action and order actions to be taken. For your information a copy of the Dam Safety Regulations, 302 CMR 10.00 Dam Safety, can be found on the ODS website.

DAM SAFETY ORDER:

In accordance with the authority of G.L. c. 253, Section 47, 302 CMR 10.07 and 10.08 you are hereby **ORDERED** to comply with the following:

1) **Conduct Follow-up Inspections:** You shall complete follow-up visual inspections at six (6)-month intervals, conducted by a registered professional civil engineer qualified to conduct dam inspections, at your cost, until adequate repairs are made or the dam is adequately breached. You shall submit the first Follow-up Inspection to ODS no later than **December 7, 2018.**

   Follow-up inspections are to be summary in format and shall provide a written description, including photographs, of any changes in condition. Your engineer is to use the attached ODS Poor Condition Dam Follow-up Inspection Form to report follow-up inspection findings. The form is also available electronically on the ODS web site. Your engineer shall include a cover letter on engineering firm letterhead that briefly summarizes the current follow-up inspection and findings.

You shall submit one (1) hard copy printed double-sided and one (1) electronic pdf copy of all completed follow-up visual inspection reports to ODS within thirty (30) days of the date of follow-up inspection field work.

2) **Conduct Phase II Inspection and Investigations.** You shall hire at your cost, a qualified registered professional engineer with dam engineering experience (engineer) to conduct a Phase II Inspection and Investigation of the dam to evaluate the structural integrity and spillway hydraulic adequacy of your dam and to develop/implement a plan to bring the dam into compliance with dam safety regulations by adequately repairing, breaching or removing the dam (see attached Phase II Investigation Outline).

   a. You shall commence the Phase II Inspection and Investigation no later than **October 16, 2018.** The Phase II Inspection and Investigation is to conform to the attached Phase II Investigation Outline. You are to, in a letter to ODS, no later than **October 2, 2018,** identify your selected engineer and inform ODS of the start date of the Phase II work.

   b. The Phase II Inspection and Investigation is to be completed, signed and stamped by your engineer and copies of the Phase II final report are to be delivered to ODS no later than **January 16, 2019.**

      You shall include a cover letter with the submitted Phase II report which describes your selected alternative to bring the dam into compliance with dam safety regulations. The owner shall submit a statement of your intent to implement inspection report recommendations to address structural and operational deficiencies to ODS upon submission of the required Phase II Inspection and Investigation completed by your engineer.

3) **Bring the dam into compliance and complete all repair, breach or removal work no later than January 16, 2020.** With your Phase II submittal, you must also provide a proposed timeline to design, permit and construct the selected alternative to repair, breach or remove the dam. The selected alternative must be completed, and the dam brought into compliance with Dam Safety regulations, by January 16, 2020.

4) **Additional Requirements:**
   a. You shall furnish copies of all required submittals listed above via certified mail.

   b. In order to maintain compliance with the Commonwealth's Wetlands Protection Laws you may have to seek requisite approval from your local Conservation Commission in accordance with G.L. c. 131, §40. You are obligated to contact and maintain communication with the Newton Conservation Commission and any other local, state or federal permitting agency the ensure compliance with the Wetlands Protection Act and any other regulatory requirements.

c. You must inform the following parties about the condition of the dam and your developing plans to bring the dam into compliance with dam safety regulations: all abutters of the impoundment upstream; property owners within one-half mile downstream of the Bulloughs Pond Dam; Northeast District, Division of Fisheries & Wildlife, 85 Fitchburg Rd, Ayer, MA 01432; Regional Director, Department of Environmental Protection, Northeast Region, 205B Lowell St, Wilmington, MA 01887; Conservation Commission, 1000 Commonwealth Ave, Newton, MA 02459; Emergency Management Director, 1164 Centre St, Newton, MA 02459.

Please be advised that in accordance with G.L. c. 253, § 47, "any person who fails to comply with the provisions of this chapter or of any order, regulation or requirement of the department relative to dam safety, shall be fined an amount not to exceed $5,000 for each offense, to be fixed by the court." Furthermore, each violation shall be regarded as a separate and distinct offense and, in case of a continuing violation, each day's continuance thereof shall be deemed to be a separate and distinct offense.

Nothing in this order releases the owner from the requirements of any prior Dam Safety Order issued for this dam.

In accordance with 302 CMR 10.08, this CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER will be recorded by the DCR at the Registry of Deeds in the county where the dam lies. Issuance of a Certificate of Compliance following adequate repair or breaching of the dam will be required to discharge the CERTIFICATE OF NON-COMPLIANCE and DAM SAFETY ORDER.

Please direct any technical questions, correspondence, or submittals to Emily Caruso, Department of Conservation and Recreation, Office of Dam Safety, 180 Beaman Street, West Boylston, MA 01583 or Emily.Caruso@state.ma.us. Other questions regarding process and administration of Dam Safety regulations should be directed to Bill Salomaa, Director of Office of Dam Safety, at William.Salomaa@state.ma.us. Additional dam safety information can be found at the DCR-ODS website: http://www.mass.gov/eea/agencies/dcr/conservation/dam-safety/.

Thank you for your coopération.

Sincerely,

Leo Roy
Commissioner, DCR

Enclosure: June 2018 Follow-Up Inspection

CC: Senator Cynthia Stone Creem
Representative Kay Khan
Newton Emergency Management Director
Newton Conservation Commission
Barbara Newman, U.S. Army Corps
Northeast Region, DEP
Deirdre Buckley, MEPA
Northeast District, DFW
Rob Lowell, DCR
William Salomaa, DCR
Ariana Johnson, Esq., DCR
Nick Wildman, DER

Department of Conservation and Recreation
Office of Dam Safety
Phase II Inspection and Investigation Outline

I.	Review of existing information.....
II.	Updated Detailed Phase I surface inspection in compliance with Office of Dam Safety Phase I Inspection format.....
III.	Subsurface Investigations – borings, sampling, analysis.....
IV.	Topographic Survey, wetlands flagging/delineation, of sufficient detail to support not only the Phase II effort, but sufficient for the future implementation of design phase.....
V.	Stability and seepage analyses – Seismic and static stability evaluation of dam (upstream and downstream slopes, internal materials), seepage potential, internal erosion potential, piping potential.....
VI.	Hydrologic/Hydraulic Analysis and spillway inadequacy resolution.....
VII.	Alternatives analysis and presentation of conceptual designs and associated estimated design, permitting and construction costs to bring the dam structure into compliance with Chapter 253 Section 44-48 and 302 CMR 10.00 Dam Safety Regulations by either executing selected repair plan or breach plan.....
VIII.	Final Report Presented to the Office of Dam Safety.....

Commonwealth of Massachusetts
Department of Conservation and Recreation
Office of Dam Safety Poor Condition Dam Follow-up Inspection Form

(Complete this inspection form and provide a cover letter on consulting firm letterhead that briefly summarizes the current follow-up inspection and findings. The cover letter shall be signed and stamped by the Registered Professional Engineer in charge of the inspection)

Dam Name:
Dam Owner:
Nat. ID Number:
Hazard Potential:
Location of Dam (town):
Coordinate location (lat, long):
Date of Inspection:
Weather:

Consultant Inspector(s): firm name and name of Registered Professional Engineer in charge of inspection.

Others in Attendance at Field Inspection: include list of names, affiliation and phone numbers.

Attachments: Updated site sketch with photo locations, Updated photos, and copy of locus map from Phase I report and other applicable attachments.

I. Previous Inspection date/Overall Condition:
- Date of most recent formal Phase I Inspection Report:
- List the overall condition reported in most recent Phase I Inspection Report:

II. Previous Inspection Deficiencies:
- List identified deficiencies in the most recent Phase I Inspection Report:

III. Overall Condition of Dam at the Time of the Current Follow-up Inspection:
   a. State the current condition
   b. Have conditions changed since the previous inspection? Yes or no.

IV. Comparison of Current Conditions to Condition Listed in Previous Phase I Inspection Report:
   a. Have any of the deficiencies listed in the previous Phase I Inspection Report worsened?
   b. If yes, list the changes.
   c. Are there any additional deficiencies that have been identified in the current inspection?

d. If yes, list the deficiencies and describe.

V. Dam Safety Orders:
- List dam safety orders that have been issued to the dam owner pertaining to this dam.

VI. Maintenance:
1. Indicate if there exists an operation and maintenance plan for the dam.
2. Indicate if it appears the dam is being maintained.

VII. Recommendations:

VIII. Other Comments or Observations:

IX. Updated Site Sketch with Photo Locations:

X. Updated Photos:

XI. Copy of Locus Map from Phase I Report:

XII. Other applicable attachment:

367-20 21.07.20

City of Newton, Massachusetts
Office of the Mayor

RUTHANNE FULLER
MAYOR

Telephone
(617) 796-1100

Telefax
(617) 796-1113

TDD
(617) 796-1089

E-mail
rfuller@newtonma.gov

August 31, 2020

Honorable City Council
Newton City Hall
1000 Commonwealth Avenue
Newton Centre, MA 02459

Councilors:

I respectfully submit a docket item to your Honorable Council requesting authorization to appropriate and expend the sum of $900,000 from Acct # 6000-3240 Water Fund Surplus – Available for Appropriation for the purpose of funding the rehabilitation of the Waban Hill Covered Reservoir (which should not be confused with the Waban Hill Reservoir park).

A list of items included in the project scope, existing photographs, and project plan drawings are attached.

Thank you for your consideration of this matter.

Sincerely,

Ruthanne Fuller

Ruthanne Fuller
Mayor

RECEIVED
2020 AUG 31 PM 12:42
CITY CLERK
NEWTON, MA. 02459

City of Newton

DEPARTMENT OF PUBLIC WORKS
OFFICE OF THE COMMISSIONER
1000 Commonwealth Avenue
Newton Centre, MA 02459-1449

Ruthanne Fuller
Mayor

August 27, 2020

To: Maureen Lemieux, Chief Financial Officer

From: James McGonagle, Commissioner of Public Works
Theodore J. Jerdee, Utilities Director
Jack Cowell, Financial Director DPW

Subject: Request to Docket funding for the Rehabilitation of the Waban Hill Covered Reservoir.

Brief Description: I would request funding in the amount of $900,000 for the rehabilitation of the city's 10.4 MG Waban Hill Covered Reservoir (WHCR), located at 166 Waban Hill Road North. The scope of work that is included in this project consists of the following:

1. Roofing improvements including:
   i. Remove existing asphalt shingles. Furnish and install new asphalt shingles.
   ii. Furnish and install ice & water shield within 6-feet of roof edge. Furnish and install new underlayment along remaining roof area.
   iii. Furnish and install new flashing and trim boards including PVC facia trim boards and vented vinyl soffit with insect screens.
   iv. Remove and replace cupola. New cupola shall include insect and security screening.
   v. Remove existing skylights. Furnish and install new skylights (4 total).
2. Remove four (4) 24" discharge gate valves along bottom of central core.
3. Remove all flanges.
4. Install new stainless-steel piping as shown on the Contract Drawings. Use existing piping as host pipe. Sleeve new piping inside existing piping into each cell with link seals.
5. Install four (4) new 24" butterfly valves.
6. Install conduit for wiring from discharge piping to PLC at doorway for Cl2 monitors (Monitors to be furnished and installed by MWRA.). Includes allowance for City's SCADA integrator, Woodard & Curran, to wire and program at PLC.
7. Concrete surface repair (Approximately 100 square feet).
8. Sand blast exterior of all process piping.
9. Sand blasting, pit filler, pit welding, and plate welding interior and exterior of central core standpipe.
10. Paint exterior of all process piping.
11. Paint interior and exterior of central core standpipe.
12. Install fiberglass-reinforced plastic (FRP) or high-density cross-linked polyethylene (HDXLPE) covers on central core standpipe and overflow. Provide manway with bolted hatch on cover for central core standpipe for inspection. Provide screened vent on both covers.

Telephone: 617-796-1009 • Fax: 617-796-1050 • Jmcgonagle@newtonma.gov

13. Inspect, tighten, or replace all light fixture brackets/supports.
14. Provide new LED light fixtures at all existing lighting locations.
15. Remove and replace entry door frame and door. New hardware including hinges, knobs, and deadbolts. All locks shall be keyed to City's existing locks. Incorporate existing door alarm.

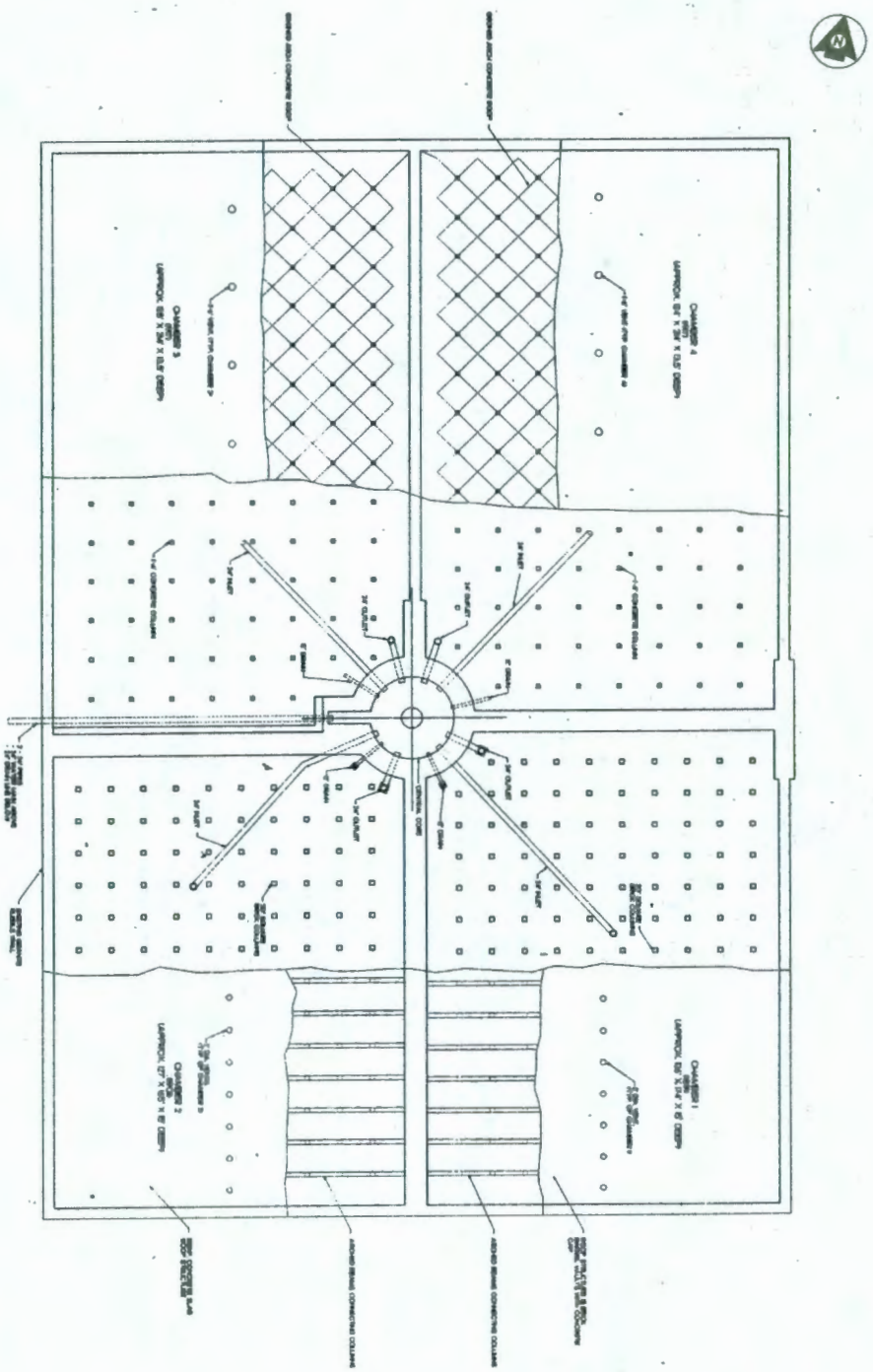
Please docket this request with the Honorable City Council for their consideration.

Sincerely,

James McGonagle
Commissioner Public Works

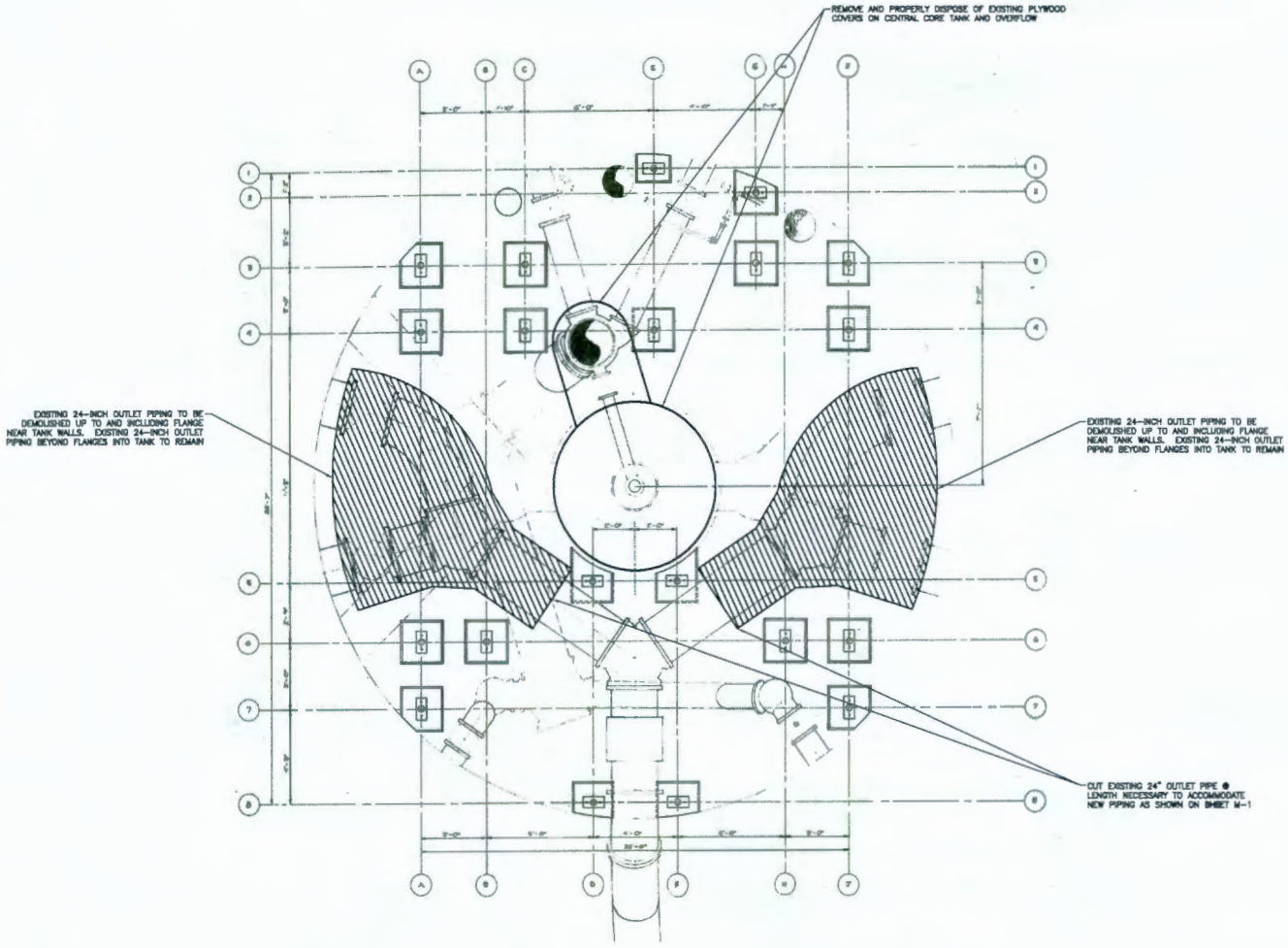
Attachment: Existing Photographs-WHCR
(90% WHCR Plans)

Telephone: 617-796-1009 • Fax: 617-796-1050 • Jmcgonagle@newtonma.gov



EXISTING RESERVOIR LAYOUT AND PIPING PLAN
SCALE: 1" = 20'

C-1	TATA & HOWARD	50% REVIEW SUBMITTAL NOT FOR CONSTRUCTION		EXISTING RESERVOIR LAYOUT AND PIPING PLAN	CITY OF NEWTON NEWTON, MASSACHUSETTS WABAN HILL RESERVOIR REHABILITATION



DEMOLITION PLAN
SCALE: 3/8" = 1'-0"

GENERAL DEMOLITION NOTES

1. CONTRACTOR SHALL REMOVE AND PROPERLY DISPOSE OF ALL MATERIALS SCHEDULED TO BE DEMOLISHED.
2. ANY EXISTING PIPING AND/OR EQUIPMENT DAMAGED BY THE CONTRACTOR DURING DEMOLITION SHALL BE REPLACE BY THE CONTRACTOR AT NO COST TO THE OWNER.

CITY OF NEWTON
NEWTON, MASSACHUSETTS
WABAN HILL RESERVOIR
REHABILITATION

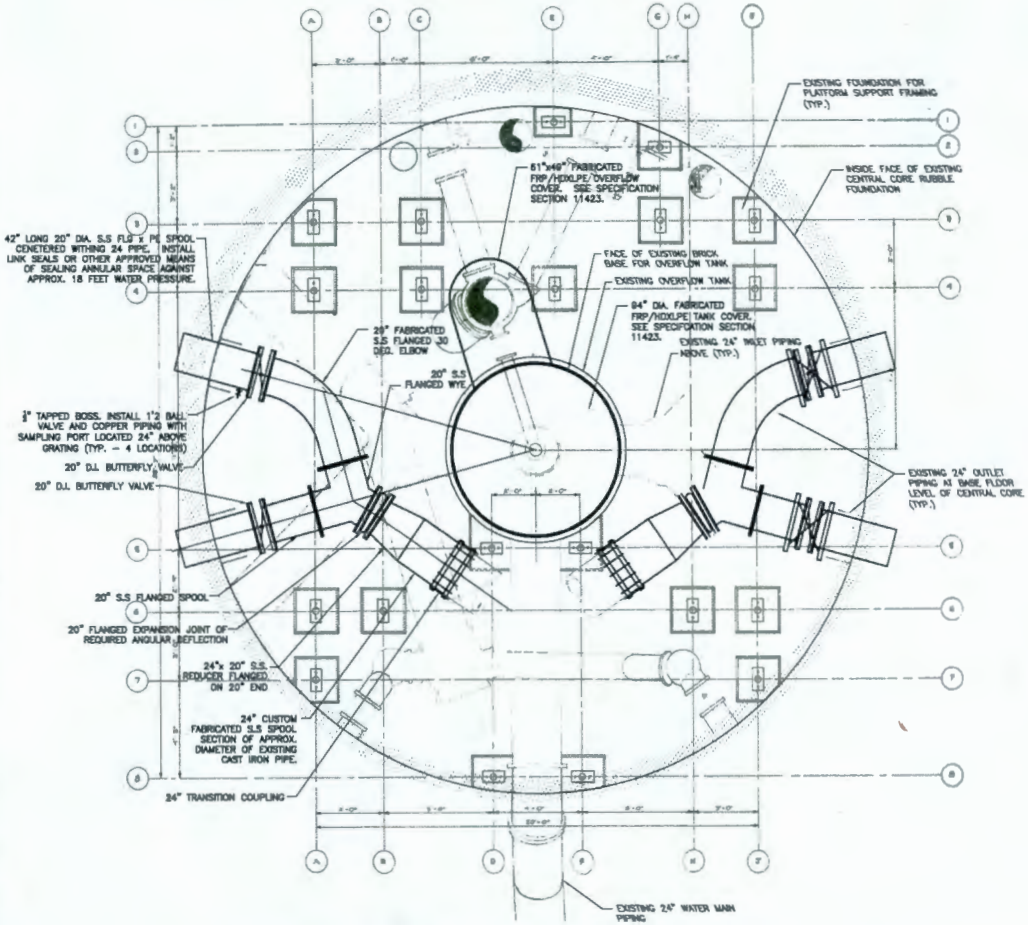
CENTRAL CORE
DEMOLITION PLAN

50% REVIEW SUBMITTAL
NOT FOR CONSTRUCTION

TATA & HOWARD

TAH NO.: 4089
DATE: FEBRUARY 2020
SCALE: AS NOTED

D-1

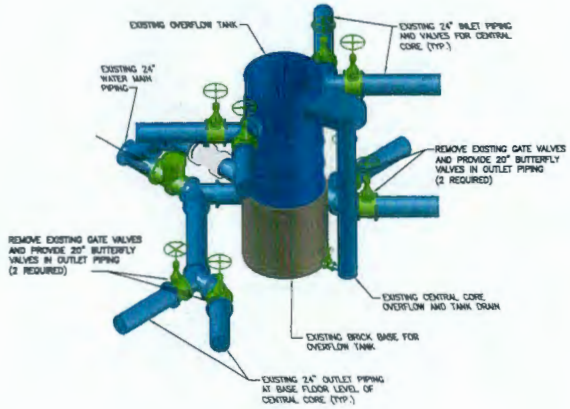


1. EXISTING CAST IRON PIPING DATES BACK TO APPROXIMATELY 1900. PIPE DIAMETERS AND FITTINGS DO NOT CORRELATE WITH CURRENT CAST/DUCTILE IRON STANDARDS.
2. THE EXISTING PIPING BASE PLAN WAS COPIED FROM EARLY DESIGN DRAWINGS AND MAY NOT REFLECT AS-BUILT CONDITIONS. THEREFORE, THE NEW PIPING CONFIGURATION AS PORTRAYED MAY NOT BE INDICATIVE OF WHAT IS REQUIRED. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL FIELD DIMENSIONS PRIOR TO PIPE FABRICATION.
3. BUTTERFLY VALVES SHALL BE INSTALLED IN THE APPROXIMATE SAME LOCATION AS THE EXISTING GATE VALVES TO ALLOW VALVE OPERATION FROM THE ELEVATED PLATFORMS.
4. THE EXISTING 24" WALL PIPES SHALL BE USED AS SLEEVES FOR THE INSTALLATION OF THE 20" S.S. PIPING, AND THE ANNULAR SPACE SEALED WATERTIGHT. THE FLANGE SHALL BE CUT AWAY AND THE PIPE EDGES GROUND SMOOTH.
5. CONTRACTOR SHALL PROVIDE CONCRETE PIPE SUPPORTS/SADDLES AS PER DRAWINGS AND AS MAY BE REQUIRED.

PROCESS PIPING PLAN

SCALE: 3/8" = 1'-0"

SCALE: 3/8" = 1'-0"



CENTRAL CORE PIPING ISOMETRIC

NOT TO SCALE

REHABILITATION NOTES:

1. ALL INTERIOR PIPING SHALL BE SAND BLASTED AND PAINTED. COLORS TO BE CHOSEN BY OWNER. SEE SPECIFICATIONS SECTIONS 09860 AND 09900.
2. SAND BLASTING, PIT FILLER, PIT WELDING, AND PLATE WELDING SHALL BE PERFORMED ALONG INTERIOR AND EXTERIOR OF CENTRAL CORE STANDPIPE. PAINT INTERIOR AND EXTERIOR OF CENTRAL CORE STANDPIPE. COLORS TO BE CHOSEN BY OWNER. SEE SPECIFICATIONS SECTIONS 09860 AND 09900.
3. FRP/HDXLPE TANK AND OVERFLOW COVERS SHALL HAVE SCREEN VENTS. FRP/HDXLPE TANK COVER SHALL HAVE 24" DIA. MANWAY WITH BOLTED COVER FOR INSPECTION OF CENTRAL CORE STANDPIPE. SEE SPECIFICATION SECTION 11423.
4. INSPECT, TIGHTEN, AND/OR REPLACE LIGHT FIXTURE BRACKETS/SUPPORTS AS REQUIRED. PROVIDE TEN (10) NEW LED LAMPS AT ALL EXISTING LIGHTING LOCATIONS. SEE SPECIFICATION SECTION 16500. SEE LIGHTING SCHEDULE THIS SHEET.

LIGHTING SCHEDULE		
QTY	DESCRIPTION	LUMENS
10	PHILIPS PAR38 LED 120V 11W 3000K LAMPS	900

CITY OF NEWTON
NEWTON, MASSACHUSETTS

WABAN HILL RESERVOIR
REHABILITATION

CENTRAL CORE
PROCESS PIPING
PLAN AND ISOMETRIC

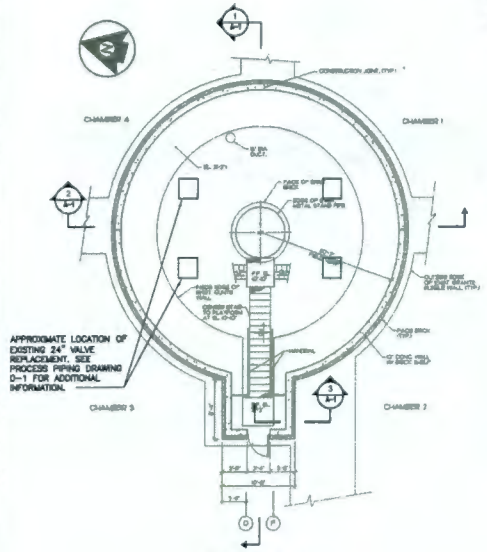
50% REVIEW SUBMITTAL
NOT FOR CONSTRUCTION

TATA & HOWARD

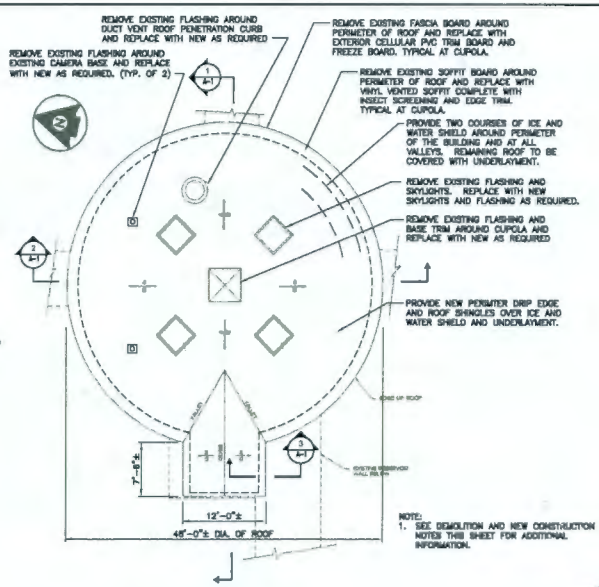
TBH NO.: 4389
DATE: FEBRUARY 2020
SCALE: AS NOTED

M-1

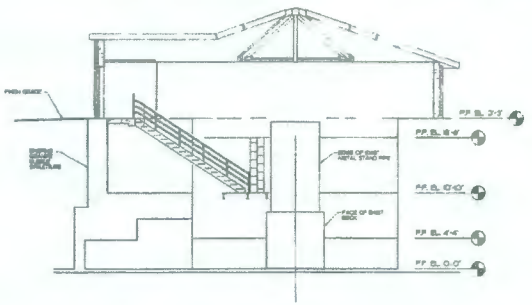
367-20



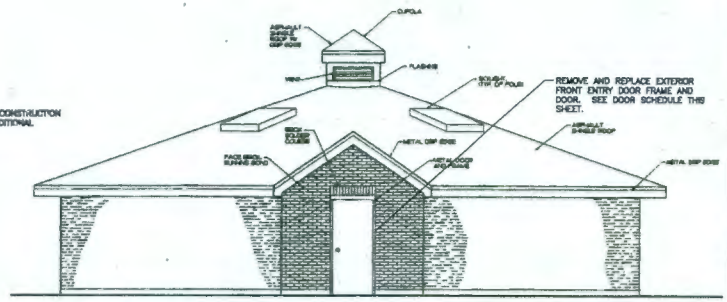
FLOOR PLAN
SCALE: 1" = 20'



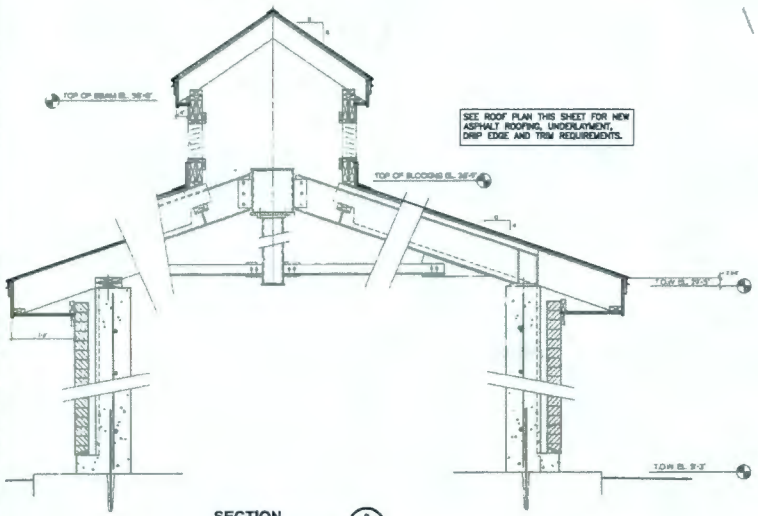
ROOF PLAN
SCALE: 1" = 20'



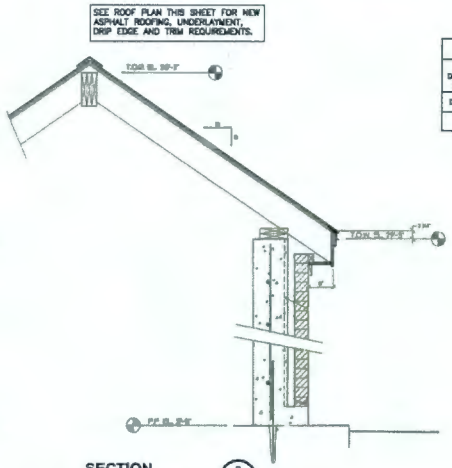
SECTION 1/A-1
SCALE: 1/8" = 1'-0"



BUILDING ELEVATION
SCALE: 1/4" = 1'-0"



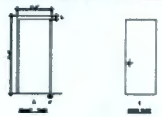
SECTION 2/A-1
SCALE: 3/4" = 1'-0"



SECTION 3/A-1
SCALE: 3/4" = 1'-0"

DOOR SCHEDULE

DOOR NO.	LOCATION	DOOR SIZE W.	DOOR SIZE H.	DOOR TYPE	DOOR THICKNESS	FRAME TYPE	HDWR. SET	LOCATION OF DETAILS FOR HEAD, JAMB AND SILL	NOTES
D-1	EXTERIOR FRONT ENTRY	3'	7'-0"	1	1-3/4"	A	1	DWG. A-1	SINGLE DOOR



DEMOLITION NOTES:

1. REMOVE ALL EXISTING ASPHALT SHINGLES, UNDERLAYMENT, AND DRIP EDGE MATERIAL TO THE PLYWOOD DECKING. TYPICAL FOR ALL ROOF AREAS.
2. REMOVE EXISTING FASCIA AND SOFFIT MATERIALS TO WOOD FRAMING. TYPICAL FOR ALL ROOF OVERHANGS.
3. INSPECT ALL WOOD FRAMING AND PLYWOOD SURFACES AND IDENTIFY ALL DECAYED AREAS. COORDINATE REPLACEMENT MATERIALS AND METHODS WITH ENGINEER FOR APPROVAL PRIOR TO REPLACEMENT.
4. REMOVE AND REPLACE FOUR (4) SKYLIGHTS.
5. REMOVE AND REPLACE CUPOLA IN-KIND.
6. PROTECT THE EXISTING ROOF SUPPORTED EQUIPMENT AS REQUIRED DURING DEMOLITION AND NEW CONSTRUCTION.

NEW CONSTRUCTION NOTES:

1. INSTALL FASCIA, FREEZE BOARD, AND SOFFIT MATERIALS AS REQUIRED FOR THE PERIMETER AND CURVATURE OF THE STRUCTURE OVERHANG. PROVIDE ADDITIONAL PRESSURE TREATED BLOCKING AS REQUIRED.
2. EXISTING SKYLIGHTS BY WASCO, LOCATED IN WELLS, MAINE. DOMED SKYLIGHT APPROXIMATELY 52"x52". REPLACE IN KIND OR APPROVED EQUAL. SEE SPECIFICATION SECTION 08655.

CITY OF NEWTON
NEWTON, MASSACHUSETTS
WABAN HILL RESERVOIR
REHABILITATION

ARCHITECTURAL
BUILDING RENOVATIONS
PLANS AND SECTIONS

60% REVIEW SUBMITTAL
NOT FOR CONSTRUCTION

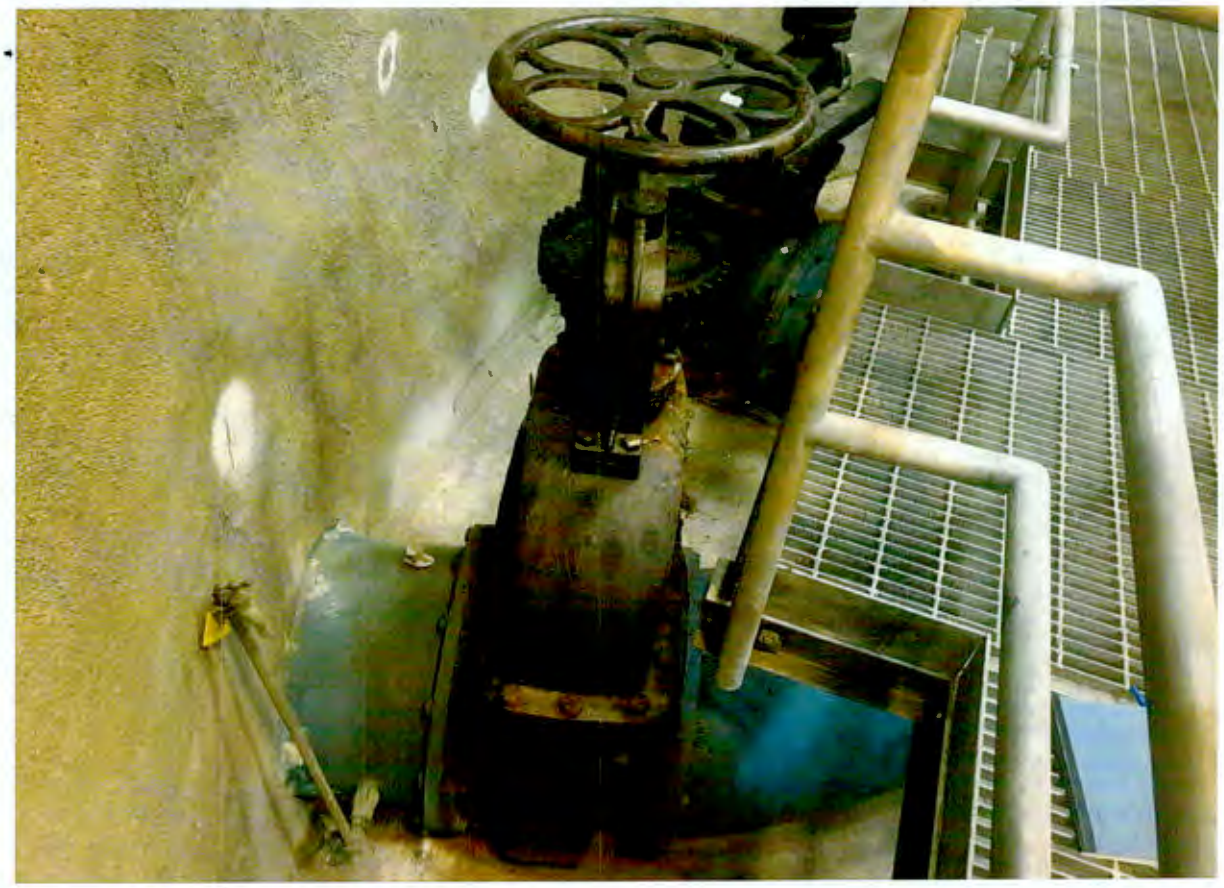
TATA & HOWARD

T&H NO.: 4089
DATE: FEBRUARY 2020
SCALE: AS NOTED

A-1


SCADA PANEL
WILSON CONTROLS


24S




16'-0"