TECHNICAL MEMORANDUM

To:	Ron Rhodes, Connecticut River Conservancy
From:	Candice Constantine and Mike Burke, PE
Date:	June 29, 2018
Re:	Harvey's Lake Design Concepts Report

Introduction

Harvey's Lake in Barnet, Vermont is a 352-acre lake and is the largest lake in the Stevens River watershed. Harvey's Lake outlets to South Peacham Brook, which flows to the Stevens River, a tributary of the Connecticut River (Figure 1). Harvey's Lake Dam is located approximately 1/3 mile downstream of the natural lake outlet and 400 feet downstream of the confluence of the outlet channel with South Peacham Brook. Combined, the brook and lake drain approximately 20.7 square miles of steep terrain to the dam site. The presence of the dam is understood to cause backwatering of South Peacham Brook's flow into the lake during high flow events, which contributes to sedimentation in the north end of the lake and other water quality issues. The dam also affects the natural flow and sediment transport regime of the brook and downstream Stevens River and blocks passage of fish and other aquatic organisms.

The project partners, including Connecticut River Conservancy, Town of Barnet (dam owner), the Lake Harvey Association, and the Vermont Agency of Natural Resources (Department of Environmental Conservation and Fish and Wildlife Department), are pursuing dam removal to address the issues listed above. In addition to dam removal, the partners require a passive hydraulic structure at the outlet of the lake to maintain current lake levels. The structure should allow outflow to mimic the hydrology of a natural stream system and provide for the safe, timely and effective passive of fish.

In May of 2018, Inter-Fluve submitted a Feasibility/Alternatives Analysis Report[1] to the project partners, which included four alternatives to address the issues described above (see Table 1). After review of the study and discussion of the alternatives, the project partners have elected to pursue Alternative 3, which involves removing most of the dam, realigning the channel, and installing grade controls near the lake outlet and downstream of the Harvey Mountain Road bridge. This preferred alternative was presented to the Town of Barnet Select Board on June 23, 2018 and approved. The purpose of this technical memo is to document the selection of Alternative 3 as the

[1] Inter-Fluve, Inc., 2018. Feasibility/Alternatives Analysis Report, Harvey's Lake Dam Removal, Barnet, VT. Submitted to Connecticut River Conservancy and Town of Barnet. May 31, 2018.

preferred alternative, and outline the project scope, design criteria, and costs associated with that choice.

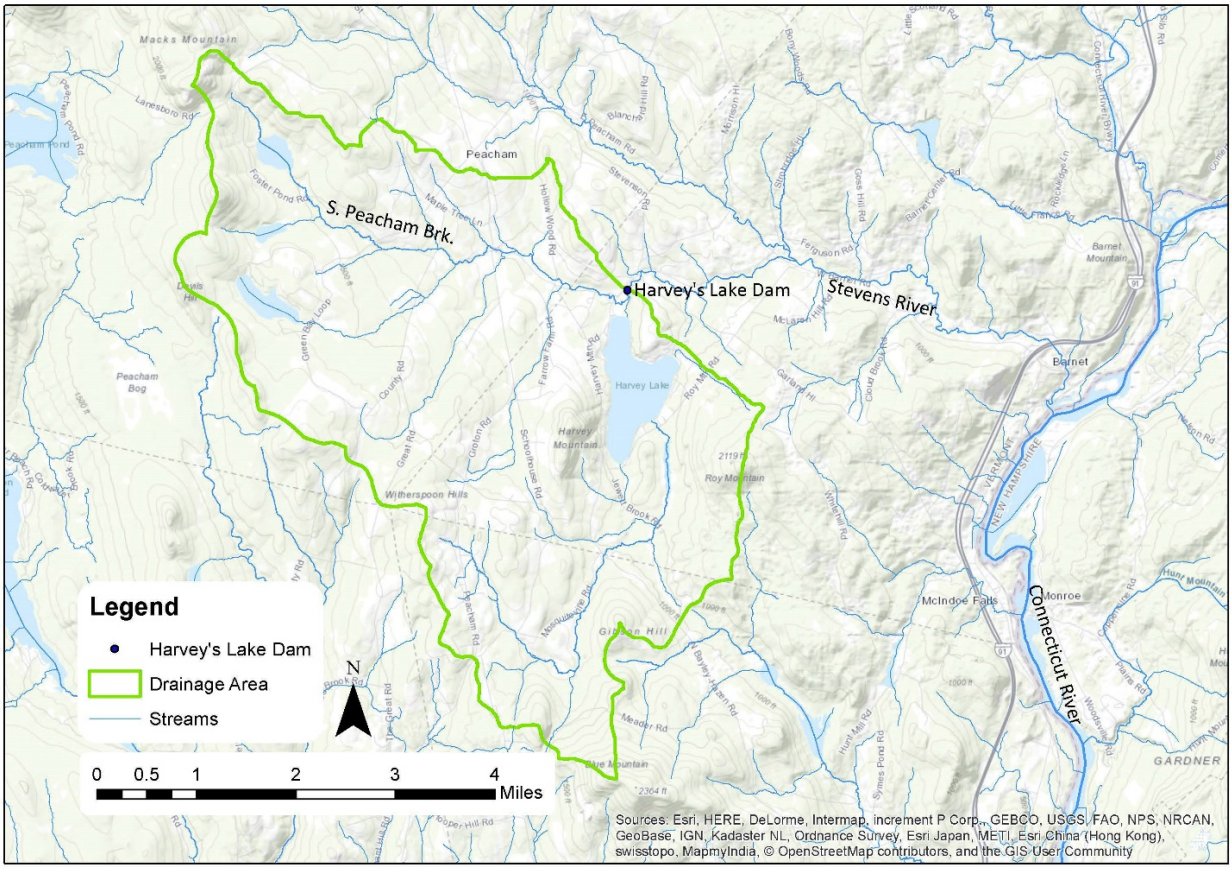

Figure 1. Harvey's Lake Dam watershed.

Conceptual Design

PREFERRED ALTERNATIVE

Following field assessments and a hydraulic analysis, four alternatives were developed and considered in the Feasibility/Alternatives Analysis Report (Table 1). Each option includes measures to address potential risks associated with dam removal. The scope of Alternative 3 is described below and depicted in Figure 2.

Table 1. Summary of project alternatives included in assessment

Project	Harvey's Lake Outlet	Harvey Mountain Road Bridge	Harvey's Lake Dam	Impoundment
Alternative 1	Passive riffle structure near lake outlet (A)	Do nothing and monitor (B)	Remove most of dam and structures and buttress left bank (C)	Realign South Peacham Brook (B)
Alternative 2	Passive riffle structure near lake outlet (A)	Additional assurance of grade control (C)	Remove most of dam and structures and buttress left bank (C)	Realign South Peacham Brook and restore floodplain (C)
Alternative 3 ***(Preferred)***	Passive riffle structure near lake outlet (A)	Additional assurance of grade control (C)	Remove most of dam and structures and shift alignment (D)	Realign South Peacham Brook and restore floodplain (C)
Alternative 4	Passive riffle structure near lake outlet (A)	Additional assurance of grade control (C)	Remove entire dam and structures and shift alignment (B)	Realign South Peacham Brook and restore floodplain (C)

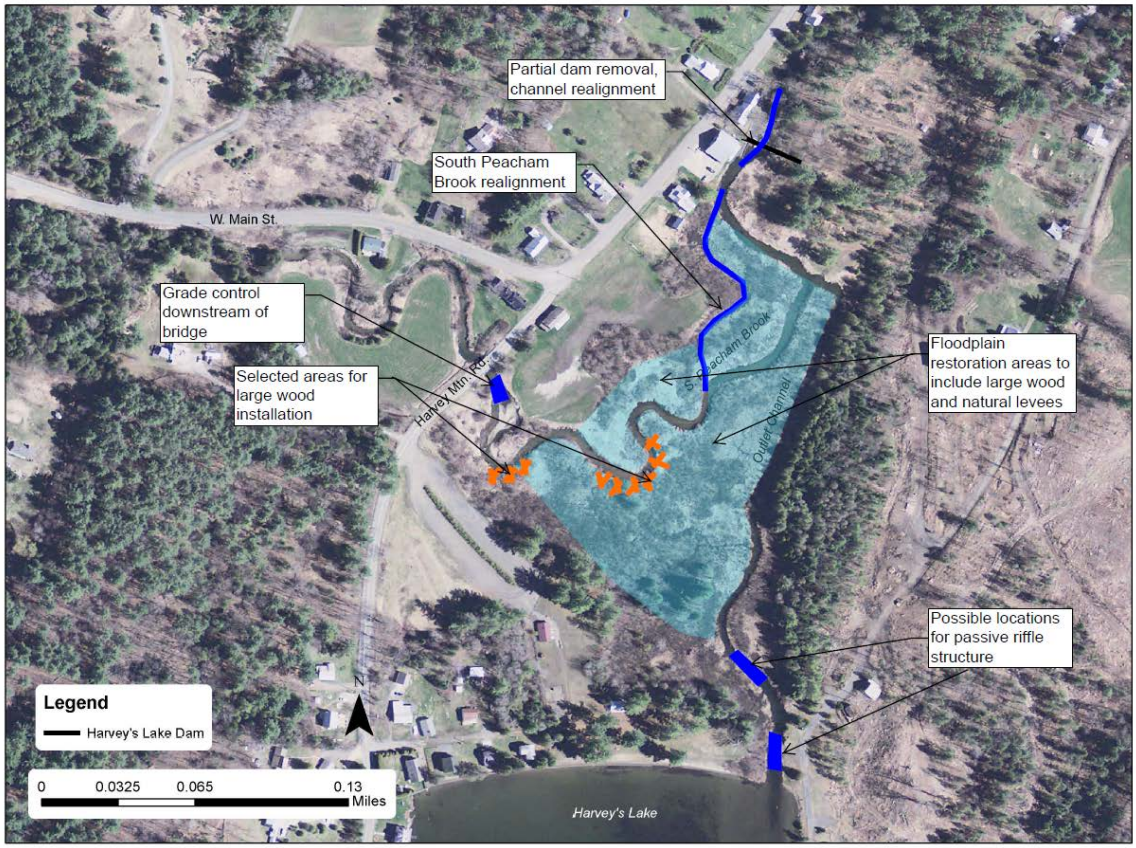

Figure 2. Alternative 3 (preferred). Aerial imagery from the 2014 National Agriculture Imagery Program (NAIP, 2014). http://maps.vcgi.vermont.gov/gisdata/metadata/NAIP_1M_CLRIR_2014.htm.

A passive riffle structure composed of rounded river rock will be constructed near the outlet of the lake to provide grade control and maintain existing minimum lake level. The riffle will be designed to remain stable during large flood events and will be tied into higher ground on both sides to prevent outflanking. Two potential locations have been shown in Figure 2. The upstream location at the lake outlet is preferred from a design and construction standpoint because of the narrow width of the channel and floodplain at this point and the relative ease with which the riffle structure could be tied into higher ground. A second possible location approximately 250 feet downstream is also being considered in order to preserve existing water levels at a loon nesting site at the upstream end of the outlet channel. A riffle here would need to be more laterally extensive. In either location, the riffle structure is expected to be self-maintaining (i.e., require no future maintenance).

The Town of Barnet and other partners prefer a proactive approach to managing the potential effects of lowering of bed levels along South Peacham Brook following dam removal. Alternative 3 involves providing additional assurance of grade control by supplementing the bed of the channel immediately downstream of the bridge with large rounded river rock.

At the dam itself, a conservative approach to managing risk to private property and buildings at the top of the left bank is preferred. Thus, the full vertical extent of most of the dam will be removed, but the fish ladder and possibly a portion of the dam at the left bank will be retained to provide stability against failure of the bank. The alignment of South Peacham Brook at the dam site will be shifted away from the left bank, returning the channel to its likely pre-1970 alignment. The bank will be built out in front of the portions of the dam structure remaining in place and the downstream bank along the private property and will be planted with native riparian trees and shrubs.

The preferred scope of work through the impoundment is that which has the greatest potential to result in water quality improvements in Harvey's Lake. South Peacham Brook will be realigned to occupy a suspected former alignment that will provide a more hydraulically efficient pathway. In addition, functional floodplain (i.e., channel-floodplain connection and regular floodplain inundation) including floodplain wetlands will be restored through the impoundment which will provide capacity for floodwaters to flow downstream along the brook rather than backflowing into the lake. Excavated material will be used to construct natural levee features along South Peacham Brook to further help focus flows down valley and discourage overflow into the outlet channel. The levees will be integrated into the landscape and planted. As shown in Figure 2, this option also includes incorporating large wood into the project at key locations to further discourage overflow, enhance floodplain habitat, and help moderate long-term geomorphic adjustment. Specifically, large wood will be incorporated into the right bank of the brook where there is a history of overtopping and movement of water from the brook into the outlet channel.

Table 2 provides a summary of the assessment criteria leading to the selection of Alternative 3. The key factors in the decision are shown in bold text.

Table 2. Excerpt from alternatives assessment table (Table 4) of May 2018 Feasibility/Alternatives Assessment Report

Project	Details	Meets Goals and Objectives	Particular Permitting Issues	Technical Feasibility and Construction	Environmental Benefits	Other
Alternative 3	• **Conservative approach to design and risk management at dam site** • **Proactive approach to managing infrastructure safety risk at bridge** • Restoration benefits at dam and maximum restoration benefits through former impoundment	• **Very good potential to meet project goals and objectives** • **Floodplain restoration including installation of large wood provides the greatest opportunity for desired water quality improvements**	• Minimizes passive release of impounded fine sediment • Construction within limits of existing wetland would require a permit • **Construction of new floodplain wetland at a lower elevation would continue to provide wetland functions and thus is likely be favored over full loss of existing wetland** • Modeling would be required to demonstrate no adverse flood risk impacts • Permits will likely require minimizing impacts to rare species and managing invasives	• Rock placement and phasing could be designed to minimize the extent of the dam structure to be retained	• Improves water quality by reducing or eliminating backflow from South Peacham Brook into Harvey's Lake and maintaining a functional floodplain • Restores aquatic organism passage • Enhances floodplain habitat through the incorporation of large wood and microtopography • Maintains wetland functions • Enhances bankside habitat at the dam location	• Access to the dam would be via parcel 32.12 and the Town's easement • Work would also affect parcels 29, 30, 31 and 44 • Most of the floodplain restoration activities would take place on the Town-owned parcel (44)

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DESIGN CRITERIA

Table 3 summarizes the current design criteria for each of the project elements. These will be refined as the project moves into more detailed design phases.

Table 3. Harvey's Lake design criteria

Design Element	Design Criteria
Harvey's Lake Outlet - Riffle	• Minimum lake level will be maintained. • Structure will remain stable up to the 100-year flood event. • Riffle will be self-maintaining. • Riffle will tie into refusal layer at downstream toe to prevent undermining. • Readily mobilized fine sediment currently stored in the outlet channel will be removed. • Riffle will allow for fish and other aquatic organism passage during low flows. • Loon nesting may be a consideration in the riffle location. • Lateral and longitudinal extents will be determined in a future design phase once the location is set. • Additional survey will be collected in a future design phase to better constrain desired lake levels.
Harvey Mountain Road Bridge – Grade control	• Grade control will remain stable up to the 100-year flood event. • The bridge and existing rip rap scour protection will remain unaltered by the proposed work.
Harvey's Lake Dam	• The full vertical extent of most of the dam structure will be removed. • The fish ladder and possibly a portion of the dam will remain in place against the existing left bank. A sufficient portion of the structure will be retained to provide stability against failure of the bank. This extent will be determined in future design phases. • Rock used to construct the toe of the new left bank will remain stable up to the 100-year flood event.
Impoundment	• The realigned segment of South Peacham Brook will follow what is thought to be a relict flow path. • Readily mobilized fine sediment stored in the reservoir immediately upstream of the dam will be removed. Fine sediment stored in the South Peacham Brook channel downstream of the limits of realignment will remain trapped on the floodplain. • Restoration of functional floodplain will maintain or improve flood conveyance capacity and will maintain wetland functions. • Incorporation of large wood and floodplain berms will discourage overflow from South Peacham Brook into the outlet channel.

PERMITTING

Based on our experience of similar projects and discussions with the relevant agencies, the following permits or reviews are likely to be required for the project:

- USACE Section 404 permit. A permit is required under Section 404 of the Clean Water Act for proposed activities that would discharge dredged material into waters of the U.S., including wetlands.
- Section 401 Water Quality Certification. Any project that requires a Section 404 permit also requires a Section 401 permit from the state (Vermont Agency of Natural Resources, Department of Environmental Conservation, Watershed Management Division).
- A permit for construction activities directly affecting the Class II wetland would be required by the Vermont Agency of Natural Resources, Department of Environmental Conservation, Wetlands Program. Wetlands that would be directly affected by construction would need to be delineated by a wetland scientist. Indirect impacts to other wetlands will also be considered in reviewing the project plans; however, all other ecosystem benefits provided by the project would also be taken into account.
- Historic resources review by the Vermont Agency of Commerce and Community Development, Division for Historic Preservation. A project review form should be completed for the project.
- Stream Alteration Permit. Stream alteration permits regulate activities that take place in or along streams. The local River Management Engineer with the Vermont Agency of Natural Resources, Department of Environmental Conservation, River Management Program should be contacted early to facilitate review.
- Chapter 43 Dam Order. A permit from the Vermont Agency of Natural Resources, Department of Environmental Conservation, Dam Safety Program is required for the alteration or removal of dams that impound more than 500,000 cubic feet of water or sediment.
- Local floodplain permit. A No-Rise Certification supported by hydraulic modeling results and signed by a registered professional engineer will be required.

COST ESTIMATE

A planning level opinion of probable construction cost was developed for the preferred alternative. We recommended that costs be refined following additional design development to produce cost opinions that are suitable for advanced planning and for use in fundraising. Costs include construction only and do not cover design, permitting, oversight, or costs associated with easements or land purchases. The construction cost of Alternative 3 is estimated to be $755,160. The costs are tabulated and itemized in the attached table.

The cost opinion was developed based on review of construction costs for similar items in past projects and applicable reference cost data. The actual implemented cost may vary from this

estimate, based on market factors, detailed design development and possible optimization, and other factors.

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

- The approach to sediment management will be primarily proactive with excavation and offsite disposal of much of the fine sediment stored in the reservoir and channels. Passive release of sediment stored along South Peacham Brook upstream of the newly realigned reach will be acceptable;
- Material excavated from the realignment of South Peacham Brook and floodplain restoration activities can be reused on site; and
- Bioengineered bank construction will only be required at key locations along the realigned South Peacham Brook. In other locations where less management of geomorphic response is necessary, the newly excavated banks will remain untreated and will be allowed to adjust.

A contingency of 10% was applied to the construction costs to account for uncertainty 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. The sediment management approach at the site will be refined in a future design phase.

Alternative 3 - Preferred option						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Initialization						
1	Mobilization	1	LS	$ 62,410	$ 62,410	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 50,000	$ 50,000	Water control at multiple locations
3	Temporary Access Roads	1	LS	$ 25,000	$ 25,000	Includes any stabilization necessary along existing access to dam, access onto floodplain, temporary crossings
Riffle structure at lake outlet						
4	Excavation and offsite disposal of impounded sediment	2,400	CY	$ 20	$ 48,000	Excavation and disposal of impounded sediment in outlet channel; excavation of low-lying floodplain to extend structure laterally to tie into high ground
5	Rock	2,590	TON	$ 50	$ 129,500	Includes provision and placement; assumes impounded sediment near lake outlet and beneath new riffle structure remains in place; riffle is 2 feet thick and ties into DOR at downstream toe
Grade control downstream of bridge						
6	Rock	160	TON	$ 50	$ 8,000	Includes provision and placement; assumes 50% augmentation over 100 feet; 25 foot wide channel based on cross section nearest to bridge; assumes excess material reused elsewhere in project
7	Bank construction	200	LF	$ 120	$ 24,000	Bioengineered bank construction; includes planting
Dam removal and shift channel alignment						
8	Demolition and disposal	1	LS	$ 25,000	$ 25,000	
9	Earthwork	120	CY	$ 20	$ 2,400	Placement of fill to construct left bank and regrading of material in channel downstream of dam
10	Bank treatment and planting	100	LF	$ 120	$ 12,000	Bioengineered bank construction; includes planting
Channel and floodplain restoration						
11	Excavation and offsite disposal of impounded sediment	1,700	CY	$ 20	$ 34,000	Excavation and disposal of impounded sediment in reservoir only; realignment precludes excavation from South Peacham Brook
12	Realign South Peacham Brook	880	CY	$ 20	$ 17,600	Assumes new aligned section is 475 feet long, 25 feet wide, and 2 feet deep; material can be used to fill former alignment
13	Bank construction at key locations	500	LF	$ 120	$ 60,000	Bioengineered bank construction; includes planting
14	Floodplain restoration	5,930	CY	$ 20	$ 118,600	Excavation and reuse on site; assumes area approximately 400 feet by 200 feet and 2 feet deep
15	Invasives control	2	AC	$ 5,000	$ 10,000	
16	Revegetation	2	AC	$ 5,000	$ 10,000	
17	Large wood	100	EA	$ 500	$ 50,000	
				Construction Subtotal	$ 686,510	
				10% Contingency	$ 68,650	
				Project Contruction Total	**$ 755,160**	