January 14, 2016

From: ad hoc Fawn Lake Committee

To: Board Selectmen

Subject: Fawn Lake Restoration Evaluation Summary

In the spring of 2015 the Town of Bedford formed an ad hoc Fawn Lake Committee to discuss the long term use of Fawn Lake and evaluate options for restoration. The meetings have included representatives from the Conservation Commission, Department of Public Works, Board Selectmen, Historic Preservation, Bedford residents appointed to the Committee, interested Bedford residents, local press, and consultants with lake restoration and dredging experience. The Committee has met monthly since April 2015.

Previous evaluations of Fawn Lake by the Town and its consultants have identified the following issues:

- Increased floating and submerged vegetation,
- Fish kills,
- Canoe and kayak access,
- Invasive species,
- Reduced lake depth,
- Soft sediment accumulation, and
- Lake converting to swamp-like conditions.

The following figures illustrate the existing conditions of Fawn Lake:

- Figure 1 is an aerial photograph of the existing conditions in the summer,
- Figure 2 illustrates the depth of water in the lake (bathymetry), and
- Figure 3 illustrates the depth of soft sediment that has accumulated at the bottom of the lake.

The Committee identified the following values and benefits Fawn Lake provides the Town:

- Conservation/Open Space – largest water body in Bedford
- Recreation – multiple generational and seasonal use
- Environmental Diversity
- Education – example of a unique and diverse ecosystem
- Historical Authenticity

The Committee discussed the “Do Nothing” option including dam removal, and identified the following effects:

- Loss of most recreational uses, open water ecosystem, and visual beauty,
- Nuissance odors and increased mosquito population because of shallow stagnant environment, and

- Lake transitions to a swamp.

The Committee recommends Fawn Lake be maintained and improved because of its significant value to the Town of Bedford. A primary goal of the Committee was to identify a conceptual restoration plan to obtain Town approval for appropriating funds to design, permit, and implement restoration of Fawn Lake. The Committee established the following pair-wise ranking evaluation criteria to identify restoration goals and evaluate restoration options:

1. Longevity of Treatment
2. Environmental Impacts/Effectiveness
3. Recreational Use and Enjoyment
4. Overall Project Cost/Future Operation and Maintenance
5. Logistics

Pair wise ranking is frequently used by communities to help prioritize goals because of its ability to help analyze the problem and not be overshadowed by a few distracting opinions. For example when Longevity of Treatment and Neighborhood impacts were paired longevity was more important because neighborhood impacts are a short term concern which can be managed effectively. Table 1 is summary of the pair-wise ranking results.

The Committee evaluated the following restoration options to restore lake depth and control aquatic vegetation:

- Hydro-raking,
- Hydraulic wet dredging,
- Mechanical wet dredging,
- Mechanical dry excavation,
- Aeration and circulation,
- Sub-aqueous vegetation barriers,
- Herbicide use,
- Water level increase/decrease, and
- Combinations of the aforementioned.

The Committee incorporated the effectiveness of maintenance methods already implemented at Fawn Lake such as herbicide use and hydro-raking into the evaluation process. It also reviewed examples of other lake restoration projects conducted in the Northeast. Figure 4 illustrates some examples of restoration options. A restoration option cost comparison is summarized in Table 2.

The Committee evaluated each restoration option in relation to the priorities as listed in the aforementioned evaluation criteria. The Fawn Lake Preservation Study (CEI, 2015) was used as a basis for ranking the restoration options. The ranking is a quantitative evaluation of the criteria established by the Committee, restoration option efficacy, and costs from the preservation study. The weighted average ranking was determined and verified by environmental consultants experience to arrive at the recommended lake restoration approach. Table 3 summarizes the weighted ranking results.

The Committee identified the following elements for restoration plan design:

- Return approximately 60% of the lake to its original depth,
- Maintain remaining 40% of the lake as shallow cove and shoreline areas for ecological diversity,
- Implement restoration without draining the lake,
- Incorporate dam replacement into the overall permitting effort as the dam is in “poor” condition according to a state Dam Safety evaluation,
- Treat storm water influent to the lake,
- Maintain and encourage native plant and animal species,
- Incorporate historic elements into the landscape/hardscape restoration,
- Preserve and enhance recreational access for boating, fishing, and skating,
- Avoid the use of current and future herbicides because of the uncertain long term effects of their use, and
- Prevent fish kills from depleted oxygen conditions.

The Committee recommends the following restoration plan be considered for funding by the Town:

- Utilize wet dredging using hydraulic methods to the original depth of the lake. Removal of soft sediment only,
- Dredge approximately 60% of the northerly section of the lake,
- Preserve existing conditions in the southwest section of the lake to maintain ecological diversity,
- Provide storm water influent treatment,
- Replace dam where a new outlet control structure can vary the lake water level for increasing overall lake depth, if appropriate, and conducting maintenance activities, and
- Evaluate specific additional measures, such as circulation, to enhance the efficacy of the restoration plan.
- Figure 5 illustrates an aerial perspective of design elements for the recommended restoration option.

The recommended restoration plan was selected because it addresses all of the goals established and is the most efficient long term restoration option evaluated by the Committee. Dredging specific areas of the lake retains ecological diversity, has significantly less initial capital cost than dredging the entire lake, removes unwanted vegetation, preserves historic and natural beauty, restores recreational use, eliminates eutrophication, and lessens impact to existing fauna.

Hydraulic dredging provides greater long term value over hydro-raking and significantly less initial capital cost than mechanical dry excavation. Dry excavation is significantly more expensive than hydraulic dredging because in order to maintain water levels in sensitive areas cofferdams or portable dams would be required to hold back the water. Hydro-raking has been used at Fawn Lake and the results were not acceptable.

Herbicides have been used and the Committee is concerned about the unknown long term effects of current and future herbicide use. Water level drawdown would adversely affect shallow habitats.

Aeration, circulation, and submerged vegetation barriers were not considered to be long term standalone options. These, however, could be retained in the design process for evaluation as long term maintenance enhancements. Combinations of available techniques should be considered in the design process that might complement hydraulic dredging.

The Committee recommends that dam replacement be included in the permitting process to avoid duplication of environmental permitting costs.

The recommended restoration plan is not overly detailed in scope so that additional items might be addressed in the design and permitting process, such as, installing land features to acknowledge the historical significance of the Bedford Springs area and considering innovative approaches to manage dredge spoils.

Attachments:

Tables:

1. Lake Management Pair-Wise Ranking Summary
2. Restoration Option Cost Comparison
3. Restoration Option Weighted Ranking Summary

Figures:

1. Existing Conditions
2. Bathymetry
3. Soft Sediment Depth
4. Restoration Options
5. Restoration Plan Design

TABLE 1 - Lake Management Pair-Wise Ranking Summary

RANK	SCORE		Environmental Impacts (positive or negative)	Effectiveness removing/reducing unwanted vegetation	Logistics (including de-watering, staging, sediment disposal)	Recreational Use and Enjoyment	Neighborhood Impacts	Future Operations and Maintenace Requirements	Time to permit and complete project	Longevity of Treatment	Overall Project Cost
2	6	Environmental Impacts (positive or negative)				50-50				50-50	
2	6	Effectiveness removing/reducing unwanted vegetation									
6	1	Logistics (including de-watering, staging, sediment disposal)									
3	5.5	Recreational Use and Enjoyment									
5	2	Neighborhood impacts									
4	4	Future Operations and Maintenace Requirements									
7	0	Time to Permit and Complete Project									
1	7.5	Longevity of Treatment									
4	4	Overall Project Cost									

TABLE 2 - Restoration Option Cost Comparison

FAWN LAKE RESTORATION COST ANALYSIS					
Method	Average Initial Cost	Permitting	Total	NPV 20 Year Cost	NPV 50 Year Cost
Dredging					
Mechanical Dry Dredging	$ 912,000	$ 100,000	$ 1,012,000	$ 982,524	$ 982,524
Mechanical Wet Dredging	$ 960,000	$ 100,000	$ 1,060,000	$ 1,029,126	$ 1,029,126
Hydraulic Dredging	$ 888,000	$ 100,000	$ 988,000	$ 959,223	$ 959,223
Chemical Treatments					
Diquat (Reward)	$ 6,500	$ 5,000	$ 11,500	$ 98,097	$ 200,251
Glyphosate (Rodeo)	$ 8,625	$ 5,000	$ 13,625	$ 116,224	$ 237,254
Fluridone (Sonar)	$ 14,625	$ 5,000	$ 19,625	$ 167,405	$ 341,733
Hydroraking	$ 140,000	$ 7,500	$ 147,500	$ 641,159	$ 1,295,367
Combination of Hydroraking and Diquat			$ 159,000	$ 728,173	$ 1,471,167
Weed/Mechnical harvesting	$ 10,638	$ 7,500	$ 18,138	$ 158,259	$ 273,700
Aeration/Artificial Circulation - Set Up	$ 18,400	$ 50,000	$ 68,400		
Maintenance	$ 4,888		$ 4,888	$ 72,714	$ 125,754

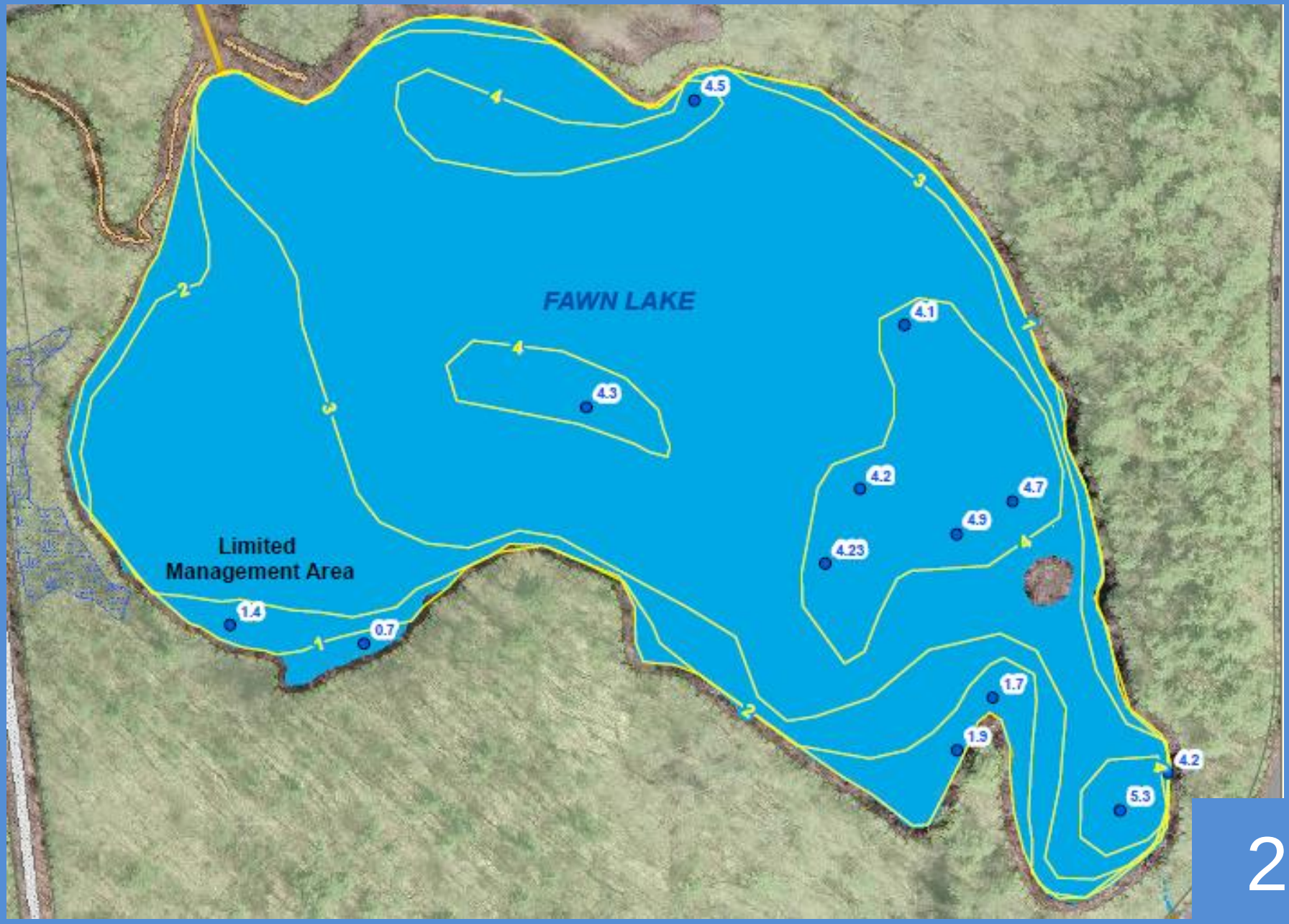
* NPV - Net Present Value calculation used an interest rate of 3%.

TABLE 3 - Restoration Option Weighted Ranking Summary

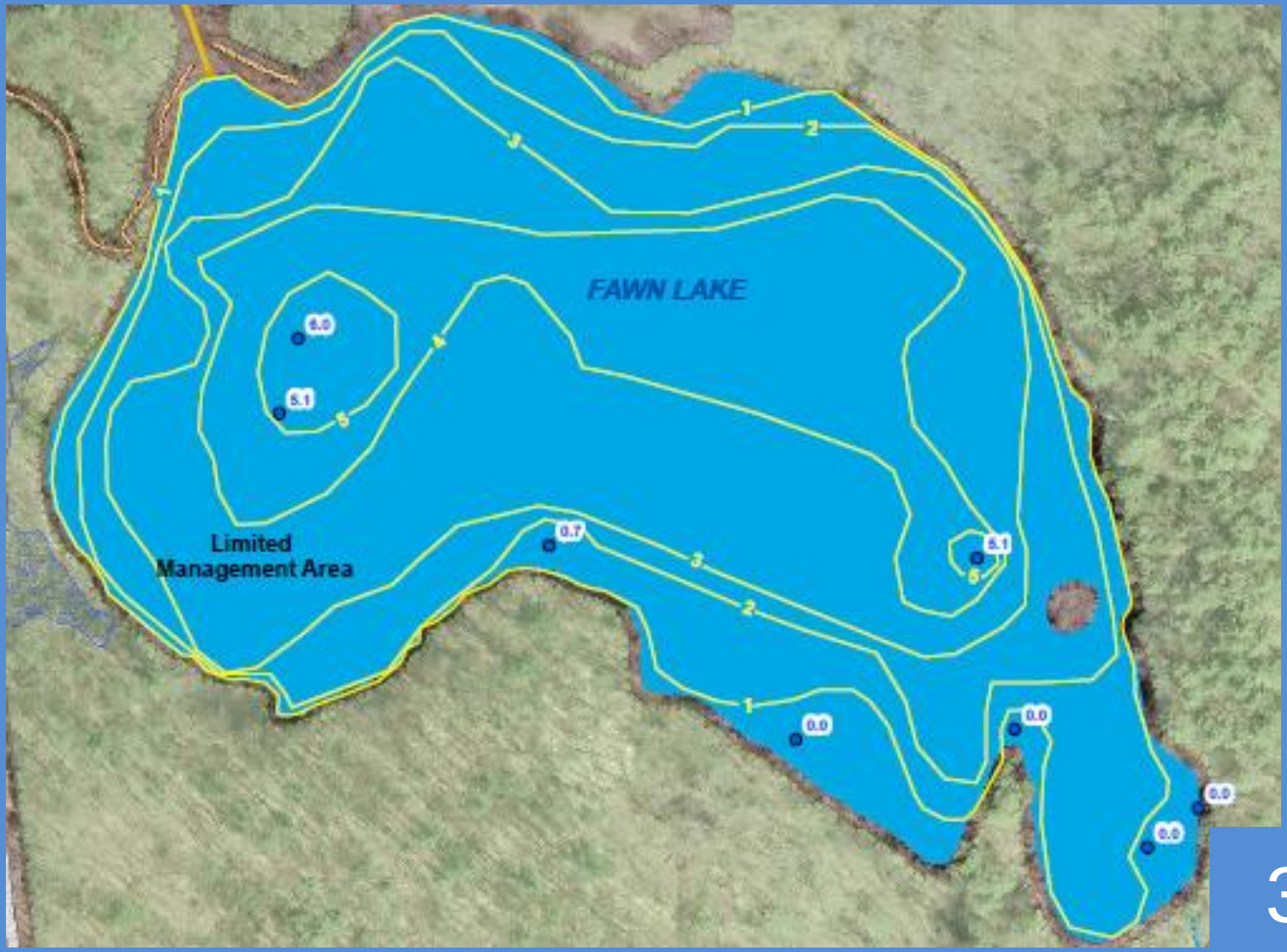
	Measurement of Method against Priority Ranking 1-10 with 10 being excellent								
Method	Longevity of Treatment 20.8%	Environmental Impacts (Positive or negative 16.7%	Effectiveness removing/ reducing unwanted vegetation 16.7%	Recreational Use and Enjoyment 15.3%	Future Operations and Maintenance Requirements 11.1%	Overall Project Cost 11.1%	Neighborhood impacts 5.6%	Logistics (including dewatering, staging, sediment disposal 2.78%	Weighted Average Ranking 1
Dredging									
Mechanical Dry Dredging	10	4	10	6	10	3	3	2	7.0
Mechanical Wet Dredging	10	8	10	9	10	4	3	3	8.3
Hydraulic Dredging	10	8	10	9	10	5	3	3	8.4
Chemical Treatments									
Diquat (Reward)	2	1	2	6	2	10	5	8	3.7
Glyphosate (Rodeo)	2	1	2	6	2	8	5	8	3.4
Fluridone (Sonar)	2	1	2	6	2	7	5	8	3.3
Hydroraking	3	5	3	6	3	3	6	6	4.0
Combination of Hydroraking and Diquat	4	3	3	6	3	2	5	6	3.8
Weed Harvesting/mechnical harvesting	1	5	3	6	3	6	5	5	3.9
Aeration/Artificial Circulation (Add-on)	2	9	1	7	2	9	8	8	5.0

EXISTING CONDITIONS - SUMMER

BATHYMETRY (depth, ft.)



SOFT SEDIMENT DEPTH (ft.)

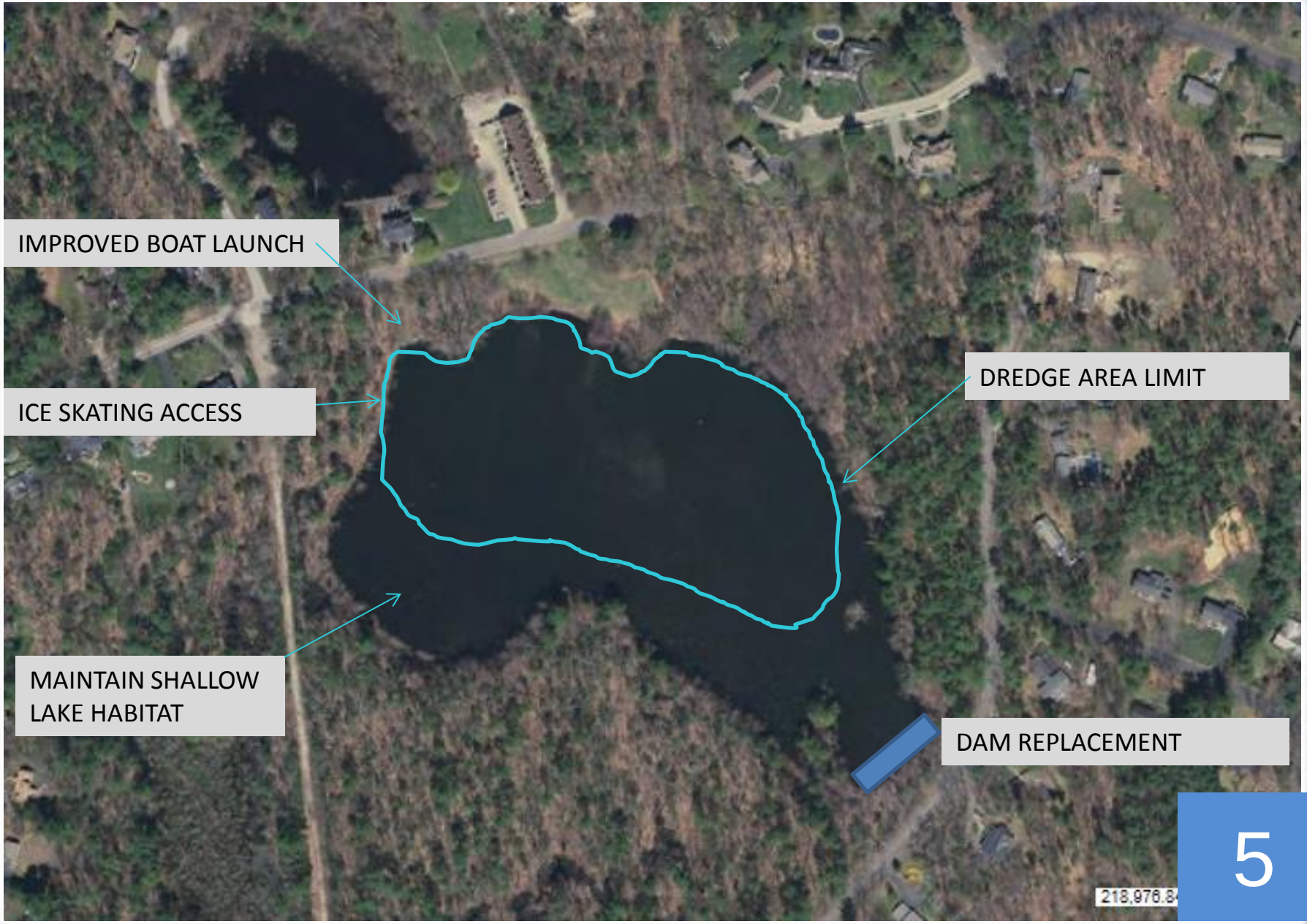


RESTORATION OPTIONS

HYDRO-RAKING

MECHANICAL WET DREDGING

MECHANICAL DRY DREDGING

HYDRAULIC DREDGING

RESTORATION PLAN DESIGN