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Revision 4
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Bare Hill Pond Watershed Committee

Re: Bare Hill Pond Chronology of Activities

There does not appear to be a document that provides a "time-line" of various activities over the past years, including activities to control weeds in Bare Hill Pond; this time-base is, therefore, the objective of the attached document.

The primary sources of information were the Harvard Annual Reports, Nourse's *History of Harvard*, interviews with various Harvard senior citizens, in particular, Charlie Rice and Charlie Perkins and others.

"Editorial" comments are those of the author.

Regards,

H. G. Marsh

Attachment (the "Chronology of Activities," early 1800s to 2000)

BARE HILL POND
Chronology of Activities
Early 1800s to 2002

Early 1800s

- First dam constructed (for downstream water power) (Nourse)

1837

- Dam rebuilt, and level raised about 6 feet (Nourse)

Mid-1930s (approximately)

- Dam modified to current configuration
- Earthen dam with concrete gate; 2 courses of removable wooden planks used for water-level control
- Top of dam elevation, 100 feet; legal water level, 98.33 feet; bottom of dam elevation, 90.5 feet; maximum drawdown, 7.88 feet

1956-58

- Weed problem had become acute

1959 (Bare Hill Pond Committee)

- Bare Hill Pond Committee (12 members) appointed by Selectmen; Paul von Loesecke, Chairman
- No Town or State funding available for weed control
- Goal of \$10,000 set (70% from abutters and 30% from other sources) for 5-year herbicide program to start in 1960

1960 (Bare Hill Pond Committee)

- Bare Hill Pond Committee kick-off, open Town meeting
- Funds of \$7,000-10,000 raised for a 5-year herbicide program
- Purchased a small weed cutter
- Herbicides applied to all areas of the pond. Silvex herbicide used. Results reported to be "very satisfactory" and pond clear of weeds. No health problems reported.

1960s

- Water level lowered to about 5.5 feet for blasting of rocks in pond. This appears to have been the only very low drawdown ever conducted with the current dam and was performed prior to Still River Road culvert replacement

1961 (Bare Hill Pond Committee)

- Spot treatment of areas using Silvex, effective on weeds
- No health problems reported

1962 (Bare Hill Pond Committee)

- Spot treatment of areas using Silvex, effective on weeds
- No health problems reported

1963 (Bare Hill Pond Committee)

- Spot treatment of areas using Silvex, effective on weeds
- No health problems reported

1964 (Bare Hill Pond Committee)

- Spot treatment of areas using Silvex, effective on weeds
- No health problems reported

1965 (no committee)

- No weed removal activities

1966 (no committee)

- No weed removal activities

1967 (no committee)

- No weed removal activities

1968 (no committee)

- Town beach constructed
- No weed removal activities

1969 (no committee)

- Pond patrol started

- No weed removal activities

1970 (no committee)

- State-provided access to the pond, off Tahanto Trail, but not ever developed
- \$100 for pond patrol
- No weed removal activities

Early 1970s (date approximate due to unavailability of records)

- Square culverts under Still River Road and Underpin Hill Road replaced with 5-foot diameter round culverts; elevations of bottoms of new culverts raised approximately 3-4 feet over the bottoms of the replaced culverts, thus creating a maximum drawdown level of 43 inches from normal.

1971 (no committee)

- No weed removal activities
- \$100 appropriated for pond patrol
- Weed coverage had again become acute due to the lack of weed removal activities during the prior years

1972 (Bare Hill Pond Study Committee)

- Established as subcommittee of the Conservation Commission; mission, to study various methods to control weed growth
- \$5,000.00 grant received from Ford Foundation and used for planning
- Bare Hill Pond Study Committee conducted a 1-day, 10-29-72, trial of a mechanical weed harvester using a harvester belonging to the Bare Hill Pond Association; 2 small areas harvested, in front of the current beach and in front of the current canoe storage location; considered not to be successful due to only a 55% rate of effectiveness

1973 (Bare Hill Pond Study Committee)

- Bare Hill Pond Study Committee recommended chemical treatment (herbicide) program, started in 1973
- Mass. Department of Environmental Management gave partial treatment
- Chemical (possibly Kuron and Aquathol) treatment probably conducted, although records not available

1974 (Bare Hill Pond Study Committee)

- Herbicide treatment program funded by State Board of Health; used Kuron (0.5 ppm) and Aquathol (0.5 ppm)
- Study Committee recommendation that herbicides be the primary method to control weeds
- Pond weeds started to be "under control"

1975 (Bare Hill Pond Study Committee)

- No weed eradication efforts, either chemical or mechanical
- Boston University consultant employed as consultant to committee
- Water quality survey conducted by Mass. Division of Water Pollution

1976 (Bare Hill Pond Study Committee)

- Bare Hill Pond Study Committee continued to study the problems
- Algae was noticed and was of concern to the committee
- No weed eradication efforts conducted; heavy weed infestation

1977 (Bare Hill Pond Study Committee)

- Area between the dam and 4-Acre Island received 30 gallons of Aquathol (1 ppm) on 6-10-77 and 7-19-77, effective on variable milfoil, by Lycott Environmental Research
- South Bay area received 50 gallons of Silver Kuron (2-(2,4,5) Trichlorophenoxy) Propionic Acid) Propylene Glycol on 6-10-77 by Lycott Environmental Research
- Results surveyed in July. Aquathol in area near 4-Acre Island showed no variable milfoil eradication
- Kuron (0.3 ppm) in South Bay area very effective on all weeds, except bladder wort and smart weed
- Water monitoring contract with Boston University consultant terminated
- Harvester, owned by the Bare Hill Pond Association, was reconditioned and leased by the Committee for an experiment in the Minister's Island area; result not satisfactory due to the low power of the harvester

1978 (Bare Hill Pond Study Committee)

- Starting in late autumn, 4-foot drawdown conducted; refill started in late December
- Area between 4-Acre Island and shoreline, 2 herbicide treatments 6-20-78 and 7-31-78 of Silvex (2,4,5 Trichlorophenoxy) Propionic Acid 4#/gal.; total, 2.6 gals.; the results: Variable milfoil killed 100%, but smart weed not affected, by mid-July

- Area in south bay, west side, 2 herbicide treatments 6-20-78 and 7-31-78 of 2,4 Dichlorophenoxy Acetic Butoxyethanol Ester (Aqua Kleen), granular, 200 184#/acre each treatment; the results, variable milfoil and water lilies killed but smart weed not affected
- Two small areas, Clinton and Lancaster Shores, received 1 herbicide treatment 6-20-78 of Silvex (2,4,5-TP); the results, variable milfoil and water lilies killed
- Area west of Minister's Island, 2 herbicide treatments 7-31-78 and 9-6-78 of 2,4-D, granular, 200#/acre; the results, variable milfoil, white water lilies and water shield killed; bladder wort and yellow water lilies not affected
- Total cost of treating all 4 areas: \$3,141.00

1979 (Bare Hill Pond Study Committee)

- "Shapiro report" to analyze and summarize all weed and water chemistry data on the pond started
- 1978-79 drawdown (completed Feb. 11) quite successful, despite a 4-foot exposure and mild winter weather
- 2 high school students employed to pull weeds for 6 weeks
- Aquatic Control Technology used Aquamarine Chub to evaluate mechanical harvesting; the results, good on variable milfoil, but less so on smart weed
- Reduced weed coverage during year, perhaps due to 1977-78 drawdown
- Beach closed 2 times due to suspected E. Coli bacteria, an indicator of pollution; tests indicated bacteria to be Aeromonas Hydrophica, a harmless naturally occurring organism
- No herbicides used during year
- Extensive testing of temperature, transparency, dissolved oxygen, total phosphorous conducted; no indication of adverse trends in 1979
- Bliss-Hoffman report over period 1972-74 delivered

1980 (Bare Hill Pond Study Committee)

- No lasting favorable results from the 1978-79 drawdowns, with the weed condition the same as pre-drawdowns. Conclusion: Drawdown effects limited to 1 year.
- A "York" rake was demonstrated and was very effective against smart weed.
- \$5,000 appropriation to the Bare Hill Pond weed control fund

- Aquatic Control Technology conducted a 1-day trial of Aquamarine Chub in the 4-Acre Island, channel and town beach areas; not successful against the targeted weed, smart weed; successful against variable milfoil, but, within 30 days, it had reappeared.
- Testing of water quality continued, with no adverse trends detected
- 2,4-D, at very low dosage (about 2 ppm), used in about 40 acres in the Minister's Island, channel, southwest cove, Thurston Beach and Camp Green Eyrie areas applied by Allied Biological Control Corp. The results: 100% of variable milfoil and water lilies killed, no effect upon smart weed and no adverse effect upon fish or reptiles. No health problems reported.

1981 (Bare Hill Pond Study Committee)

- 1980 2,4-D herbicide-treated areas in southwest cove and Minister's Island areas clear of weeds during the early part of the second year after application
- York rake used in swimming areas (cost of \$2,000)
- Aquamarine Chub mechanical harvesting effort around 4-Acre Island in 1980 had no "lay over" effect in 1981
- 1980 manual pulling efforts in the swimming and boat launching areas had no "lay over" effect
- By late 7/81, variable milfoil around Minister's Island and southwest cove had recovered, despite of, or perhaps because of, a very low application of 2,4-D in 1980
- In July, 10 acres behind 4-Acre Island had 2,4-D granular at a low dosage applied; the results, very effective on variable milfoil
- Shapiro report received

1982 (Bare Hill Pond Study Committee)

- 2,4-D granular applied to about 35 acres in the southwest cove; 4 acres treated with Aquathol-K for pond weed; heavy rainfall decreased effectiveness
- 4-Acre Island, treated with 2,4-D in 1981, still clear of variable milfoil
- Areas in Minister's Island and south cove, not treated in 1981, covered with milfoil

1983 (Bare Hill Pond Study Committee)

- New harvester (Aquamarine) ordered
- Hydro-rake effort (cost of \$2,000) with Aquatic Control Technology in area of Town beach
- 3/83 Town Meeting resulted in moratorium (Article 16; 238 votes yes; 124 votes, no) restricting the future use of herbicides, eliminated a very promising integrated (herbicide,

harvester and drawdown) plan developed by the Pond Committee. The moratorium included instructions to the Pond Study Committee to continue to study the use of herbicides.

- Town leased Aquamarine harvester (from July 5 to Sept. 1); harvested about 200 tons (loads) of weeds from over 100 acres; 2 shifts in operation

1984 (Bare Hill Pond Study Committee)

- New (current) harvester delivered, 2 weeks late; 387 tons (loads) harvested
- 2nd weed offloading area belonging to an abutter used as a harvester dumping area at the south end of the pond
- Aquascreen installed in 8,400 square feet in swimming area at Town beach, very successful as weed control mechanism
- "Pondgram" newsletter to Town started (no copies available in archives)
- \$5,000 appropriated at Town meeting for study of Bare Hill Pond (Whitman-Howard study)
- Battelle Research conducted test for dioxin

1985 (Bare Hill Pond Study Committee)

- Harvesting started 6-14-85; logged 200 hours; removed 690 tons (loads?) of weeds
- More Aquascreen added to Town beach. Silt had started to accumulate on screen installed in 1984. The need for cleaning was recognized. (Note: Cleaning of silt was not ever performed, and currently (1999) the weeds in the screens in the swimming area cause serious problems.)
- Dioxin testing of fish indicated no detectable traces (cost of \$5,100) by Battelle, Duxbury, MA
- Whitman-Howard Study continued

1986 (Bare Hill Pond Study Committee)

- Harvesting started in early 6/86; logged 469 hours; removed 385 tons (loads)
- Whitman-Howard study delivered

1987 (Bare Hill Pond Watershed Management Committee)

- Bare Hill Pond Watershed Management Committee formed (7 members), reporting to Selectmen, replaced Bare Hill Pond Study Committee
- Harvesting started in early 6/87; logged 485 hours; removed 250 tons
- Warrant article for herbicide treatment withdrawn at Town meeting

- Whitman-Howard diagnostic/feasibility report delivered

1988 (Bare Hill Pond Watershed Management Committee)

- Harvesting started in early 6/88; logged 415 hours; removed 127 loads (loads); channel lanes for boating, swimming and access to home fronts kept free of weeds
- Clean Lakes program not funded by state
- Drawdown started in 10/88

1989 (Bare Hill Pond Watershed Management Committee)

- Drawdown refill started in 3/89
- Good climatic conditions during the weed contributed to the good results in the areas exposed in the 43-inch drawdown
- Some harvesting activities, but no data on amounts harvested available

1990 (Bare Hill Pond Watershed Management Committee)

- Some harvesting activities, but no data on amounts harvested available
- Weeds had again becoming a problem

1991 (Bare Hill Pond Watershed Management Committee)

- No funding available and, therefore, no harvesting activities
- Harvester mothballed and transferred from Bare Hill Pond Watershed Committee to Highway Department
- Bare Hill Pond Watershed Management Committee joined Mass Water Watch Partnership

1992 (Bare Hill Pond Watershed Management Committee)

- No annual report by committee
- No harvesting activities due to lack of funding
- Weed situation very serious
- Committee effort at a low ebb (understandably, in view of lack of support from the town)

1993 (Bare Hill Pond Watershed Management Committee)

- All new Bare Hill Pond Watershed Management Committee membership (except for student member)

- After 3 years' idleness, harvester resurrected
- Funding from private parties, a corporation and the Conservation Commission, used to put harvester back into limited operation
- Harvester operated for a total of 5½ weeks (the starter for the motor the only problem)
- Weed chestnut pull conducted by volunteers

1994 (Bare Hill Pond Watershed Management Committee)

- Water chemistry testing was performed by Mark Hastings. Tests were for temperature, dissolved oxygen, turbidity, pH, acidity and Secchi disk measurements.
- Mark Hastings appointed Chairman of Bare Hill Pond Watershed Management Committee
- Water chestnut pull conducted on 4 occasions
- Harvester in operation by Highway Department, under the operational direction of the Bare Hill Pond Watershed Management Committee
- No funds from Town, other than for the harvester

1995 (Bare Hill Pond Watershed Management Committee)

- 4 Water chestnut pulls; however, area of weeds increased from about 7,000 square feet to an estimated 49,000 square feet
- Weed harvester in limited operation, but decreased volume as compared to 1994, despite increased weed coverage in pond. No indication as to why the decreased volume.

1996 (Bare Hill Pond Watershed Management Committee)

- No Town report on committee activities
- Harvester in operation (with reduced output); variable milfoil greatly increased in Clapps Brook/Minister's Island area
- 4 Water chestnut pulls conducted by volunteers

1997 (Bare Hill Pond Watershed Management Committee)

- Total coliform testing by Board of Health, Thurston Brook, very high
- No Town funding requested
- Harvester in very limited operation, but essentially not effective; weeds in pond very heavy in all areas less than 8-feet deep

1998 (Bare Hill Pond Watershed Management Committee)

- In early 1998, the committee, with a suite of new, aggressive members, and recognizing the deteriorating condition of the pond, undertook an expanded recovery program for the pond.
- \$30,000 for harvester restoration appropriated by Town; harvester totally reconditioned
- 204.75 hours of harvesting in southwest cove, town beach and boat park; 198 loads harvested; 35% down time due to harvester maintenance
- Most harvesting effort conducted in south bay in an effort to evaluate multiple harvesting passes; the results: repeated passes not effective due to rapid weed re-growth (approximately 1 inch per 1-2 days) experienced
- The results of this year's harvester efforts, as well as previous year's activities, leads one to conclude that mechanical harvesting (1) has no year-to-year lasting carry-over effect; (2) even with the current year, harvested areas recover as quickly as to be not detectable at the end of the season; and (3) only weeds in a depth of 4 feet or less are affected since the harvester has a depth capability of only 4 feet
- A detailed review of the harvester activities during 1998 indicated the major changes in all areas of harvesting (maintenance of harvester, philosophy, etc.) would be necessary in 1999.
- 4 Water chestnut pulls; while the weeds were not eliminated, the growth was under control and confined to only the Clapps Brook inlet
- Drawdown started 11-1-98; reached maximum depth of 43 inches 12-17-98
- \$12,000.00 appropriated for contract with ENSR, Westborough, MA, to conduct a study of weed mapping and water chemistry; report delivered in 12/98

1999

- Started pond refill March 1 and completed approximately May 15, somewhat later than expected (due to the lack of rain in April and May)
- By approximately June 15, the effects of the drawdown were observed as follows:
 - Water Lily growth has been reduced by 95 percent or more over the entire Pond
 - Smart weed areas (Bowers' Brook inlet) have been reduced from about 8 acres to 1 acre
 - The water chestnut infestation in upper Clapps' Brook had not been affected at all
 - Variable milfoil beyond the 4-foot level was not affected
 - Variable milfoil out to a depth of 4 feet has been considerably reduced in growth, probably due to heavy infection of "attached" algae
 - "Good weeds" not affected

- By late summer, however, all variable milfoil at any depth had been destroyed. Dead weeds were covered with a slimy growth identified as "attached algae." This seems to coincide with a severe drought during the summer that had the effect of eliminating water flow in all of the water inlet tributaries to the Pond and lowering the Pond water level to 18 inches below normal. The "attached algae" probably resulted from (1) no protection from sunlight (filtering), (2) high water temperatures and (3) no "flow thru" of water in the Pond and, thus, no "washing" action on weeds.
- Harvester used only on a limited basis due to the lack of weeds. An estimated 50 loads were harvested. Little down time due to maintenance. Smart weed areas at Bowers Brook harvested.
- Recreational boat use had increased 4 or 5-fold over previous years
- Unfortunately, the weeds still remain, despite the algae attached, and will be present in 2000

40-Year Summary of Bare Hill Pond Activities

With 1999, some 40 years have elapsed since the initiation of efforts to monitor and control the weed life and water chemistry of Bare Hill Pond. These 40 years have provided considerable insight, the high points of which are summarized below:

A. Management Considerations

1. Committees. Three different committees have been involved during this period. Initially a private committee, secondly, a subcommittee of the Conservation Commission and, finally, a committee reporting to the Selectmen.
2. Herbicide treatments. Three different committees had recommended the use of herbicides, and the use was very effective. A moratorium by the Town on the use of herbicides stopped the most useful weed technique in 1983.
3. Funding. The critical funding situation in the mid-1980s closed down all weed control activities for a 2-3 year period.

The effect of the above "start and stop" management of Bare Hill Pond prevented maximum effectiveness and, by 1998, this inactivity was reflected in the widespread presence of weeds. It is clear from the above that weed control requires continuous activity on an annual basis.

B. Water Quality Chemistry

Over the 40-year period of time, water chemistry testing has been performed by both professional consultants and volunteer lay persons. Testing was performed for water clarity, total phosphorous, alkalinity, pH, chlorophyll and dissolved oxygen. With the exception of total phosphorous, these indicators all are within acceptable limits and have shown no disturbing trends. In the 1970s, the total phosphorous indicator was approximately 0.02 mgP/L. By mid-1998, the total phosphorous had increased to 0.05 mgP/L. This increase in all probability, reflected the increased building construction occurring in the watershed during this period.

C. Weed Control

The 1998 consultant showed that the weed situation was the most serious of any recorded time. Essentially all of the pond area with less than a 7 to 8 foot depth (about 1/3 of the pond) had the majority of the water column occupied by weeds. Moreover, a new weed, fan wort, was located in 2 separate areas of Bare Hill Pond.

The various weed control mechanisms employed during the 40 years included manual weed pulling and mechanical harvesting, water level drawdown and the use of herbicides.

1. **MECHANICAL HARVESTING.** In the mid-1980s the Town purchased its own mechanical harvester. With the exception of 2 years when funding prevented it, the harvester has been operated for approximately 3 months each year, with mixed results. It has become evident that the harvester alone can only control in a limited way a small portion of the pond. This is due to the very rapid summer growth of the weed population, especially the primary offender, variable milfoil. The 4-foot cutter depth, and the very slow speed of the harvester, limit the usefulness of the harvester. It has also become evident that mechanical harvesting effects do not carry over into the next year. In fact, they do not carry through the entire summer.
2. **DRAWDOWNS.** Four drawdowns occurred during the latter half of this period. Unfortunately, although the dam permits the water level to be lowered by 8 feet, downstream culvert obstructions limit the actual drawdown to slightly less than 4 feet. It has been found that severe winters produce very significant perturbations to the weed population located within approximately a 4-foot depth. Weeds in deeper water are not affected. It also appears that even mild winters have sufficient impact in the less than 4-foot level to make periodic drawdowns effective, considering the low cost involved.
3. **HERBICIDES.** Herbicides were used on multi-year occasions over 3 different periods during the first half of the 40-year period. Various chemicals available at the time were used. Repeated use of 2,4-D (granular) indicated that this herbicide was extremely effective against all weed population, except for smart weed. No medical problems were reported in Bare Hill Pond. Subsequent to 1983, herbicides have not been utilized, with a resulting increase in weed population.
4. **MANUAL.** Volunteers and employed summer help was used to control the water chestnut weeds.

Conclusion as of 1999

It has become apparent that an integrated weed control program involving manual and mechanical harvesting, drawdowns and herbicides is required for weed control in Bare Hill Pond. Even then, this will not eliminate the weeds and, instead, will require a continuing annual 3-phase program.

Update 2000

- An attempt to utilize a very mild herbicide weed treatment was defeated by a small amount at the town meeting
- A second drawdown of 43 inches was performed in 1999-2000
- Results, as of late July, 2000, indicate an exact duplicate of the summer of 1999, i.e., reduced milfoil, followed by attached algae
- Harvesting in the spring of 1999 virtually eliminated smart weed
- Harvester used for first time to harvest water chestnuts in Clapps Brook. Harvesting occurred prior to July, 2000, so as to avoid the spreading of water chestnuts outside the Clapps Brook

area. Approximately 90% of water chestnuts in Clapps Brook removed by the harvesting. The year 2001 will see the results of this effort.

- Harvester not used elsewhere in the pond due to concerns about the spread of fan wart and milfoil

2001

- Ross Engineering estimated \$250,000 to \$300,000 for an 8-foot drawdown. Later, they raised their estimate to \$500,000, the amount currently being used in pond committee planning.
- Used harvester to harvest water chestnuts in Clapp's Brook – great success! It is obvious that repeated usage of the harvester, together with manual pulling of water chestnuts around the entire edge by paid crew (not volunteers) can eliminate (not just reduce) water chestnuts.
- Harvester used for keeping pathways to abutters free of milfoil. Many problems with breakdowns (11 days during the season). The current arrangement of using the Highway Dept. simply is not satisfactory.
- Started 43-inch drawdown on 15 October, 2001.

2002

- Stopped refill 20 February 2002, but pond not filled until end of May
- Drawdown comments
 - Little or no rainfall between October 2001 and May 2002 made it very difficult to refill the pond. It was not entirely clear until the heavy rainfall in May 2002 that the pond would, indeed, be refilled. It is estimated that, under similar low rainfall conditions, the pond would not be refilled until July, if at all.
 - The temperatures during the winter were abnormally high, not at all favorable to a drawdown.
 - Results: There was absolutely no impact on milfoil, or even water lilies due, of course, to the high winter temperatures.
- New harvester
 - Harvester again used to harvest weeds in the pond. Three years of harvesting has essentially eradicated the weeds in the center of the pond, leaving chestnuts only in the 15-20 feet from the shore edge around the pond. A concentrated effort of about 1,000 man hours of dedicated manual harvesters for about 3 years, in combination with the mechanical harvester, would effectively eliminate the water chestnuts.
 - Harvester used in milfoil. However, breakdowns essentially eliminated any effective use this summer.
- Notice of intent
 - A NOI has been submitted to the Conservation Commission for a 48-inch drawdown for the season 2002-2003 and a future concurrence for a 6-foot drawdown.
- Buoys
 - A system of buoys were installed to identify the water ski circuit in the pond and to provide notice of underwater obstacles