FINAL

PRELIMINARY DESIGN MEMORANDUM

FOR

RESERVOIR DAM FISH PASSAGE PROJECT

JUNE 2014

PREPARED FOR

TOWN OF SCITUATE

SUBMITTED BY

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PRELIMINARY DESIGN MEMORANDUM
RESERVOIR DAM FISH PASSAGE PROJECT

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EXECUTIVE SUMMARY

The Town of Scituate Department of Public Works (DPW) conducted a feasibility study in 2013 of alternatives for managing Reservoir Dam on First Herring Brook to improve water supply and fish passage. The 2013 study was funded through a grant from the Sustainable Watershed Management Initiative (SWMI) through the Massachusetts Department of Environmental Protection (DEP). The results of the study indicated that management of the reservoir in the spring to store more water would meet the Town's water demands throughout the summer and provide adequate flow for fish passage and stream habitat in the fall.

In 2014, the DPW received a second SWMI grant to complete the preliminary design of spillway and fishway modifications needed to implement the selected management plan for expanding the storage capacity at Reservoir Dam. The preliminary design is the subject of this report. The recommended plan would add 108.8 acre feet (ac-ft) of storage capacity with installation of a bottom-hinged crest gate on the spillway and a lower the fishway exit channel. This storage is equivalent to 35.45 million gallons or 28 days of additional storage at the Town's typical winter time pumping rate. In the spring, the crest gate would store water in the reservoir up to El. 40.4 feet (ft) North American Vertical Datum 1988 (NAVD88), which is 1.5 ft higher than the existing spillway crest and is the normal high water level for the reservoir in the spring. The crest gate would have a motor operator and would be remotely controlled from the Water Treatment Plant using the existing supervisory control and data acquisition (SCADA) system.

The fishway exit channel would be lowered to El. 35.0 ft, which is 3.9 ft lower than the existing spillway crest and fishway exit channel bottom. Seven (7) removable weirs would be installed in the exit channel and would be manually positioned with a monorail hoist system as necessary to control the fishway flow over the range of reservoir levels. A footbridge across the spillway and the fishway exit channel would be constructed for personnel access to the removable weir hoisting system. The existing weirs in the lower portion of the fishway would be modified to incorporate a 1.5-ft wide weir for upstream fish passage and a 6-inch wide low flow notch for downstream passage.

The proposed management plan would incorporate shoreline improvements along Chief Justice Cushing Highway (CHJH) and Sherman Drive. Erosion protection would be installed along 700 ft of the CJCH highway embankment. The Tack Factory Dam gate structure, which is northwest of the highway, would be modified to assure continued access and minimize gate maintenance. A bioswale would be installed at the end of Sherman Drive to treat stormwater and protect the reservoir water quality.

The estimated construction cost for implementing the proposed reservoir management plan is $740,000. The cost includes:

Spillway modifications	$274,000
Fishway modifications	$188,000
Shoreline improvements	$122,000
Contractor costs (mobilization/temporary facilities)	$ 89,000
Allowance for indeterminants/contingency	$ 67,000

Engineering, design, permitting, and construction management would cost $126,000, resulting in a total project cost of $866,000.

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
1/2 PMF	one-half Probable Maximum Flood
ac-ft	acre-feet
Cavanaro	Cavanaro Consulting, Inc.
cfs	cubic feet per second
CHJH	Chief Justice Cushing Highway
CMR	Code of Massachusetts Regulations
DCR	Department of Conservation and Recreation
DPW	Scituate Department of Public Works
EAP	Emergency Action Plan
EHG	estimated high groundwater
ft	feet
IOP	Interim Operational Plan
LF	linear feet
DER	Massachusetts Division Ecological Restoration
DMF	Massachusetts Division of Marine Fisheries
DEP	Massachusetts Department of Environmental Protection
MBP	Massachusetts Bays Program
NAD83	North American Datum 1983
NAVD88	North American Vertical Datum 1988
NSRWA	North and South Rivers Watershed Association
ODS	Office of Dam Safety
SCADA	supervisory control and data acquisition
SWMI	Sustainable Watershed Management Initiative
TSS	total suspended solids
WEAP	Water Evaluation and Planning
WRC	Scituate Water Resource Committee
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 INTRODUCTION

The Scituate Department of Public Works (DPW) and Water Resource Committee (WRC) has been partnering with the North and South Rivers Watershed Association (NSRWA), Massachusetts Bays Program (MBP), U.S. Fish and Wildlife Service (USFWS), Massachusetts Division Ecological Restoration (DER) and Massachusetts Division of Marine Fisheries (DMF) to expand the Town's water supply while restoring the river herring (alewife) run back to First Herring Brook and its impoundments. In the fall of 2012, the Town of Scituate, MA conducted a preliminary assessment of improvements for Old Oaken Bucket Dam and Reservoir Dam. The results of that assessment indicated that providing more storage in the Reservoir by maintaining a higher normal pool level could allow the existing fishway to function during the spring upstream migration and fall out-migration periods while providing additional storage for the Town's water demand. The 2012 assessment recommended a more detailed feasibility study of Reservoir Dam to further investigate options to restore fish passage to the Reservoir and evaluate potential impacts on the infrastructure around the Reservoir.

The Scituate DPW was awarded a grant by the Massachusetts Department of Environmental Protection (DEP) under the Sustainable Watershed Management Initiative (SWMI) in 2013 to conduct a detailed feasibility study of alternatives available to improve fish passage utilizing the existing fishway at Reservoir Dam to the maximum extent possible by raising the normal pool levels. The results of the feasibility study indicated that raising the Reservoir Dam normal pool one foot would have minimal impact on properties adjacent to the impoundment and recommended lowering of the fishway exit channel by 3.5 ft and triggering the outside water ban 3.5 feet higher than the current trigger. This scenario would allow operation of the fishway for upstream and downstream herring migration and would provide effective fish passage 98% of the time at both the Reservoir Dam and Old Oaken Bucket Dam fish ladders for the spring migration and 94% of the time at Reservoir Dam fish ladder and 75% of the time at Old Oaken Bucket Dam fish ladder for the fall migration. This scenario of raising the reservoir and lowering the fish ladder also resulted in added drought resilience for the town and no reservoir failure.

A second SWMI grant was award to the Town in 2014 to complete the preliminary design of the spillway modifications needed to raise the normal pool elevations and fishway modifications necessary for upstream fish passage in the spring and downstream passage in the fall. The preliminary design also included initial resource agency consultation and public outreach meetings about the approach to improving fish passage in First Herring Brook. This report summarizes the preliminary design of the spillway and fishway modifications selected by the DPW and WRC to increase water storage and restore fish passage at Reservoir Dam.

2.0 EXISTING PROJECT FEATURES

Reservoir Dam was constructed on First Herring Brook in the early 1960s as a storage reservoir for the Town of Scituate's public water supply. The Reservoir is used to supplement well water delivery to the water treatment plant at Old Oaken Bucket Dam. The existing project features are similar to the original design with the spillway structure repaired in 1994. Routine maintenance on the dam and structures are completed on an as needed basis. A summary of the pertinent project data is presented in Table 2-1 on the following page.

Reservoir Dam is an earthen embankment with a concrete core wall. The dam has an ogee-shaped concrete spillway, a low level outlet, and a pool and weir fishway. The low level outlet is a 12-inch diameter pipe through

the dam with an inlet structure at the bottom of the reservoir and a flow control valve at the downstream side of the dam. The low level outlet flow control valve has an electric motor and is operated through a supervisory control and data acquisition (SCADA) system. The fishway has 21 weirs approximately 3 ft wide creating pools that are approximately 3.5 ft long.

Table 2-1
Pertinent Reservoir Dam Project Data[1)]

Impountment:	
Drainage area	4.4 sq mi
Normal pool elevation level[2)]	38.9 ft
Flood pool elevation level	45.8 ft
Top of dam elevation level[2)]	45.0 ft
Surface area at normal pool	80 ac
Surface area at top of dam	140 ac
Storage at normal pool	500 ac-ft
Storage at flood pool	1,150 ac-ft
Spillway:	
Crest elevation[2)]	38.9 ft
Crest length[2)]	37.5 ft
Streambed elevation at toe of spillway[2)]	25.0 ft
Flood discharge at top of dam	2,300 cfs
Low Level Outlet:	
Type	Pipe with butterfly valve
Size	12 inch diameter
Operator	Motor remotely controlled
Invert elevation[2)]	25.3 ft (outlet)
Discharge capacity at normal pool	12 cfs (valve full open)
Discharge capacity at flood pool	42 cfs (valve full open)
Fishway:	
Type	Pool and weir
Number of pools	21
Pool width	3 ft
Pool length[3)]	3.67 ft
Pool depth below weir	1.5 ft
Pool elevation differential[3)]	7-10 inches
Entrance bottom elevation[2)]	23.9 ft
Exit bottom elevation[2)]	38.9 ft
Discharge capacity at normal pool	0 cfs (not operable)
Discharge capacity at flood pool	115 cfs (no stoplogs)
Channel Downstream of Fishway[2)]:	
Slope[2)]	1V:30H (maximum)
width[2)]	20 ft (minimum)

[1)] Data based on First Herring Brook Reservoir Dam, Phase I Inspection/Evaluation Report, April 10, 2013, except as otherwise noted. All elevations referenced to NAVD 1988.

[2)] Data are based on Cavanaro Consulting field survey measurement, May 2014 (see Drawings C-101 and C-102, Appendix A).

[3)] Based on engineer's measurements in 2012 with no water in fishway.

The fishway exit channel is at the same elevation as the spillway crest and functions only when impoundment levels are higher than the spillway crest. The dam does not currently have any downstream passage facilities except for the existing fishway when there is flow over the spillway. Since blueback herring and alewife, collectively known as river herring, key on surface flow for late summer/fall out-migration, the Reservoir Dam low-level outlet is not effective for downstream passage.

DPW contracted Cavanaro Consulting, Inc. (Cavanaro) in March 2014 to conduct a topographic survey of Reservoir Dam and Route 3A, also referred to Chief Justice Cushing Highway (CJCH), across the impoundment. Control points were set and surveyed tying the system into the North American Datum 1983 (NAD83) and North American Vertical Datum 1988 (NAVD88). The U.S. Geological Survey (USGS) disk at the CJCH culvert was found to be El. 38.9 ft NAVD 1988, corresponding to El. 39.7 ft NGVD 1929. All Reservoir Dam water levels were referenced to this disk as El. 40.0 ft NGVD 1929 prior to this survey. NAVD 1988 plus 0.80 ft equals NGVD 1929. **All elevations in this report reference NAVD 1988 unless otherwise noted.**

The topographic survey defined the overall dimensions and elevations of the embankment, spillway, fishway, and outlet channel at Reservoir Dam and the road surface, embankment, and stormwater catch basin locations along CJCH where it crosses between the reservoir and Tack Factory Pond. The spillway was measured at the same elevation as the USGS disk with a 37.5 ft wide crest at the narrowest point at the top of the ogee. The low point in CJCH was found to be near #401 CJCH at El. 42.4 ft. The existing conditions survey data are shown on Drawings C-101 and C-102 in Appendix A.

The Scituate DPW is currently implementing an Interim Operational Plan (IOP) (Kearns, 2012) recommended by the NSRWA and its partners. The IOP utilizes reservoir storage below the spillway crest (El. 38.9 ft) to meet water supply demands and environmental flow releases needed to maintain the habitat in First Herring Brook between Reservoir Dam and Old Oaken Bucket Pond, and downstream of Old Oaken Bucket Dam. Streamflow guidelines in the IOP are summarized in Table 2-2. The Feasibility Report, “Reservoir Dam Modifications for Higher Pond Levels, First Herring Brook Fish Passage Improvements”, (June 2013), describes the hydraulic modeling used to develop the streamflow guidelines and presents the results of numerous scenarios evaluated to develop the 2011 IOP which was updated in 2012 to reflect changes in the irrigation watering ban.

Table 2-2
2011 IOP Streamflow Guidelines

Bioperiod	Eisenhower Lane (Downstream of Reservoir Dam)			Country Way (Downstream of Old Oaken Bucket Dam)	
	Water Supply (cfs)[2]	Fishway[3] (cfs)	River (cfs)	Fishway (cfs)	River (cfs)
March	0.61/0.31	0	2.56	0	3.78
April-May[1]	0.98/0.64	0	2.56	5.20[4]	3.78
June-August	1.23/0.82	0	0.22	0	0.39
September-October[1]	0.82/0.48	0	0.25	2.56[4]	0.45
November	0.53/0.28	0	0.25	0	0.45
December-February	0.36/0.27	0	2.13	0	3.15

[1] April-May and September-October: manage releases over fishway weirs unless water is not available. If drought conditions are occurring, use staff gages to provide minimum river flow to maintain stream habitat.

2) First number represents average flow meeting 2011 IOP irrigation water ban trigger level. Second number represents one day per irrigation water limit implemented by the DPW in 2012. Average flows are the gallons per day (gpd) used by the town during each period, converted to cubic feet per second (cfs). Complete outside water ban instituted when Reservoir Dam level drops to El. 33.9 ft. Streamflow guidelines discontinued when Reservoir Dam level drops to El. 30.9 ft.

[3] Fishway not currently operable except at water levels higher than spillway crest.

[4] An eight (8) inch water depth over the fishway weirs corresponds to 5.2 cfs; a five (5) inch water depth over the fishway weirs corresponds to 2.56 cfs. Because these flows exceed the river flow goals, all downstream releases during the migration season should be made through the fish ladder.

3.0 PRELIMINARY DESIGN CRITERIA

3.1 DAM SAFETY

Reservoir Dam is a Class I high hazard dam. Any modifications to the spillway cannot reduce the discharge capacity for the design flood equal to the one-half Probable Maximum Flood (1/2 PMF) in accordance with Massachusetts General Law c.253, Section 46 and 301 Code of Massachusetts Regulations (CMR) 10.07. All modifications to the dam, spillway, and fishway must conform to the dam safety regulations and must be approved by the Department of Conservation and Recreation (DCR), Office of Dam Safety (ODS).

3.2 WATER SUPPLY

The primary purpose of Reservoir Dam is to provide water storage for the Town of Scituate's public water supply. The Scituate DPW will continue to implement the IOP developed by the NSRWA to meet downstream water supply demands and environmental flow releases at Old Oaken Bucket Pond until any changes are implemented and a new operating plan is developed. Modifications to the spillway and fishway must maximize reservoir storage capacity without impacting dam safety. Higher pool levels must have minimal impact on Route 3A and properties adjacent to the reservoir.

Results of the Water Evaluation and Planning (WEAP) modeling for the 2013 Feasibility Study indicated that raising the normal pool only 1 ft, lowering the fishway exit channel by 3.5 ft to El. 35.4 ft, and raising the water ban trigger by 3.5 ft would create sufficient storage to meet the water supply demand and the BioQ90 flows in the

different downstream river reaches. BioQ90 flows are rates that exceed the minimum flow requirement 90% of the time for each biological period. The WEAP model results for these modifications (Scenario 5 in 2013 Feasibility Report) indicate that fish ladder flows would occur 98% of the time at Reservoir Dam and 94% of the time at Old Oaken Bucket Dam during the spring in-migration and 98% of the time at Reservoir Dam and 74% of the time at Old Oaken Bucket Dam during the fall out-migration. Water supply and BioQ90 flows would be released through the low level outlet when the reservoir levels are too low to operate the fishway. The frequency of the water ban for this option was 9-20% of the summer days depending on the trigger points consistent with the existing IOP. When raising the trigger 3.5 ft from the current operation, the frequency of summer days with with total outdoor watering ban was 12% throughout the period of record - compared with the current situation of 11%.

In order to maximize water storage, the Scituate Water Resource Committee (WRC) agreed that the proposed management plan should reflect El. 40.4 ft as the normal pool level since a 1.5 ft higher pool would not be significantly different than the existing conditions.

3.3 PROPERTY PROTECTION

Modifications to the spillway, fishway, and normal pond levels must minimize impacts on CJCH and properties adjacent to the Reservoir Dam impoundment. The 2013 Feasibility Study indicated that there may be potential impact to CJCH, the three properties on CJCH closest to reservoir, and several properties at the end of Sherman Drive near the access easement to the Reservoir Dam. Normal pool levels are constrained by the lowest point in the centerline profile of CJCH where there should be at least 2.0 ft of freeboard. Slope protection must be provided along the CJCH embankments in areas that would be subjected to potential erosion resulting from higher normal pond levels. Mitigation measures must be implemented to minimize impacts on property use, structures, and septic systems to private homeowners adjacent to the impoundment resulting from higher normal pond levels and higher groundwater levels resulting from higher normal reservoir levels.

3.4 FISH PASSAGE

The existing pool and weir fishway generally conforms to USFWS guidelines. However, the fishway exit channel will be reconstructed to allow operation at lower reservoir levels for upstream and downstream fish passage. Removable weirs are required to expand the operating range for fish passage. The weirs in the lower portion of the fishway would be retrofitted with notched weirs for downstream passage, similar to the notched weirs installed at the Old Oaken Bucket Dam fishway in 2013. All fishway modifications must be designed in accordance with USFWS guidelines.

Fish passage criteria based on the proposed management plan developed for Reservoir Dam are:

- *Target species:* Alewife, smelt, and American eel
- *Migration period:* *Upstream – March-June*
  Downstream – September-October
- *Reservoir Dam operating stream flows:*
  Minimum upstream passage – 2.6 cfs (5 inch depth over fishway weirs)
  Maximum upstream passage – 116 cfs (1.0 ft depth over spillway)
  Minimum downstream passage – 0.25 cfs (Interim Operational Plan)
  Maximum downstream passage – 9 cfs (1.0 ft depth over fishway weirs)

- *Reservoir Dam operating headpond water levels:*
  Normal pond – El. 40.4 ft
  Minimum upstream passage – El. 36.8 ft (5 inches above top weir)
  Maximum upstream passage – El. 41.4 ft (limited by existing fishway)
  Minimum downstream passage – El. 36.1 ft (5 inch depth over low flow notch)
  Maximum downstream passage – El. 41.4 ft (1.0 ft depth over top weir)
  One half probable maximum flow (½ PMF) – El. 45.0 ft (top of dam)
- *Reservoir Dam operating tailwater levels:*
  Minimum upstream passage – El. 25.0 ft
  Maximum upstream passage – El. 25.7 ft
  Minimum downstream passage – El. 25.0 ft
  Maximum downstream passage – El. 25.4 ft
- *Pool and weir fishways*:
  Pool drop – 8 inches
  Water depth over weir – 8 inches
  Pool size – 3-5 minutes per pool
  Pool volume – 0.5 ft3 per pound of fish
  Energy Dissipation Factor (EDF) < 4.0
  EDF = (Q x W x D)/Vol
  Q = fishway flow (cfs)
  W = unit weight of water (lbs/ft^3)
  D = drop per pool (ft)
  Vol = pool volume (ft^3) = width (ft) x length (ft) x depth (ft)
- *Downstream fish bypass:*
  Type – surface bypass
  Minimum depth of water – 4-5 inches
  Minimum width – 6 inches with no spillway flow; 3 ft with spillway flow

Using USFWS guidelines for pool and weir fishways, estimates for the existing pool and weir configuration indicate that the fishway could handle as many as 72 alewives per minute (4,300 alewives per hour) at Old Oaken Bucket Dam and 33 alewives per minute (2,000 alewives per hour) at Reservoir Dam. The median habitat carrying capacity of Reservoir Dam is 25,000-30,000 alewife as discussed in the 2013 Feasibility Report.

4.0 PROPOSED MODIFICATIONS

Water supply storage and fish passage objectives at Reservoir Dam would be achieved with modifications to the spillway and fishway structures and improvements to properties adjacent to the impoundment and CJCH. These modifications are described in the following sections with preliminary design drawings provided in Appendix A.

4.1 RESERVOIR LEVELS

Normal water level in the Reservoir Dam impoundment would be managed at El. 40.4 ft, 1.5 ft higher than its current level of El. 38.9 ft. The higher normal pool would add 108.8 ac-ft of usable storage volume to the reservoir which is an increase in storage of approximately 23% of the existing reservoir storage (476.6 ac-ft). A

normal pool at El. 40.4 ft would increase the reservoir surface area by 14.2 acres which is approximately 20% more than the 69.5 acre surface area with the existing El. 38.9 ft normal pool. Historical reservoir conditions and the proposed operating plan are discussed below.

4.1.1 Historical Conditions

Reservoir Dam water level measurements were obtained from the Water Department for January 1972 through mid-April 2014. The records indicate that:

- The Water Department manages Reservoir Dam levels to minimize spillway flow and provide more storage using the low-level outlet valve to lower the pool level in anticipation of flood events.
- Water levels in the reservoir exceeded 2 ft above the spillway crest (El. 38.9 ft) 2 days out the 15,458 days of record (0.01%), which occurred during the Mother's Day storm in 2006. On these two days the water level was too high to obtain a measurement. According to the DPW, however, the water was 4 ft above the spillway crest.
- Water levels in the reservoir exceeded 1 ft above the spillway crest 47 days out the 15,458 days of record (0.3% of time). Other than the 2006 Mother's Day storm, the highest recorded reservoir level was El. 40.48 ft in March 2001.

The May 2014 survey of the dam measured the existing spillway crest minimum length at 37.5 ft rather than the 42.0 ft reported in the 2014 Feasibility Study. The crest length between abutment walls is not uniform and varies along the approach apron as well as vertically from the crest to the top of the walls. Discharge data and the rating curve for the actual surveyed spillway are presented on Table 4-1 and Figure 4-1, respectively. The rating curve assumes a constant 3.1 discharge coefficient over the entire range of flows. The ogee shaped spillway has a total discharge capacity of 1,750 cubic feet per second (cfs) with the pond level at the top of dam El. 45.0 ft.

Table 4-1
Reservoir Dam Spillway Discharge Data

Reservoir Level (ft. NAVD 1988)	Spillway Discharge (cfs)
38.9	0
39.9	116
40.9	329
41.9	604
42.9	930
43.9	1,300
45.0	1,751
45.43	2,306

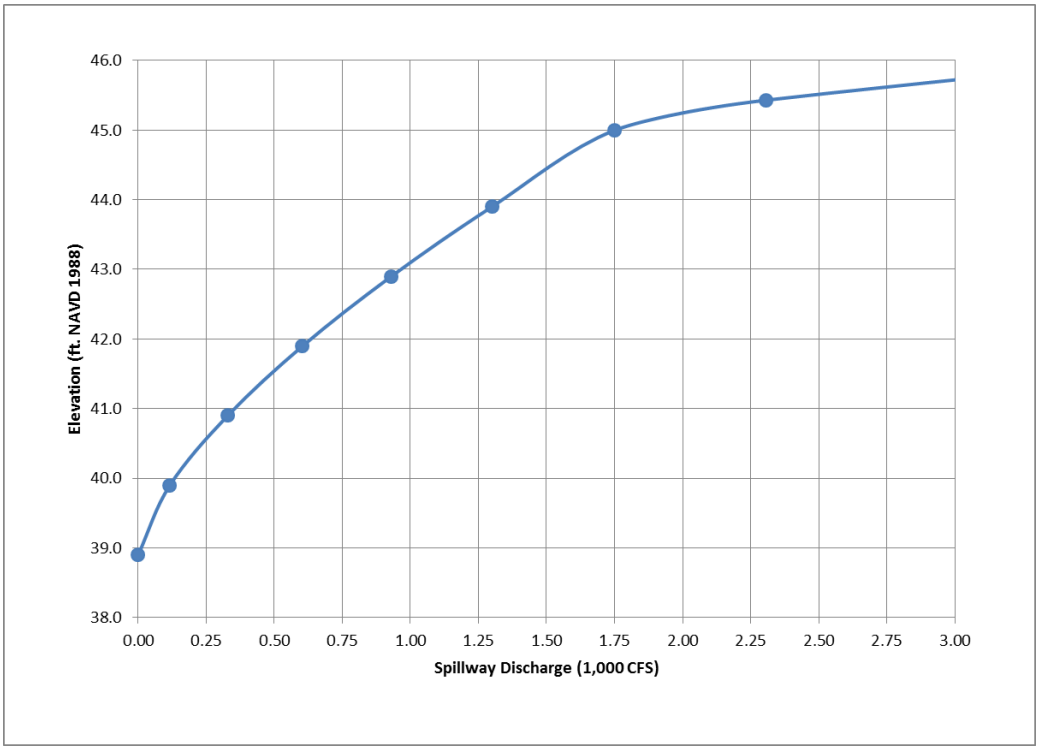

Figure 4-1 Reservoir Dam Spillway Discharge Rating Curve

The storage rating curve for Reservoir Dam is presented in Table 4-2 and illustrated on Figure 4-2. There are 422.1 ac-ft of useable storage between the existing normal pool (El. 38.9 ft) and the low level at which the current streamflow guidelines are discontinued (El. 30.9 ft).

Table 4-2
Reservoir Dam Storage Rating Curve Data

Reservoir Level (ft. NAVD 1988)	Total Storage (Acre-ft)	Reservoir Level (ft. NGVD 1988)	Total Storage (Acre-ft)
26.9	0.0	39.9	549.9
28.9	4.5	40.4	585.4
30.9	54.5	40.9	634.1
32.9	134.3	41.4	680.9
34.9	231.9	41.9	730.2
36.9	348.6	42.4	782.0
38.9	476.6	42.9	836.2
39.4	512.3	43.9	951.6

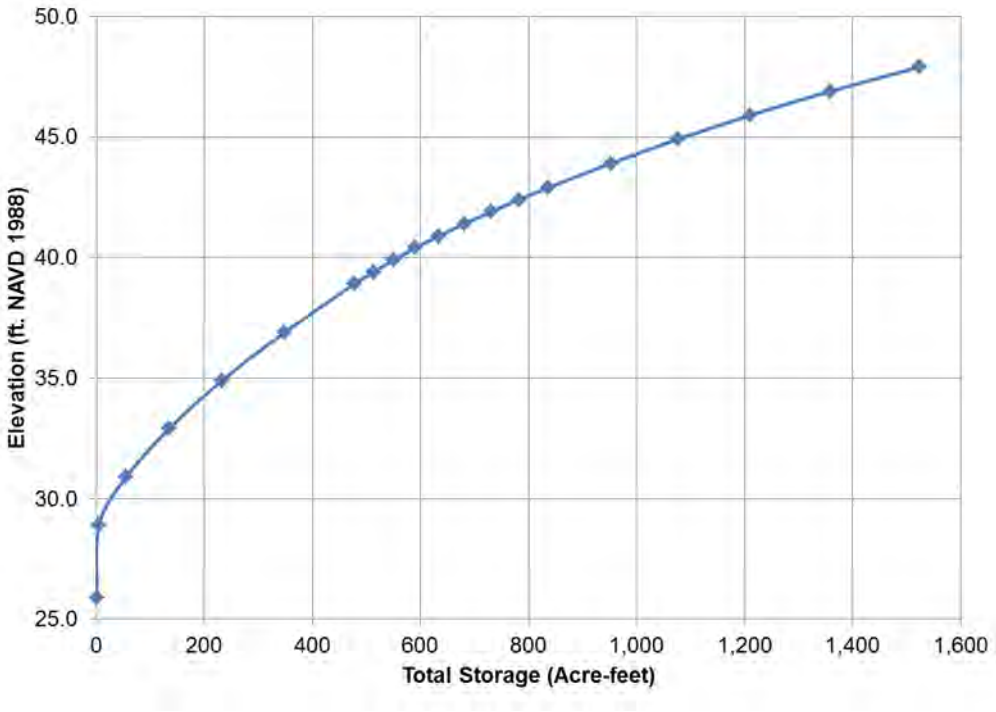

Figure 4-2 Reservoir Dam Rating Storage Curve

4.1.2 Proposed Operational Plan

Additional water storage would be provided at Reservoir Dam by managing normal pool at El. 40.4 ft, 1.5 ft higher than existing normal pool and the spillway crest. This higher normal pool would add 108.8 ac-ft of storage capacity, approximately 23% of the storage currently available in the reservoir. The higher pool level would be achieved by the installation of a hinged crest gate on the spillway as discussed in Section 4.4. Modifications to the fishway, as discussed in Section 4.5, would be implemented to restore upstream and downstream passage.

The existing low level outlet and the fishway would be used to release water supply and BioQ90 flows from the reservoir. Quantities and timing of the releases would be similar to the IOP, but a new model scenario should be run with the proposed conditions and incorporated into a future operational plan.

During the March-June and September-October fish migration periods, the fishway would be the primary outlet with the low level outlet used to supplement the fishways flow when needed to meet the streamflow guidelines. The spillway crest gate would be fully opened during flood events where water levels reach El. 40.9 ft (6 inches above the normal pool). The crest gate would not reduce the spillway discharge capacity when fully opened and flood levels would not change from the current conditions.

Reservoir levels at El. 40.4 ft have occurred as recently as March 2001. In the spring, the proposed normal pool would be 9-12 inches higher than the water depth typically flowing over the existing spillway crest. The spillway gate would be operated to maintain the pond as close to the normal level as possible. As storage is released, pond level drops would be dependent on rainfall. The WEAP modeling in 2013 indicate that levels would typically drop 4.5 ft below normal to El. 35.9 ft. This level is 5 ft higher than the low operating limit with the existing IOP streamflow guidelines (El. 30.9 ft).

4.2 SHORELINE AND PROPERTY IMPROVEMENTS

The higher normal pond would have minimal impact on properties and groundwater levels adjacent to the impoundment. Septic systems should not be impacted by proposed reservoir operations, but some shoreline and property improvements would be provided to protect the reservoir water quality and shoreline property.

Managing reservoir levels at El. 40.4 ft would increase the normal pool surface area to 83.7 acres, as shown on Figure B-1 in Appendix B. The extended surface area would be completely within the existing 150 ft buffer zone around the reservoir as required by the Town's Water Resource District Bylaw. The higher normal pool would not change the Town's 150 ft buffer zone since the bylaw is based on high water level mark. The 200 ft buffer zone required by DEP relative to Title V septic systems near water supplies would be extended, but would not affect any additional properties with the higher normal pond. The proposed management plan would not change flood conditions that properties adjacent to the impoundment currently experience.

4.2.1 Septic Systems

Properties adjacent to the Reservoir Dam impoundment are generally at elevations higher than the dam embankment (El. 45.0 ft). However, there are three properties with septic systems very close to the reservoir and are only 2-3 ft above the existing normal pool level. These properties are for #401 CJCH, #436 CJCH, and #439 CJCH, as shown on Drawing C-106 in Appendix A.

The Scituate Board of Health records for #401, #436, and #439 CJCH were obtained and reviewed to determine groundwater level data used for the septic system design. The property at #436 CJCH has a septic system which does not comply with Title V because of proximity to the reservoir and high groundwater, and has been abandoned by the owner. The Board of Health records do not have any specific information about the groundwater levels at #436 CJCH. The properties at #401 and #439 CJCH have Title V compliant wastewater treatment systems with mounded leach fields.

The Scituate DPW contracted Geo Logic Earth, Inc. to install groundwater monitoring wells at #401, #436, and #439 CJCH. The wells were installed on April 28, 2014 on these properties at locations between the reservoir and the existing septic systems. On May 1, NSRWA began collecting groundwater level information at these wells. Observations for these properties are:

- #401 CJCH – Treatment system with raised leaching field
  Board of Health Records for estimated high groundwater (EHG) El. 39.6 ft
  Leach field/groundwater separation of 5 ft
  Top of monitoring well El. 41.28 ft
  Groundwater measurements at El. 39.6 - 40.4 ft (0.8 ft maximum above EHG)
- #436 CJCH – Property abandoned
  No Board of Health information on groundwater.
  Top of monitoring well – El. 41.00 ft
  Groundwater measured at El. 39.4 - 39.7 ft (comparable to existing normal pool)
- #439 CJCH – Treatment system with raised leaching field.
  Board of Health Records for estimated high groundwater (EHG) El. 41.8 ft
  Leach field/groundwater separation of 5 ft
  Top of monitoring well – El. 40.65 ft
  Groundwater measured at El. 39.5 ft - 40.0 ft (1.8 ft minimum below EHG)

Measured groundwater levels in the monitoring well at #401 CJCH are higher than the EHG. However, differences in the subsurface conditions at the monitoring well and the leach field may result in lower groundwater levels at the leach field. The homeowners report that their septic system has had no problems, even in the Mother's Day storm of 2006.

Even if groundwater level at the leach field is assumed to be similar to the monitoring well or to the proposed normal pool El. 40.4 ft, Title V allows the Board of Health to issue a variance to reduce the 5 ft separation requirement to 4 ft and the existing septic system would be in compliance with Title V. In addition, DEP approval of alternative treatment systems (like those at #401 and #439 CHCH) allows further reduction of groundwater separation to 2 ft, which would also assure the existing system remains in in compliance.

Measured groundwater levels in the monitoring well at #439 CJCH are below the EHG and the septic system would still be in compliance with Title V even if the groundwater level is the same as the proposed pool El. 40.4 ft. A new septic system at #436 CJCH would have to be designed for high groundwater determined during percolation tests.

In addition, the NSRWA also collected samples from the monitoring wells for water quality analysis. G&L Laboratories of Quincy, MA analyzed the samples for total coliform (TC), E. coli, heterotrophic plate count (HPC), nitrate, and nitrite. Test results indicate that nitrate is well below background levels (0.58 mg/L, USGS 2010) as well as the MCLs for both nitrate (10 mg/L) and nitrite (1 mg/L) in drinking water. Bacteria results are typical of groundwater under the direct influence of surface water (R. Mosca, Scituate Water, pers. comm.). Water level measurements and two rounds of test results of samples from the monitoring wells are presented in Appendix C; the third round of sample results is pending. The monitoring wells will be left in place and will be available to the Board of Health for future monitoring, if necessary.

4.2.2 Erosion Protection

The Reservoir Dam impoundment is owned by the Town and the extended surface area under the proposed management plan would not affect adjacent properties. Water levels would be similar to levels currently experienced in the spring and would be below flood levels. The shoreline around the impoundment, except for CJCH, is heavily vegetated and additional shoreline stabilization would not be necessary to prevent erosion in areas exposed to wave action. Any erosion areas that may develop in the future would be repaired as necessary in accordance with the DPW's inspection and maintenance plan currently being implemented.

4.2.3 Groundwater Control

Owners of the three properties closest to the reservoir were contacted to determine the condition of their basements which are below the existing normal pond level. The houses at #401 CJCH and #439 CJCH have sump pumps in the basement that continually operate in the spring when the reservoir is at its highest level. The house at #436 CJCH appears to have water in the basement and has a sump pump that runs intermittently.

The proposed management plan for Reservoir Dam should not change groundwater conditions at the properties on CJCH. However, the DPW's inspection and maintenance plan would incorporate inspection and monitoring of conditions at these properties, and if necessary, upgrades of the basement sump pumps.

4.2.4 Stormwater System Upgrades

Stormwater drainage systems for roadways around the reservoir have the potential to impact the quality of the Town's water supply. Section 4.3 discusses potential upgrades for CJCH. The stormwater system on Sherman Drive appears to be the only other system that has potential impact on the reservoir water quality.

Sherman Drive has a stormwater catch basin system that terminates at the cul-de-sac at the end of the street. The catch basin in the center of the cul-de-sac has an outlet pipe that terminates in a drainage ditch extending from the street to the northwest and the impoundment. The drainage ditch appears to be located on its own parcel of land. According to property owners on Sherman Drive, the catch basin system does not properly function and water ponds in the cul-de-sac.

In order to protect the quality of water, a bioswale would be constructed in the location of the drainage ditch. The catch basin outlet pipe would be cleaned, vegetation removed from the drainage ditch, and a bioswale system installed along the drainage ditch. The bioswale would have peat and stone layers with a perforated pipe underdrain collection system that would discharge back to the drainage ditch and eventually to the reservoir. Vegetation specially selected to treat nitrogen and phosphorus would be planted in the bioswale to remove nutrients from the stormwater. Additional survey and design work will be required to complete the bioswale.

4.3 CJCH ROADWAY IMPROVEMENTS

State Highway Route 3A (Chief Justice Cushing Highway) divides the Reservoir Dam impoundment over a span of approximately 675 feet (0.125 miles). Embankment erosion and stormwater management should be considered to assure public safety. There will be 2.0 ft of freeboard at the low point in the CJCH centerline profile with the proposed normal reservoir level at El. 40.4 ft. Although the spillway modifications would not change flood levels, the highway embankment would require erosion protection along both side slopes of CJCH that are exposed to wave action with the higher normal pond.

Existing stormwater management along this portion of highway consists of approximately 40 catch basins, 20 on each side of the highway, spaced between 100 and 150 feet apart. Although an assessment of the impacts of these catch basins on the reservoir water quality is not included in this report, these catch basins may convey stormwater from the highway directly into the reservoir without total suspended solids (TSS) or nitrogen/phosphorus treatment. The Town should consider stormwater management options to eliminate highway runoff into the reservoir without treatment.

4.3.1 Embankment Erosion Protection

Stone riprap would be installed along both sides of CJCH to prevent erosion of the highway embankment with the higher reservoir normal pool at El. 40.4 ft. The riprap would be installed up to El. 41.9 ft in locations where the proposed normal pool elevation is less than 15 ft from the edge of pavement. As shown on Drawing C-106 in Appendix A, approximately 300 linear feet (LF) of riprap would be installed along the northeast side of the highway and 80 LF along the southwest side near the existing culvert between Tack Factory Pond and the reservoir. Fifty percent of the stone would have a diameter equal to 8 inches (D_{50} = 8 inches), similar to the existing riprap protection at the culvert.

4.3.2 Stormwater Management

Several stormwater management options are available to mitigate the effects of CJCH runoff discharging directly into the Reservoir. These options vary in terms of cost, degree of treatment, and level of structural modifications to the existing system. Options include retrofitting existing catch basins with water quality protection systems (structural), installing sediment filters in existing catch basins (non-structural), installing complete stormwater filter systems in place of existing catch basins (structural), and constructing bioswales in conjunction with existing catch basins along portions of CJCH (structural/non-structural).

Retrofitting existing catch basins with water quality protection systems would provide a primary level of treatment at each inlet. Catch basin inlet retrofits are available to treat total suspended solids (TSS) along with free oils and a small percentage of nutrients that adhere to fine sediment particles. The majority of contaminant nutrients (nitrogen/phosphorus) remain untreated.

The installation of sediment filters in the existing catch basins would remove sediment, trash, and other debris from stormwater. This option would not treat total nutrients. Although the lowest capital cost of all the options, sediment filters would require the greatest level of maintenance to periodically remove all accumulated sediment and debris.

The installation of complete stormwater filter systems could be used in place of existing catch basins. These structures treat TSS, heavy metals, free oils, and total nutrients prior to discharge. This option would likely be the most costly of all proposed options, but would treat all pollutants typically targeted when discharging to a potable water source. Replacement of the catch basins with infiltration catch basins without outlet pipes would eliminate direct discharges to the reservoir and provide short term protection, but not any treatment.

The construction of bioswales would treat both TSS and nutrient pollution before discharging to the Reservoir. Portions of the existing highway shoulders could be converted to bioswales where there is adequate highway shoulder width. Existing catch basins within these segments would either be removed or converted to drop inlets to convey runoff to the bioswales. The bioswales would be designed for 1 inch rainfall, as the first 1 inch of rain carries the majority of pollutants off of the road surface. All stormwater entering the bioswales would infiltrate through layers of peat and stone and eventually discharge through a perforated pipe to the reservoir. Vegetation specially selected to treat nitrogen and phosphorus would remove nutrients from the stormwater before discharge. During peak storm events, high intensity volumes would overtop the bioswale berms in specifically designed areas to minimize highway flooding.

Bioswales could be installed near #401 CJCH and #436 CJCH. These bioswales would be sized to accommodate highway runoff between these two addresses and would eliminate approximately 12 catch basins closest to the reservoir. Runoff from the highway would be directed into open channels along the roadway shoulders. Bioswales would be installed in areas with sufficient width to provide for the treatment plants. The lowest storm drain catch basins would be abandoned with the higher ones modified to discharge into the collection channels where possible. Catch basins further north and south of the reservoir could be replaced with higher capacity infiltration catch basins or modified to discharge into additional bioswales or treatment basin.

4.4 SPILLWAY MODIFICATIONS

The proposed reservoir management plan would be implemented by installation of a bottom hinged crest gate on the existing ogee spillway. The gate would have an electric motor operator and would be remotely controlled from the DPW's Water Treatment Plant. A plan and sections of the spillway modifications incorporating the crest gate are provided on Drawing C-104 in Appendix A.

4.4.1 Ogee Crest

The existing spillway ogee section would be extended in the downstream direction to support the crest gate (see Appendix A). The new ogee would have the same shape as the existing spillway. Concrete dowels would be drilled into the existing crest and abutment walls to anchor the new concrete ogee section to the existing structure. The new ogee would have two layers of reinforcing steel and would be designed to transfer all the forces on the crest gate to the existing spillway mass concrete block.

The abutment walls would be extended to contain flood flows and prevent erosion of the dam embankment adjacent to the spillway. The concrete wall extensions would be reinforced concrete doweled into the existing abutments. The new wall on the west side of the spillway would be designed to support the hinged crest gate operator.

A walkway bridge would be installed over the spillway to allow DPW personnel to access the fishway exit channel. The spillway bridge would be a pre-fabricated steel footbridge anchored to the spillway concrete abutment walls.

Modification of the spillway for the crest gate would increase the stability of the existing structure. The new ogee concrete provides additional weight to resist overturning and sliding. Since the spillway was originally designed for 2 ft high flashboards, the water forces on the crest gate would be similar to the forces on flashboards that resulted in overturning and sliding forces similar to the original design. Preliminary stability calculations for the proposed spillway modifications are provided in Appendix D.

4.4.2 Bottom Hinged Gate

The bottom hinged gate would be installed on the new spillway ogee crest as shown on Drawing C-104. The gate would be 36.5 ft long and 2 ft high with side seals on each abutment wall. The gate would have two hinges spaced at 18.25 ft on-center and a bottom seal along the entire gate. In the fully closed position the top of the gate would be El. 38.65 ft maximum to assure the discharge through the gate is equal to or greater than the existing unregulated ogee spillway.

Discharge data and the rating curve for the proposed crest gate are presented on Table 4-3 and Figure 4-3. The gate discharge capacity would be greater than the existing ogee spillway data (Table 4-1) over the full range of reservoir levels.

An electric motor operator would be located on the right side of the gate at the top of the abutment wall. The gate stem would have a swivel joint at the top of the gate and an intermediate support at the top of the abutment. The motor would have a support stand mounted on the abutment wall and would be equipped with a handwheel to allow manual operation in the event of a power failure.

The gate would be incorporated into the DPW's SCADA system. A new pressure transducer would be installed on the low level outlet structure in the reservoir and hardwired to the SCADA system. The gate would be automatically operated by the SCADA system or could be manually opened from the Water Treatment Plant. In the automatic mode, the gate would open in six-inch increments when the pool level reaches El. 40.9 ft. During flood conditions, the gate will continue to open in six-inch increments until fully open or the pond level starts to drop. When the pond drops to El. 40.4 ft, the gate will fully close to maintain normal pool levels.

Table 4-3
Reservoir Dam Spillway Crest Gate Discharge Data

Reservoir Level (ft. NAVD 1988)	Spillway Discharge (cfs)
38.65	0
39.9	158
40.9	382
41.9	663
42.9	991
43.9	1,361
45.0	1,811
45.43	2,364

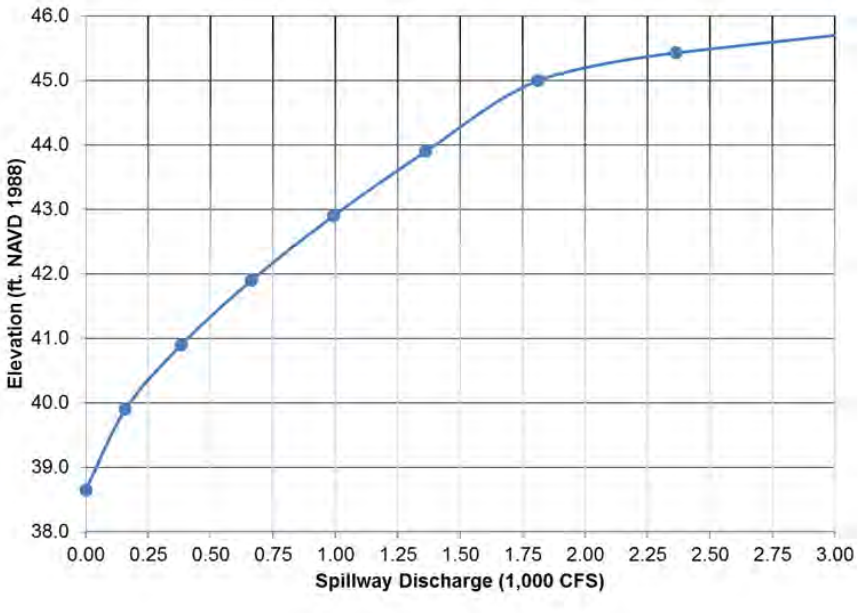

Figure 4-3 Reservoir Dam Spillway Crest Gate Discharge Rating Curve

4.4.3 Dam Failure Analysis

Since Reservoir Dam is a Class I high hazard dam, any modifications to the spillway cannot reduce the discharge capacity for the design flood equal to the 1/2 PMF. The Town's Emergency Action Plan (EAP) dated January 2014 considered failure of Reservoir Dam, but ODS has requested the Town to consider a multiple dam failure scenario with Old Oaken Bucket Dam failing subsequently to Reservoir Dam. Tetra Tech has conducted a simplified analysis of multiple dam failure using the EAP analysis and conservative assumptions for failure of Old Oaken Bucket Dam. Assumptions for the analysis are:

1. There are no changes to EAP flood levels and breach flows at Old Oaken Bucket Dam and upstream of Country Way for both the Sunny Day and ½ PMF failure scenarios.
2. Country Way is an integral part of Old Oaken Bucket Dam and the twin stone culverts are the primary outlet. The culverts have a discharge capacity of approximately 300 cfs without overtopping Country Way.
3. Instantaneous failure of a 14 ft wide by 12 ft deep section of Country Way at the twin stone culverts. This breach represents the width and depth of the culverts and is the weakest point where a sudden failure could occur in the dam. Failure of Old Oaken Bucket Dam/Country Way occurs when the flood wave (peak breach flow and maximum water elevation) resulting from failure Reservoir Dam arrive at Old Oaken Bucket Dam/Country Way.
4. Culverts under Driftway have minimal discharge capacity and flood levels at Drift Way are controlled by the highway profile.
5. No attenuation of the peak breach flow downstream of Old Oaken Bucket Dam/Country Way to the limits of the analysis at the North River, i.e., peak breach flow at the North River is the same as peak breach flow at Old Oaken Bucket/Country Way.

The results of the multiple failure analysis are presented in Table 4-4.

Peak flood levels at Country Way for the multiple dam failure analysis are 1.9 ft higher than single failure of Reservoir Dam because of the assumption that Country Way controls water levels in Old Oaken Bucket and that Country Way is overtopped at river flows greater than 300 cfs. Downstream at Driftway Road and the North River, flood levels with multiple dam failure are less than 0.5 ft higher than single dam failure.

Peak flood levels at Country Way for the multiple dam failure analysis are 1.9 ft higher than single failure of Reservoir Dam because of the assumption that Country Way controls water levels in Old Oaken Bucket and that Country Way is overtopped at river flows greater than 300 cfs. Downstream at Driftway Road and the North River, flood levels with multiple dam failure are less than 0.5 ft higher than single dam failure.

An inundation map for First Herring Brook reflecting the simplified multiple dam failure analysis described above is provided in Appendix E. As requested by the OSD, the Reservoir Dam EAP should be revised to reflect the multiple dam failure.

Table 4-4
Reservoir Dam Failure Analysis

	Sunny Day Failure		½ PMF Failure	
	Single Dam	Multiple Dam	Single Dam	Multiple Dam
Reservoir Dam (River Mile 0.0)				
Maximum Breach Flow (cfs)	3,950	3,950	9,250	9,250
Peak Flood Level (ft NAVD88)	38.9	38.9	42.9	42.9
Toe of Dam (River Mile 0.01)				
Maximum Breach Flow (cfs)	3,950	3,950	9,250	9,250
Peak Flood Level (ft NAVD88)	32.4	32.4	34.8	34.8
First Herring Brook (River Mile 0.36)				
Maximum Breach Flow (cfs)	3,350	3,350	7,900	7,900
Peak Flood Level (ft NAVD88)	23.3	23.3	25.3	25.3
Country Way (River Mile 0.69)				
Maximum Breach Flow (cfs)	2,725	3,700	6,830	8,405
Peak Flood Level (ft NAVD88)	22.4	23.7	23.7	25.6
Driftway Road (River Mile 0.81)				
Maximum Breach Flow (cfs)	2,230	3,700	6,825	8,405
Peak Flood Level (ft NAVD88)	13.0	13.4	15.0	15.2
Downstream Flood Plain (River Mile 1.16)				
Maximum Breach Flow (cfs)	2,190	3,700	6,825	8,405
Peak Flood Level (ft NAVD88)	0.0	2.8	9.1	9.4
North River (River Mile 1.8)				
Maximum Breach Flow (cfs)	2,100	3,700	6,825	8,405
Peak Flood Level (ft NAVD88)	0.0	2.7	9.1	9.3

4.5 FISHWAY

The existing pool and weir fishway at Reservoir Dam generally conforms to USFWS guidelines. However, the fishway exit channel elevation at Reservoir Dam is too high to allow operation at low reservoir levels. The fishway exit channel would be lowered to allow passage at lower pond levels. Removable notched weirs would be installed in the exit channel to provide passage over the range of reservoir levels. The concrete weirs in the lower portion of the existing fishway would be retrofitted with notched weirs similar to the wooden notched weirs installed at the Old Oaken Bucket Dam fishway in 2013. The notched weirs would provide sufficient depth of water for downstream fish migration while minimizing the amount of water required for effective fish passage.

Fish passage into Reservoir Dam Pond and Tack Factory Pond would restore approximately 75 acres of pond for American eels in addition to river herring. Based on the 2013 Feasibility Study, the median habitat carrying capacity is estimated to be 25,000-30,000 herring with reservoir levels at El. 40.4 ft. Stream channel habitat upstream of Tack Factory Pond would be available for blueback herring spawning with the proposed Reservoir Dam managed water levels.

4.5.1 Upstream Passage

Reservoir Dam has a three (3) foot wide pool and weir fishway with a total height of 15.0 ft. There are twenty-one (21) pools, each approximately 3 ft wide by 3 ft long by 1.5 ft deep. Estimated flow in the existing fishway is 2.50 cfs with a 5-inch water depth over the weirs and 5.06 cfs with an 8-inch water depth. These calculated flows are consistent with the flows used to develop the IOP being implemented by the DPW.

Modifications to the fishway to improve fish passage would include demolition of the existing fishway upstream of weir #16 and the entire exit channel, as shown on Drawing C-105 in Appendix A. The first sixteen weirs in the lower portion of the fishway would be retrofitted with fixed notched weirs. The exit channel would be reconstructed at 3 ft wide with the bottom lowered from El. 38.9 ft to El. 35.0 ft. Seven (7) removable weirs would be installed in the new fishway exit channel to extend the operating range of the fishway between El. 36.4 ft minimum up to El. 41.0 ft maximum.

Both the fixed and removable weirs would be notched to minimize flow required for effective fish passage with a sufficient depth over the weirs. Each weir would have a 1.5 ft wide notch providing 2.53 cfs with an 8 inch water depth for upstream passage and a six (6) inch wide notch providing 0.42 cfs with a 5 inch depth. The 1.5 ft notch width meets the IOP streamflow guidelines between Reservoir Dam and Old Oaken Bucket Dam with a greater depth than the existing 3 ft wide weirs. The 6 inch wide notches would be similar to the notched weirs installed in the summer of 2013 at the Old Oaken Bucket fishway and would minimize flow while providing acceptable water depths over the weir for acceptable downstream fish passage. The smaller notches would be centered on the larger notches. The low level outlet would be used to provide any additional releases to meet the IOP streamflow guidelines.

The fixed weirs would be bolted to the existing concrete weirs and fishway walls. The removable weirs would be installed in guides in the exit channel walls. A trolley system with a manually operated hoist will be mounted on top of the exit channel walls to raise and lower the weirs to follow the water level changes. The removable weirs would be dogged in the raised position when not needed for fish passage. A walkway would be installed along both sides of the exit channel walls to access the hoist system over the most downstream removable weirs.

A 3.0 ft wide by 7.5 ft high slide gate would be installed upstream of the removable weirs with stoplog guides located at the upstream end of the fishway exit channel. The slide gate frame would be mounted to fishway exit channel walls. The gate would have a manual operator with a hand wheel located at El. 59.0 ft. A walkway bridge would be installed over the fishway exit channel to allow DPW personnel to access both sides of the fishway exit channel. The fishway footbridge would be a pre-fabricated floor grating spanning the 3 ft wide exit channel with handrails mounted on top of the fishway walls.

The stream channel downstream of the Reservoir Dam fishway entrance would be reconfigured to create acceptable hydraulic conditions for fish to reach the fishway entrance and the proper water depth in the fishway entrance. Existing stones in the stream would be used to create channels and pools with sufficient depth for fish passage, velocities less than 5 ft/sec, and pools with vertical drops less than 8 inches.

4.5.2 Downstream Bypass

The proposed fishway would be used for downstream fish passage. As discussed in the previous section, the 6-inch wide notches on the fishway fixed weirs and the exit channel removable weirs are sized to minimize flow in

the September-October downstream migration period while providing sufficient depth through the notch for fish passage. Minimum water depth through each notch would be 5 inches.

4.5.3 Operation and Maintenance

During the spring and fall fish migration periods, all flow would be conveyed through the modified fishway at Reservoir Dam for pool levels ranging between El. 41.0 ft and El. 36.4 ft. At pond levels below El. 40.4 ft, DPW personnel would operate the low-level outlet valve to provide the required water demand and environmental flows in First Herring Brook downstream of Reservoir Dam. During rainfall events when the pond rises to El. 41.0 ft, the fishway isolation gate would be manually closed to prevent damage to the fishway weirs. The gate would be opened when the pond level can be stabilized at El. 41.0 ft or lower.

During non-migration periods, the fishway isolation gate would be closed and the low-level outlet operated for all water supply and environmental releases. Prior to the spring migration period and opening of the isolation gate, the fishway would be inspected for damage and the 18-inch wide notched removable weirs installed in the exit channel. The removable weirs would be installed and removed during April and May to follow the pond level in 0.5 ft increments. Monitoring of the pond levels would initially be conducted on a daily basis and adjusted to a frequency consistent with the monitoring effort currently being implemented for the IOP.

In June, the fishway isolation gate would be closed and the 6-inch wide notch weirs installed in the exit channel and fishway weirs. At the beginning of September, the isolation gate would be opened and the removable weirs adjusted to track changes in Reservoir Dam pond level and conserve as much water as possible. In November after out-migration, the isolation gate would be closed and all releases would be controlled through the low-level outlet.

5.0 ESTIMATED COSTS

The probable construction costs presented in the 2013 Feasibility Study for water supply and fish passage improvement have been updated to reflect the proposed reservoir management plan and preliminary design of the spillway and fishway modifications and shoreline improvements. The costs are based on quantity takeoffs for major items defined on the preliminary drawings and construction industry and comparable project cost data. The costs are considered order of magnitude estimates suitable for budgetary planning purposes. The costs include modifications to the spillway and fishway at Reservoir Dam and shoreline improvements around the reservoir.

Table 5-1 on the next page presents the estimated cost for construction, engineering, permitting, and construction administration for implementing the proposed modifications for maintaining the normal pond at El. 40.4 ft in the spring. A detailed cost breakdown is provided in Appendix F. The costs assume fully-contracted rates by a General Construction Contractor and include a 10% contingency factor to account for uncertainties at this preliminary design phase. The contingency factor reflects an allowance for indeterminant items that are known to exist, but are not included in the estimate, and for unforeseeable events that may affect the construction cost.

Table 5-1
Estimated Costs for Implementation of Selected Alternatives

Item	Cost ($)
Mobilization/Demobilization	**61,000**
Temporary Construction Facilities	**28,000**
Spillway Modifications	
Ogee and Abutment Walls	59,000
Bottom Hinged Crest Gate w/ Electric Motor Operator	162,000
Pre-fabricated Walkway Bridge	39,000
Water Level Sensor and SCADA Upgrade	14,000
Subtotal	**274,000**
Fishway Modifications	
Embankment Excavation	12,000
Existing Fishway Exit Channel Demolition	13,000
New Concrete Exit Channel	71,000
Exit Channel Removable Baffles	23,000
Exit Channel Isolation Slide Gate w/ Electric Motor Operator	24,000
Exit Channel Access Walkways and Handrails	14,000
Exit Channel Security Fence	2,000
Existing Weir Modifications	23,000
Entrance Channel Improvements	6,000
Subtotal	**188,000**
Shoreline Improvements	
CJCH Erosion Protection	102,000
Modifications to Tack Factory Pond Slide Gate	6,000
Sherman Drive BioSwale	14,000
Subtotal	**122,000**
Total Construction Costs	**673,000**
Contingency (10%)	**67,000**
Subtotal Probable Construction Costs	**740,000**
Engineering, Design, and Permitting Costs	**89,000**
Construction Management (5%)	**37,000**
Total Project Cost	**866,000**

6.0 INTERAGENCY AND PUBLIC OUTREACH MEETINGS

Communication records and notes of meetings held with the resource agencies and the public are provided in Appendix G. State agency meetings were held with DMF and ODS. Meetings with Scituate boards and departments included: DPW (Water Department and Engineering), WRC, Board of Health, Planning Board, and Board of Selectman.

7.0 RECOMMENDATIONS

The Scituate DPW should prepare permit applications and detailed design and construction documents for implementation of the spillway and fishway modifications to improve fish passage at Reservoir Dam. Project design and permitting should be completed in the following sequential steps:

- Apply for grants and secure local match to design and construct the spillway and fishway modifications.
- Run WEAP model for the proposed reservoir management plan with the preliminary design modifications of the spillway and fishway.
- Complete initial agency consultation with DMF, ODS, DOT, DEP, and US Army Corps of Engineers.
- Revise the preliminary design drawings to reflect agency comments and prepare permit applications based on the preliminary design.
- Prepare final design and construction documents.
- Investigate stormwater management options for water quality protection along CJCH.

8.0 BIBLIOGRAPHY

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APPENDIX A – PRELIMINARY DESIGN DRAWINGS

TOWN OF SCITUATE

DEPARTMENT OF PUBLIC WORKS

FIRST HERRING BROOK

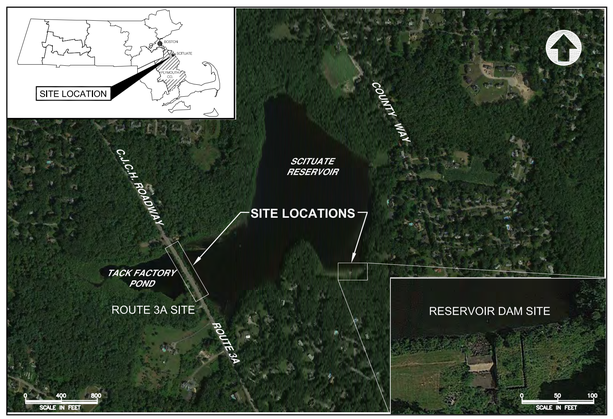
FISH LADDER IMPROVEMENTS

AT RESERVOIR DAM

PLYMOUTH COUNTY

SCITUATE, MASSACHUSETTS

JUNE 27, 2014



SITE LOCATION MAP

SCALE: AS SHOWN

PREPARED FOR:

TOWN OF SCITUATE
DEPARTMENT OF PUBLIC WORKS
600 CHIEF JUSTICE CUSHING HIGHWAY
SCITUATE, MASSACHUSETTS 02066
TEL: 781-545-8731

PREPARED BY:

TETRA TECH
160 FEDERAL STREET, 3RD FLOOR
BOSTON, MASSACHUSETTS 02110
TEL: 617-443-7500

INDEX TO DRAWINGS	
DRAWING NO.	DRAWING TITLE
G-101	COVER SHEET AND INDEX TO DRAWINGS
C-101	EXISTING CONDITIONS PLAN - ROUTE 3A CULVERT
C-102	EXISTING CONDITONS PLAN - RESERVOIR DAM
C-103	SPILLWAY AND FISHWAY - GENERAL ARRANGEMENT PLAN
C-104	SPILLWAY MODIFICATIONS - PLAN, PROFILE & SECTIONS
C-105	FISHWAY MODIFICATIONS - PLAN, PROFILE & SECTIONS
C-106	C.J.C.H. ROADWAY IMPROVEMENTS - PLAN & SECTION

ISSUED FOR 30% DESIGN
- NOT FOR CONSTRUCTION -

REV	DESCRIPTION	DRN	DES	CHK	APP	DATE
A	ISSUED FOR 30% DESIGN	FM	BJ	MR	TC	06/27/14

DESIGNED BY: B. JOHNSON
DRAWN BY: F. MENICHELLI
CHECKED BY: M. WORTH'
APPROVED BY: T. COOK
DATE: JUNE 27, 2014

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FIRST HERRING BROOK
FISH LADDER IMPROVEMENTS AT RESERVOIR DAM
SCITUATE, MASSACHUSETTS

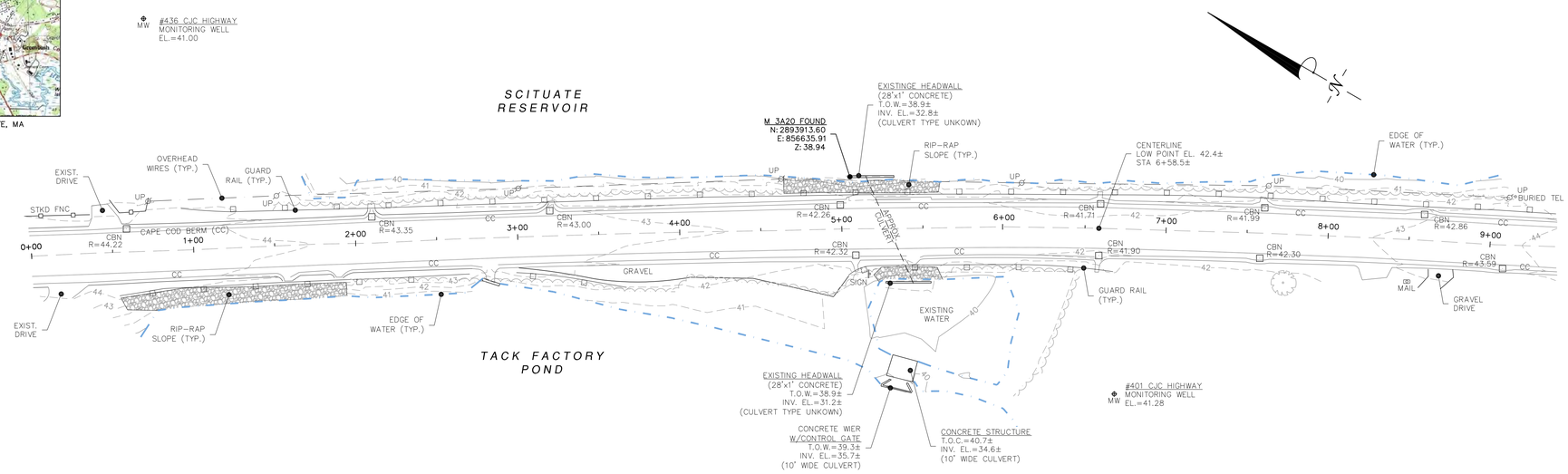
COVER SHEET AND INDEX TO DRAWINGS

P. E. SEAL

PE : PROFESSIONAL ENGINEER LIC. NO.

CONTRACT NO.: 14-WA-13
SPEC. NO.
SCALE : AS SHOWN
CAD FILE: 4961_12_G-101-REV A.DWG
SHEET -- OF --
SIZE: G-101

LOCUS: TACK FACTORY POND – SCITUATE, MA



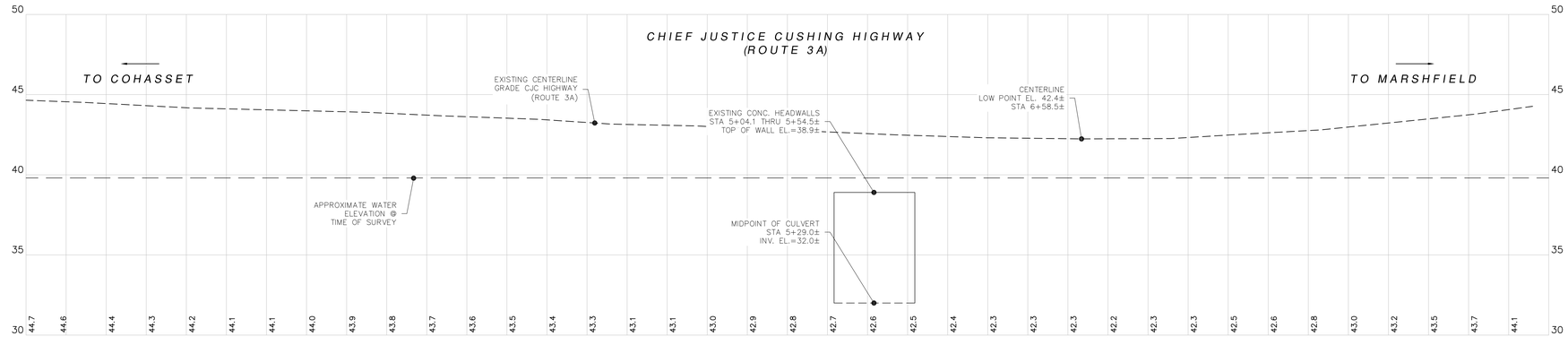
PLAN VIEW

C.J.C. HIGHWAY (ROUTE 3A)
(Public - Variable Width - 1901 County Layout)

SCALE: 1" = 40'

0' 20' 40' 80' 120'

#439 CJC HIGHWAY
MONITORING WELL
EL.=40.65



PROFILE

C.J.C. HIGHWAY (ROUTE 3A)

SCALE: 1" = 40'

0' 20' 40' 80' 120'

HORIZONTAL

SCALE: 1" = 4'

0' 2' 4' 8' 12'

VERTICAL

LEGEND
NOT TO SCALE

DMH	DRAIN MANHOLE	55	EXIST. CONTOUR
SMH	SEWER MANHOLE		WETLAND BUFFER ZONE
CBN	CATCH BASIN		FLOOD ZONE
HYD	HYDRANT		OVERHEAD WIRES
WG	WATER GATE		STONE WALL
WS	WATER SERVICE		EXISTING TREES AND SHRUBS
UP	UTILITY POLE		TREELINE/LANDSCAPE
LP	LIGHT	WETLAND / UPLAND	WETLAND LINE
GV	GAS VALVE		

DRAWING REVISIONS

ACTION	DATE	DESCRIPTION

DATUM:

VERTICAL REFERENCE: NAVD 1988
HORIZONTAL REFERENCE: NAD 1983
(CONVERSION: NAVD88 + 0.8 = NGVD29)

FEMA:

LOCUS LIES IN F.I.R.M. ZONE AE (EL.42 @ RESERVOIR), ZONE AE (EL. 44 @ POND) AND FLOODWAY AREAS IN ZONE AE AS SHOWN ON COMMUNITY PANEL NO. 25023C0117J DATED JULY 17, 2012.

UTILITIES:

UNDERGROUND UTILITIES SHOWN ON THIS PLAN ARE BASED UPON VISIBLE ABOVE GROUND UTILITIES AND RECORD INFORMATION OF BELOW GROUND UTILITIES AND ARE APPROXIMATE ONLY. CONTRACTOR IS RESPONSIBLE FOR TAKING ALL NECESSARY PRECAUTIONS BEFORE BEGINNING ANY EXCAVATION. (DIGSAFE 1-800-322-4844)

SURVEY NOTES:

1. THIS PLAN IS THE RESULT OF AN ON THE GROUND FIELD CONDUCTED BY CAVANARO CONSULTING, INC. IN APRIL/MAY 2014.

2. ANY EASEMENTS SHOWN HEREON ARE IN ACCORDANCE WITH CURRENT RECORD DESCRIPTIONS AND/OR THOSE THAT ARE VISIBLE OR OF PUBLIC RECORD.

EXISTING CONDITIONS NOTE:

THE PURPOSE OF THIS PLAN IS TO ILLUSTRATE THE SITE CONDITIONS FOUND AT THE TIME OF FIELD SURVEY CONDUCTED BY CAVANARO CONSULTING, INC..

CAVANARO CONSULTING, INC. HAS NOT PREPARED AND/OR PROVIDED ANY PERMIT PLANS FOR THIS PROJECT TO DATE; THE STATUS OF ANY OPEN PERMITS IS NOT KNOWN. THIS PLAN DOES NOT EXPRESS OR IMPLY COMPLIANCE WITH CURRENT ZONING BYLAWS AND/OR OTHER REGULATORY AGENCY THRESHOLDS.

DIG SAFE
MA – RI – ME – NH – VT
CALL TOLL FREE
1-888-344-7233
UTILITIES UNDERGROUND PLANT DAMAGE PREVENTION SYSTEM

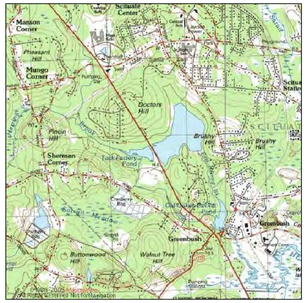
COMMONWEALTH OF MASSACHUSETTS
BRENDAN P. SULLIVAN
No. 46922
REGISTERED PROFESSIONAL LAND SURVEYOR

CAVANARO CONSULTING
687 MAIN STREET
P.O. BOX 5175
NORWELL, MASSACHUSETTS 02061
PHONE: 781.659.8187
FAX: 781.659.8186

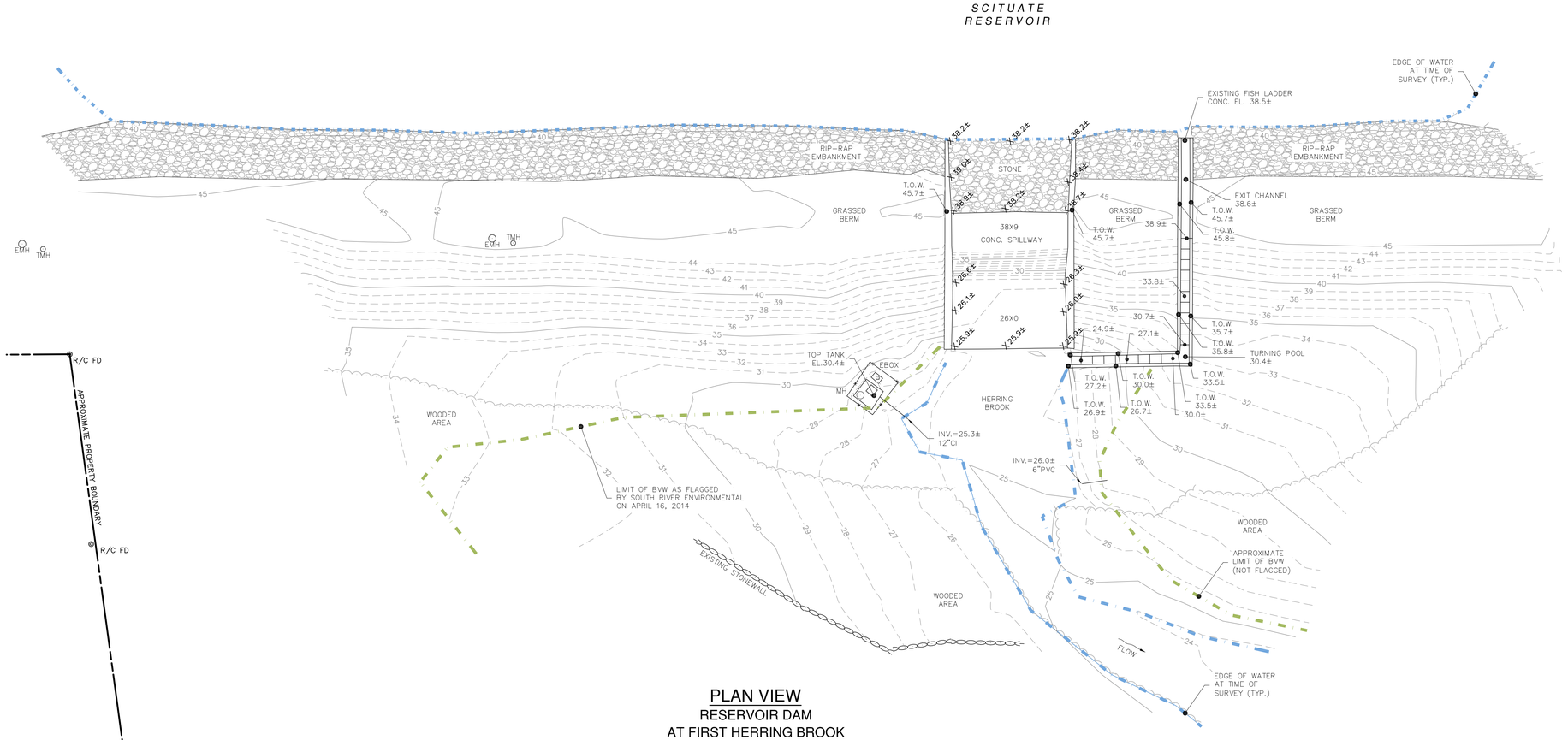
EXISTING CONDITIONS PLAN
ROUTE 3A CULVERT
SCITUATE, MA

PREPARED FOR:
TOWN OF SCITUATE
ENGINEERING DIVISION
SCITUATE, MA 02066

PROJECT NO. : 14.029	DRAWING NO. C-101
SCALE : AS SHOWN	
DATE : 05.13.14	
DESIGNED BY : –	
DRAWN BY : DB	SHEET NO. 1 OF 1
CHECKED BY : BPS	FILENAME: X:\PROJECTS\2014\14029\DWG\14029_NEW.DWG



LOCUS: TACK FACTORY POND – SCITUATE, MA



PLAN VIEW
RESERVOIR DAM
AT FIRST HERRING BROOK

SCALE: 1" = 20'

0' 10' 20' 40' 60'

LEGEND
NOT TO SCALE

DMH	DRAIN MANHOLE	55	EXIST. CONTOUR
SMH	SEWER MANHOLE		WETLAND BUFFER ZONE
CBN	CATCH BASIN		FLOOD ZONE
HYD	HYDRANT		OVERHEAD WIRES
WG	WATER GATE		STONE WALL
WS	WATER SERVICE		EXISTING TREES AND SHRUBS
UP	UTILITY POLE		TREELINE/LANDSCAPE
LP	LIGHT	WETLAND	WETLAND LINE
GV	GAS VALVE	UPLAND	

DRAWING REVISIONS

ACTION	DATE	DESCRIPTION

DATUM:

VERTICAL REFERENCE: NAVD 1988
HORIZONTAL REFERENCE: NAD 1983
(CONVERSION: NAVD88 + 0.8 = NGVD29)

FEMA:

LOCUS LIES IN F.I.R.M. ZONE AE (EL.42 UPSTREAM OF DAM), ZONE AE (EL. 29 DOWNSTREAM OF DAM) AND FLOODWAY AREAS IN ZONE AE AS SHOWN ON COMMUNITY PANEL NO. 25023C0117J DATED JULY 17, 2012.

UTILITIES:

UNDERGROUND UTILITIES SHOWN ON THIS PLAN ARE BASED UPON VISIBLE ABOVE GROUND UTILITIES AND RECORD INFORMATION OF BELOW GROUND UTILITIES AND ARE APPROXIMATE ONLY. CONTRACTOR IS RESPONSIBLE FOR TAKING ALL NECESSARY PRECAUTIONS BEFORE BEGINNING ANY EXCAVATION. (DIGSAFE 1-800-322-4844)

SURVEY NOTES:

1. THIS PLAN IS THE RESULT OF AN ON THE GROUND FIELD CONDUCTED BY CAVANARO CONSULTING, INC. IN APRIL/MAY 2014.

2. ANY EASEMENTS SHOWN HEREON ARE IN ACCORDANCE WITH CURRENT RECORD DESCRIPTIONS AND/OR THOSE THAT ARE VISIBLE OR OF PUBLIC RECORD.

EXISTING CONDITIONS NOTE:

THE PURPOSE OF THIS PLAN IS TO ILLUSTRATE THE SITE CONDITIONS FOUND AT THE TIME OF FIELD SURVEY CONDUCTED BY CAVANARO CONSULTING, INC..

CAVANARO CONSULTING, INC. HAS NOT PREPARED AND/OR PROVIDED ANY PERMIT PLANS FOR THIS PROJECT TO DATE; THE STATUS OF ANY OPEN PERMITS IS NOT KNOWN. THIS PLAN DOES NOT EXPRESS OR IMPLY COMPLIANCE WITH CURRENT ZONING BYLAWS AND/OR OTHER REGULATORY AGENCY THRESHOLDS.

DIG SAFE
MA – RI – ME – NH – VT
CALL TOLL FREE 1-888-344-7233
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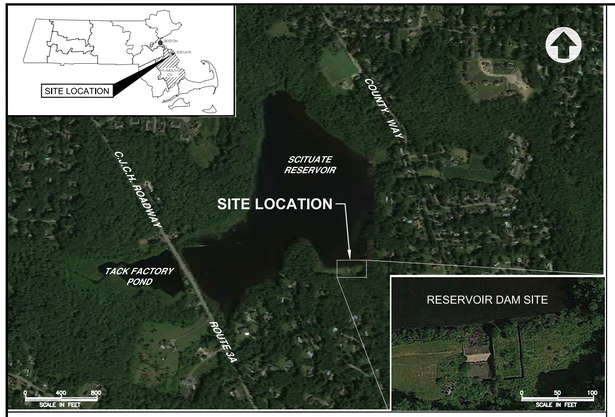
COMMONWEALTH OF MASSACHUSETTS
BRENDAN P. SULLIVAN
No. 46922
REGISTERED PROFESSIONAL LAND SURVEYOR

CAVANARO CONSULTING
687 MAIN STREET
P.O. BOX 5175
NORWELL, MASSACHUSETTS 02061
PHONE: 781.659.8187
FAX: 781.659.8186

EXISTING CONDITIONS PLAN
RESERVOIR DAM
SCITUATE, MA

PREPARED FOR:
TOWN OF SCITUATE
ENGINEERING DIVISION
SCITUATE, MA 02066

PROJECT NO. : 14.029	DRAWING NO. C-102
SCALE : AS SHOWN	
DATE : 05.15.14	
DESIGNED BY : –	
DRAWN BY : DB	SHEET NO. 1 OF 1
CHECKED BY : BPS	FILENAME: X:\PROJECTS\2014\14029\DWG\14029_NEW.DWG



SITE LOCATION MAP

SCALE: AS SHOWN

SCITUATE RESERVOIR

EDGE OF WATER AT TIME OF SURVEY (TYP.)

FOR GENERAL LAYOUT AND DETAIL - SEE DRAWING C-104

FOR GENERAL LAYOUT AND DETAIL - SEE DRAWING C-105

EXISTING FISH WAY EXIT CHANNEL BOTTOM CONC. EL. 38.5± N=2894027.73 E=858470.24

RIP-RAP EMBANKMENT

STONE

RIP-RAP EMBANKMENT

T.O.W. 45.7±

EARTHEN EMBANKMENT (GRASSED)

38X9 CONC. SPILLWAY

GRASSED BERM

T.O.W. 45.8±

T.O.W. 45.7±

T.O.W. 45.7±

FISHWAY EXIT CHANNEL 38.6±

EARTHEN EMBANKMENT (GRASSED)

DRILL HOLE IN MANHOLE COVER EL. 45.07' RT N=2893972.74 E=858248.54

EMH

TMH

SPILLWAY APPROACH APRON

CENTERLINE EMBANKMENT OGEE-SHAPED SPILLWAY CREST CONC. EL. 38.9' N=2893985.53 E=858417.11

SPILLWAY APPROACH CREST

SPILLWAY DISCHARGE APRON

26X0

N=2893954.16 E=858420.24

38.9±

FISHWAY POOL (TYP)

FISHWAY WEIR (TYP)

33.8±

30.7±

24.9±

27.1±

T.O.W. 35.7±

T.O.W. 35.8±

CENTER OF EXISTING FISHWAY TURNING POOL 30.4±

TOP TANK EL.30.4±

EBOX

MH

DRILL HOLE IN MANHOLE COVER N=2893934.10 E=858373.37

EXISTING FISHWAY ENTRANCE N=2893952.29 E=858439.50

T.O.W. 27.2±

T.O.W. 30.0±

30.0±

T.O.W. 33.5±

T.O.W. 33.5±

T.O.W. 26.7±

T.O.W. 26.9±

1008 Spike

FIRST HERRING BROOK

INV.=25.3± 12"CI

INV.=26.0± 6"PVC

LIMIT OF BVW AS FLAGGED BY SOUTH RIVER ENVIRONMENTAL ON APRIL 16, 2014

WOODED AREA

WOODED AREA

APPROXIMATE LIMIT OF BVW (NOT FLAGGED)

EXISTING STONEWALL

FIRST HERRING BROOK FLOW

EDGE OF WATER AT TIME OF SURVEY (TYP.)

0 10 20
SCALE IN FEET

NOTES:

1. THE TOPOGRAPHY AND SITE DETAILS SURVEYED BY CAVANARO CONSULTING, 687 MAIN STREET, NORWELL, MA 02061, CONDUCTED APRIL/MAY 2014. DATUM: VERTICAL NAD 1983, HORIZONTAL NAD 1983 (CONVERSION: NAVD88 = 0.8 = NGVD29).
2. WETLAND FLAGS DEPICTED WERE DEMARCATED BY SOUTH RIVER ENVIRONMENTAL ON APRIL 16, 2014.
3. FOR LEGEND, SEE SHEETS C-101 & C-102.

ISSUED FOR 30% DESIGN - NOT FOR CONSTRUCTION -

REV	DESCRIPTION	DRN	DES	CHK	APPR	DATE
A.	ISSUED FOR 30% DESIGN	FM	RJ	MM	TC	06/27/14

DESIGNED BY: B. JOHNSON
DRAWN BY: E. MENICHELLI
CHECKED BY: M. WORTHY
APPROVED BY: T. COOK
DATE: JUNE 19, 2014

TETRA TECH
160 FEDERAL STREET, 3RD FLOOR
BOSTON, MASSACHUSETTS 02110
TEL: 617-443-7500

TOWN OF SCITUATE
DEPARTMENT OF PUBLIC WORKS
600 CHIEF JUSTICE CUSHING HIGHWAY
SCITUATE, MASSACHUSETTS 02066
TEL: (781) 545-8721

FIRST HERRING BROOK
FISH LADDER IMPROVEMENTS AT RESERVOIR DAM
SCITUATE, MASSACHUSETTS

SPILLWAY AND FISHWAY GENERAL ARRANGEMENT PLAN

P. E. SEAL

PE - PROFESSIONAL ENGINEER LIC. NO.

CONTRACT NO.: 14-WA-13

SPEC. NO.

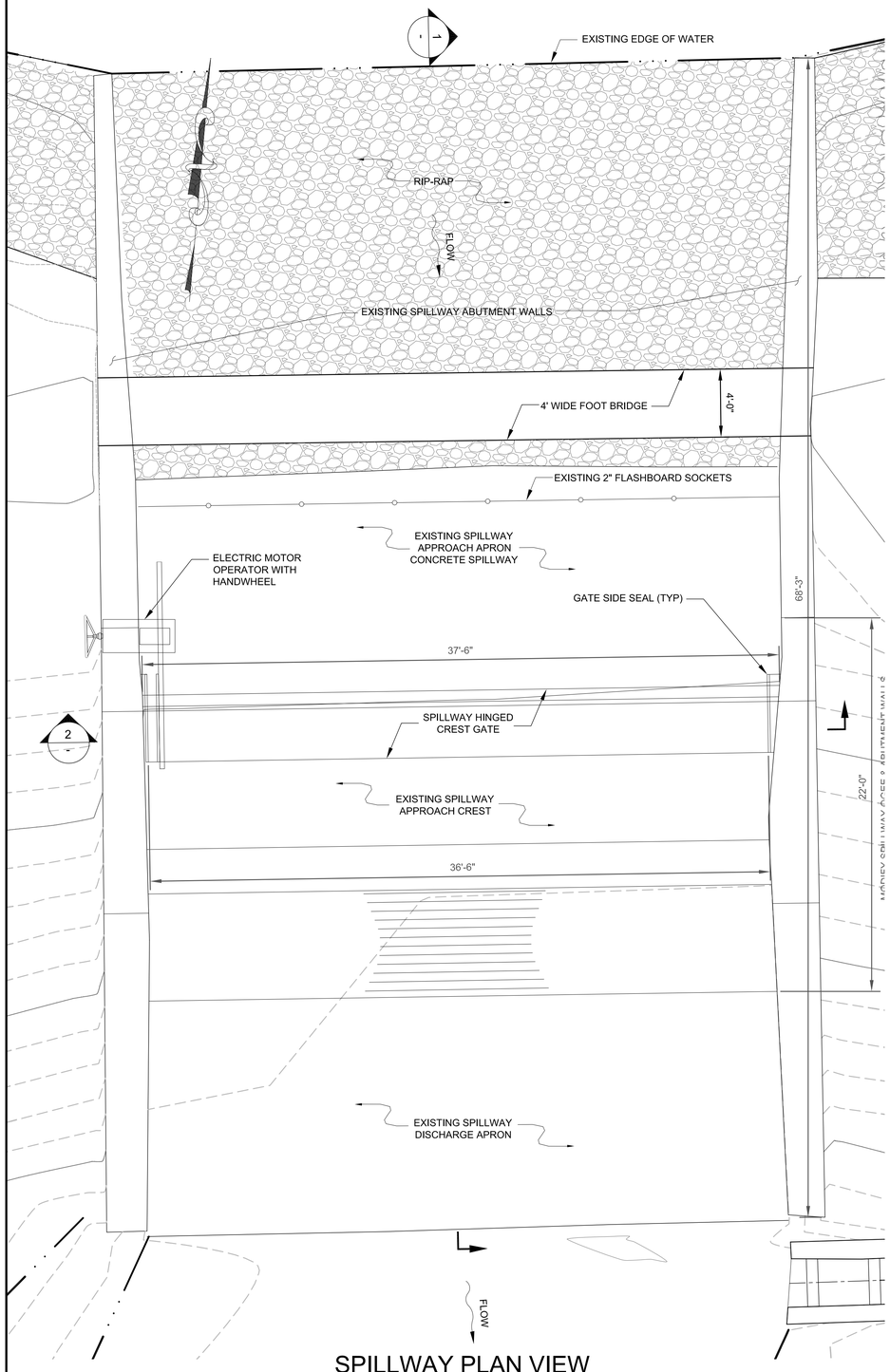
SCALE : AS SHOWN

CAD FILE: 4961_12_C-103-REV A.DWG

SHEET - OF -

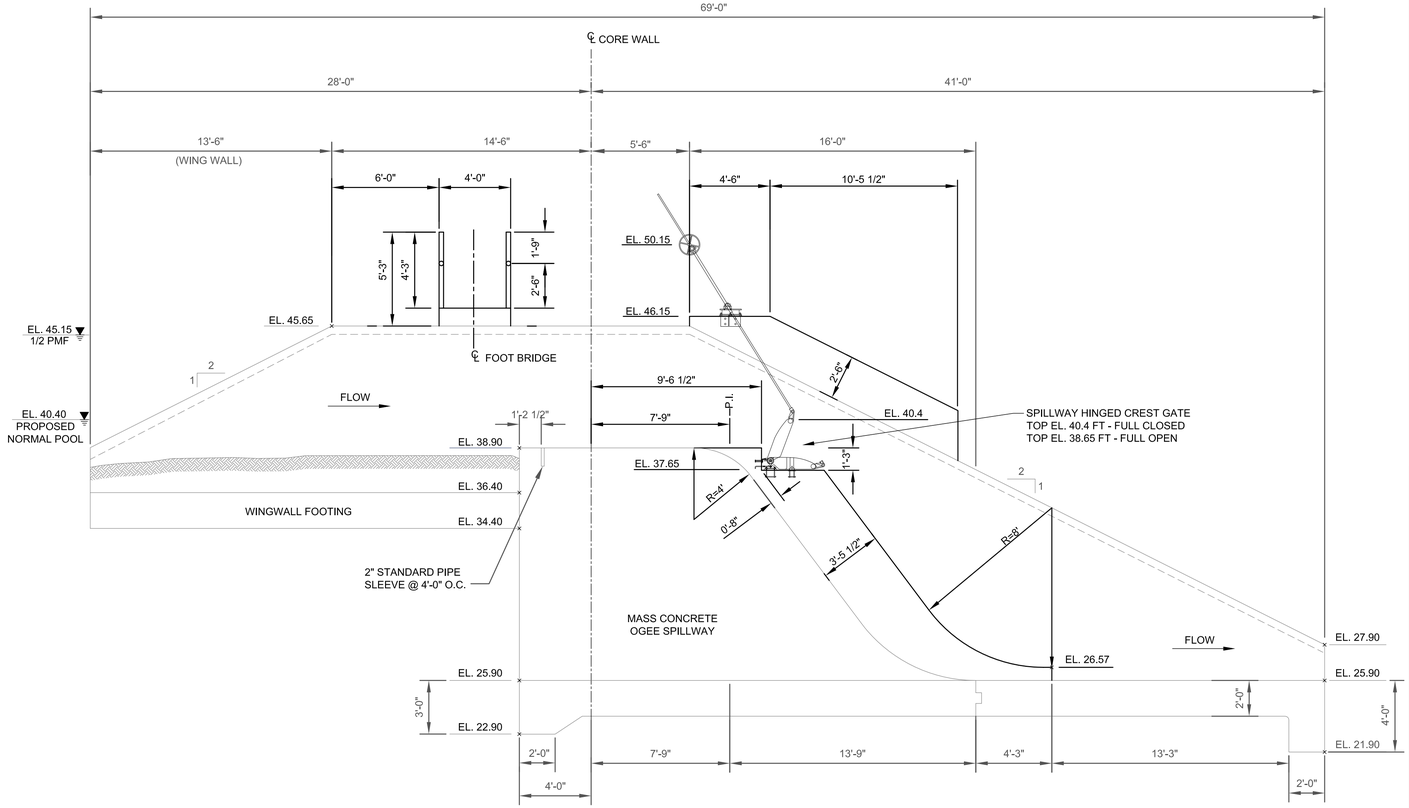
SIZE: _

C-103



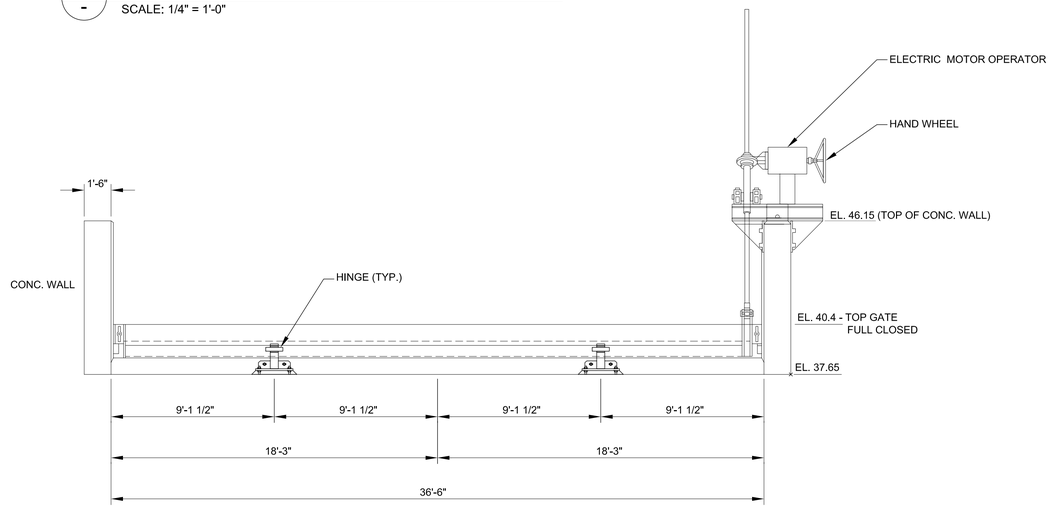
SPILLWAY PLAN VIEW

SCALE: 1/4" = 1'-0"



1 OGEE-SHAPED SPILLWAY PROFILE

SCALE: 1/4" = 1'-0"



2 ELEVATION SPILLWAY HINGED GATE

SCALE: 1/4" = 1'-0"

0 2' 4' 8'

SCALE: 1/4"=1'

NOTES:

1. ALL ELEVATIONS IN NAVD88.

ISSUED FOR 30% DESIGN
- NOT FOR CONSTRUCTION -

REV.	DESCRIPTION	DRN	DES	CHK	APR	DATE
A.	ISSUED FOR 30% DESIGN	FM	BJ	MW	TC	06/27/14

DESIGNED BY: B. JOHNSON
DRAWN BY: F. MENICHELLI
CHECKED BY: M. WORTH
APPROVED BY: T. COOK
DATE: JUNE 19, 2014

TETRA TECH
160 FEDERAL STREET, 3RD FLOOR
BOSTON, MASSACHUSETTS 02110
TEL: 617-443-7500

TOWN OF SCITUATE
DEPARTMENT OF PUBLIC WORKS
600 CHIEF JUSTICE CUSHING HIGHWAY
SCITUATE, MASSACHUSETTS 02066
TEL: (781) 545-8721

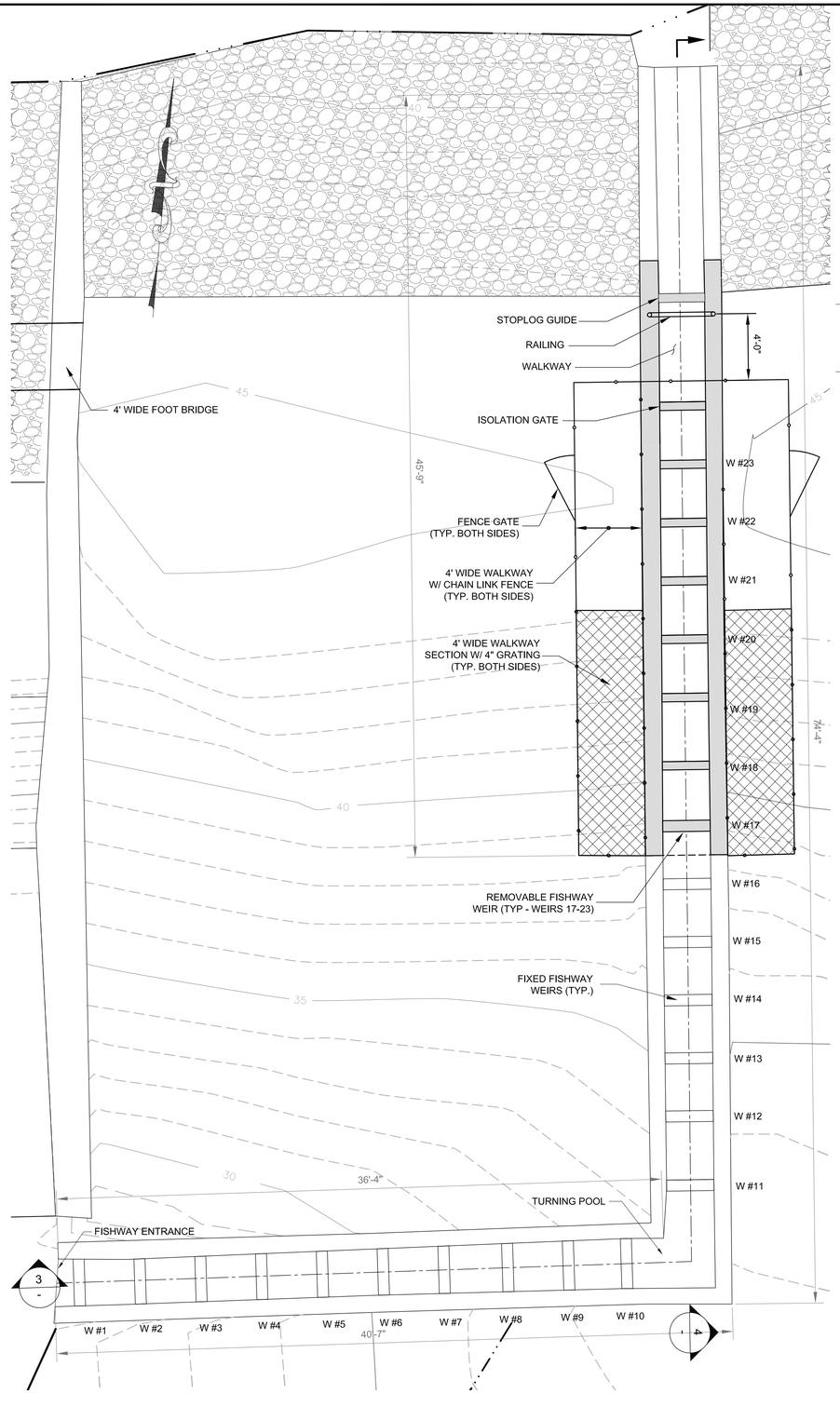
FIRST HERRING BROOK
FISH LADDER IMPROVEMENTS AT RESERVOIR DAM
SCITUATE, MASSACHUSETTS

SPILLWAY AND FISHWAY
PLAN, PROFILE & SECTIONS

P. E. SEAL

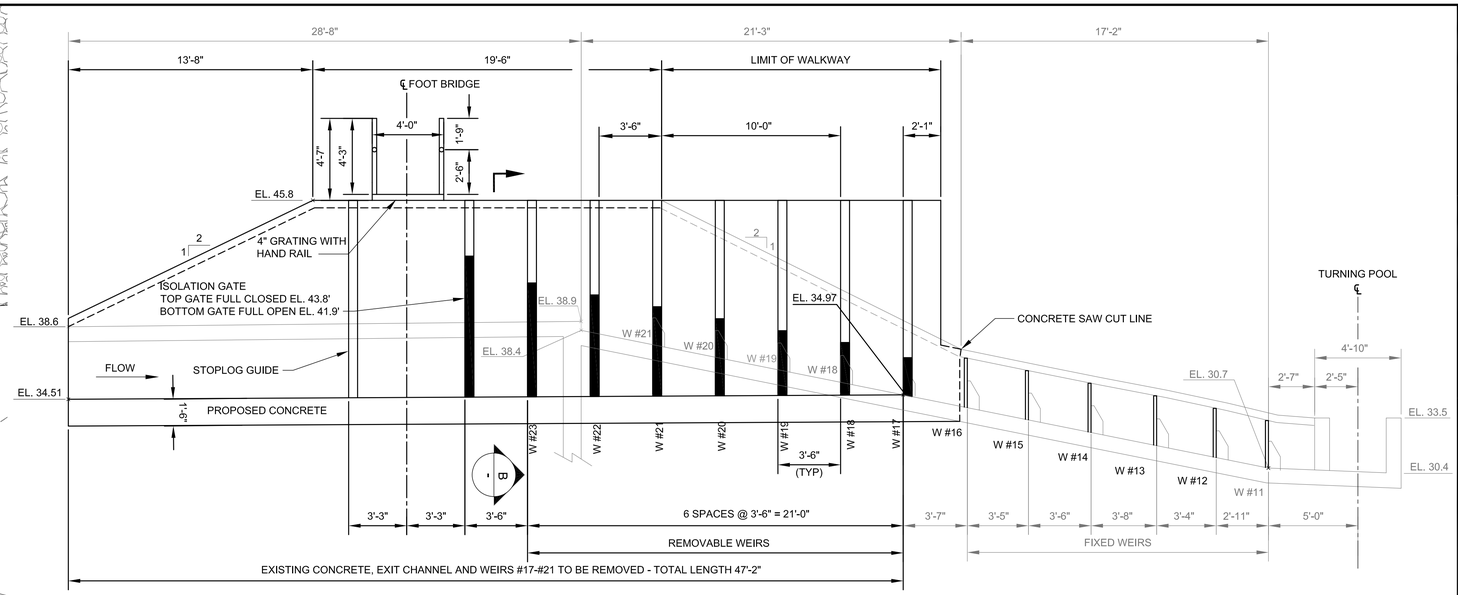
PE - PROFESSIONAL ENGINEER LIC. NO.

CONTRACT NO.: 14-WA-13
SPEC. NO.
SCALE : AS SHOWN
CAD FILE: 4961_12_C-104-REV A.DWG
SHEET - OF -
SIZE: C-104



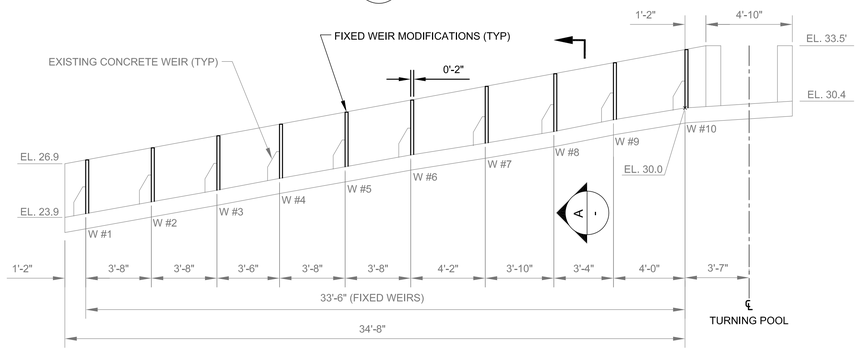
FISHWAY PLAN VIEW

SCALE: 1/4" = 1'-0"



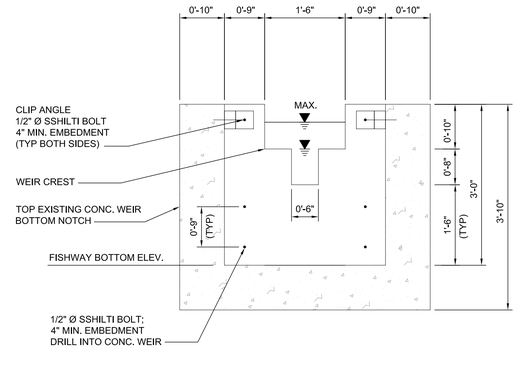
4 FISHWAY CENTERLINE PROFILE - WEIRS #11 - #23

SCALE: 1/4" = 1'-0"



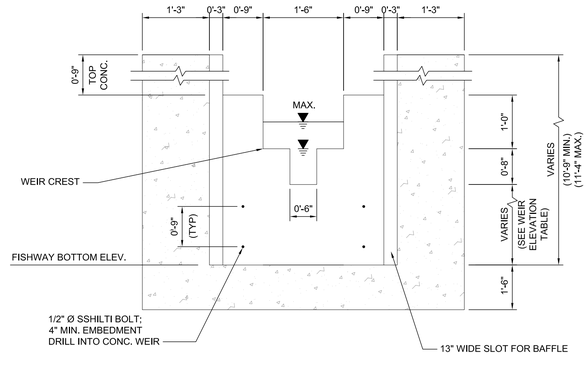
3 FISHWAY CENTERLINE PROFILE - WEIRS #1 - #10

SCALE: 1/4" = 1'-0"



A TYPICAL FIXED WEIR MODIFICATION

SCALE: 3/4" = 1'-0"



B TYPICAL REMOVABLE WEIR

SCALE: NTS

SCALE: 1/4"=1'

SCALE: 3/4"=1'

WEIR ELEVATIONS			
Location	Bottom El. (ft NAVD 88)	Notch El. (ft NAVD 88)	Weir Crest El. (ft NAVD 88)
Entrance Pool	23.90		
Weir #1 (Fixed)	24.11	25.61	26.28
Weir #2 (Fixed)	24.77	26.27	26.93
Weir #3 (Fixed)	25.42	26.92	27.59
Weir #4 (Fixed)	26.08	27.58	28.25
Weir #5 (Fixed)	26.73	28.23	28.90
Weir #6 (Fixed)	27.39	28.89	29.56
Weir #7 (Fixed)	28.05	29.55	30.21
Weir #8 (Fixed)	28.70	30.20	30.87
Weir #9 (Fixed)	29.36	30.86	31.53
Weir #10 (Fixed)	30.02	31.52	32.18
Centerline Turning Pool	30.40		
Weir #11 (Fixed)	30.70	32.20	32.87
Weir #12 (Fixed)	31.40	32.90	33.57
Weir #13 (Fixed)	32.11	33.61	34.27
Weir #14 (Fixed)	32.81	34.31	34.98
Weir #15 (Fixed)	33.51	35.01	35.68
Weir #16 (Fixed)	34.21	35.71	36.38
Weir #17 (Removable)	34.97	36.38	37.05
Weir #18 (Removable)	34.93	37.05	37.72
Weir #19 (Removable)	34.90	37.72	38.38
Weir #20 (Removable)	34.86	38.38	39.05
Weir #21 (Removable)	34.83	39.05	39.72
Weir #22 (Removable)	34.79	39.72	40.38
Weir #23 (Removable)	34.76	40.38	41.05
Isolation Gate	34.72		
Stoplog Guide	34.66		
Exit Channel	34.51		

ISSUED FOR 30% DESIGN
- NOT FOR CONSTRUCTION -

REV	DESCRIPTION	DRN	DES	CHK	APP	DATE
A	ISSUED FOR 30% DESIGN	FV	BJ	MW	TC	06/27/14

DESIGNED BY: B. JOHNSON
DRAWN BY: E. MENICHELLI
CHECKED BY: M. WORTH
APPROVED BY: T. COOK
DATE: JUNE 19, 2014

TETRA TECH
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BOSTON, MASSACHUSETTS 02110
TEL: 617-443-7500

TOWN OF SCITUATE
DEPARTMENT OF PUBLIC WORKS
600 CHIEF JUSTICE CUSHING HIGHWAY
SCITUATE, MASSACHUSETTS 02066
TEL: (781) 545-8721

FIRST HERRING BROOK
FISH LADDER IMPROVEMENTS AT RESERVOIR DAM
SCITUATE, MASSACHUSETTS

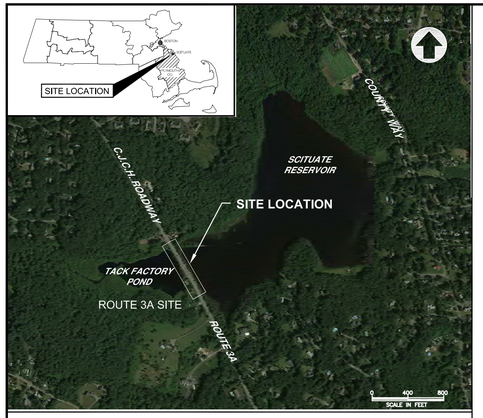
FISHWAY MODIFICATIONS
PLAN, PROFILE & SECTIONS

P. E. SEAL

PE : PROFESSIONAL ENGINEER LIC. NO.

CONTRACT NO.: 14-WA-13
SPEC. NO.
SCALE : AS SHOWN
CAD FILE: 4961_12_C-105-REV A.DWG
SHEET - OF -
SIZE: __

C-105

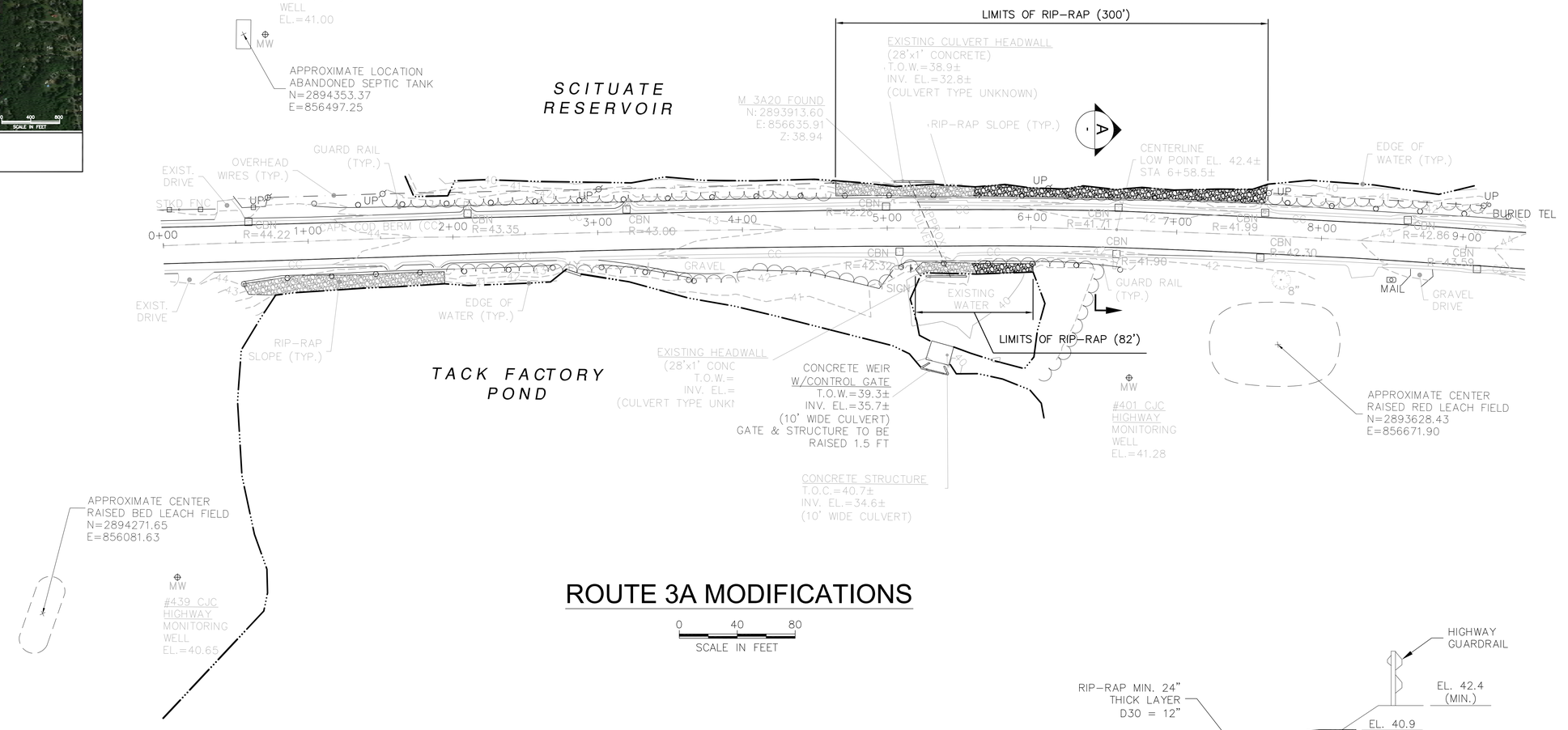


SITE LOCATION MAP

SCALE: AS SHOWN

NOTES:

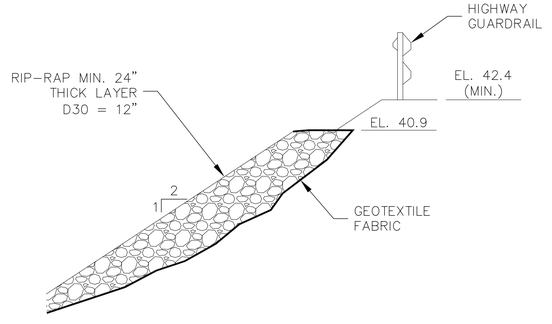
1. THE TOPOGRAPHY AND SITE DETAILS SURVEYED BY CAVANARO CONSULTING, 687 MAIN STREET, NORWELL, MA 02061, CONDUCTED APRIL/MAY 2014. DATUM: VERTICAL NAD 1983, HORIZONTAL NAD 1983 (CONVERSION: NAVD88 = 0.8 = NGVD29).
2. WETLAND FLAGS DEPICTED WERE DEMARCATED BY SOUTH RIVER ENVIRONMENTAL ON APRIL 16, 2014.
3. FOR LEGEND, SEE SHEETS C-101 & C-102.



ROUTE 3A MODIFICATIONS

0 40 80

SCALE IN FEET



A - RIP-RAP MODIFICATIONS

SCALE: N.T.S.

ISSUED FOR 30% DESIGN
- NOT FOR CONSTRUCTION -

REV	DESCRIPTION	DRN	DES	CHK	APR	DATE
A.	ISSUED FOR 30% DESIGN	FM	BJ	MW	TC	06/23/14

DESIGNED BY: B. JOHNSON
DRAWN BY: E. MENICHELLI
CHECKED BY: M. WORTHY
APPROVED BY: T. COOK
DATE: JUNE 19, 2014

TETRA TECH
150 FEDERAL STREET, 3RD FLOOR
BOSTON, MASSACHUSETTS 02110
TEL: 617-443-7500

TOWN OF SCITUATE
DEPARTMENT OF PUBLIC WORKS
600 CHIEF JUSTICE CUSHING HIGHWAY
SCITUATE, MASSACHUSETTS 02066
TEL: (781) 545-8721

FIRST HERRING BROOK
FISH LADDER IMPROVEMENTS AT RESERVOIR DAM
SCITUATE, MASSACHUSETTS

C.J.C.H. ROADWAY IMPROVEMENTS
PLAN & SECTION

P. E. SEAL

PE :
PROFESSIONAL ENGINEER LIC. NO.

CONTRACT NO.: 14-WA-13
SPEC. NO.
SCALE : AS SHOWN
CAD FILE: 4961_12_C-106-REV A.DWG
SHEET - OF -
SIZE:

C-106

APPENDIX B – RESERVOIR DAM PROPOSED MANAGEMENT LEVELS

TETRA TECH

TOWN OF SCITUATE
SCITUATE, MASSACHUSETTS

PROPOSED MANAGEMENT LEVELS
RESERVOIR DAM FISH PASSAGE PROJECT

APPENDIX B
FIGURE B-1

P:\SCITUATE RESERVOIR DAM – 4961\CAD\FIGURES\FIG 4\FIG B-1 PROPOSED MGMT LEVELS.DWG PLOT/UPDATE: Jun 16 2014 16:51:07

APPENDIX C – PROPERTY OWNER INTERVIEWS AND GROUNDWATER MONITORING WELL DATA

Homeowner Interviews/Meetings

March 25, 2014

Sara Grady (Mass. Bays/NSRWA) and Jim DeBarros (Scituate Water) met with the owners of #401 CJCH and #439 CJCH. Both of the homeowners were interested in the project and willing to allow groundwater wells to be installed on their property. The owners of #401 noted that their sump pump runs frequently. Sara Grady and Jim DeBarros also called the owners of #436 CHCH, who currently reside in Florida and have abandoned their Scituate home, partially due to an inability to pay for septic upgrades (per Scituate Board of Health records.) The owners were willing to have a groundwater well installed.

June 9, 2014

Sara Grady and Jim DeBarros met with the owners of #401 to personally invite them to the public meeting on June 19th and note that while the groundwater measurements have been high on their property (higher than estimated high groundwater for the septic system design), it is likely that their septic system high groundwater level was measured in an area with different geology than the project well location.

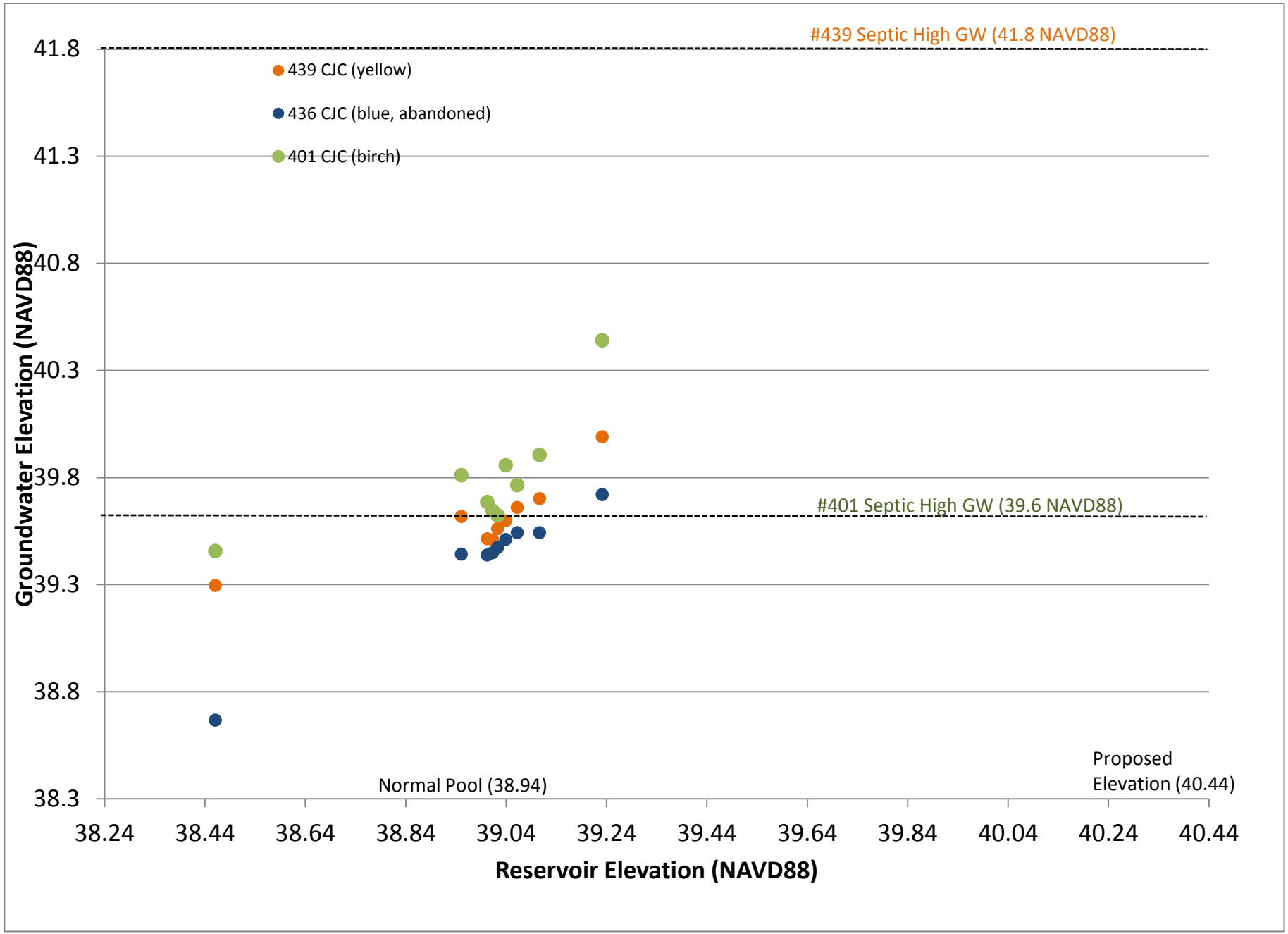
June 11, 2014

While sampling, Sara Grady spoke with the owner of #439 and personally invited her to the June 19th public meeting. The owner asked permission to remove the small flag marking the groundwater well. Sara Grady also had a discussion with the owners of #401 while sampling about the Mother's Day Storm of 2006, where the flooding occurred, and whether they had any issues with their septic system (they did not.)

Reservoir Groundwater Monitoring

			439 CJC (yellow)			436 CJC (blue, abandoned)			401 CJC (birch)						
Date	Time	Monitor	Tape Top	Chalk Wet	Depth	Tape Top	Chalk Wet	Depth	Tape Top	Chalk Wet	Depth	Res Lvl NSRWA	ResLvl WTP	"Avg" ResLvl	Notes
1-May	9:15	SW			-7.92			-15.36			-10.08		3.5	3.5	
6-May	10:45	SPG	12	5.75	-6.25	18	5	-13	18	7.63	-10.37		2	2	
9-May	10:30	SPG			-6.75			-13			-12.06	1.69	1.25	1.47	
13-May	8:50	SPG	18	10.06	-7.94	18	4.19	-13.81	24	10.25	-13.75	0.75	1.25	1	waves in reservoir
16-May	14:05	SPG	18	9.44	-8.56	18	3.88	-14.12	24	10.5	-13.5	0.88		0.88	
20-May	8:55	SPG	18	10.5	-7.5	18	4.63	-13.37	18	7.06	-10.94	1.19		1.19	
22-May	10:45	SPG	18	9.5	-8.5	18	3.75	-14.25	18	5	-13	0.75		0.75	waves in reservoir
29-May	9:00	SPG	18	10.75	-7.25	18	3.81	-14.19	24	12.5	-11.5	0.13		0.13	releasing from reserv
4-Jun	10:21	SPG/VH			-11.12			-23.5			-15.75	-5.75		-5.75	
11-Jun	12:15	SPG/VH			-9.6			-31.8			-16.44	-4.8		-4.8	
16-Jun	14:01	SPG+3			-10.8			-23.4			-20.4	-1.8		-1.8	

	Spillway Crest USGS Bench Mark (El. 38.94 ft NAVD 1988)	439 CJC (yellow) [Top monitoring well El. 40.65 ft NAVD 1988]		436 CJC (blue, abandoned) [Top monitoring well El. 41.00 ft NAVD 1988]		401 CJC (birch) [Top monitoring well El. 41.00 ft NAVD 1988]	
Date	Reservoir level (El. Ft NAVD 1988)	Groundwater level (El. Ft NAVD 1988)	Groundwater level relative to Reservoir level (ft)	Groundwater level (El. Ft NAVD 1988)	Groundwater level relative to Reservoir level (ft)	Groundwater level (El. Ft NAVD 1988)	Groundwater level relative to Reservoir level (ft)
1-May	39.23	39.99	0.76	39.72	0.49	40.44	1.21
6-May	39.11	39.70	0.59	39.54	0.44	39.91	0.80
9-May	39.06	39.66	0.60	39.54	0.48	39.76	0.70
13-May	39.02	39.56	0.54	39.47	0.45	39.62	0.60
16-May	39.01	39.51	0.50	39.45	0.44	39.64	0.63
20-May	39.04	39.60	0.56	39.51	0.47	39.86	0.82
22-May	39.00	39.51	0.51	39.44	0.44	39.69	0.68
29-May	38.95	39.62	0.67	39.44	0.49	39.81	0.86
4-Jun	38.46	39.30	0.83	38.67	0.21	39.46	1.00
11-Jun	38.54	39.42	0.88	37.98	-0.56	39.40	0.86
16-Jun	38.79	39.32	0.53	38.68	-0.12	39.07	0.28


#439 Septic High GW (41.8 NAVD88)
439 CJC (yellow)
436 CJC (blue, abandoned)
401 CJC (birch)
#401 Septic High GW (39.6 NAVD88)
Normal Pool (38.94)
Proposed Elevation (40.44)
Groundwater Elevation (NAVD88)
Reservoir Elevation (NAVD88)
41.8
41.3
40.8
40.3
39.8
39.3
38.8
38.3
38.24
38.44
38.64
38.84
39.04
39.24
39.44
39.64
39.84
40.04
40.24
40.44

Reservoir Abutter Groundwater Sampling

Sample Date	Site	E. coli	Total coliform	HPC	nitrate	nitrite	GW level
4-Jun	#401	<10	640	5300	0.28	0.010	39.46
11-Jun	#401	<10	300	3900	0.44	0.027	39.40
16-Jun		Pending Lab Report					39.07
4-Jun	#436	<10	1400	1200	0.17	0.012	38.67
11-Jun	#436	50	420	16000	0.13	0.082	37.98
16-Jun		Pending Lab Report					38.68
4-Jun	#439	10	12000	1400	0.13	0.013	39.30
11-Jun	#439	120	3400	6900	0.27	<.007	39.42
16-Jun		Pending Lab Report					39.32

APPENDIX D – PRELIMINARY SPILLWAY STABILITY CALCULATIONS

TETRA TECH

SUBJECT SPILLWAY STABILITY ANALYSIS

PROJECT RESERVOIR DAM

TC/P NO. 194-4961

ORIGINATOR BEJ CHECKED TCC

DATE 6-24-14 PAGE 1 OF 9 PAGES

PURPOSE: ~~ANALYZE~~ SPILLWAY STABILITY WITH BOTTOM HINGED CREST GATE

ASSUMPTIONS:

1) EXISTING CREST @ EL. 38.4 FT. NAVD 1988 PER 2014 CAVANARO SURVEY (SEE DWG C-102)

2) GATE CONFIGURATION SHOWN ON DWG C-104.

3) TOP GATE FULL CLOSED @ EL. 40.4 FT NAVD 1988

4) MAX. FLOOD (½ PMF) @ EL. 45.0 FT NAVD 1988

5) SPILLWAY ORIGINALLY DESIGNED FOR 2 FT HIGH FLASH BOARD PER ORIGINAL DRAWINGS.

6) CONCRETE ON SOIL COEFFICIENT OF FRICTION = μ = 0.50, see pg. 2

7) SOIL DENSITY ≥ 120 #/FT³ DRY.

METHODOLOGY: CHECK 3 CRITICAL CONDITIONS.

CONDITION 1 - ½ PMF; NO FLASHBOARD; CREST GATE FULL OPEN.

CONDITION 2 - 2' FLASHBOARD; NO FLOW

CONDITION 3 - CREST GATE FULL UP; NO FLOW

SPILLWAY
STABILITY ANALYSES
B. JOHNSON TCOOK

RESERVOIR DAM
194-4961
6-24-14 PG-2 of

TABLE C-1

Friction Coefficient for Concrete Cast on Soil
(reference 4)

Interface Materials	Friction Coefficient, f
Mass concrete on the following foundation materials:	
Clean sound rock	0.70
Clean gravel, gravel--sand mixtures, coarse sand	0.55 to 0.60
Clean fine to medium sand, silty medium to coarse sand, silty or clayey gravel	0.45 to 0.55
Clean fine sand, silty or clayey fine to medium sand	0.35 to 0.45
Fine sandy silt, nonplastic silt	0.30 to 0.35
Very stiff and hard residual or preconsolidated clay	0.40 to 0.50
Medium stiff and stiff clay and silty clay	0.30 to 0.35

C-4.2. The size of thrust block for downward directed thrust is calculated by;

$$A_{TB} \geq F_S T_Y / q_S$$

where;

A_{TB} = bottom area of thrust block,
T_Y = vertical component of thrust force,
q_S = allowable bearing capacity of soil, and
F_S = Factor of Safety.

C-4.3. There is also a horizontal component of thrust (T_X) in vertical bends. The sizing of thrust block for the horizontal component is calculated by the same formula used for horizontal bends, except the term T is replaced by $T_X = 2PA \sin 0/2 \cos 0$.

C-4.4. These are shown in Figures C-4, C-5, C-6 and C-7.

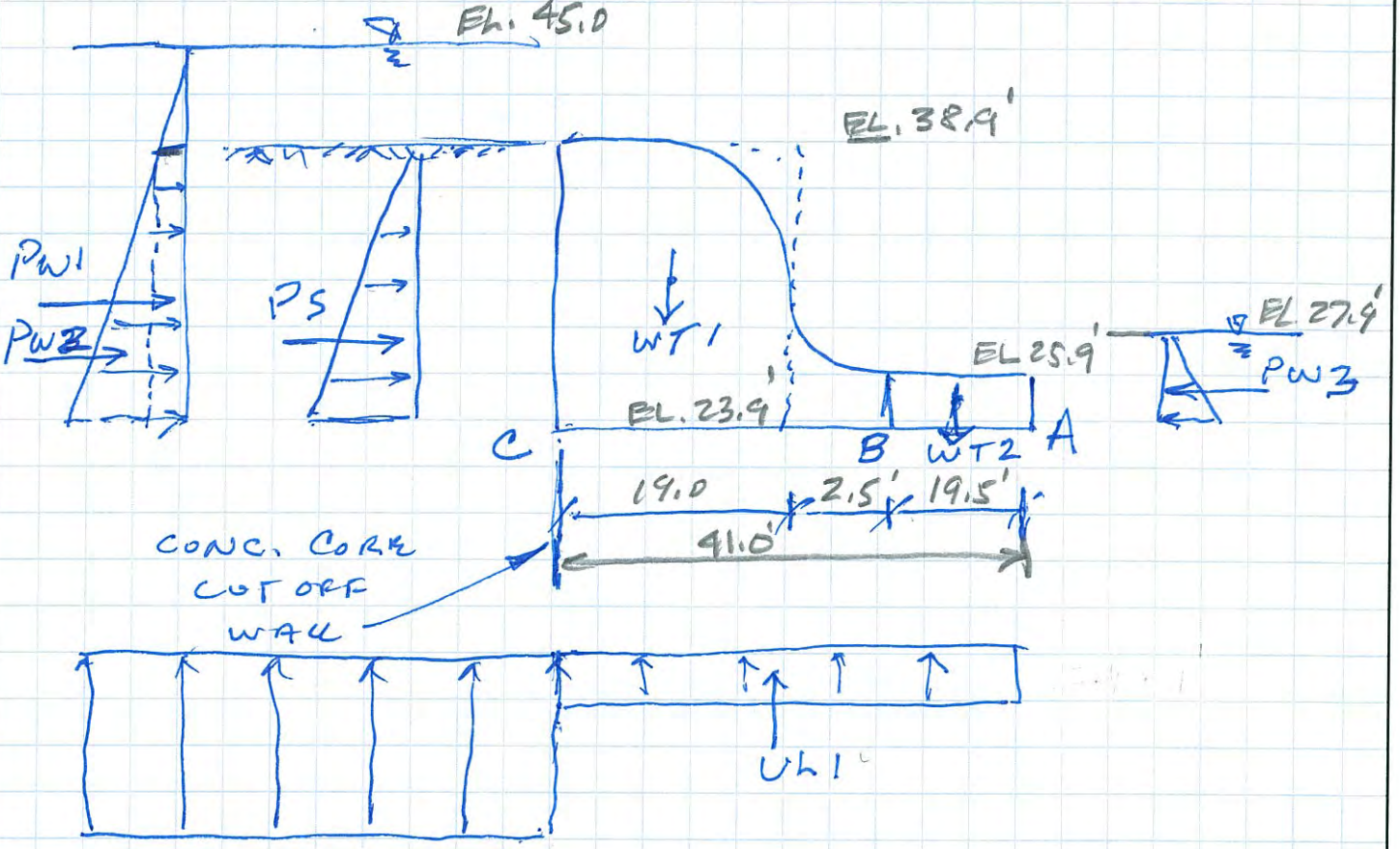
C--5. Restrained Joints. There are several approaches to this. They all calculate the length of pipe to be restrained on both sides of the joint. The length to be restrained may be determined by;

$$L \geq F_S(PA \tan 2/2)/(F_f + 0.5 R (s Z K_p D_o)$$

where;

CONDITION I – ½ PMF; NO FLASHBOARDS; CREST GATE PULL OPEN.

LOADING DIAGRAM #1



$$P_{W1} = (62.4\,^{\#}/_{FT^3})\left(45.0 - 38.9\right)^{6.1}\left(\frac{38.9 - 23.9}{2}\right)^{15'} = 5.71^{\#/'} \rightarrow$$

$$M_{A\,PW1} = 5.71^{\#/'} \times \frac{15'}{2} = 42.8^{\#/'} \curvearrowright$$

$$P_{W2} = (62.4\,^{\#}/_{FT^3})\left(38.9 - \frac{15'}{2} 3.9'\right)^2 \times 1/2 = 7.02^{\#/'} \rightarrow$$

$$M_{A\,PW2} = 7.02^{\#/'} \times \frac{15'}{3} = 35.1^{\#/'} \curvearrowright$$

$$P_S = (120\,\#/FT^3 - 62.4\,\#/FT^3)(38.9 - 23.9)^2 \times \tfrac{1}{2} \times 0.33$$

$P_S = 2.14^{K/L}$ →

K_a = ACTIVE PRESSURE COEFFICIENT

$$M_A P_S = 2.14^{K/L} \times \frac{15'}{3} = 10.7^{K/L}$$ ←

$$P_{W3} = (62.4\,\#/FT^3)(27.9 - 23.9)^2 \times \tfrac{1}{2} = 0.50^{K/L}$$ ←

$$M_A P_{W3} = 0.50^{K/L} \times \frac{4'}{3} = 0.7^{K/L}$$ ←

$$U_{L1} = (62.4\,\#/FT^3)(27.9 - 23.9) \times 4' = 10.2^{K/L}$$ ↑

$$M_A U_{L1} = 10.2^{K/L} \times \frac{41'}{2} = 209.1^{K/L}$$ →

$$wt.1 = 150\,\#/FT^3 \times 19.0' \times (38.9 - 23.9) = 42.8^{K/L}$$ ↓

$$M_A wt.1 = 42.8^{K/L} \times \left[\frac{19'}{2} + 19.5'\right] = 1{,}241.2^{K/L}$$ ←

$$wt.2 = 150\,\#/FT^3 \times 19.5' \times (25.9 - 23.9) = 5.85^{K/L}$$ ↓

$$M_A wt2 = 5.85^{K/L} \times \frac{19.5'}{2} = 57.0^{K/L}$$ ←

SLIDING FACTOR OF SAFETY

$$\frac{\Sigma F_R}{\Sigma F_S} = \frac{P_{W3} + [(WT1 + WT2 - UL1)0.5]}{\vec{P}_{W1} + \vec{P}_{W2} + \vec{P}_S}$$

$$\frac{\Sigma F_R}{\Sigma F_S} = \frac{0.5 + [(42.8 + 5.8 - 10.2)0.5]}{5.71 + 7.02 + 2.13}$$

$$\frac{\Sigma F_R}{\Sigma F_S} = \frac{19.7^{k}}{14.4^{k}} = 1.3$$ STABLE FOR SLIDING FLOOD CONDITION 1

OVERTURNING FACTOR OF SAFETY

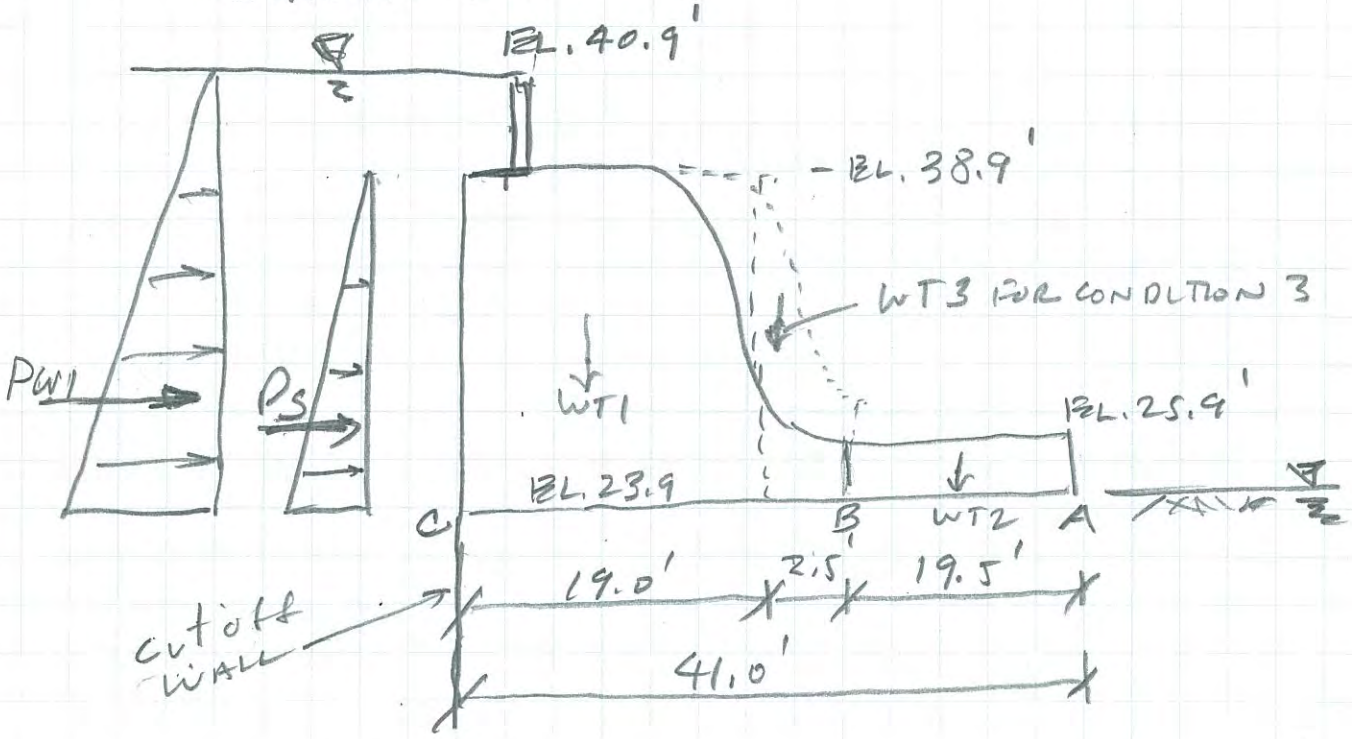
$$\frac{\Sigma M_R}{\Sigma M_O} = \frac{M_A WT1 + M_A WT2 + M_A PW3}{M_A P_{W1} + M_A P_{W2} + M_A P_S + M_A UL1}$$

$$\frac{\Sigma M_R}{\Sigma M_O} = \frac{\overleftarrow{1241.2}^{k} + \overleftarrow{57.0}^{k} + \overleftarrow{0.7}^{k}}{\vec{42.8}^{k} + \vec{35.1}^{k} + \vec{10.7}^{k} + \vec{209.1}^{k}}$$

$$\frac{\Sigma M_R}{\Sigma M_O} = \frac{1299.0^{k}}{297.5^{k}} = 4.4 >> 1.7$$ STABLE FOR OVERTURNING FLOOD CONDITION 1.

CONDITION 2 – FULL POND; 2 FT FLASHBOARD (EXISTING DESIGN)

LOADING DIAGRAM



$P_{W1} = (62.4^{\#}/_{FT^3})(40.9' - 23.9')^2 \times 1/2 = 9.02^{K/1}$ (17')

$M_A P_{W1} = 9.02^{K/1} \times \frac{17'}{3} = 51.1^{1K/1}$

$P_S = (120 - 62.4)^{\#}/_{FT^3}(38.9' - 23.9')^2 \times 1/2 \times 0.33 = 2.14^{K/1}$ (15')

$M_A P_S = 2.14^{K/1} \times \frac{15'}{3} = 10.7^{1K/1}$

$wt_1 = 42.8^{K/1}$ ↓ see pg. 4 $M_A WT1 = 1,241.2^{1K/1}$ see pg. 4

$wt_2 = 5.8^{K/1}$ ↓ $M_A wt_2 = 57.0^{1K/1}$ see pg. 4

SLIDING FACTOR OF SAFETY:

$$\frac{\Sigma F_R}{\Sigma F_S} = \frac{[Wt_1 + Wt_2]\mu}{P_{W1} + P_S} = \frac{[\overrightarrow{42.8}^{k} + 5.8]\,0.5}{\overrightarrow{9.02} + \overrightarrow{2.14}^{k}}$$

$$\frac{\Sigma F_R}{F_S} = \frac{\overleftarrow{24.3}^{k}}{11.2^{k}} = 2.2 > 1.7$$ STABLE FOR SLIDING W/ CONDITION 2, EXISTING 2' FLASHBOARDS

OVERTURNING FACTOR OF SAFETY

$$\frac{\Sigma M_R}{\Sigma M_O} = \frac{M_A W_T + M_A W_{T2}}{M_A P_{W1} + M_A P_S}$$

$$\frac{\Sigma M_R}{\Sigma M_O} = \frac{\overleftarrow{1241.2}^{k} + \overleftarrow{57.0}^{k}}{\overrightarrow{51.1}^{k} + \overrightarrow{10.7}^{k}} = \frac{\overleftarrow{1298.2}^{k}}{\overrightarrow{61.8}^{k}}$$

$$\frac{\Sigma M_R}{\Sigma M_O} = 21.0 >>> 2.0$$ STABLE FOR OVERTURNING CONDITION 2 EXISTING 2' FLASHBOARDS

CONDITION 3 - FULL POND; 1.5 HIGH CREST GATE FULL CLOSED

LOADING DIAGRAM SAME AS CONDITION 2 EXCEPT POND AT EL. 40.4' (SEE PG. 6)

$P_{W1} = (62.4)(40.4 - 23.9)^2 \times 1/2 = 8.5^{16.5}\ ^{K}/_{L}$

$M_A P_{W1} = 8.5\ ^{K}/_{L} \times \frac{16.5'}{3} = 46.7\ ^{K}/_{L}$

$P_{S2} = 2.14\ ^{K}/_{L}$; $M_A P_S = 10.7\ ^{K}/_{L}$ SAME AS PG. 6

$Wt_1 = 42.8^{K}\downarrow$; $M_A Wt_1 = 1241.2\ ^{K}/_{L}$ SAME AS PAGE 6

$Wt_2 = 5.8^{K}\downarrow$; $M_A Wt_2 = 57.0\ ^{K}/_{L}$ SAME AS PG. 6

$Wt_3 = 150\ ^{K}/_{A3}(3' \times 13') = 5.8^{K}\downarrow$; $M_A Wt_3 = 5.8^{K} \times 21' = 122.8\ ^{K}/_{L}$

SLIDING FACTOR SAFETY:

$$\frac{\Sigma F_R}{\Sigma F_S} = \frac{[Wt_1 + W_2 + W_3]f}{P_{W1} + P_S} = \frac{(42.8 + 5.8 + 5.8)^{K}\ 0.5}{8.5^{K} + 46.7\ ^{K}/_{L}}$$

$$\frac{\Sigma F_R}{\Sigma F_S} = \frac{27.2^{K}}{8.5 + 2.1} = \frac{27.2}{10.6} = 2.6$$ SLIDING STABLE FOR CONDITION 3

OVERTURNING FACTOR OF SAFETY

$$\frac{\Sigma M_R}{\Sigma M_O} = \frac{M_A Wt1 + M_A Wt2 + M_A Wt_3}{M_A P_{W1} + M_A P_S} = \frac{1241.2^{K}/_{L} + 57.0^{K}/_{L} + 122.8}{46.7 + 10.7}$$

$\frac{\Sigma M_R}{\Sigma M_O} = \frac{1421.0^{1k/1}}{57.4^{1k/1}} = 24.8 >> 2.0$ STABLE FOR OVERTURNING CONDITION 3 PROPOSED CREST GATE.

SUMMARY

CONDITION	FACTOR OF SAFETY OVERTURNING	SLIDING
½ PMF (EXISTING)	4.4	1.3
½ PMF (PROPOSED) SEE BELOW.	4.8	1.5
2 FT FLASHBOARDS; NO SPILL (EXISTING)	21.0	2.2
1.5 FT CREST GATE; NO SPILL (PROPOSED)	24.8	2.6

½ PMF PROPOSED —

ADD WT. 3 = $5.8^{1k/1}\downarrow$; M_A WT3 = $122.8^{1k/1}\leftarrow$

FROM Pg. 5 $\frac{\Sigma F_R}{\Sigma F_O} = \frac{19.7 + (5.8 \times 0.5)}{14.9} = \frac{22.6}{14.9} = 1.5$

$\frac{\Sigma M_R}{\Sigma M_O} = \frac{1299.0 + 122.8}{297.5} = 4.8$

APPENDIX E – FIRST HERRING BROOK MULTIPLE DAM FAILURE INUNDATION MAP

SCITUATE RESERVOIR DAM
SPILLWAY CREST 38.9 ±
LOW LEVEL OUT INVERT 26.1 ±
DAM CREST ELEVATION 45.65 ±
NORMAL POOL ELEVATION 38.9 ±

RIVER MILE 0.00 - AT DAM
NORMAL RIVER ELEVATION 38.9 ± (FT)

SUNNY DAY		1/2 PMF
38.9	PEAK ELEVATION (FT)	42.9
0.5	TIME TO PEAK (HR)	0.5
0.0	FLOOD ARRIVAL TIME (HR)	0.0
3,950	PEAK FLOW (CFS)	9,250

RIVER MILE 0.01 - TOE OF DAM
NORMAL RIVER ELEVATION 25.9 ± (FT)

SUNNY DAY		1/2 PMF
32.4	PEAK ELEVATION (FT)	34.8
0.5	TIME TO PEAK (HR)	0.5
0.1	FLOOD ARRIVAL TIME (HR)	0.1
3,950	PEAK FLOW (CFS)	9,250

RIVER MILE 0.36 - FIRST HERRING BROOK
NORMAL RIVER ELEVATION 21.2 ± (FT)

SUNNY DAY		1/2 PMF
23.3	PEAK ELEVATION (FT)	25.3
0.6	TIME TO PEAK (HR)	0.6
0.2	FLOOD ARRIVAL TIME (HR)	0.2
3,350	PEAK FLOW (CFS)	7,900

RIVER MILE 0.69 - COUNTRY WAY - OLD OAKEN DAM
NORMAL RIVER ELEVATION 19.4 ± (FT)

SUNNY DAY		1/2 PMF
23.7	PEAK ELEVATION (FT)	25.6
1.0	TIME TO PEAK (HR)	1.0
0.4	FLOOD ARRIVAL TIME (HR)	0.4
3,700	PEAK FLOW (CFS)	8,405

RIVER MILE 0.81 - DRIFTWAY ROAD
NORMAL RIVER ELEVATION TIDAL (FT)

SUNNY DAY		1/2 PMF
13.4	PEAK ELEVATION (FT)	15.2
1.2	TIME TO PEAK (HR)	1.2
0.45	FLOOD ARRIVAL TIME (HR)	0.45
3,700	PEAK FLOW (CFS)	8,405

RIVER MILE 1.8 - HERRING RIVER/NORTH RIVER
NORMAL RIVER ELEVATION TIDAL (FT)

SUNNY DAY		1/2 PMF
2.7	PEAK ELEVATION (FT)	9.3
2.1	TIME TO PEAK (HR)	2.1
1.1	FLOOD ARRIVAL TIME (HR)	1.1
3,700	PEAK FLOW (CFS)	8,405

RIVER MILE 1.16 - D/S FLOODPLAIN
NORMAL RIVER ELEVATION TIDAL (FT)

SUNNY DAY		1/2 PMF
2.8	PEAK ELEVATION (FT)	9.4
1.2	TIME TO PEAK (HR)	1.2
0.8	FLOOD ARRIVAL TIME (HR)	0.8
3,700	PEAK FLOW (CFS)	8,405

SCITUATE RESERVOIR
FLOW
COUNTY WAY
CHIEF JUSTICE CUSHING HIGHWAY (ROUTE 3A)
OLD OAKEN BUCKET ROAD
OLD OAKEN BUCKET POND
DRIFTWAY
CORNET STETSON ROAD (ROUTE 123)
WOOD ISLAND
FLOW
HERRING RIVER
BEAR ISLAND
CHIEF JUSTICE CUSHING HIGHWAY (ROUTE 3A)
DAMONS POINT ROAD
WILLIS ISLAND
RIVER MILE 1.8
END OF STUDY
FLOW
NORTH RIVER

LEGEND
1/2 PMF INUNDATION AREA
SUNNY DAY INUNDATION AREA
RIVER MILE SECTION

Source: Imagery and elevation contours from MassGIS June 2014.

KEY
PEAK ELEVATION - FEET
TIME TO PEAK - HRS. FROM START OF BREACH
FLOOD ARRIVAL TIME - HRS. FROM START OF BREACH
PEAK FLOW - FLOW THROUGH SECTIUON AT PEAK TIME

N
0 500 FEET
0 1/10 MILES
VERTICAL DATUM: NAVD 1988

TETRA TECH

TOWN OF SCITUATE
SCITUATE, MASSACHUSETTS

FIRST HERRING BROOK MULTIPLE DAM FAILURE INUNDATION MAP
RESERVOIR DAM FISH PASSAGE PROJECT

APPENDIX E
FIGURE E-1

P:\SCITUATE RESERVOIR DAM – 4961\CAD\FIGURES\4961-INUNDATION MAP-REV B.DWG PLOT/UPDATE: Jun 25 2014 13:44:29

APPENDIX F – BUDGETARY COST ESTIMATE

Item	Normal Pond El. 40.4 ft NAVD 1988			
	Unit	Quantity	Unit Price ($/Unit)	Cost ($)
Mobilization/demobilization	LS	1	61,211	**$61,211**
Temporary Construction Facilities				
Silt Fences	LF	1,000	3.99	$3,991
Prepare Staging Areas	AC	1.4	7,128	$9,979
Security Fencing	LF	250	17	$4,148
Access Road Improvements	LS	1	5,000	$5,000
Site Restoration	LS	1	5,000	$5,000
Subtotal Temporary Construction Facilities				**$28,118**
Spillway Modifications				
Ogee				
Clean approach apron	LS	1	2,000	$2,000
Prepare concrete surface	SF	750	10.0	$7,500
Concrete dowels	TN	4	1,813	$7,253
Concrete	CY	90	200	$18,000
Rebar (epoxy coated)	TN	5	1,813	$9,066
Formwork	SF	750	14	$10,264
Subtotal				**$54,083**
Abutment Walls				
Prepare concrete surface	SF	60	10.0	$600
Concrete dowels	TN	0.3	1,813	$544
Concrete	CY	5.0	200	$1,000
Rebar (epoxy coated)	TN	0.4	1,813	$725
Formwork	SF	130	13.7	$1,779
Subtotal				**$4,648**
Crest Gate				
Procure and Deliver Gate and Control System	LS	1	120,000	$120,000
Mechanical Installation of Gate	HRS	200	75	$15,000
Control System (electric motor)	LS	1	15,000	$15,000
Powerline Upgrade (1/0 in existing conduit)	LF	700	8	$5,348
Water level sensor	LS	1	3,000	$3,000
Water level sensor underwater cable to gate motor	LF	100	10	$1,000
SCADA system update	LS	1	10,000	$10,000
Security fence and gate	LF	160	15.00	$2,400
Crane	Days	1	4,084	$4,084
Subtotal				**$175,832**
Pedestrian Bridge Across Spillway				
Excavation	CY	3	19	$58
Concrete	CY	2.0	200	$400
Rebar (epoxy coated)	TN	0.2	1,813	$363
Formwork	SF	36	13.7	$493
Procure and Deliver footbridge	LS	1	26,000	$26,000
Install footbridge	HRS	72	75	$5,400
Handrail on spillway walls	LF	65	30	$1,950
Crane	Days	1	4,084	$4,084
Subtotal				**$38,747**
Subtotal Spillway Modifications				**$273,310**

Item	Normal Pond El. 40.4 ft NAVD 1988			
	Unit	Quantity	Unit Price ($/Unit)	Cost ($)
Fishway Modifications				
Exit Channel				
Excavation and on-site stockpiling	CY	600	19	$11,632
Concrete Demolition (sawcut and disposal)	CY	40	320	$12,800
Concrete dowels to cutoff wall	TN	0.2	1,813	$363
Concrete	CY	65	63	$4,077
Rebar	TN	7	1,813	$11,786
Formwork	SF	2,000	13.7	$27,370
Backfill and compaction	CY	525	52	$27,300
Seeding	SF	8,000	0.09	$744
Access platform support steel	TN	1	4,800	$4,800
Access platform grating	SF	120	40	$4,800
Access platform handrail	LF	64	30	$1,920
Security fence and 2 gates	LF	86	25.00	$2,150
Subtotal				**$109,741**
Exit Channel Removable Baffles				
Aluminum Guides	TN	0.1	10,000	$1,000
Aluminum Weirs (7 sets)	TN	1	10,000	$10,000
Procure and Deliver trolley-mounted chain fall hoist	LS	1	4,000	$4,000
Trolley rail and support columns installed	TN	1.5	4,800	$7,200
Install trolley hoist (1 ton)	HRS	20	75	$1,500
Subtotal				**$23,700**
Exit Channel Isolation Slide Gate				
Procure and Deliver Gate with Guides and Manual Operator	LS	1	18,303	$18,303
Procure and Deliver Gate Motor Operator (5 HP)	LS	1	3,500	$3,500
Install Guides and Gates	HRS	40	75	$3,000
Subtotal				**$24,803**
Weir Modifications				
Repair concrete weirs and walls	CY	5	2,500	$12,500
Install Aluminum Guides for Fixed Notched Weirs	EA	16	275	$4,400
Fabricate and Install Weir Boards	EA	16	400	$6,400
Subtotal				**$23,300**
Entrance Channel Improvement				
Clean Concrete Fishway Entrance	HRS	8	62	$493
Procure and deliver weir stones	TNS	40	100	$4,000
Modify channel stone and install to stone weirs to Fishway Entrance	HRS	32	62	$1,984
Subtotal				**$6,477**
Subtotal Fishway Modifications				**$188,021**
Infrastructure Improvements				
Route 3A Erosion Protection				
Clear and Grub	AC	0.10	7,128	$713
Remove Guardrail	LF	400	6	$2,400
Excavation	CY	120	19	$2,326
Geotextile Fabric	SY	450	2.5	$1,108
Foundation Material	CY	150	59	$8,844
Riprap Slope Protection	TNS	720	100	$72,000
Asphalt curb	LF	135	15	$2,025
Install Guardrail	LF	400	29	$11,404
Lane Painting	LF	1,200	0.3	$397
Signage	EA	2	388	$775
Subtotal				**$101,993**

Item	Normal Pond El. 40.4 ft NAVD 1988			
	Unit	Quantity	Unit Price ($/Unit)	Cost ($)
Sherman Drive Drainage				
Clear and Grub	AC	0.02	7,128	$143
Excavation	CY	125	19	$2,375
Bioswale Fill	CY	65	52	$3,388
Geotextile Fabric	SY	115	2.5	$283
Riprap Stabilization	TNS	9	100	$900
Top Soil	CY	60	40	$2,400
Seeding/Plantings	SF	1,000	5.00	$5,000
Subtotal				**$14,488**
Tack Factory Pond Gate Upgrade				
Concrete dowels to cutoff wall	TN	0.1	1,813	$181
Concrete	CY	1	200	$200
Rebar	TN	0	1,813	$181
Formwork	SF	60	13.7	$821
Remove and reinstall gate	HRS	80	60.0	$4,800
Subtotal				**$6,184**
Subtotal Infrastructure Improvements				**$122,665**
Total Construction Costs				**$673,326**
Contingency (10%)				**$67,333**
Subtotal Probable Construction Costs				**$740,658**
Engineering, Design, and Permitting Costs				**$88,879**
Construction Management and Administration (5%)				**$37,033**
Total Project Cost				**$866,570**

APPENDIX G – INTERAGENCY AND PUBLIC OUTREACH MEETING NOTES

TETRA TECH

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

NOTES OF TELECONFERENCE

Department of Marine Fisheries
April 7, 2014

1. ATTENDEES

Department Marine Fisheries (DMF)	Brad Chase
Tetra Tech, Inc.:	Tom Cook

2. DISCUSSION

Tetra Tech and DMF held a teleconference to discuss the proposed spillway and fishway modifications with DMF because DMF was not available to meet until after the spring migration.

Discussions included:

- An overview of the design criteria presented in the 2013 Feasibility Report was presented.
- Tetra Tech will send DMF a copy of the 2013 Feasibility Report and provide comments.
- DMF will visit the site in May after the spring migration is done.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date: 8 April 2014

TETRA TECH

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

NOTES OF TELECONFERENCE

Department of Conservation and Recreation, Office of Dam Safety (ODS)
April 22, 2014

1. ATTENDEES

Office of Dam Safety (ODS)	Emily Caruso
Tetra Tech, Inc.:	Tom Cook

2. DISCUSSION

Tetra Tech informed ODS about the proposed spillway and fishway modifications.

Discussions included:

- Changes to the spillway and dam will have to meet all of the dam safety regulations.
- Tetra Tech will send ODS a copy of the 2013 Feasibility Report for review and their files.
- ODS will visit the site during the permitting phase of the project.
- Tetra Tech will send ODS a copy of the 2014 Preliminary Design Memorandum once it is complete.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date: 8 April 2014

TETRA TECH

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

NOTES OF MEETING

SCITUATE WATER RESOURCES COMMITTEE
APRIL 24, 2014

1. ATTENDEES

Water Resources Committee (WRC): John Clarkeson
Jim DeBarros
Martha Cook
Becky Malamut
Samantha Woods
Sara Grady

Tetra Tech, Inc.: Tom Cook

2. DISCUSSION

Tetra Tech presented the attached interim design memo.

Comments provided by the WRC are as follows:

- Impacts on the Town's Water District buffer zone should be included in report.
- Public outreach meeting should be scheduled for June 12, 2014 with a presentation practice on June 8th or 9th.
- An update of the preliminary design of the spillway and fishway modifications should be presented at the next WRC meeting on May 27, 2014.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date: 25 April 2014

TETRA TECH

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

NOTES OF MEETING

Department of Marine Fisheries
May 13, 2014

1. ATTENDEES

Department Marine Fisheries (DMF)	Brad Chase
Scituate Water Department	Jim DeBarros
	Rick Mosca
North & South River Watershed	Samantha Woods
	Sara Grady
Tetra Tech, Inc.:	Tom Cook

2. DISCUSSION

Tetra Tech reviewed the proposed spillway and fishway modifications with DMF and discussed design criteria for fish passage.

Discussions included:

- Normal pond level would be raised above the spillway crest and the fishway exit channel lowered to assure upstream and downstream passage through the fishay.
- The method for eel passage has to be investigated. Eel do not like high velocities and may have trouble with weirs. Eel passage over the crest gate will be difficult.
- A herring was observed in the turning pool of the existing ladder even though there was only 1-2 inches of water over the weirs.
- DMF will review fish passage criteria in 2013 Feasibility Report.
- The Preliminary Design Memorandum will be sent to DMF for review.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date:
14 May 2014

TETRA TECH

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

NOTES OF MEETING

SCITUATE BOARD OF SELECTMAN
May 23, 2014

1. ATTENDEES

Scituate Board of Selectmen:	Rick Murray
Scituate Water Department	Jim DeBarros
Scituate Department Public Works	Al Bangert
North & South River Watershed	Samantha Woods
	Sara Grady
Tetra Tech, Inc.:	Tom Cook
US Congress	Congressman Steven Lynch
	Katherine Shea

2. DISCUSSION

Tetra Tech presented a draft of the interim preliminary design memorandum.

Discussions included:

- Normal pond level raised to El. 40.4 ft, 1.5 ft above spillway crest, since that is existing flood level. This elevation provides 2 ft freeboard at the low point in Route 3A centerline profile.
- Electric operator will be provided on spillway crest gate to simply operation and assure opening during flood conditions.
- Some riprap slope protection required on Route 3A.
- An upgrade of the stormwater management system on Sherman Drive is recommended to protect water quality of reservoir.
- The public outreach meeting should be scheduled to be held on June 19, 2014.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date: 26 May 2014

WATER RESOURCES COMMITTEE

DRAFT AGENDA

TUESDAY, 27 MAY 2014

TOWN HALL – DPW OFFICE

7:30 PM

Item	Topic	Discussion Leader
1.	Call to Order	John Clarkeson
2.	Review of Agenda	John Clarkeson
3.	Acceptance of Meeting Minutes	John Clarkeson
4.	Status of Water Resources	James DeBarros
5.	Water System Update – Pipe Replacement	James DeBarros
6.	Water Resource Protection - Guidelines	
1.	Water Conservation	
	Plan development	
	New Strategies	

Old Business

8. Updates:
   a) New Developments –
   b) SWMI Grant

New Business

9.	Recent correspondence	John Clarkeson
10.	Open Discussion	
11.	Adjournment	

Summary of Public Meetings

On May 27, 2014 the Scituate Water Resources Committee held a public meeting at the Scituate Town Hall in which the SWMI grant project was discussed. The Interim Preliminary Design Memo dated May 27, 2014 was the basis of the discussion. Please see attached Design Memo and Agenda from that meeting. In addition, further discussion on schedule for completing the project as well as the hosting of another public meeting which would engage homeowners abutting the reservoir and present the findings of the project. It was decided to host the meeting on June 19th, 2014 and that the NSRWA would send postcard invitations to the surrounding abutting homeowners around the reservoir and post a meeting notice in the local newspaper. In attendance were members of the Scituate Water Resources Committee, James DeBarros, Scituate Water Superintendent, Samantha Woods, Executive Director of the NSRWA and Tom Cook, project engineer from TetraTech.

Comments were solicited on the project from the Scituate Water Resource Commissioners who are Scituate's Selectmen via their liason to the Scituate Water Resources Committee – Selectman Richard Murray. The discussion with both the Scituate Water Resources Committee and Selectman Murray led to a recommendation that a 1.5 foot increase would gain storage in the Reservoir and have little impact on existing infrastructure and offered the most benefit for the most reasonable cost.

On June 19, 2014 a public meeting was held at the Scituate Library to present the findings of the project and the proposal to increase the reservoir normal pool height and provide for fish passage at the reservoir. Please see attached PowerPoint presentation from the meeting, sign in sheet and invitation that was sent to abutters.

There was no opposition to the project, however concerns were raised from one homeowner about his sump pump going on more with higher reservoir levels. The engineer noted that the proposed reservoir level is within the range of what is seen currently and he wouldn't anticipate any increase water in the homeowner's basement than he already experiences. There was concern raised from the public about untreated stormwater runoff from Route 3A into the Reservoir. The engineer explained that there are over 40 catch basins along that road that drain into the reservoir with little treatment but they are owned by the Massachusetts Department of Transportation and the Town should work with them to identify solutions to remedy this situation and he intended to make that a recommendation in the final report.

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

NOTES OF MEETING

SCITUATE WATER RESOURCES COMMITTEE
May 27, 2014

1. ATTENDEES

Water Resources Committee (WRC): John Clarkeson
Jim DeBarros
Martha Cook
Becky Malamut
Samantha Woods
Sara Grady

Tetra Tech, Inc.: Tom Cook

2. DISCUSSION

Tetra Tech presented a draft of the final preliminary design memorandum.

Discussions included:

- Normal pond level raised to El. 40.4 ft, 1.5 ft above spillway crest, since that is existing flood level.
- Some riprap slope protection required on Route 3A.
- An upgrade of the stormwater management system on Sherman Drive is recommended to protect water quality of reservoir.
- Public outreach meeting scheduled for June 19, 2014.
- Final preliminary design memorandum will be prepared for submittal to Department of Environmental Protection by June 30, 2014.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date: 28 May 2014

TETRA TECH

Preliminary Design Engineering Services

RESERVOIR DAM FISH PASSAGE PROJECT

First Herring Brook Fish Passage Improvements

Town of Scituate, MA Contract Number: 14-WA-13
Funded by SWMI-2 Grant

INTERIM PRELIMINARY DESIGN MEMORANDUM

May 27, 2014

1. INTRODUCTION

Preliminary design for the Reservoir Dam Fish Passage Project was initiated on March 14, 2014. Preliminary design efforts included: topographic surveying, an assessment of Reservoir levels and flood conditions, installation of groundwater monitoring wells and review of available groundwater level, development of design criteria, and preliminary design of spillway and fishway modifications. Results of the design efforts to date are summarized in the following sections.

2. TOPOGRAPHIC SURVEY

The Scituate Department of Public Works (DPW) contracted Cavanaro Consulting, Inc. (Cavanaro) on March 25th to conduct topographic surveying of Reservoir Dam and Route 3A across the impoundment. Results of the survey indicated:

- The control points were surveyed tying the system into the North American Datum 1983 (NAD83) and North American Vertical Datum 1988 (NAVD88). The USGS disk at the Route 3A culvert was found to be El. 38.9 ft NAVD 1988, corresponding to El. 39.7 ft NGVD 1929. All prior Reservoir Dam water levels were referenced to this disk as El. 40.0 ft NGVD 1929. NAVD 1988 plus 0.80 ft equals NGVD 1929. The Reservoir Dam spillway was measured at the same elevation as the USGS disk.

- The low point is Route 3A was found to be near 401 Chief Justice Cushing Highway (CJCH) at El. 42.4 ft NAVD 1988.

3. RESERVOIR LEVELS

Reservoir Dam water levels measurements were obtained from the Water Department. The records (1972 – present) indicate that:

- Water levels in the Reservoir exceeded 2 ft above the spillway crest (El. 38.9 ft NAVD 1988) only 3 days out the 15,500 days of records and that was the Mother's Day storm in 2006.

- Water levels in the Reservoir exceeded 1 ft above the spillway crest only 50 days out the 15,500 days of record (0.3% of time).

4. FLOOD CONDITIONS

Since Reservoir Dam is a Class I high hazard, any modifications to the spillway cannot reduce the discharge capacity for the design flood equal to the one-half Probable Maximum Flood (1/2 PMF). The Town's Emergency Action Plan considered failure of Reservoir Dam, but has been requested to consider the multiple dam failure scenario with failure of Old Oaken Bucket Dam subsequent to failure of Reservoir Dam. Tetra Tech has conducted a simplified analysis of multiple dam failure using the EAP analysis and conservative assumptions for failure of Old Oaken Bucket Dam. The results of the multiple failure analysis are:

	Sunny Day Failure		½ PMF Failure	
	Single Dam	Multiple Dam	Single Dam	Multiple Dam
Country Way				
Maximum Breach Flow (cfs)	2,725	3,700	6,830	8,405
Peak Flood Level (ft NAVD88)	22.4	23.7	23.7	25.6
Driftway Road				
Maximum Breach Flow (cfs)	2,230	3,700	6,825	8,405
Peak Flood Level (ft NAVD88)	13.0	13.4	15.0	15.2
North River				
Maximum Breach Flow (cfs)	2,100	3,700	6,825	8,405
Peak Flood Level (ft NAVD88)	0.0	2.7	9.1	9.3

5. GROUNDWATER LEVELS

The Scituate Board of Health records for #401 CJCH, #436 CJCH, and #439 CJCH were obtained and reviewed to determine groundwater level data used for the septic system design. These properties are closest to the Reservoir Dam impoundment where Reservoir levels would impact the septic systems. Groundwater monitoring wells have been installed at the properties between the reservoir and the existing septic systems and groundwater measurements have been obtained by the NSRWA. Observations for these properties are:

- #401 CJCH - Treatment system with raised leaching field.
  Board of Health Records for estimated high groundwater (EHG) El. 39.6 ft NAVD 1988
  Leach field/groundwater separation of 5 ft
  Top of monitoring well – El. 41.28 ft NAVD 1988
  Groundwater measurements – El. 39.6 - 40.4 ft NAVD 1988 (normal pool El. 38.9 ft NAVD 1988)

- #436 CJCH –. Property abandoned.
  No Board of Health information on groundwater.
  Top of monitoring well – El. 41.00 ft NAVD 1988
  Groundwater measurements – El. 39.4 - 39.7 ft NAVD 1988 (normal pool El. 38.9 ft NAVD 1988)

- #439 CJCH – Treatment system with raised leaching field.
  Board of Health Records for estimated high groundwater (EHG) El. 41.8 ft NAVD 1988

Leach field/groundwater separation of 5 ft
Top of monitoring well – El. 40.65 ft NAVD 1988
Groundwater measurements – El. 39.5 ft - 40.0 ft NAVD 1988 (normal pool El. 38.9 ft NAVD 1988)

6. PRELIMINARY DESIGN CRITERIA

Reservoir operation and spillway/fishway modifications criteria are:

1) Maximize storage capacity while minimizing impacts on Route 3A and properties adjacent to impoundment.
   - Raising normal pool level 1.5 ft in Reservoir Dam to El. 40.4 ft NAVD 1988 provides 2.0 ft of freeboard at low point on Route 3A.
   - Groundwater levels at the three properties along Route 3A are at or above the current normal Reservoir levels. Additional water level monitoring and water quality test data are required to determine if raising normal pool 1.5 ft impacts the two septic systems which are currently in compliance with Title V.

2) No reduction in spillway capacity. Hinged crest gates with a top elevation equal to the existing spillway crest will provide the same discharge capacity as the existing ogee-shaped spillway.

3) Fish passage requirements are:
   - *Target species:* Alewife, smelt, and American eel
   - *Migration period:* Upstream – March-June;
     Downstream – September-October
   - *Reservoir Dam operating stream flows:*
     Minimum upstream passage – 2.6 cfs (5 inch depth over fishway weirs)
     Maximum upstream passage – 124 cfs (1.0 ft depth over spillway)
     Minimum downstream passage – 0.25 cfs (Interim Operational Plan)
     Maximum downstream passage – 9 cfs (1.0 ft depth over fishway weirs)
   - *Reservoir Dam operating headpond water levels:*
     Minimum upstream passage – El. 40.8 ft (5 inches above top weir)
     Maximum upstream passage – El. 41.8 ft (limited by existing fishway)
     Minimum downstream passage – El. 32.0 ft (Interim Operational Plan)
     Maximum downstream passage – El. 41.8 ft (1.5 ft depth over top weir)
   - *Reservoir Dam operating tailwater levels:*
     Minimum upstream passage – El. 25.0 ft
     Maximum upstream passage – El. 25.7 ft
     Minimum downstream passage – El. 25.0ft
     Maximum downstream passage – El. 25.4 ft
   - *Pool and weir fishways*:
     Pool drop – 8 inches
     Water depth over weir – 8 inches
     Pool size – 3-5 minutes per pool
     Pool volume – 0.5 ft^3 per pound of fish
     Energy Dissipation Factor (EDF) < 4.0
     EDF = (Q x W x D)/Vol
     Q = fishway flow (cfs)
     W = unit weight of water (lbs/ft^3)
     D = drop per pool (ft)
     Vol = pool volume (ft^3) = width (ft) x length (ft) x depth (ft)

- *Downstream fish bypass:*
  Type – surface bypass
  Minimum depth of water – 4-5 inches
  Minimum width – 6 inches with no spillway flow; 3 ft with spillway flow

4) The spillway gate will have an electric motor or hydraulic drive system that can be manually operated from the Water Department. The existing SCADA system will be modified to monitor the Reservoir level and allow remote operation of the gate.

5) Removable fishway baffles will be manually removed to match the Reservoir levels for acceptable operation of the fishway.

Tom Cook, Tetra Tech Project Manager

Signature: Thomas C. Cook

Date: 27 May 2014

Public Meeting on Managing Reservoir Levels for Increased Water Supply Security and Herring Restoration

Thursday, June 19, 2014
7 – 8:45 pm
Scituate Town Library - 85 Branch Street, Scituate, Lower Level Meeting Room

Sponsored by: Town of Scituate Water Division, Scituate Water Resource Committee, North and South Rivers Watershed Association, Mass Bays Program and MassDEP

As a person who lives next to the reservoir, we wanted you to be aware of a public meeting to discuss proposals to restore herring to the First Herring Brook and to improve the town's water supply capacity and security, particularly its ability to deal with droughts.

Scituate Department of Public Works
Town Hall
600 Chief Justice Cushing Hwy
Scituate, MA 02066

North and South Rivers Watershed Association

NEWS RELEASE

CONTACT:
Samantha Woods Executive Director
(781) 659-8168
Samantha@nsrwa.org

FOR IMMEDIATE RELEASE

June 10, 2014

Public Meeting on Managing Reservoir Levels
for Increased Water Supply Security
and Herring Restoration

The Town of Scituate Water Division, Scituate Water Resource Committee, North and South Rivers Watershed Association, and Massachusetts Bays Program with support from Massachusetts Department of Environmental Protection will host a public meeting on Managing Reservoir Levels for Increased Water Supply Security and Herring Restoration on Thursday June 19, 2014 from 7 pm – 8:45 pm. The public meeting will take place at the Scituate Town Library – 85 Branch Street, Scituate, in the Lower Level Meeting Room.

The focus of the meeting will be to discuss proposed capital improvements to the town's water supply infrastructure at the reservoir to increase water supply capacity and security, particularly the ability to deal with droughts, and to restore river herring to the reservoir. The proposed improvements include alterations to the reservoir dam spillway to manage reservoir levels at higher levels for longer periods in the springtime and for improvements to the fish ladder to allow for herring outmigration in the fall. Engineering plans and cost estimates for the project will be presented. This work was supported through a grant from the Massachusetts Department of Environmental Protection through their Sustainable Water Management Initiative.

Preliminary Design of Reservoir Dam Modifications
Water Supply & First Herring Brook Fish Passage Improvements

June 19, 2014 Public Meeting

TETRA TECH

Participants

FHBWI

CZM

Massachusetts Department of Environmental Protection

Commonwealth of Massachusetts Division of Fisheries & Wildlife — MassWildlife

Commonwealth of Massachusetts Division of Marine Fisheries

The Nature Conservancy — Protecting nature. Preserving life.

Tufts University

National Oceanic and Atmospheric Administration — NOAA — U.S. Department of Commerce

MassDER

SEI Stockholm Environment Institute

NSRWA

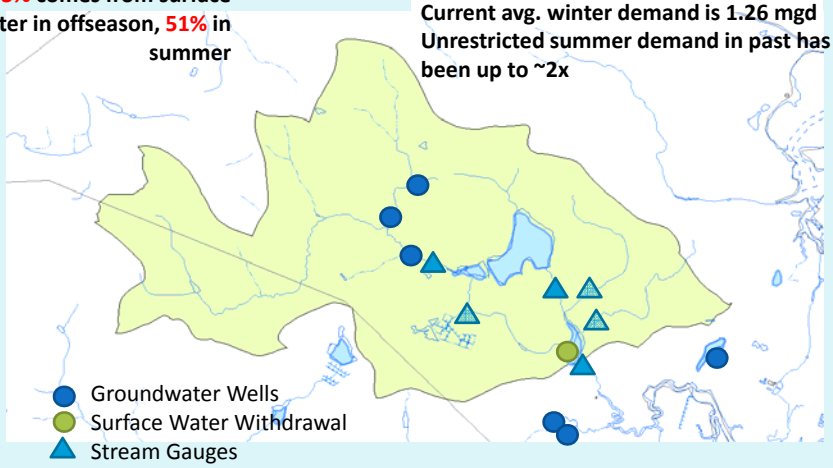
U.S. Fish & Wildlife Service

Massachusetts Bays Program

~73% of water supply for Scituate comes from the First Herring Brook watershed
23% comes from surface water in offseason, 51% in summer

First Herring Brook
Stream Gauges and Water Supply

Current avg. winter demand is 1.26 mgd
Unrestricted summer demand in past has been up to ~2x



Project Goals

- Meet Scituate's water needs
- Provide adequate seasonal stream flow for native aquatic species
- Effectively operate fish ladders to restore the herring run

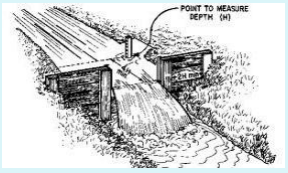
2011 Interim Operating Plan

- Seasonal minimum stream flow
- Severe drought stream flow shut off (8 ft)
- Fish ladder operation: Old Oaken Bucket Pond
- Water system updates (0.17 mgd)
- Irrigation system summer restriction: 1 day a week (0.38 mgd)
- Total outdoor watering ban (5 ft down)

Scenario Components

Seasonal stream flow release for habitat

Different fishway designs



Weirs and pulsed flows for fall juvenile herring out-migration

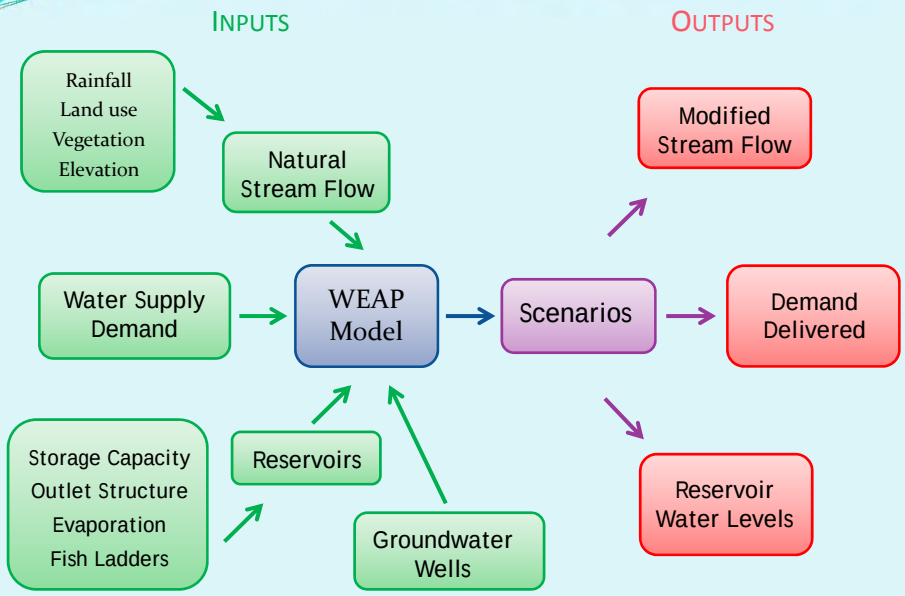
Water conservation & watering restrictions

New well

Reservoir dredging

Modifying dam outlet

The Scituate Decision Support System



2013 Reservoir Scenario Components

- Water level management: up to 3.5 ft higher
- Fishway exit elevation: down to 3.5 ft lower
- Fish ladder flow: full or reduced
- Irrigation season: 5/1 – 9/30 or 5/31 – 9/4

- 28 different combinations of parameters

Most Promising Model Scenario

- Water level management: +1 ft
- Fishway exit elevation: -3.5 ft
- Fish ladder flow: reduced
- Irrigation season: 5/31 – 9/4

Scenario Performance Indicators at Old Oaken Bucket

	Current Operations	Best Modeled Scenario
Spring fishway success	63%	98%
Fall fishway success	26%	75%
Effective years (>50 days out of 61): Spring/Fall	36% / 8%	100% / 67%
Ineffective Years (<30 days out of 61): Spring/Fall	31% / 77%	0% /23%
Seasonal minimum flow exceeded	85-88%	85-88%
Seasonal median flow achieved	13-47%	13-51%

Scenario Performance Indicators at Reservoir

	Current Operations	Best Modeled Scenario
Spring fishway success	0%	98%
Fall fishway success	0%	94%
Effective years (>50 days out of 61): Spring/Fall	0%	97% / 95%
Ineffective Years (<30 days out of 61): Spring/Fall	100%	0% / 3%
Seasonal minimum flow exceeded	44-100%	92-100%
Seasonal median flow achieved	26-77%	18-69%
Seasonal reservoir habitat goals achieved	12-97%	58-100%
Minimum reservoir level (NAVD88)	30.89 ft	34.33 ft
Average number of summer days with water ban	11	12

DESIGN CHALLENGE

Reservoir Dam impoundment typically full in the spring with sufficient stream flow for upstream passage of river herring through fishway.

Water supply and environmental releases from Reservoir Dam through the low-level outlet during summer lower impoundment water levels below the fishway exit channel and spillway crest.

River herring juvenile out-migrants cannot find the low-level outlet and the low-level outlet does not provide effective downstream passage.

DESIGN GOALS

Increase reservoir storage capacity with installation of spillway crest gate

Modify fishway for downstream fish passage
- *lower fishway exit channel*
- *notch fishway weirs for effective fish passage with minimal flow*

Improve fishway approach channel

PROPOSED RESERVOIR MANAGEMENT PLAN

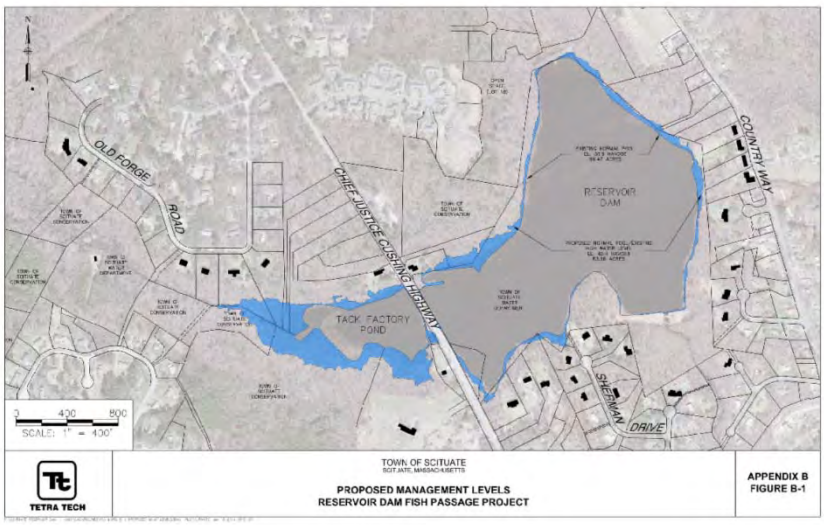
Increase reservoir storage capacity

Modify existing fishway for downstream passage:
- *Install spillway bottom-hinged crest gates*
- *Lower fishway exit channel and install removable weirs*
- *Install low flow notches on fishway weirs*

Normal pond levels: El. 40.4 ft in spring; 1.5 ft above spillway crest (El. 38.9 ft)
- *23% increase in storage capacity; 108.8 ac-ft (35.4 million gallons)*
- *Same level as existing high water*
- *No reduction in spillway capacity*
- *Minimal change in typical spring levels (12 inches ± above spillway crest)*

Fishway exit channel elevation: 3.9 ft below existing channel (El. 38.9 ft)
- *Spring – El. 40.4 ft to El. 38.5 ft minimum depending in inflow*
- *Fall – El. 37.2 ft to El. 36.4 ft minimum depending on inflow*

RESERVOIR DAM



EXISTING PROJECT FEATURES

Dam

Spillway

Low Level Outlet

Pool & Weir Fishway

Outlet Channel

PRELIMINARY DESIGN

Fishway exit channel modifications

Spillway bottom hinged crest gate

Fishway weir modifications

Fishway entrance channel improvements

WATER SUPPLY BENEFITS

Water supply storage increased 23%; 108.8 ac-ft (35.4 million gallons)

Same water supply delivered while providing environmental flows for downstream habitat

Greater resiliency to drought and emergencies (fires, loss of groundwater well power) with greater reservoir storage and higher minimum reservoir elevation

ECOLOGICAL BENEFITS

Fish passage into Reservoir Dam restores 70 acres of pond habitat for alewife and American eel and stream channel habitat upstream of the reservoir for blueback herring

Maintaining reservoir at a more constant level provides more shoreline habitat for alewife:

11,800 ft at El. 38.9 ft
15,500 ft at El. 40.4 ft

Medium carrying capacity of Reservoir Dam impoundment is 25,000-30,000 alewife

SHORELINE IMPROVEMENTS

Shoreline –	*No change in high water level El. 40.4 ft* *14.2 acres in floodplain inundated at normal pond El. 40.4 ft (high water level)*
Water supply buffer zone –	*No change in Town's 150 ft Water Protection District* *All properties currently within DEP Title V regulated areas within 200 ft of reservoir*
Septic systems -	*Septic systems adjacent to reservoir currently meet DEP Title V regulations except one abandoned property* *Monitoring well samples indicate treatment systems properly functioning*
Stormwater Management -	*Construct bioswale at end of Sherman Drive to treat road runoff discharging to reservoir*

SHORELINE IMPROVEMENTS

Route 3A –
380 ft embankment erosion protection

Tack Factory Pond –
Raise gate and structure for access

ESTIMATED CONSTRUCTION COSTS

Spillway modifications	**$281,000**
Fishway modifications	**$195,000**
Shoreline improvements	**$ 83,000**
Contractor costs/temporary facilities	**$ 83,000**
Allowance for indeterminants/contingency	**$ 65,000**
TOTAL CONSTRUCTION COSTS	***$707,000***
Engineering, design, permitting, & construction management	***$121,000***
TOTAL PROJECT COSTS	***$828,000***

RECOMMENDATIONS

1) Complete initial agency consultation and prepare permit applications based on preliminary design

2) Apply for grants to design and construct

3) Investigate stormwater management options for water quality protection along CJCH

QUESTIONS ???

6/19/2014 MEETING

NAME	ADDRESS
DICK GREEN	98 OLD OAKEN BUCKET RD
PAUL SCOTT	359 COUNTRY WAY, SCITUATE, MA.
Rick Murray	Board of Selectman
Becky Makamut	WRC
CHARLIE TREZISE	32 SHERMAN
Richard Kenney	26 Utility Rd
PETER KELLY-JETWIER	114 TILDEN RD
Bill Krusell	275 Country Way
Dave Simmer	36 Sherman Dr.
Andy Cancellieri	33 Sherman Dr
Al Bangert	105 Captain Penn Rd
RICK MARCESSON	320 CHIEF JUSTICE CUSHING HWY