Becker Pond Dam Removal
100% Design Report
FINAL

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100% Design Report

SUBMITTED TO
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1. Introduction

In 2019, Inter-Fluve developed preliminary (30%) engineering designs and a sediment management plan for the removal of Becker Pond Dam in Mount Washington, Massachusetts.

In 2020, the project began reaching out to regulatory agencies. The Becker Pond Dam Removal Project Area is located in an Area of Critical Environmental Concern (ACEC area), and is subject to the Massachusetts Environment Policy Act (MEPA) review process, which requires a Mandatory Environmental Impact Report (EIR). During the spring of 2020, the project submitted a request for a waiver from this requirement. On June 24, 2020, the MEPA review team held a virtual site walk and public hearing. Participants in the public hearing raised concerns about sediment management and site access. On July 2, 2020, the project proponents provided supplemental information to the MEPA review team including an expanded alternatives analysis. On July 31, 2020, MEPA issued the response denying the full waiver, but allowing a Single EIR.

In 2022, Inter-Fluve advanced the designs to a level of completeness appropriate for permitting (75%). The 2022 version of this report, which accompanied the 75% design documents, incorporated the supplemental expanded alternatives analysis and included the following elements to acknowledge and address the key concerns as the project advanced through the local, state, and federal permitting processes:

- Two alternative access entrances off of East Street;
- A pilot channel, excavated through the impoundment;
- Stabilization of the remaining impounded sediment using bioengineering;
- Estimated sediment volumes:
    - portion to be stabilized in place;
    - excavated portion to be disposed upland on site; and
    - excavated portion to be disposed offsite.
- Updated Limit of Disturbance; and
- Updated impacts to Resource Areas as defined in 310 CMR 10.

In 2024, Inter-Fluve, under contract with The Nature Conservancy (TNC), has progressed the designs to a level of completeness appropriate for soliciting bids from contractors (100%). This current version of the report provides updated documentation to address project feedback received from permitting agencies as it pertains to the basis of our designs including:

- Permitted footprints and volumes of temporary fill associated with water control and sediment management (to address Section 404 requirements).
- Earthwork volumes including use, reuse, and disposal volumes for sediment, soil, and concrete debris associated with the dam (to address Section 401 and 404 requirements).
- Footprints for clearing and grubbing associated with preparation of the access road and staging areas (to address Section 404 requirements).

1.1 THE SITE

Becker Pond Dam is located on an unnamed brook in a relatively remote area near Mount Washington State Forest in the southwestern corner of Massachusetts (Figure 1). Downstream of the Site, the brook flows through Sages Ravine and eventually drains to Schenob Brook, a tributary to the Housatonic River. The brook is mapped as a coldwater fishery by Massachusetts Division of Fisheries and Wildlife (MassWildlife). The dam and surrounding property are part of the 1,600-acre Mount Plantain Preserve, owned by The Nature Conservancy (TNC), and are accessible via an unpaved road through private property off of East Street, south of Mount Washington. The TNC property is used by the public for hunting, fishing, and other recreation. TNC recently constructed a footbridge upstream of the impoundment to connect the original and new Hallig Trails on either side of the brook. The next bridge over the brook (Undermountain Road, Salisbury, Connecticut) is approximately two miles downstream.

Becker Pond covers an area of approximately 0.65 acres. Becker Pond Dam is composed of a 95-foot-long earthen embankment and a concrete core wall (Figure 2). The dam outlet consists of a rectangular weir spillway with a concrete apron and concrete training walls. The structural height of the dam is approximately 14.25 feet. The crest of the concrete spillway is set approximately 2.25 feet below the top of the concrete core wall and has a weir length of 23.2 feet. The concrete training walls retain the earthen embankments adjacent to the spillway section and direct flow over the concrete apron. The concrete apron extends approximately 16.75 feet downstream of the base of the spillway (Figure 3). A low-level outlet is present, but we understand from others that it is inoperable.

A visual inspection carried out in 2016 (Fuss & O'Neill, 2016) found the dam to be in poor condition with several critical issues, notably, the left training wall, which is cracked and failing, has slipped off its foundation (Figure 4). The inspection also found significant erosion of the earthen embankment adjacent to the wall and cracked and spalling concrete in other areas. The wooden bridge crossing the dam has partially collapsed and has been cordoned off by TNC and warning signs posted.

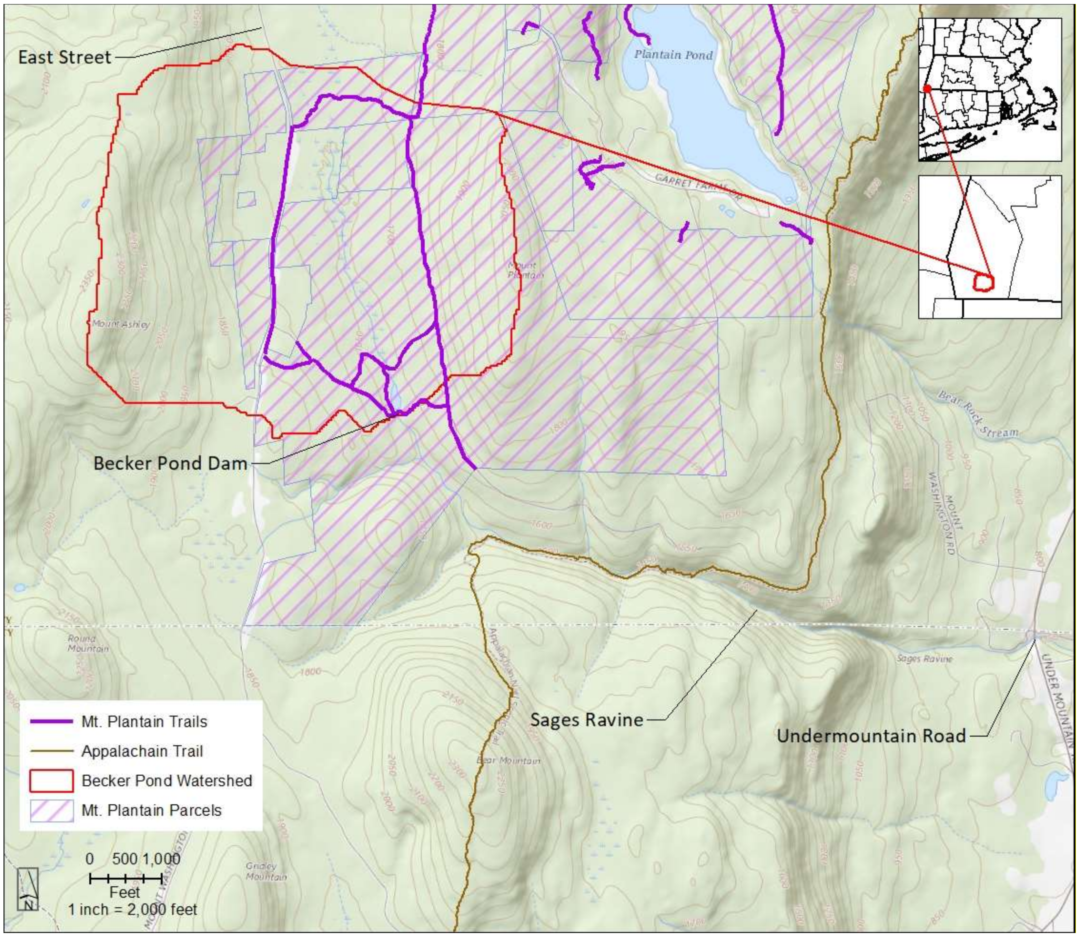

__Figure 1. Becker Pond location map__

Figure 2. Becker Pond Dam showing concrete core wall, spillway, and failing bridge

Figure 3. Right concrete training wall and concrete apron

Figure 4. Left concrete training wall slipped off of its foundation and resting on concrete apron

1.2 GOALS AND OBJECTIVES

The primary goals of the project are to restore aquatic and hydrologic connectivity through the site and eliminate the safety hazard posed by the dam. TNC and its partners are seeking a simple, low-cost solution to dam removal that will restore habitat for brook trout.

2. Existing Conditions

2.1 FIELD SURVEY

Inter-Fluve geomorphologists and an engineer visited the site on April 26, 2018 for the project kick-off meeting and to carry out the field survey. Our survey scope included collection of topographic, bathymetric, and depth-of-refusal data; evaluation of the presence or absence of wetlands within the anticipated limits of disturbance; collection of impounded sediment samples for grain-size analysis; and observation of the brook's geomorphology upstream and downstream of the dam and impoundment. The depth-of-refusal survey involved probing the soft bed of the existing impoundment and recording the elevation of a competent surface consisting of gravel, cobble, or bedrock. The depth-of-refusal surface suggests the location former longitudinal profile of the channel prior to dam construction, which often also represents the most probable long-term profile of the channel following dam removal. We revisited the site on May 20, 2019 to survey a potential alternative access road location, assess potential wetland impacts of the new access, collect sediment samples for quality testing, and assess potential downstream impacts of passive release.

2.2 GEOMORPHOLOGY

Downstream of Becker Pond Dam, the brook flows over steep terrain within a narrow, hemlock and birch-dominated forested valley. The channel is approximately 12 to 15 feet wide with a 1 to 1.5-foot bankfull depth. Frequent, but irregularly spaced constrictions, created by bedrock, narrow the channel to approximately 8 feet in some locations. The channel exhibits substantial complexity in substrate, form, and habitat (Figure 5). Exposed bedrock, fallen logs, and boulders create steps with 1 to 3 feet of vertical drop in water surface elevation. Plunge pools are located below these drops. Pools are also located downstream of riffles and on the outside of bends where the channel is eroding along the valley edge. Moss covers most of the larger substrate material, suggesting that primarily sand and gravel up to a particle diameter of approximately 2 to 3 inches are frequently mobilized. More information on downstream reaches can be found in the sediment management plan (Appendix A). Approximately two miles downstream, the combined channels pass underneath Undermountain Road at Joyceville (Salisbury, Connecticut, State Route 41).

Upstream of the impoundment, a small stone wall crosses the channel and marks the approximate upstream limit of influence of the dam. The new footbridge, constructed by TNC, is located approximately 50 feet upstream of this stone wall. Upstream of the bridge, for a distance of approximately 100 feet, the channel is steep with boulders and cobbles. Upstream of the steep boulder/cobble area, the channel becomes a lower gradient wetland channel with extensive deciduous wooded swamp wetlands influenced by beaver activity.

Figure 5. Looking upstream towards the dam along the channel, which exhibits complexity in substrate, form, and habitat

2.3 IMPOUNDED SEDIMENT

During the April 2018 field visit, Inter-Fluve field staff collected three sediment cores within the Becker Pond Dam impoundment. Cores were collected from upstream (BPD1), middle (BPD2), and downstream (BPD3) locations and sent to a laboratory for grain-size analysis. Sampling locations are shown in Figure 6. The material sampled was composed of sand, silt, and clay with a median grain size (D_{50}) for all samples in the medium sand range. The analyses showed a reduction in median grain size and increase in fines (silt and clay) content in the downstream direction from approximately 19% fines in the upstream sample to 39% fines in the downstream sample.

We used the bathymetric and depth-of-refusal survey data collection to estimate the volume of impounded sediment. We developed topographic surfaces of the existing pond bed (the top of the impounded sediment) and refusal layer (the bottom of the impounded sediment) from survey data and calculated the volume difference in a GIS environment. The estimated total volume of impounded sediment is approximately 1,500 cubic yards.

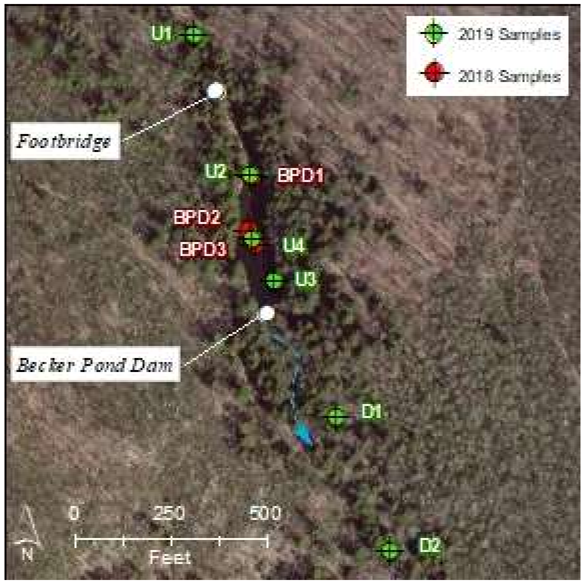

Figure 6. April 2018 and May 2019 sediment sampling locations

The refusal layer through the impoundment is anticipated to be composed of cobbles, boulders, or bedrock based on the sound and feel when probing. This matches with observations of the brook geomorphology upstream and downstream of the impoundment. To estimate the volume of sediment that may be readily mobilized following dam removal, we assumed erosion of a channel along the length of the impoundment. We assumed an average channel width of 25 feet, calculated an average impounded sediment depth of 1.5 feet, and used a channel length of 400 feet. This resulted in an estimated mobilization volume of approximately 550 cubic yards, or roughly one third of the total volume of impounded sediment.

The watershed upstream of Becker Pond Dam is approximately one square mile and is primarily forested with land covers of forest (78%), water (8.9%), wetland (6.7%), and developed (1.8%). Less than half a percent of the watershed is composed of impervious surfaces. We performed a desktop due-diligence review to determine possible sources of contamination within the watershed. We reviewed the following data:

- US EPA – no Superfund/Brownfields sites and no National Priorities List sites shown within the watershed;
- MassDEP (USTs) – no underground storage tanks were identified in the town of Mount Washington;
- MassDEP Reportable Release Sites – two sites were identified in the Town of Mount Washington, but both were outside of the project watershed and both were given Release Action Outcome statements of no significant risk;
- RTN 1-0015514 – 2004 - near Hunts Pond, north of the project watershed;
- RTN 1-0014693 – 2003 – at the intersection of East Street and Cross Road, more than two miles north of the project watershed; and

- Massachusetts Source Water Assessment and Protection Program – no source water sites listed for the town of Mount Washington.

No sources of contamination were identified within these public lists, and no additional sources of contamination were identified through reviews of historic topographic maps and aerial photos dating back to the 1890s.

Additional sediment sampling for quality testing was performed in May 2019 along with further due diligence research by MA DER. The results of this work are presented in the sediment management plan included as Appendix A.

To summarize the findings reported in Appendix A, the watershed has seen little development or agriculture, and the due diligence reviews carried out to date suggest there is low potential for the impounded sediment to contain of oil or other hazardous materials. Chemical testing results show that concentrations of the majority of the pollutants tested were below detection levels. Where concentrations were detected, they were below freshwater probable effects concentrations (PECs) (MassDEP, 1996) and therefore, exposures caused by the release of sediment from the impoundment are unlikely to result in environmental harm. Taking all of these things into consideration, the project partners opted initially to pursue passive release of impounded sediment (i.e., no mechanical removal).

Based on feedback received during the MEPA process in June 2020, the sediment management alternatives analysis was expanded to include partial removal of impounded sediment by constructing a pilot channel through the former impoundment. The partial removal option, Alternative 4, was selected. The expanded analysis and a description of the selected sediment management alternative can be found in Appendix B.

2.4 HYDROLOGY

We evaluated the hydrologic conditions of the study area using the regional regression method for ungauged streams described in the U.S. Geological Survey Scientific Investigations Report 2016-5156 (Zarriello, 2017). The hydrologic study area consists of the contributing drainage basin to Becker Pond Dam. Becker Pond Dam is located on an ungauged tributary of the Housatonic River.
The USGS regression method uses characteristics of the contributing watershed including the total contributing area, the mean elevation of the basin, and the total storage in the basin to estimate a peak flood discharge frequency curve. We used the web-based StreamStats tool (USGS, 2016) to delineate the contributing area, estimate the characteristics of the contributing watershed, and calculate peak flood discharges with various return periods.

The StreamStats tool uses the Global Watershed data source to delineate the watershed from a user-specified point. The tool then uses the USGS 30-meter National Elevation Dataset to calculate the mean basin elevation, and the wetland and open water areas defined in the National Land Cover Database (2006) dataset to calculate the total storage within the watershed. We reviewed the watershed delineation and modified it for consistency with the underlying U.S. Geological Survey topographic map prior to calculating the regression method results. StreamStats results (Appendix

C) indicate that the contributing drainage area is approximately one square mile, the mean basin elevation is approximately 1,840 feet, and the total water storage in the basin (as a percent of the total area) is approximately 7.6%. The analysis returns an upper prediction, a lower prediction, and a recommended value. These are presented in Table 2.

For comparison, we also used the gage transfer method of estimating peak flows. The Green River watershed is also located in western Massachusetts in Berkshire County and has an active USGS gage (71 years of record) in Williamstown (USGS gage no. 01333000). We examined a number of other gages in central and western Massachusetts, but selected the Green River because of the similarity between the two basin characteristics (Table 1). Peak flood discharges for specific annual exceedance probabilities at the Green River gage were estimated from gage records of annual peak flows using the USGS program PeakFQ (USGS, 2019). The Bulletin 17B methodology was selected, and a regional skew coefficient of 0.37 was used (Veilleux et al., 2019). The results are provided in Table 2.

Of the two methods, gage transfer results in lower estimates that approximate or fall below the lower bounds of the 95% confidence interval on the StreamStats estimates. Characteristics of the Green River watershed suggest that the gage transfer method may underestimate peak flows at the Becker Pond Dam site. Specifically, the watershed at the Green River gage has lower historical average precipitation, which is likely associated with the lower mean basin elevation. Additionally, more of the watershed is underlain by sand and gravel, which should be inversely related to runoff rates. The Becker Pond Dam watershed does have a greater proportion of waterbodies and wetlands, which is considered a proxy for storage; however, the estimated area (approximately 8%) is primarily Becker Pond, which is a run-of-river dam and provides little storage.

With respect to the StreamStats results, Zarriello (2017) states that many of the stream gages with small drainage areas used in developing the regional flood flow equations have a short period of record spanning from the mid-1960s to the mid-1970s and do not capture recent trends in increasing precipitation and runoff rates. The author suggests that this may bias the magnitude of annual exceedance probability flows for small drainage areas towards the low end. This suggests that for Becker Pond Dam, StreamStats results should error on the side of under- rather than over-estimation. Because both methods appear to have the potential to underestimate peak flows at the site, we recommend taking a conservative approach and adopting the higher estimates, which are the StreamStats estimates (shown in bold in Table 2).

Table 1. Becker Pond Dam and Green River (USGS 01333000) watershed characteristics

Characteristic	**Becker Pond Dam site**	**Green River gage**
Drainage area (square miles)	1.05	42.7
Mean basin elevation (feet)	1,840	1,560
Basin average mean annual precip. 1971-2000 (inches)	54.3	48.5
Forest cover (%)	81	78
Waterbodies and wetlands cover (%)	7.6	0.3
Impervious cover (%)	0.05	0.97
Underlain by sand and gravel (%)	3	11

Table 2. Peak flood discharge estimates in cfs

Annual exceedance probability (AEP) %	**Average return period (years)**	**StreamStats**			**Gage transfer**
		Estimate	**Lower limit[a]**	**Upper limit**	
50	2	**80**	35	170	35
10	10	**190**	85	445	70
4	25	**275**	115	660	95
2	50	**345**	135	870	115
1	100	**425**	160	1110	135

[a]The lower and upper limits shown represent the bounds of the 95% confidence interval for the estimate

Climate change projections suggest that precipitation patterns in Massachusetts will trend toward increased total precipitation, increased frequency of extreme precipitation events, and more precipitation falling as rain instead of snow (EEA, 2011; 2018), all of which will result in higher flood peaks. Trends supporting these projections have been observed in historical records since the 1970s (e.g., Collins, 2009; Walter and Vogel, 2010; Barrett and Salis, 2017).

While state-wide flow design guidance is still under development in Massachusetts, the neighboring state of New York published a draft flood risk management guidance document in June 2018 that contains suggested flood peak multipliers for use in designing for future conditions (NYSDEC, 2018). For eastern New York, a multiplier of 1.2 is recommended for projects with a design life ending in the period 2025 to 2100. Anticipated precipitation trends are similar for eastern New York and western Massachusetts; therefore, we recommend adopting a multiplier of 1.2 for estimating future flood peaks at the Becker Pond Dam site if simulation of climate change impacts is deemed necessary. Additional site-specific discussion can be found in Section 3.1.

Fish passage flows were estimated using StreamStats, and the estimates available through the program are summarized in Table 3. Percentile flows are predicted flows equaled or exceeded 99, 95, and 50% of the time.

Table 3. Low flow estimates in cfs

Estimate	Flow
99^{th} percentile	0.06
95^{th} percentile	0.13
50^{th} percentile	1
7-day, 2-year low flow	0.11
7-day, 10-year low flow	0.06

2.5 HYDRAULICS

We used U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center-River Analysis System (HEC-RAS) software to develop a 1-dimensional model of the subject reach to simulate water surface profiles of the Becker Pond stream channel for two conditions: the existing condition and the post-project dam removal condition. The existing condition represents the site condition surveyed in April 2018. The subject reach begins approximately 160 feet downstream of the existing dam and extends approximately 860 feet to a point upstream of the limit of the existing impoundment.

We developed the existing condition model geometry in a GIS environment using the Geo-RAS toolset. The channel and structure cross-section geometries are based on the 3-dimensional model of the terrain developed from the site-specific survey data collected in April 2018 and shown on the plans. For both the existing and proposed model scenarios, we assumed a downstream boundary condition defined by the normal friction slope, approximately 2%. StreamStats peak flow estimates from Table 2 were used in the simulations.

In general, we assumed a Manning's "n" value for the channel of 0.07, which is consistent with boulder step-pool streams (mountain streams with a bottom of gravel, cobble, and few boulders) and a Manning's "n" value for the overbank of 0.12, which is consistent with forested floodplains (forested areas with little undergrowth, with flood stage reaching branches). For the existing condition model, we assumed a Manning's "n" value of 0.023 for areas occupied by concrete and 0.03 for the area within the impoundment, which is consistent with a clean, winding channel with pools and shoals.

2.1 WETLANDS AND ECOLOGY

2.1.1 Resource Areas

The MassDEP wetlands database (MassDEP, 2005) includes Becker Pond and defines the area as open water (Figure 7). Upstream of the impoundment, the database indicates that there is an area of wooded deciduous swamp. Field observations are consistent with the database. The area upstream of the pond is dominated by low-gradient stream conditions and beaver activity. The database does not indicate wetland areas downstream of the dam within the proposed limits of disturbance.

Immediately downstream of the dam, the channel is formed by steep hillslopes meeting the edge of the stream. We observed no wetlands in these steep, narrow areas. Further downstream, there are a few locations where the stream valley broadens for a short distance. In these broad areas, we observed small areas of bordering vegetated wetland occupying depressions in the active floodplain. The brook is mapped by MassWildlife as a coldwater fishery and is known to support brook trout.

Figure 7. DEP wetlands

2.1.2 Potential Impacts to Wetlands Related to Access

Two options for access to the dam are currently being considered. One option (Access Entrance Alternative 1) involves the use of an existing dirt road from East Street to the dam. Approximately 350 feet of this road, beginning at East Street, are within private property. TNC is currently coordinating with the owner to gain access to this road during construction. The alternative access option (Access Entrance Alternative 2) is to construct a new access road that is entirely within TNC property and that connects East Street to the existing dirt road. This new access road would be located approximately 100 feet from a concentrated drainage flow path that originates at the outlet of a drainage relief culvert under East Street. Sand and gravel have accumulated on the downstream (eastern) side of the culvert crossing and have covered the roots of several trees. The accumulated material has also raised the concentrated drainage flow path above the adjacent ground and prevents a small area north of the flow path from draining (Figure 8).

Figure 8. Wet, low-elevation areas in the foreground, and higher ground dominated by mountain laurel in the background

BSC Group performed a wetland delineation on May 16, 2022 to determine if the area between the concentrated drainage flowpath and the proposed access road alignment meets the definition of a bordering vegetated wetland under 310CMR10.55 (et seq). They concluded that the site meets the definition of a bordering vegetated wetland (BVW)[1]. The wetland was delineated using handheld GPS with submeter accuracy and is shown on the Plans. The area of BVW is approximately 4,245 square feet and is a forested wetland dominated by red maple (Acer rubrum) with an herbaceous understory containing lady fern (Athyrium augustum), white meadowsweet (Spirea alba), and sensitive fern (Onoclea sensibilis).

2.1.3 Endangered Species

The project site is located within a priority habitat of a state-listed species protected under the Massachusetts Endangered Species Act. Natural Heritage & Endangered Species Program (NHESP) staff reviewed and commented on the 30% designs in August 2018 (Misty-Anne Marold, personal communication with Karen Lombard of TNC, 10 August 2018), and the MassWildlife provided comments on July 16, 2020. It was determined that the project would likely require a species-protection plan but would not require a MESA Conservation and Management Permit.

On July 28, 2022, MassWildlife provided permit conditions associated with NHESP File Number 18-37448 and DEP Wetlands File Number 232-0046 (MassWildlife, 2022). The permit conditions referenced the materials associated with the SEIR and the MESA filing including the 75% Design Plans (Inter-Fluve, 2020b), the Environmental Resources Map Proposed Conditions (BSC Group, 2022), and the Snake Protection Plan.

MassWildlife determined that the project, as proposed, will not adversely affect the actual Resource Area Habitat of state-protected rare wildlife species. However, the project, as proposed, must be conditioned to avoid a prohibited Take of state-listed species.

Conditions include:

- **Limit of Work:** All work on the property shall be located within the limits of work as shown on the Plans. Changes to the limits of work require additional review and written approval from MassWildlife.
- **Timing:** Work conducted between November 1 and April 14 (the inactive season) may proceed without restrictions. Work conducted between April 15 and October 31 must be conducted under the direct supervision of a Division-approved biologist in accordance with a protection plan (SPP) and additional provisions included in the response provided by MassWildlife.

In addition, MassWildlife requested that small wire mesh or caging should be provided at any pumping inlets to prevent fish being drawn into pump systems. MassWildlife has requested a presence during drawdown of the impoundment to help relocate fish stranded in the impoundment as needed (Leanda Fontaine, personal communication with Eric Ford of DER, 31 May 2022).

[1] Bordering vegetated wetlands as defined in 310CMR10.55

3. Project Design

3.1 SUMMARY OF DESIGN APPROACH

The design presented in this memorandum and on the associated plans (the Plans) includes (1) removing the full vertical and lateral extent of concrete associated with the dam, (2) re-grading the earthen portion of the embankment to approximate the pre-dam cross section, (3) excavating a pilot channel through the impoundment, and (4) stabilizing the impounded sediment to remain in place. The aim is a minimal-effort approach to minimize impacts to the site and downstream channel, achieve the primary project goals to eliminate the safety hazard posed by the dam, and restore aquatic connectivity through the site.

Our hydrologic study of the watershed indicates that the contributing area to the Becker Pond Dam remains undeveloped. The existing characteristics of the watershed including land use, land cover, and soils are consistent with the conditions that existed when the impoundment was created. Therefore, we do not anticipate a need to design countermeasures for increases in peak flood flows resulting from changes to the watershed condition. Some aspects of the riparian corridor that provided stability before the dam was installed (i.e., vegetation) have been compromised. We propose to use large wood to stabilize the remaining impounded sediment until vegetation can re-establish. The approach to vegetation re-establishment and management is described below.

Our depth-of-refusal survey data suggests that material found below the impounded fine sediment is likely to be consistent with the material observed in the bed and banks both up and downstream of the impoundment, (i.e., cobbles, boulders, and bedrock). The existing material upstream and downstream of the impoundment is currently stable; it is not prone to erosion. We expect the overlying sediment to evacuate the former impoundment over time to reveal the underlying cobbles, boulders, and bedrock. We propose to excavate a pilot channel through the impoundment, broadcast native seed onto land formerly under water, and install large wood structures along the banks of the pilot channel. These measures will reduce the risk of sedimentation to points downstream by reducing the volume of mobilized sediment and accelerating vegetative stabilization of the banks and floodplain. Project iterations have entertained the possibility of placing an optional large wood jam in the channel downstream of the dam to capture and temporarily store sediment released from the impoundment. However, permitting requirements associated with the placement of fill[2] and the obstruction to navigability[3] have eliminated this possibility from the project. We do not expect that additional channel stabilization or armoring measures will be necessary to prevent extraordinary erosion or to protect adjacent and/or upstream infrastructure (there is none).

Future increases in peak flood flows are anticipated at the site as a result of climate change. At the Becker Pond Dam project site, there is no infrastructure that would be at risk of changing hydraulic conditions. We therefore simulated present day predictions of peak flood flows for comparison of pre- and post-project hydraulic conditions. Although it is reasonable to anticipate some evolution of

[2] USACE Section 404, NAE-2020-1622-20240412.

[3] MassDEP Chapter 91 license, pending as of June 30, 2024.

the channel and of the wider watershed as precipitation changes, restoration of flow and sediment continuity through dam removal will restore natural resilience at the site by allowing the brook to adjust naturally through time.

Based on the assumptions that the condition of the stream prior to the construction of the dam was stable and that the watershed conditions that affect the stability have not been altered, our proposed design limits the area of direct excavation to (1) the dam structure itself: the entire lateral and vertical extent of the concrete core-wall, spillway, training walls, and apron, and portions of the earthen embankment and (2) a pilot channel within the former impoundment.

The proposed embankment re-grading reflects an intent to tie into contours of the existing valley slopes and stream channel, both upstream and downstream of the dam. At this time, the Plans reflect the implicit assumption that the material within the limits of grading is unconsolidated; however, based on our observations of the valley slopes downstream of the dam, we think it is likely that the embankment is constructed of fill placed on boulders and bedrock. If consolidated, stable material is not encountered within the proposed grading area, we propose to excavate material to achieve an approximately 2H:1V slope from the channel bed to the valley slope tie-in location.

We propose that excavated earthen material be reused on site. One potential area of reuse that has been identified is the area of material placement shown on the Plans along the right bank immediately downstream of the existing dam. The intent is to use salvaged soil to fill a low spot in the bank. Field evidence suggests that this low spot was a borrow area for the original dam construction. The volume of the borrow pit void is approximately 215 cubic yards. The proposed contours reflect an intent to restore the historical borrow pit. Material placement will tie into the existing contours downstream where the bank is undisturbed, thus restoring the bank in this location to something closer to its likely original form.

The Plans indicate pilot channel excavation and large wood stabilization following the removal of the dam. Cobble and boulder material found in the excavation spoils will be placed in the area currently occupied by the concrete apron. Aside from this, no active channel construction downstream of the dam is proposed.

Text on the Plans reflects the stated intent to remove the full vertical and lateral extent of the concrete core wall. At this time, the vertical and lateral extents are unknown. The Plans reflect the intent to remove other concrete components including the apron, the spillway, and the training walls. We recommend that the concrete material be removed from the channel (to a staging area), broken into pieces, and removed to an approved facility.

The Plans and intent reflect Sediment Management Alternative 4, a limited sediment management approach with excavation of a pilot channel within the impoundment. See the sediment management plan included as Appendix A, the supplemental information provided to the MEPA Review office (Appendix B), and the section on sediment management below.

The Plans indicate that land formerly underwater is to receive a treatment of native stabilization seed mix and that all excavated slopes that result in bare soil are to receive a slope treatment of native upland/stabilization seed mix with biodegradable surface fabric on top, staked in place to retain the soil on the slope until the vegetation has been established. In addition to seeding and surface fabric, native shrub plantings are shown within the limits of the former borrow area where fill is proposed to help speed up establishment of good vegetative cover. Plant species will be native species as indicated in, "The Vascular Plants of Massachusetts: A County Checklist First Revision (Dow Cullina, M, B Connolly, B Sorrie, and P Somers. 2011. MA NHESP DFW)".

3.2 SEDIMENT MANAGEMENT

We anticipate that the mobile portion of sediment is approximately one-third (~550 cubic yards) of the estimated total of 1,500 cubic yards of impounded fine sediment contained behind the dam. This is the volume is likely to be readily mobilized following dam removal. Potential impacts of mobilization on downstream reaches is discussed in the sediment management plan in Appendix A. Based on agency feedback[4], partial removal of impounded sediment will be pursued at this site.

Construction of the pilot channel as shown on the Plans will result in the excavation of approximately 310 cubic yards of impounded sediment. This volume is based on the excavation of impounded sediment immediately upstream of the dam and of a simple channel defined by a thalweg and side slopes at approximately 2H:1V with a maximum top width of 23 feet to match site conditions. Excavation will proceed from downstream to upstream and will cease before reaching the upstream boundary of the impoundment. The upstream limit of excavation shown on the Plans has been set to avoid direct impacts to wetland areas in the upstream part of the impoundment. The volume of impounded sediment removal is a best estimate based on a finite depth-of-refusal point dataset; the native refusal surface of cobbles, boulders, and bedrock is likely to be very irregular, so the final excavation volume may vary from this estimate.

Excavated impounded sediment will be disposed of off site.

3.3 HYDRAULICS

We developed the full dam removal condition model geometry by modifying the existing condition model geometry in the following ways:

- Removing the dam (the inline structure);
- Modifying the overbank and channel grading between sections 1+86 and 2+25 (Plan stations) to represent the removal of material (both earth and concrete) within the footprint of the dam; and
- Adding a pilot channel from the former dam up to station 6+40 (Plan station).

The post-project dam removal condition represents the site condition shown on the proposed grading immediately following construction; it does not anticipate the long-term evolution of the streambed. Refer to the previous section on existing conditions hydraulics for a discussion of downstream boundary conditions and manning's "n" values used in the model. A summary of the hydraulic modeling results is provided in Appendix D.

[4] MassDEP 401 Water Quality Certification for Dredging. #23-WW26-0005-APP. March 11, 2024.

Model estimates indicate that the removal of the dam will reduce the elevation of the flood profile (for all events) immediately upstream of the dam by approximately 12 feet. Model results also indicate that hydraulic impact of the dam extends to a location approximately 600 feet upstream of the dam. Upstream of that location, the removal of the dam will not affect the hydraulic conditions within the stream channel. Figure 9 illustrates the impact of the dam removal on the flood profiles of the subject reach for the 2-, 5-, 10-, 25-, 50- , 100-, 200- and 500-year return period events.

We do not anticipate that the removal of the Becker Pond Dam will impact infrastructure. Model results and site visit observations support the conclusion that there is no infrastructure within the upstream limits of the hydraulic influence of the dam. Together, the storage in the impoundment and the outlet structure at the dam do not provide significant attenuation of flood flows of any frequency, small or large. Model results indicate that the dam overtops during an event with an average return period between 5 and 10 years. Removal of the dam will have a negligible impact on peak flood flow conditions at infrastructure downstream, namely Undermountain Road (State Route 41).

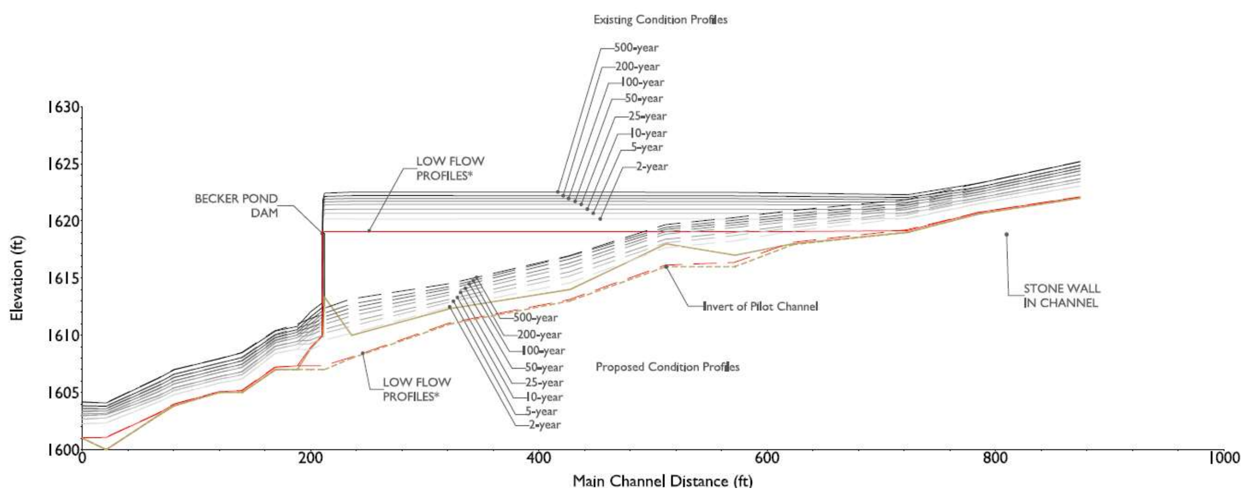

Figure 9. Comparison of flood profiles: 2-, 10-, 25-, 50-, 100-year events

3.1 ECOLOGICAL BENEFITS

We anticipate that the removal of the Becker Pond Dam will have a favorable impact on aquatic habitat and connectivity along the brook. Removal of the dam will eliminate a 12- to 14 -foot vertical discontinuity in the hydraulic grade line of the brook. Hydraulic model results predict that for the range of low flows simulated, average channel velocities will remain below sustained burst speeds of brook trout (2 to 3.5 ft/s) and well below maximum burst speeds (4 to 7 ft/s). We anticipate that the condition of the streambed within the impoundment will evolve to a condition that is similar to that of the bounding reaches, which exhibit both substrate and flow complexity.

Elimination of the impoundment has the potential to improve water quality within the coldwater fishery. Water held in impoundments is often warmer with lower levels of dissolved oxygen than water in surrounding free-flowing reaches, although no data specific to Becker Pond are available.

Generally, by eliminating an impoundment and returning the stream to its free-flowing condition, cooler water temperatures and higher levels of dissolved oxygen are restored and better support coldwater species such as brook trout.

3.2 WETLAND IMPACTS

No permanent impacts to bordering vegetated wetland (BVW) are anticipated as a result of the removal of Becker Pond Dam. As indicated above, one area of BVW was identified adjacent to the limits of work. A small area (approximately 4,245 square feet) of BVW was identified southwest of Becker Pond off of East Street near Access Entrance Alternative 2 as shown on the Plans. If Access Alternative 2 is implemented, impacts to the BVW will be temporary and associated with the use of temporary construction matting to provide access for wider construction equipment adjacent to and/or through the BVW.

Existing wetlands upstream of Becker Pond will be unaffected by the project. Becker Pond itself will transition from primarily open water to open water with bordering land subject to flooding (BLSF). Anticipated permanent and temporary impacts to resource areas are indicated on the Plans.

3.3 COST OPINION

An opinion of probable construction costs is provided in Appendix E. We estimated lump sum and unit costs based on review of construction costs for similar items in past projects and applicable reference cost data. The actual implemented cost may vary from these estimates as a result of market factors, detailed design development, or other factors.

Several assumptions were made in developing costs. Key assumptions include:

- A construction duration of approximately eight weeks;
- Excavated concrete (119 cubic yards) and other demolition debris will be disposed of off site;
- Excavated sediment (310 cubic yards) will be dewatered and disposed of off site;
- A portion of the excavated soil (215 out of 287 total cubic yards) will be reused to fill the historical borrow pit and to meet the lines and grades for grading of the pilot channel banks as shown on the Plans, the remainder (72 cubic yards) will be disposed of off site;
- We have assumed no special landfill requirement.
- Additional excavation as required to remove the full vertical and lateral extent of the concrete core wall is considered incidental to the Dam Demolition and Disposal item;
- Wood for large wood structures will be harvested/salvaged from on site from within the limits of disturbance and may include downed logs, logs removed for access and staging, and logs with rootwads removed for grading; and
- Construction of drainage facilities for the access road will not be necessary.
- At this time, the access to the site is not finalized. Two options have been permitted. The cost estimate includes ADD/ALT items for each of the construction access alternatives.
- Access Alternative 1 is the standard assumption. This access alternative passes through a neighboring property, along an extant access road.
- Access Alternative 2 is the alternate assumption. Work will be required to construct the new access entrance and road. Work will consist of clearing and grubbing. Cleared vegetation

will be chipped and left on site, and material import for road construction will not be required. The new road will be partially seeded and planted following construction to narrow its width for permanent pedestrian access only;

We applied a contingency of 20% to account for uncertainty in associated with bidding and the construction process, uncertainty or future changes in unit costs, and scope or design changes that may arise during the design process or as a result of permit conditions.

4. Construction

4.1 ACCESS AND STAGING

Construction period access to the dam will occur from the west side via East Street. At this time, the project is considering two alternate access routes. The preferred access route (Access Entrance Alternative 1) follows an existing access road that originates on private residential property on East Street and proceeds all the way to the dam. The alternate access route (Access Entrance Alternative 2) is located entirely on TNC property. It also originates on East Street, and joins the existing access road approximately 700 linear feet from East Street.

It is TNC's preference to avoid the disturbance associated with Access Entrance Alternative 2. However, the ultimate feasibility of using Access Entrance Alternative 1 depends on securing permission from the landowner. Securing this permission is complicated by uncertainty associated with the current and potential future landowners. TNC is diligently working on this sensitive challenge. If permission cannot be secured, Alternative 2 represents an investigated, designed, permitted alternative on land currently owned by TNC.

At the locations of the access points, East Street is a well-maintained gravel road. In winter, Mount Washington plows the road to the Connecticut State Line. The existing dirt access road is approximately 10 to 12 feet wide and will be wide enough for access of heavy construction vehicles (Figure 10). Some vegetation clearing may be necessary; tree branches may need to be trimmed and removed. Where the existing access road approaches the dam, there is a small loop around a few mature hemlock trees. The interior of this loop may be cleared for access and staging and the harvested large wood may be incorporated into the project.

Figure 10. Existing dirt access road to be used during the removal of Becker Pond Dam (left) looking north along the road and (right) looking east towards the dam.

The potential new route associated with Access Entrance Alternative 2 passes through areas with mature trees, mountain laurel, and underbrush. The pathway illustrated on the plans is prioritized to avoid mature trees; however, some harvesting along this route will likely be necessary to provide wood for large wood structures.

If TNC uses Access Entrance Alternative 2 to complete the project work, they would convert the route to a permanent pedestrian-only trail. Its permanent width would be reduced from the construction width using native plantings and/or seeding. The details of the restoration would be developed in consultation with NHESP.

4.2 SUGGESTED CONSTRUCTION SEQUENCE

The construction contractor typically identifies a preferred construction sequence that is reviewed and approved by the Owner and Owner's Technical Representative. Primary considerations for sequencing at this site are access constraints, minimizing safety risk associated with operating near the failing training walls, and minimizing disturbance within the channel. For planning purposes, the following is a suggested construction sequencing based on our experience with other dam removal projects and this dam's specific site conditions.

1. Access Entrance: Alternative 1 or 2: Establish stabilized construction entrances (and staging area, Alternative 1 only) at East Street. Install erosion and sedimentation control BMPs, high visibility fencing, and temporary closure signs.

2. Access Entrance Alternative 2 (only): Clear and grub for new permanent access road. Prepare ground surface to protect wetland resource areas and other areas from the impacts of heavy equipment. Harvest and stockpile trees and slash for use in large wood structures.
3. Establish staging area adjacent to the dam. Install erosion and sedimentation control BMPs, high visibility fencing, and temporary closure signs.
4. Implement water management plan. Pump flow around the limits of work.
5. Remove footbridge, signs, and fencing.
6. Drain down the impoundment in such a way that the release of impounded sediment is minimized.
7. Excavate the pilot channel when sediment is sufficiently drained such that newly graded pilot channel banks do not slump.
8. Install seed and large wood structures along the pilot channel.
9. Remove the spillway and training walls.
10. Excavate the earthen embankments, remove the concrete core walls, and grade the slopes on river right and left.
11. Install surface fabric, remaining seed, and plantings within limits shown.
12. Remove water management controls.
13. Restore disturbed areas to a suitable condition.
14. Remove erosion and sedimentation controls.
15. Remove equipment and seed and plant along the new permanent access. (Alternative 2 only).
16. Remove temporary fencing and signs.

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Appendix A - Sediment Management Plan

Revised 07 October 2020 and provided under separate cover.

Appendix B - Revised Sediment Management Alternatives Analysis

Appendix C - StreamStats Summary

Appendix D - Hydraulic Modeling Summary

Appendix E - Cost Opinion