Town of Weymouth, Massachusetts

Whitman's Pond
Comprehensive Investigation, Evaluation, And Hydrological Study

Weymouth, Massachusetts

February 2004

Prepared for:

Town of Weymouth, Massachusetts

Prepared by:

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FIGURES

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APPENDICES

1.0 INTRODUCTION

1.1 Purpose

The purpose of this study was to evaluate sources of pollution; water quality, trophic, and sediment conditions of Whitman's Pond; assess current actions being performed to identify pollutant contributions into the pond; efforts being conducted to eliminate those sources; recommend and conduct immediate remedial actions, if warranted; and provide comprehensive recommendations for future efforts.

The scope of this project was to develop a Watershed Master Plan for Whitman's Pond. Tasks conducted included an intensive evaluation of the water quality and sediment quality of the Pond, including the West Basin and South Basin, evaluating the watershed and drainage system's hydraulic capacity, evaluating drainage system conditions, identifying deficiencies, and prioritizing recommended improvements. Inputs of pollutants and nutrients from the Mill River, the Old Swamp River, unnamed tributaries and storm drain discharges were also investigated. Tasks performed for this project included:

- A review of previous studies, maintenance, and restoration efforts conducted for Whitman's Pond.
- Complete bathymetric survey of the West Cove, South Cove and Main Basin of the Pond to evaluate restoration options.
- Intensive sediment sampling program to evaluate restoration options.
- Intensive storm water system and outfall investigation, including inspections and sampling.
- Intensive catch basin cleaning program.
- Purchase of catch basin labeling stencils for Town.**
- Hydrological study of contributing watersheds and sub-watersheds.
- Coordination and oversight of hydro-raking, weed harvesting, and chemical herbicide treatments in Main Basin and West Cove.**
- GIS base map preparation of the Whitman's Pond watershed.
- Evaluation of macrophytic vegetation.
- Evaluation of fish and wildlife habitat.
- Coordination and oversight of fish testing.**

- Design of new 20' fish gate system to be located in Jackson Square adjacent to the herring run, to prevent herring from entering the drainage system, and cannot survive. Repairs to the gate are scheduled for the spring of 2004. This will result in significant numbers of herring being redirected up the Back River herring run.**

- Recommendations for 5 year Capital Improvement Program for funding.

- Public Participation, including a storm drain stenciling program.

- Public awareness, including two meetings with residents and science classroom field activities (with Bill McEckhern, Weymouth Public Schools – Science Program).**

- Presentation of conclusions and comprehensive recommendations based on new and previous data.

- Additional testing of pollutants within the Old Swamp River at the request of the Town.**

** These tasks were performed outside the original Scope of Services for this project.

During the course of this study, the EPA withdrew its Total Maximum Daily Load (TMDL) Final Rule, which had been passed in July 2000. The TMDL Rule set maximum quantities of pollutants which a water body, if the water body is listed on the federal "303d list", could tolerate without being impaired. The EPA claimed the Rule was "un-workable." It is unclear when (or if) a new TMDL Rule will be developed. Whitman's Pond is not listed on the federal 303d list, so that a TMDL will not be prepared. Due to this fact, tasks associated with TMDL issues, such as calculating flow rates, land use, and wet weather sampling, were replaced with the additional tasks referenced above.

2.0 SITE DESCRIPTION

2.1 Location and Description

The project location is Whitman's Pond, located in central part of Weymouth, Massachusetts. Please refer to the attached USGS Locus Map (Figure 1) for the Site location. Whitman's Pond has a surface area of approximately 210 acres (Department of Environmental Quality Engineering-1981). The Pond has approximately six miles of shoreline. According to the USGS Locus Map (1987 Weymouth, MA Quadrangle), Mill River and Old Swamp River are the two major tributaries that drain into Whitman's Pond. In addition, a small stream drains into the northwest corner of the West Basin. The Whitman's Pond watershed area consists of approximately 13 square miles. Most of the Town of Weymouth is developed, with minimal space for future development. The area around the Main Basin of Whitman's Pond is also nearly totally developed. The watersheds of the West and South Basins have more open space than the Main Basin. A Site Plan of Whitman's Pond is included as Figure 2.

Historically, Whitman's Pond has not always been as large as it is currently. A Town map dated 1830 shows the Main Basin as the entire extent of the pond. The pond in its current shape and extent was formed when a dam was constructed at the northeastern outlet to the Back River. The area currently known as West Cove, in addition to the northwestern portion of the Main Basin, once operated as apple orchards prior to construction of the dam, according to Town personnel. The South Cove was marsh area prior to the construction of the dam. An 1830 map of the Town of Weymouth, illustrating the previous shape of Whitman's Pond, is included as Figure 3.

2.2 Pond Uses

Whitman's Pond is an important resource to the Town of Weymouth and provides a number of benefits. In dry months, the Town of Weymouth uses the South Cove of Whitman's Pond as a secondary source of drinking water. When needed, water is pumped from the South Cove to Great Pond, located approximately 2.5 miles to the southwest of Whitman's Pond. Water from Great Pond is then treated and distributed to residents through the municipal water system.

In addition to providing a secondary source of drinking water, Whitman's Pond is utilized for recreational purposes. Public uses of the pond include fishing, swimming, boating, bird watching, and ice-skating. A public beach is located on the north shore of the Main Basin and is accessible by Lake Street. A boat launch is located on the western shore of the Main Basin and is accessible by Middle Street. Several residential boating and swimming docks are located in the pond as well.

Whitman's Pond is a major spawning ground for *Alosa pseudoharengus*, a species of herring. These fish migrate to Whitman's Pond from Hingham Bay each spring via fish ladders along Weymouth's Back River. It is the second largest herring run on the eastern coast.

During the course of this study, the Town developed a park in the vicinity of the boat launch area on Middle Street. The park includes a gazebo, a fishing pier, parking facilities and handicapped access. The area has dramatically increased the public use of the Pond.

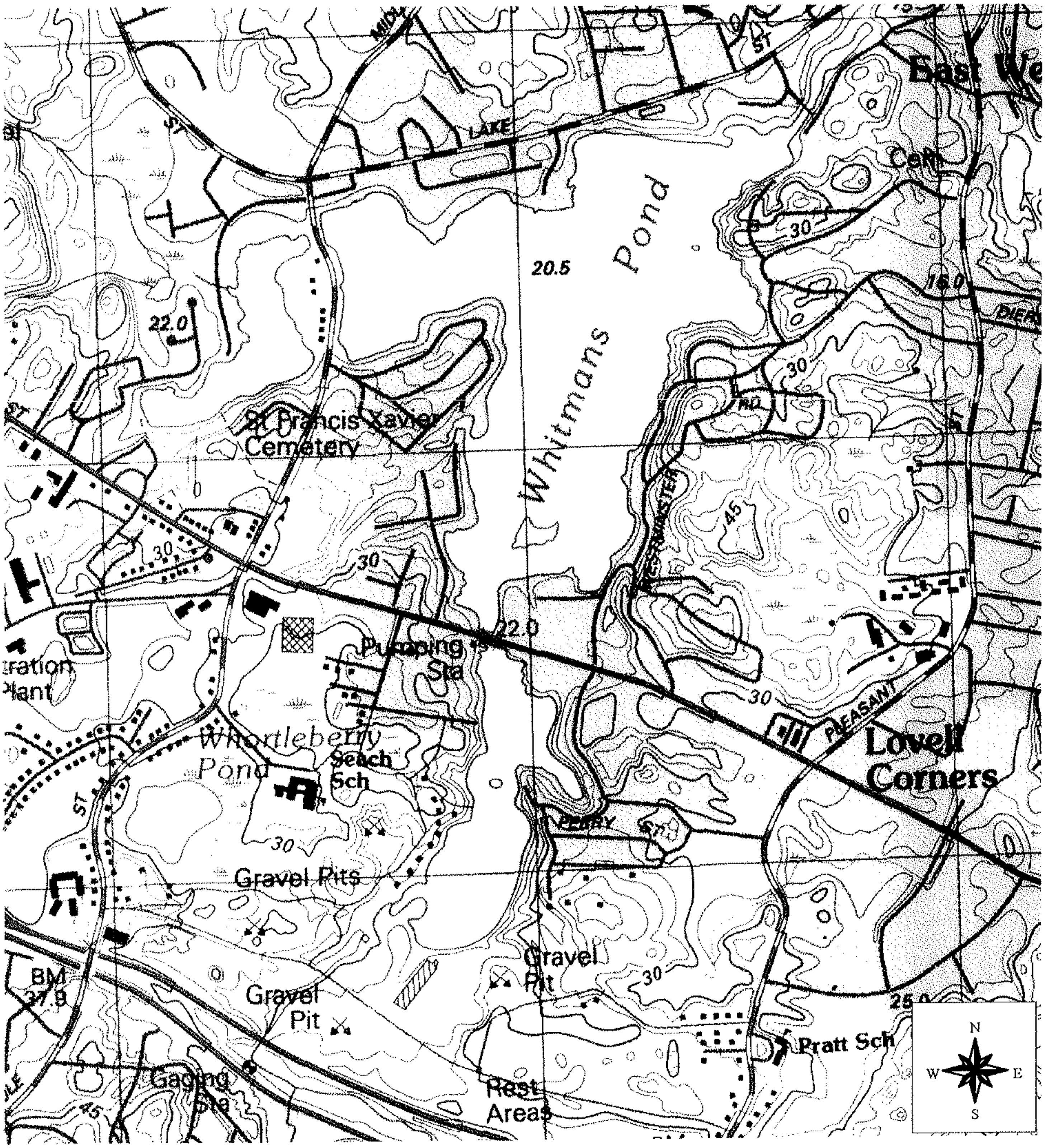

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Figure 1
Whitman's Pond
USGS Locus Map

Whitman, MA Quadrangle
Scale 1:24,000

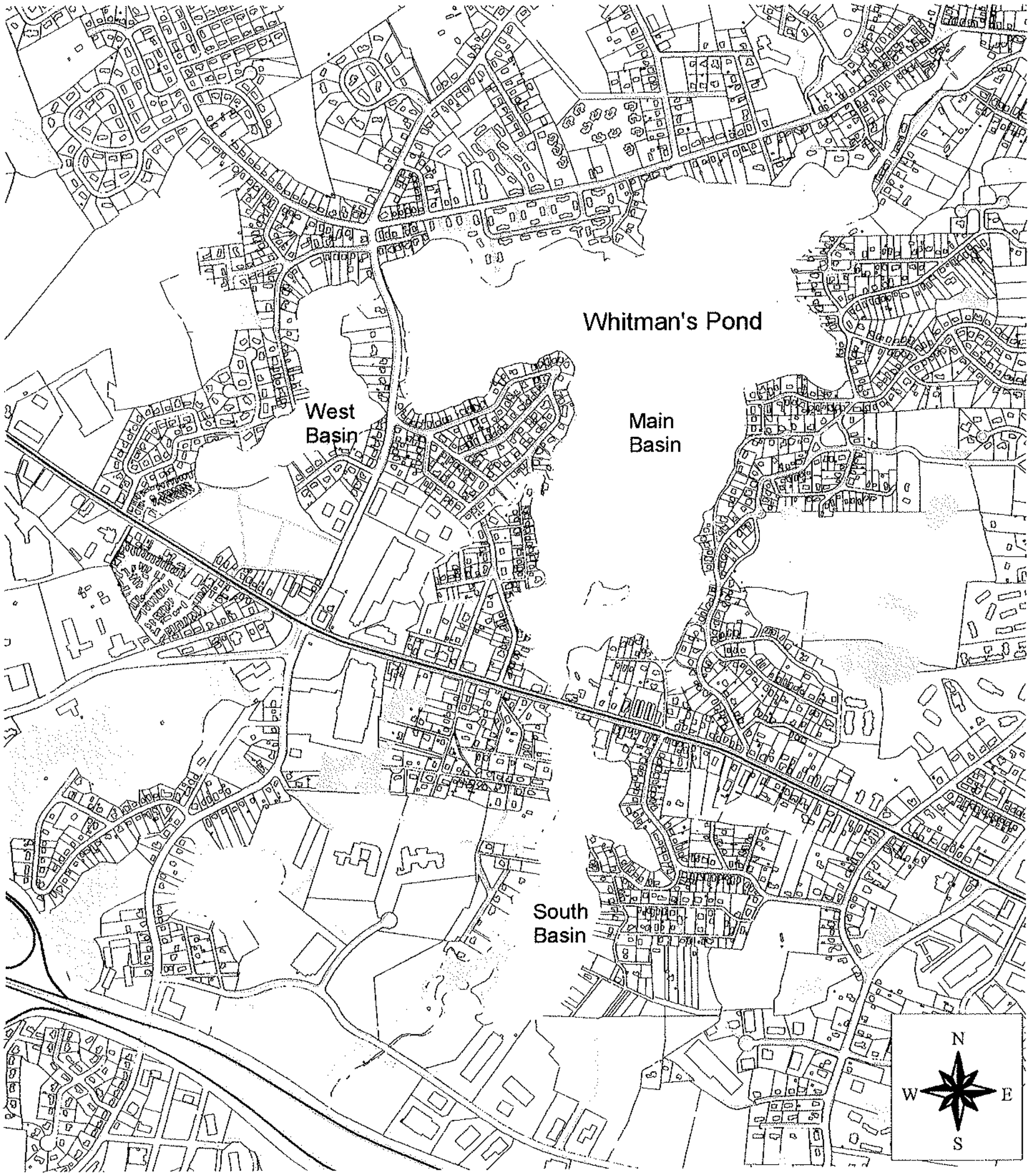

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Figure 2
Whitman's Pond
Site Plan

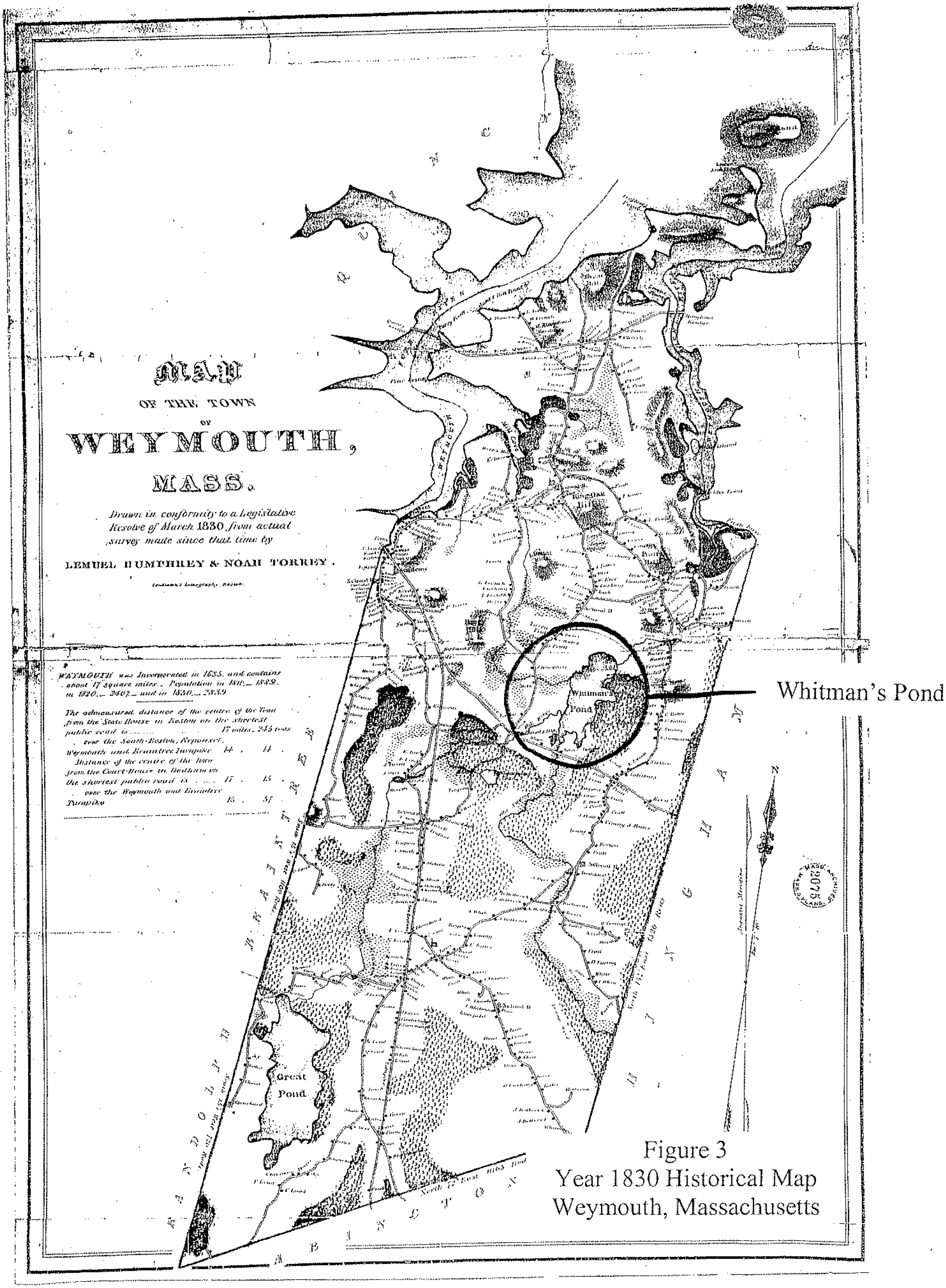


Figure 3
Year 1830 Historical Map
Weymouth, Massachusetts

3.0 HISTORICAL REFERENCES

Research reports on Whitman's Pond which were prepared for the Town of Weymouth since the 1980's were reviewed for relevant information. The main conclusions and recommendations of each report are presented below. For the recommendations, a statement (in bold print) is presented on the status of each recommendation.

A report entitled "Diagnostic Study" was completed by the Massachusetts Department of Environmental Quality Engineering-Division of Pollution Control during April 1980 and March 1981. The purpose of this report was to preclude a feasibility study to be performed by Metcalf and Eddy, Inc. Conclusions were as follows:

- Accelerated eutrophication (rapid aging) of Whitman's Pond potentially could be abated by controlling nutrient (phosphorus) loading into the pond **(addressed in 1983 Report).**
- Methods to control the nutrients, such as improving failed septic systems and reducing storm drain discharges, needed to be further evaluated **(addressed in 1983 Report and in this Report).**

In May 1983, a report entitled "Feasibility Study of Lake Restoration for Whitman's Pond" was submitted to Massachusetts Department of Environmental Protection Division of Pollution Control by Metcalf and Eddy, Inc. This report included an assessment of conditions, assessment of alternatives, and a recommended restoration plan. The restoration plan included the following:

- An annual voluntary clean-up day of the Pond was important **(ongoing)**
- Relocate the water pumping station intake on Washington Street **(conducted in 1986)**
- For the public education program, formation of the Whitman's Pond Association and a public awareness program was needed **(conducted)**
- Over 60% of the phosphorus loading upon Whitman's Pond comes from the Old Swamp River. To reduce eutrophication of the Pond, a reduction in total phosphorus (P) of 50% in the Old Swamp River was necessary. The construction of a sediment nutrient uptake pond (SNUP) was recommended **(conducted in 1987)**
- Phosphorus from storm drains contributes 15% of the total phosphorus in the Pond. Source controls for phosphorus included increased rates of catch basin cleaning and street sweeping, and maintaining vegetative buffers within the Whitman's Pond drainage basin were needed **(on-going, all catch basins were cleaned during this study)**
- Aeration of the Pond would improve fish habitat, improve aesthetics and reduce available phosphorus release from Pond sediments, since anaerobic conditions increase the release of phosphorus from sediments **(to be completed in spring 2004)**
- Dredging of shallow portions of the South and West Coves was recommended. Extensive testing was conducted to determine if the sediment had any toxic chemicals which would cause an environmental impact, including the cost of disposal **(sediment testing completed under this study, dredging feasibility under review, hydro-raking performed two times during this study)**

In February 1997, a report entitled "Diagnostic Feasibility Study-West Basin-Whitman's Pond" was submitted by Lycott Environmental, Inc. The purpose of this report was to evaluate the in-lake water quality, the storm water quality, and the current level of eutrophication in the West Basin. In addition, a management plan was proposed for the maintenance of the Basin. The plan included the following:

- To reduce eutrophication of the Western Basin, nutrient inactivation (adding Alum) could be conducted. Alum binds with nutrients and sinks to the bottom as a flocculent.
- Vegetation management of lilies and the invasive species Cabomba (fanwort), purple loosestrife and the common reed (Phragmites australis) was recommended. The use of herbicides was recommended for this effort **(lilies and Cabomba treated under this study, purple loosestrife treatments recommended in Section 8)**
- Dredging was considered "cost prohibitive" **(funding sources under review)**
- The use of sediment traps and artificial wetlands was encouraged near storm drain outfalls to reduce nutrient loads during rain events **(recommended in Section 8)**

In February 1998, a report entitled "Annual Report for Whitman's Pond Project 1997" was completed by Ambient Engineering and Ocean Arks International. This report outlined Ambient's stormwater management plan and discussed the sediment nutrient uptake pond and "Lake Restorer" efforts conducted for the report. Recommendations were as follows:

- Follow-up monitoring of the performance of the SNUP was needed, since none had been conducted to date **(conducted under this study).**
- The performance of the "Lake Restorer Raft" was notable within the immediate proximity (30 meters) of the Raft. A significant reduction in nutrients within the water column and sediments were noted. Funding for continued operation of the SNUP was recommended.
- Development of a "Storm Water Management Plan" was recommended to be eligible for state and federal grants and loans. In 1997, the office of Coastal Zone Management (CZM) denied an application for funding for a storm water treatment device (sediment trap) due to the lack of such a plan **(completed by BETA in association with this study).**

BETA completed a "Habitat Study of Whitman's Pond" in January 2001. This report included pond water sampling data, a macrophytic and benthic vegetation survey, a fish habitat evaluation and recommendations for future efforts. The future efforts included the following:

- Development of a Master Plan for Pond improvements **(completed under this study)**
- Development of base mapping of the watershed and a bathymetric survey of the Pond to meet state requirements **(completed under this study)**
- A storm drain inspection and sampling program **(completed under this study)**
- A hydrological study of the watershed **(completed under this study)**
- A structural assessment of the storm water collection system **(completed under this study)**
- Development of a plan for improvements, including the sanitary sewer, storm drains, best management practices (BMP's), feasibility of dredging and a review of sedimentation regulations **(completed under this study)**
- Management of invasive plant species through biological, chemical and mechanical methods **(conducted under this study, additional efforts detailed in Section 8)**
- Development of a community participation plan **(conducted under this study and ongoing)**

In January of 2001, a report entitled "Phase II Remedial Investigation – Rubble Disposal Area – South Weymouth Naval Air Station," was prepared by Tetra Tech NUS, Inc. BETA obtained a copy of this report from the Department of the Navy – Caretaker Site Office. This report included the results of intensive testing of a disposal site along the banks of the Old Swamp River on the former Naval Air Base. Issues such as PCB's ands metals contamination were investigated. The Report included information on metals and PCB's (Aroclor-1254 and Aroclor-1260) which were present in sediment and soils of this disposal area. Sediment testing during this study revealed Aroclor 1260 throughout approximately half of the Main Basin, north of Washington Street. It was not detected in the South Cove, indicating it is likely from another source other than the air base.

In December 2001, and again in November 2002, Ocean Arks International issued Final Reports for a three year bioremediation project for the West Cove of Whitman's Pond. The project included a survey of existing plant species, construction of a floating lake restorer, operation, oversight, and maintenance of the restorer, bioaugmentation of the West Cove through the restorer, and the distribution of micronutrient minerals. The restorer in West Cove had limited success. Ocean Arks explained that, while the restorer had a noticeable impact on water quality and sediment quality in the immediate vicinity (within 75 feet) of the restorer raft, the eutrophication process in West Cove was too far advanced to be halted or reversed by means of the restorer alone. Ocean Arks reached the following conclusions:

- In the 2001 report, Ocean Arks concluded that the restorer was successful in improving water and sediment quality within a small radius. Ocean Arks recommended continued operation of the restorer in conjunction with weed harvesting and aeration activities.
- However, in the 2002 report, Ocean Arks conceded that the eutrophication process was so far advanced that operation of the restorer would no longer be beneficial unless combined with significant weed harvesting efforts and the installation of upwelling windmills to agitate and increase flow in the Cove.

On July 10, 2003, a meeting was held at the Naval Air Station by the South Weymouth Restoration Advisory Board. The EPA and its consultants discussed, among other things, environmental issues at the base with concerned citizens. The minutes of the meeting indicate that levels of beryllium in Pond sediment, discovered by BETA in 1999 to be somewhat elevated, were well below the EPA's threshold for risk assessment of 150 mg/kg. Additionally, while beryllium was likely used at the base, levels in soils at the base reflect background levels obtained during EPA studies in urban areas. Levels of beryllium detected in six (6) sediment samples, taken between the base and South Cove during this study, revealed an average level of 1.0 mg/kg. Based upon recent EPA guidance, these levels are consistent with those found in soils of urban areas.

4.0 PREVIOUS INVESTIGATION, MAINTENANCE AND RESTORATION EFFORTS

4.1 Preliminary Investigation

BETA has performed a review of Town files and records, interviews with Town and State officials and concerned residents, and review of previous reports to determine what previous efforts had been made with respect to pond restoration, and whether they were successful. The following are some of the main restoration efforts previously conducted.

4.2 Restorer Technology

There have historically been two "Restorers" maintained by OceanArks, Inc. in Whitman's Pond. One is located in West Cove and the other is located in South Cove. These "Restorers" consist of floating rafts containing organisms (bacteria, zooplankton, plants, snails, and fish). Lake water enters the center of the raft via an air lift pump where the water flows through a manufactured media used to induce nitrification. The lake water is then air lifted through floating mats containing aquatic biota. The purpose of the restorer is to reduce nutrient levels in the pond and increase dissolved oxygen levels.

The clarity of the water in the vicinity of these rafts indicates that there is a potential for a localized effect. Water sampling was performed in order to assess the overall effectiveness of the restorers in the West and South Coves of Whitman's Pond. However, definitive data is not available to confirm before and after conditions. As previously discussed, the restorers operated with limited success. Ocean Arks explained that, while the restorer in West Cove had a noticeable impact on water quality and sediment quality in the immediate vicinity (within 75 feet) of the restorer raft, the eutrophication process in West Cove was too far advanced to be halted or reversed by means of the restorer alone. Both restorers are currently not operating.

4.3 Herbicide Treatments in the West Basin

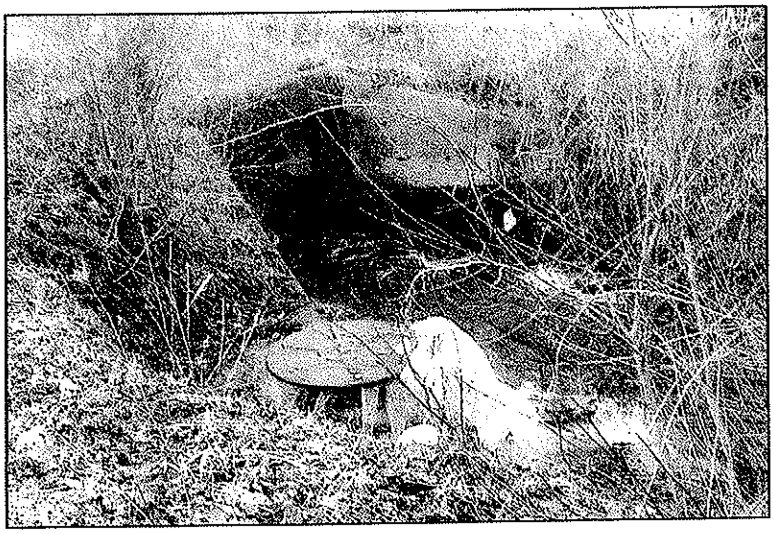
According to the "Diagnostic Feasibility Study for the Western Basin", submitted to the Town of Weymouth on February 11, 1997, fluridone was applied to the West Basin for the control of purple loosestrife (*Lithrum salicaria)*, common reed (*Phragmites australis)*, and fanwort (*Cabomba Caroliniana)*. The effectiveness on *Cabomba caroliniana* was not discussed, as results were not conclusive at the time of the report. However, fluridone was reported to be 30%-40% successful on *Phragmites australis*. While effective in reducing nuisance vegetation conditions, the nutrients of the vegetation again become available when the plants decompose, resulting in a short-term benefit. In the Western Basin, however, herbicides can effectively delay the Basin from converting back to a swamp, which it was prior to dam construction at the Back River discharge of the Main Basin in 1905. Recommended additional herbicide treatments are discussed in section 6.2.

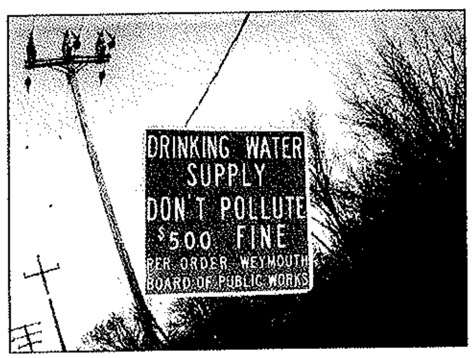
4.4 Septic Systems and Sewers

Approximately 95% of the Town is sewered, while the remaining portion is on septic systems. The Weymouth DPW estimated that in 1999 there were only 1,100 homes not connected to their sewer system. Based on an average of 3.5 people per home, this would represent a total of 3,850 people that are un-sewered. In 1992, Town Meeting voted that all homes with septic systems that did not meet Title V had to connect to the sewer system.

Septic systems are often a major source of nutrient loading in ponds and streams. This is especially true given that most of the soils around Whitman's Pond have a rapid permeability and offer minimal filtration to septic system effluent. Additionally, there are areas with shallow bedrock. The Town of Weymouth has addressed this issue by extending municipal sewer lines into most areas around the Pond. However, there are still some residential homes in the vicinity of the pond that utilize septic systems (see Figure 4).

Despite improvement efforts, the sewer system still experiences overflows during periods of heavy rain and/or snowmelt. In 1998, the DPW and the DEP signed a consent order calling for a reduction in sewer demand, tying any new demand for sewer capacity into a corresponding reduction in I/I. At the same time, the DPW initiated a multi-year, comprehensive sewer repair program aimed at preventing millions of gallons a day from entering the system while addressing sewer capacity deficiencies. This project is known as the Town of Weymouth Capital Improvement Program (CIP), a sewer system improvement project (source: Weymouth DPW).





The CIP includes construction of a new pump station on Libbey Industrial Parkway and a new force main to divert flow back into the Lower Central Interceptor where the existing interceptor now crosses Washington Street; conversion of the existing pressure sewer on Pleasant Street and between Pleasant Street and the Route 3/Route 18 Cloverleaf to a gravity sewer; and construction of a new gravity sewer in the Landing to divert flow from Commercial Street to the MWRA sewer at Smelt Brook (source: Weymouth DPW).

The CIP is designed to alleviate the chronic sanitary sewer overflows that Weymouth's existing wastewater collection system experiences. Over the next three (3) years, and at a cost of 13

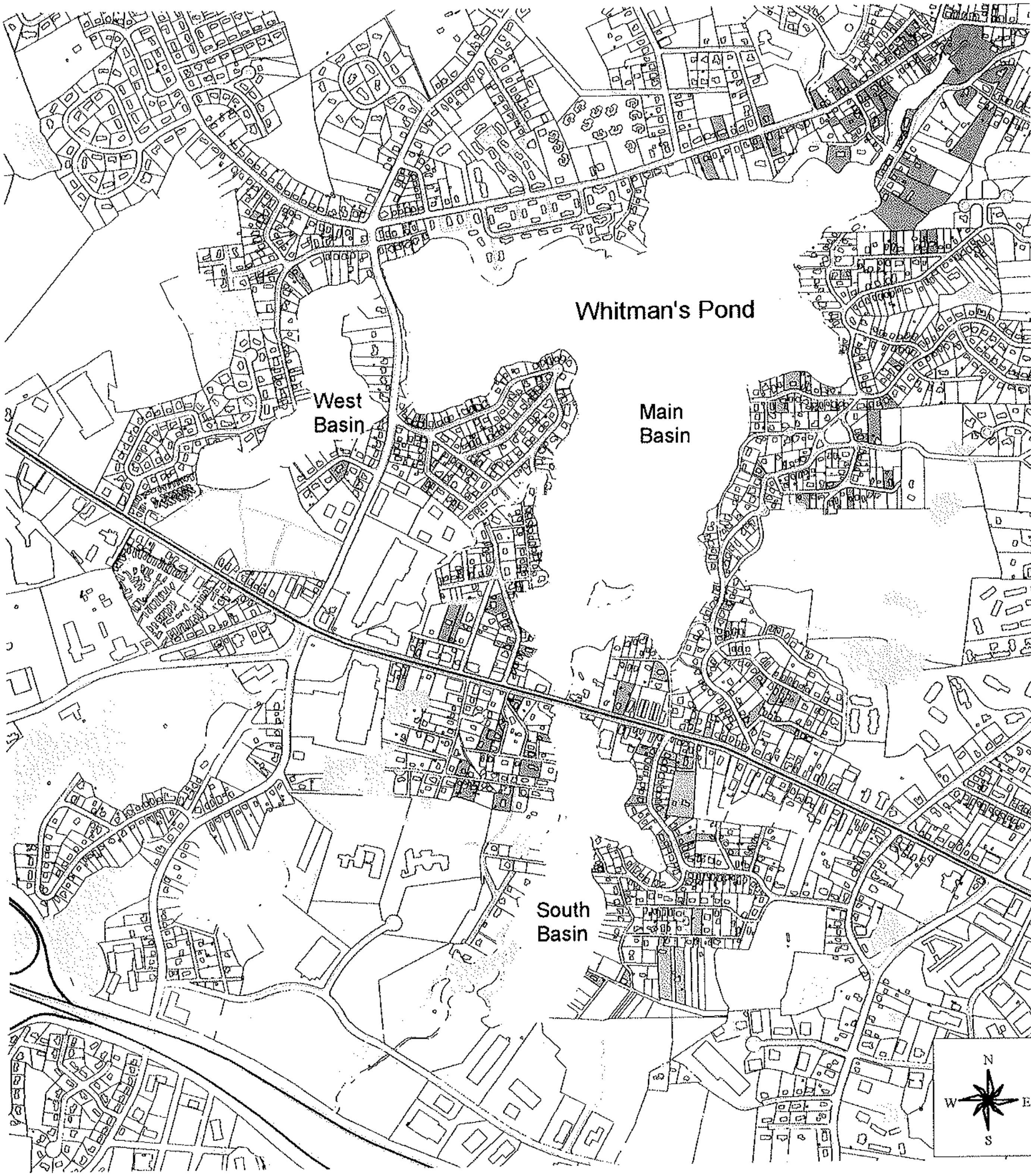


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Figure 4
Whitman's Pond
Un-sewered Lots

Note: Unsewered lots shaded in yellow.

million dollars, several new sewer infrastructure improvement projects are planned which will have a direct impact upon Whitman's Pond. The CIP will be implemented under five contracts:

- **Contract No. 1 - Lower Central Interceptor Sewer Replacement-Winter Street to Essex Street**
- **Contract No. 2 - Lower Central Interceptor Sewer Replacement – Commercial Street to Old Country Way**
- **Contract No. 3 - Pump Station and Influent Gravity Sewer**
- **Contract No. 4 - Force Main**
- **Contract No. 5 - Landing Area Gravity Sewer**

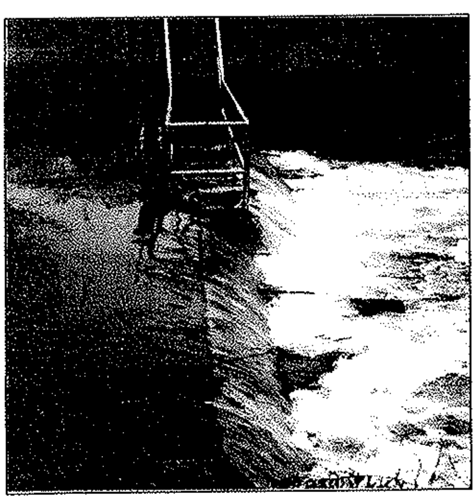
Sewer system improvements and ongoing infiltration/inflow (I/I) projects have reduced I/I into the sewer system by approximately 0.2 million gallons per day (MGD). Additional work around Whitman's Pond is expected to remove an additional 1.5 MGD. These projects will collectively result in the elimination of millions of gallons of raw sewage overflows to the West, South, and ultimately the Main Basin (source: Weymouth DPW).

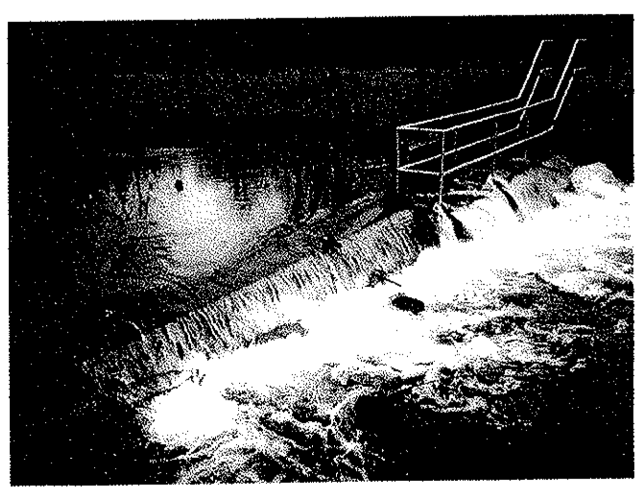
4.5 Sediment Nutrient Uptake Pond

In 1998, a considerable effort was made to reduce phosphorus loads to Whitman's Pond. A sediment nutrient uptake pond (SNUP) was constructed along the Old Swamp River, located to the south of Libbey Industrial Parkway and the South Basin. The SNUP was engineered as a man-made wetland, utilizing settling and natural plant systems to remove phosphorous and other nutrients from the River, prior to discharging into the South Basin of Whitman's Pond. The vegetation and sediment need to be periodically removed, along with the corresponding nutrients.

Original engineering plans for the SNUP were rejected by the U.S. Environmental Protection Agency (EPA) on the basis that too much existing natural wetland area would be disturbed. The SNUP was redesigned, and the final construction of the SNUP was allegedly only one half the size of the original. According to the designers, this significantly reduced the efficiency of the SNUP, however, there is little documentation as to the effectiveness of the SNUP since its construction. Upon review of the construction plans, however, the effective area of the constructed SNUP is similar to the area of the original design, as detailed below.

Figure 5: Storm Flows Over-top Control Structure When Sluice Gate is Not Opened





PROPOSED DESIGN

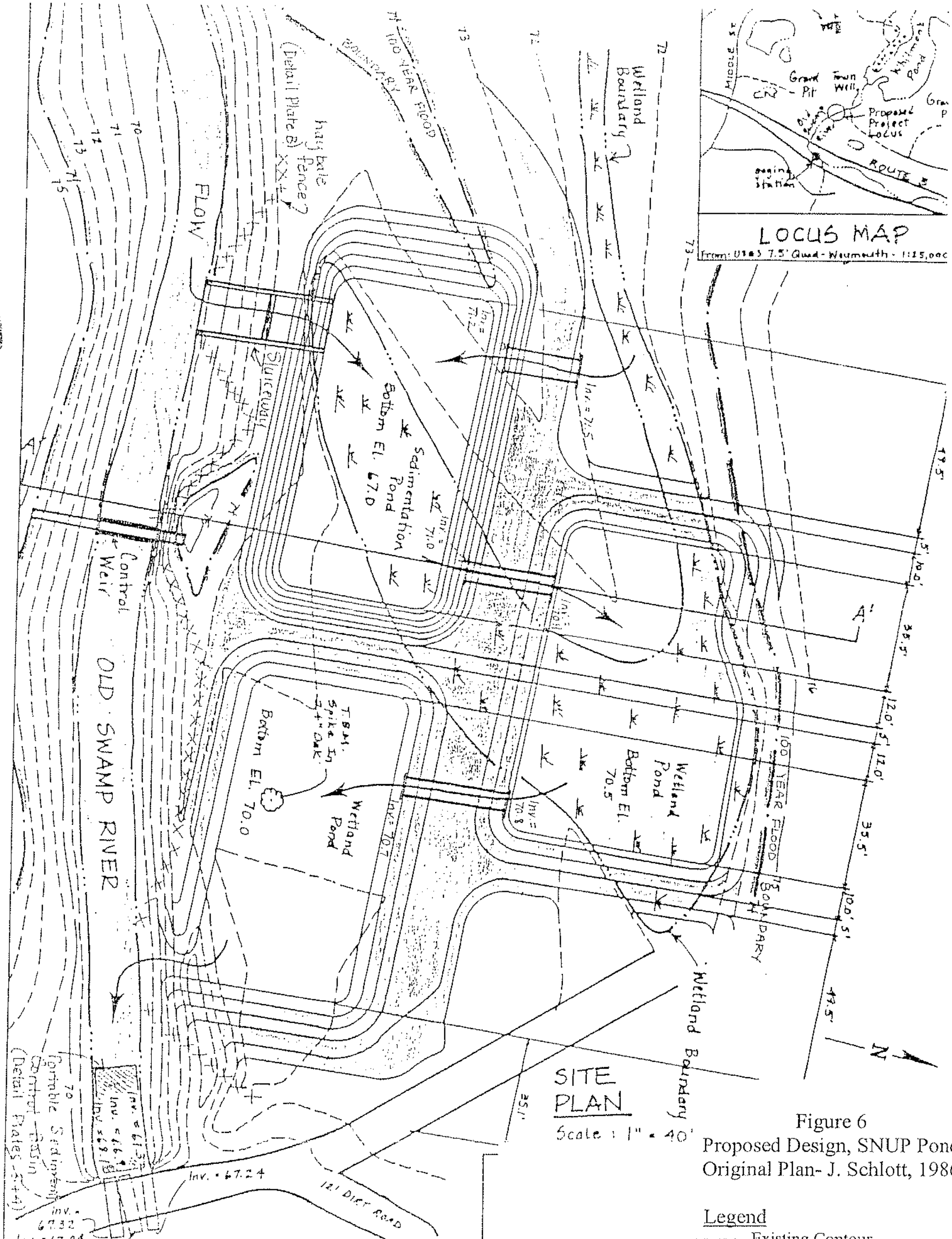


Figure 6
Proposed Design, SNUP Pond
Original Plan- J. Schlott, 1986

Legend
- Existing Contour
- Proposed Contour
- 100 Year Flood Boundary
- River and Wetland Boundary
- Hay Bale Fence

Plans accompanying the petition of Town of Weymouth, Planning & Community Development Office for the construction of Sediment/Nutrient Uptake Ponds along

AS-BUILT

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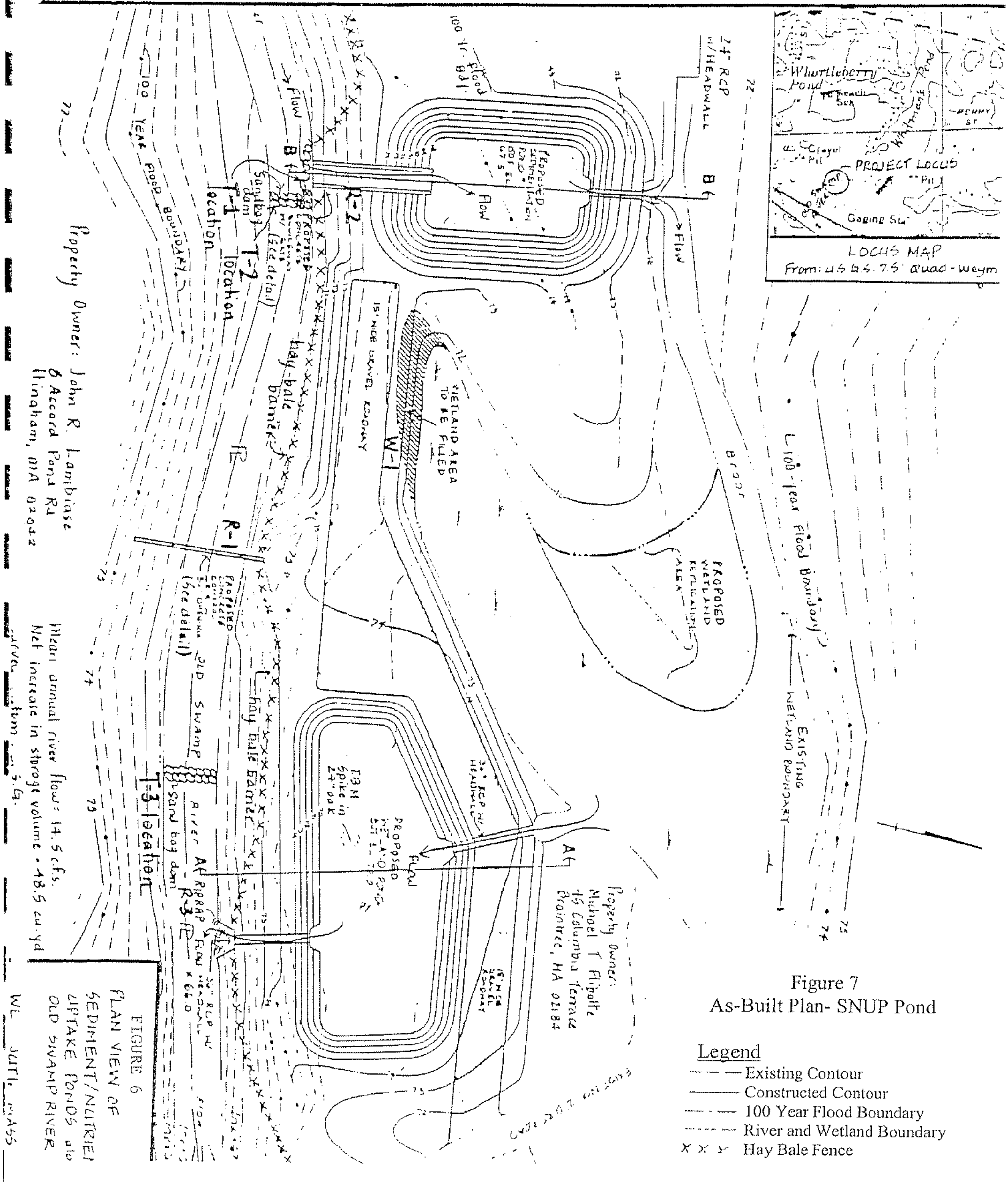


Figure 7
As-Built Plan- SNUP Pond

The difference is that the constructed SNUP utilizes an existing "natural" wetland instead of a constructed wetland, as originally planned. See Figures 6 and 7.
Original Design: three (3) basins each 5,000 s.f. in area : Total proposed area of 15,000 s.f.
As-built: One (1) basin 1,800 s.f., a natural wetland area 8,000 s.f. and one (1) basin 4,000 s.f. :Total as-built area of 13,800 s.f.

The SNUP system is maintained by the Department of Public Works. The system is designed so that the base flow (and small rain events) of the Old Swamp River are diverted through the SNUP. Larger rain events produce flows which exceed the capacity of the SNUP. This results in a lack of nutrient uptake, and also can actually increase nutrients in the River by river flow scouring accumulated sediment from the SNUP back into the River.

Therefore, the system requires significant maintenance. Each time there is a rain event, the gate diverting flow away from the SNUP must be opened by a DPW employee. This is obviously a problem, since rain events are often spontaneous, and occur at night, on weekends and holidays when no staff is available (see Figure 5). Additional maintenance activities include the periodic removal of accumulated sediment and vegetation, although this is much less labor intensive. Improvements to the operation and efficiency of the SNUP are discussed in Section 7.0.

4.6 Whitman's Pond Cleanup Day

Each year, the Whitman's Pond Association, volunteers, and DPW staff engage in a cleanup effort to clean the shores and remove debris from sections of the Pond. Vegetation, muck and debris, such as shopping carts, automobiles and an occasional boat are removed and hauled away for disposal. Literally tons of debris are collected annually by these individuals. In 2003, the cleanup day was held on September 13th. The picture below shows some of the debris removed this year.

5.0 INVESTIGATIONS AND PROGRAMS (2002-2003)

5.1 Introduction

In order to address non-point source pollution, a storm drain inspection, sampling, and watershed analysis was conducted to evaluate potential sources of pollutant loading. This included testing of the Old Swamp River and the inspection of 46 storm water drainage outfalls that discharge into the pond. From this information and previous data, maximum pollutant and nutrient loads are estimated in order to establish thresholds and water quality improvement goals for nutrient and pollutant loading into Whitman's Pond. The three sampling sets included:

- Sampling of the Old Swamp River
- Dry weather sampling of all storm drain discharges
- Sediment sampling

5.2 Old Swamp River/South Cove Sampling Program

As previously mentioned, no follow-up testing of the SNUP was conducted after its construction. To demonstrate the effectiveness of the SNUP, BETA closed the gate and diverted dry weather flow of the Old Swamp River through the SNUP. Samples were taken at the influent and effluent pipes, and were analyzed for total phosphorus, nitrate and total kjeldahl nitrogen (TKN). Samples were submitted to Geolabs, Inc. of Braintree, MA for analysis. The results are shown below. While nitrate levels in the influent and effluent samples are similar, the Total Nitrogen was reduced by nearly twenty percent (20%), and Total Phosphorus by fifty percent (50%).

TABLE 1 - SNUP SAMPLING RESULTS

	Total Phosphorus	**Nitrate Nitrogen**	**Total (Kjeldahl) Nitrogen**
SNUP Inlet	0.104	0.556	1.06
SNUP Outlet	0.0545	0.631	0.867

(Results in mg/L)

The reduction (uptake) of phosphorus is significant, since historically it has been demonstrated that phosphorus is the limiting nutrient with respect to eutrophication in Whitman's Pond. In addition, the reduction of phosphorus in the Old Swamp River by 50% was deemed necessary to prevent further eutrophication of Whitman's Pond. The reduction of phosphorus by 50% in the Old Swamp River was a part of the "Recommended Plan" of the "Feasibility Study of Lake Restoration for Whitman's Pond prepared for the Massachusetts Department of Environmental Quality Engineering - Division of Water Pollution Control by Metcalf and Eddy, Inc., 1983." Perhaps most importantly, the EPA has established a maximum threshold of 0.05 for streams entering a pond or lake to prevent eutrophication.

Recommended improvements to the design, operation and maintenance of the SNUP are discussed in Section 7 of this report. These improvements will improve the efficiency and reduce the maintenance needs for the SNUP.

Heavy Metals in Old Swamp River

In 1999, levels of beryllium in the South Cove and Main Basin sediments were discovered by BETA to be somewhat elevated, based upon Massachusetts risk standards (MCP-S1). This raised a concern among some residents. However, based upon recent EPA guidance, the levels were well below the EPA's threshold for risk assessment of 150 mg/kg. Additionally, while beryllium was likely used at the Naval Air Station, levels in soils at the base reflect background levels obtained during EPA studies in urban areas. Levels of beryllium detected in six (6) sediment samples, taken between the base and South Cove during this study, revealed an average level of 1.0 mg/kg. Based upon recent EPA guidance, these levels are consistent with those found in soils of urban areas. Old Swamp River sediment sampling locations are illustrated on Figure 8, and results are tabulated in Table 2 below:

Table 2-Old Swamp River Sediment Sampling Results

Parameter	DEP Threshold Effect Concentrations (TEC)	Sampling Location					
		OSR-1	OSR-2	OSR-3	OSR-4	OSR-5	OSR-6
Metals (mg/Kg)							
Arsenic	9.79	ND	ND	ND	ND	ND	ND
Barium	NE	18.9	8.21	219	162	174	144
Beryllium	NE	0.229	0.128	1.04	1.48	ND	0.60
Cadmium	0.99	ND	ND	ND	ND	ND	ND
Chromium	43.4	16.9	5.44	ND	ND	ND	ND
Lead	35.8	24.1	11.4	ND	ND	ND	ND
Mercury	0.18	ND	ND	ND	ND	ND	ND
Selenium	NE	ND	ND	ND	ND	ND	ND
Silver	NE	ND	ND	ND	ND	ND	ND

All concentrations compared to DEP Threshold Effect Concentrations (TEC).
Shaded areas represent concentrations above DEP Threshold Effect Concentrations (TEC).
ND-not detected above minimum laboratory reporting limit.
NE-standard not established.

South Cove Drinking Water Testing

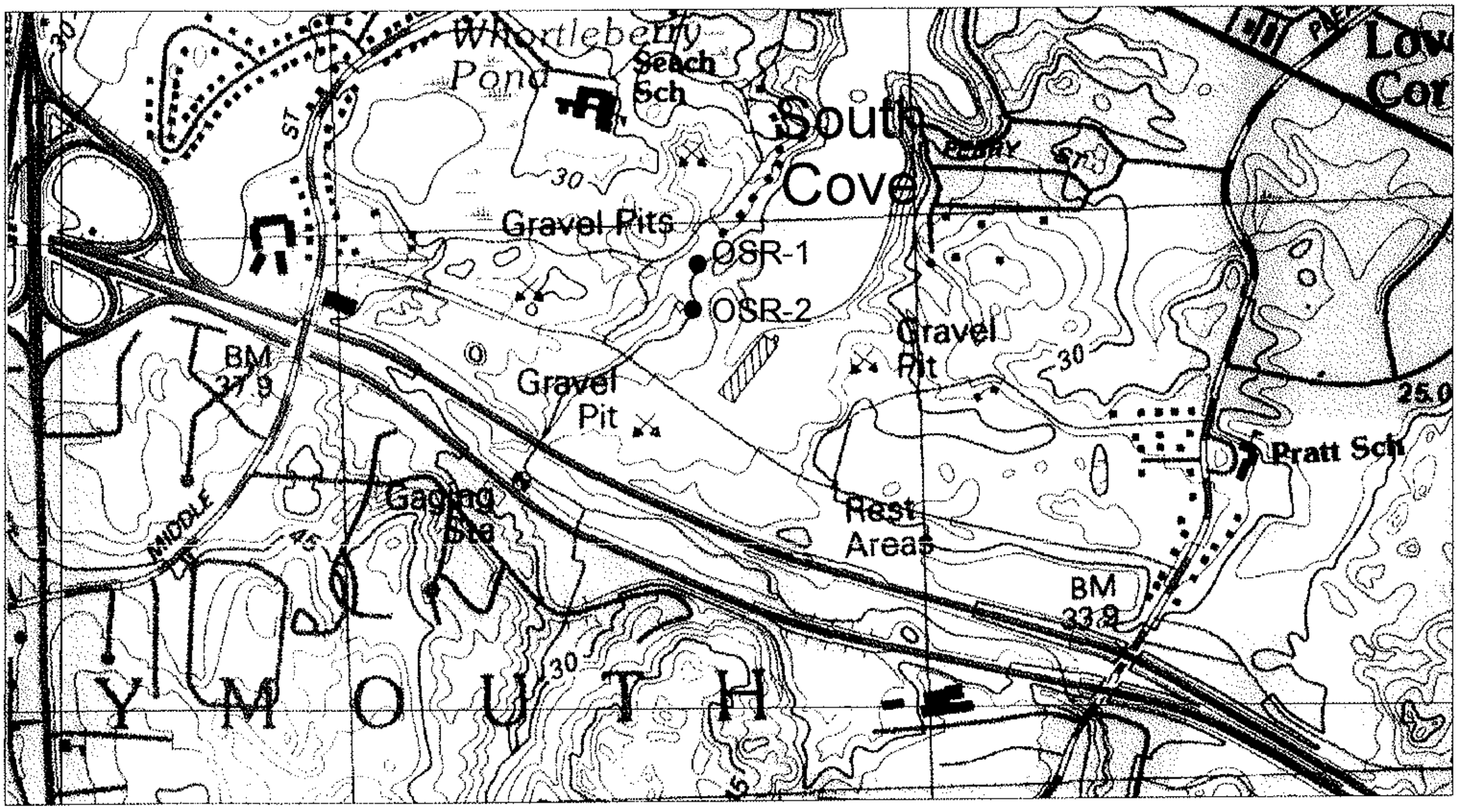
The Town of Weymouth collects water samples from South Cove semiannually, at the pump discharge to Great Pond. The samples are analyzed for total metals (arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, and silver), PAHs, PCBs, total nitrogen, total phosphorous, total kjeldahl nitrogen (TKN), and TPH. Town personnel refer to the pump intake to Great Pond as Washington Street Discharge. The most recent round of sampling results, conducted November 4th, 2003, is included in Table 3 below:

Table 3-South Cove Drinking Water Sampling Results

Analyte	Massachusetts Maximum Contaminant Level (MMCL or SMCL*)	Washington Street Discharge
Total Metals (mg/L)		
Arsenic	0.05	ND
Barium	2.0	0.034
Beryllium	0.004	ND
Cadmium	0.005	ND
Chromium	0.10	0.005
Lead	0.015	0.001
Mercury	0.002	ND
Selenium	0.05	ND
Silver*	0.1	ND
Other Analytes (mg/L)		
PCBs	0.0005	ND
TPH	0.2	ND
Total PAHs	NE	ND
Total Nitrogen	NE	0.96
Phosphorous	NE	0.04
TKN	NE	0.61

All concentrations compared to Massachusetts Maximum Contaminant Levels (MMCLs), except when noted with * (SMCLs).
ND-not detected above minimum laboratory reporting limit.
NE-standard not established.

As demonstrated in the above sampling results, all of the analytes tested are within the established Massachusetts Maximum Contaminant Levels for drinking water.



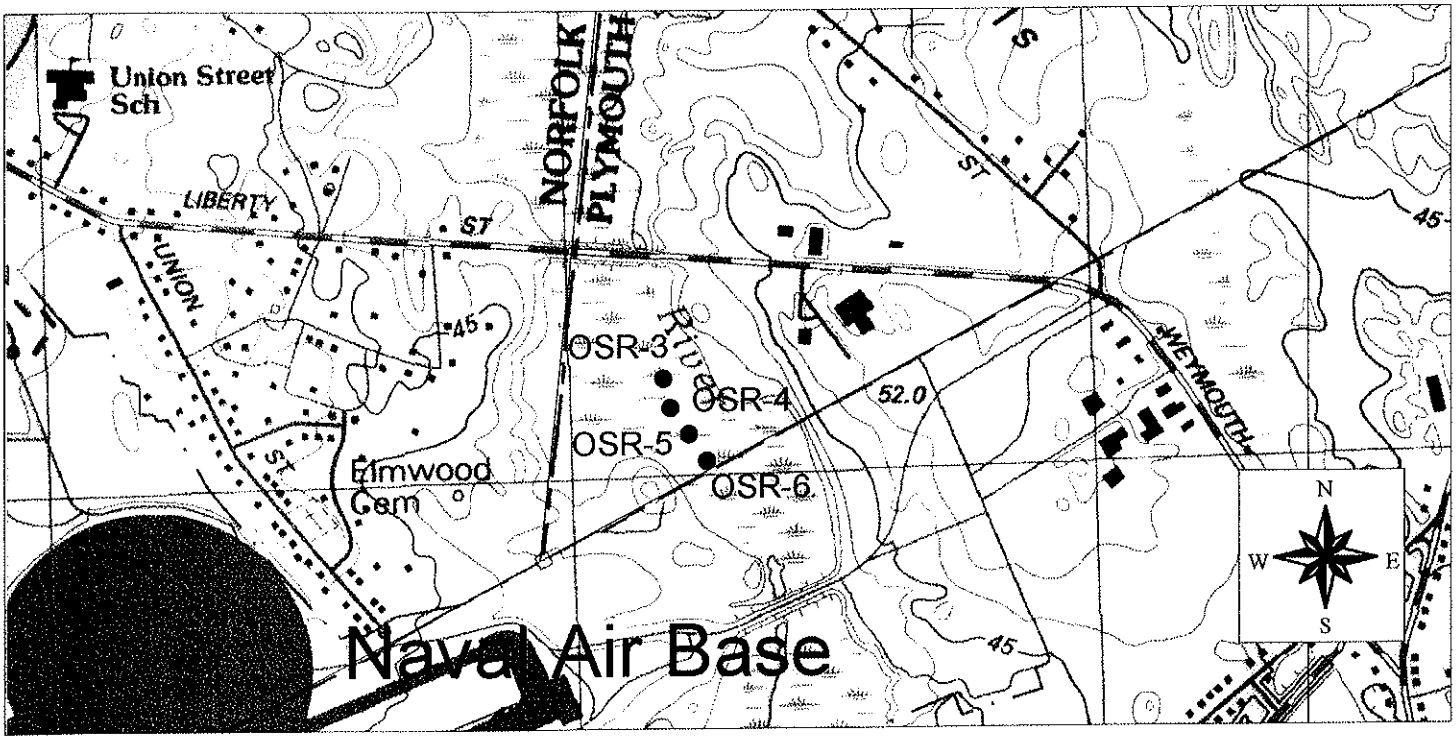


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Figure 8
Old Swamp River
Sediment Sampling

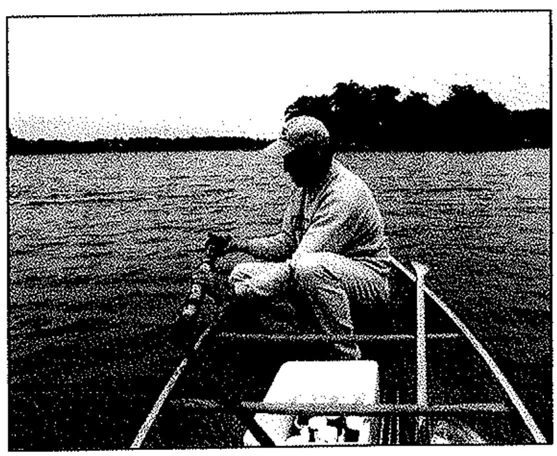
Notes:
OSR-1-Sediment Sampling Location

5.3 Sediment Sampling of Main, South and West Coves

As part of the study, BETA collected sediment samples from the Main, West, and South Basins of Whitman's Pond. Due to a potential interest in dredging portions of the Main Basin and West Cove, an intensive sediment sampling program was included in the scope of work for this project. While developing the scope of work, correspondence with the Department of Environmental Management (DEM), which funded 50% of this study, indicated that any dredging projects funded by DEM needed to include an intensive sediment sampling and benthic survey program. The benthic survey is discussed later in this section under **"Base Map Preparation"**.

In accordance with dredging and Water Quality Certification permit requirements, samples from the Main and West Basins were analyzed for total nitrogen, total phosphate, total organic carbon, total metals (12), total petroleum hydrocarbons (TPH), polynuclear aromatic hydrocarbons (PAH's), and polychlorinated biphenyls (PCB's). In response to elevated PBC concentrations in the Main Basin, samples were collected from the South Cove and were analyzed for PCBs. Sediment sampling locations are illustrated in Figure 9.

Sediment sampling was expanded to include organic constituents, which have not been included in sampling efforts of any of the studies dating back to the early 1980's. Organic compounds are often persistent in the environment, and include compounds generated by combustion, automobiles, manufacturing and industry, and application of pesticides and herbicides. Due to their persistence, they are often found in sediments of waterways and water bodies. Due to the toxicity of many of these compounds, dredging and disposal of the material is often difficult. Since restoration efforts might include dredging as an alternative, a complete assessment of the quality of the sediment was needed.



Analytical results were compared to the Freshwater Sediment Threshold Effect Concentrations (TECs), as adopted by the Massachusetts Department of Environmental Protection (DEP). Results of the sediment sampling activities are described in the narratives below, and the results are tabulated in Tables 3, 4, and 5.

Total Nitrogen

Nitrogen may enter a lake or pond in many forms: dissolved N_2, nitric acid, NH_4^+, and NO_3^-, as NH_4^+ adsorbed to inorganic particulate matter, and as organic compounds. Sources of nutrient loading in the pond include fertilizers, agricultural runoff, sewage and industrial wastes, and atmospheric pollutants. In addition, wetland areas associated with South Basin and West Basin will have an increase in nitrogen due to senescence of herbaceous plants and direct leaf fall in the autumn.

Figure 9
Whitman's Pond Sediment Sampling Polychlorinated Biphenyls (PCBs)

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Notes:
MS-1-Sediment Sampling Location
ND-Not Detected
All concentrations listed in parts per billion (PPB)

Sediment samples from the Main and West Basins of Whitman's Pond were analyzed for total nitrogen. Nitrogen concentrations in the Main Basin ranged from 823 to 29,200 mg/kg, with an average concentration of 8,940 mg/kg. Total nitrogen concentrations in the West Basin ranged from 9,290 mg/kg to 28,000 mg/kg, with an average concentration of 18,520 mg/kg. While there is no established TEC standard for total nitrogen, it is measured to determine nutrient levels available to the water column. For example, clean sand would have a nitrogen level near 0 mg/l, while decayed vegetation would have levels similar to those obtained in Whitman's Pond.

The higher concentrations of total nitrogen were noted in the West Basin and the western portion of the Main Basin. These areas were noted to contain excessive plant and algae growth as well. The average concentration of nitrogen from the two Basins was 11,335 mg/kg. These levels are somewhat elevated, and are consistent with levels obtained in sediment in 1981 and 1999.

Total Phosphate

Organic phosphates originate primarily from organic matter in and around a water body. Inorganic phosphates generally originate from synthetic detergents and enter lakes and ponds via storm water runoff and leachate from septic systems and dry wells. Phosphates tend to accumulate in sediments due to affinity for colloids and organic matter. Of the myriad of substances that enter a lake or pond from the surrounding watershed, phosphates are often of primary concern. All lakes have the ability to adsorb some phosphates before experiencing a negative impact. However, when the levels become excessive, phosphates can cause algae to flourish. With the decomposition of excessive algae, the concentration of dissolved oxygen decreases, causing anoxic conditions. Anoxic conditions, in turn, release more phosphorus from the sediment.

Sediment samples in the Main and West Basins of Whitman's Pond were analyzed for total phosphate. Total phosphate concentrations in the Main Basin ranged from not detected (ND) to 278 mg/kg, with an average concentration of 58.5 mg/kg. Total phosphate concentrations in the West Basin ranged from 52 mg/kg to 190 mg/kg, with an average concentration of 109 mg/kg. As with nitrogen, while there is no established TEC standard for total phosphate, it is measured to determine available phosphate to the water column. Clean sand would have levels of phosphate near 0 mg/l, while organic sediments have elevated levels similar to those obtained during this study.

Sediment samples collected from the West Basin and the western portion of the Main Basin contained higher levels of total phosphate, with an anomaly of the highest concentration location along the eastern portion of the Main Basin. The average phosphate concentration from the two basins was 71 mg/kg. Due to the abundance of organic material in the West Basin, the phosphate levels would be expected to be higher. As previously discussed, the West Basin was once a swamp, and therefore has organic material enriched with phosphate. Hydro-raking and dredging of this organic material are alternatives for removal of the phosphate.

Total Organic Carbon

Sediment samples in the Main and West Basins were analyzed for total organic carbon (TOC). Concentrations of TOC in the Main Basin ranged from 1,500 mg/kg to 97,000 mg/kg, with an average concentration of 38,900 mg/kg. There is no established TEC standard for TOC, but these levels are consistent with sediments within a eutrophic pond. Concentrations of TOC were higher in the western portion of the Main Basin, with an average concentration of 54,000 mg/kg, versus an average of 31,350 in the rest of the Main Basin.

Concentrations of TOC in the West Basin ranged from 46,000 mg/kg to 64,000 mg/kg, with an average concentration of 54,000 mg/kg. As with phosphate, organic material has high levels of TOC as well.

Table 4 - Whitman's Pond Sediment Sampling - Total Metals

Analyte	Freshwater Sediment Threshold Effect Concentrations	Sampling Location									
		MS-1	MS-2	MS-3	MS-4	MS-5	MS-6	MS-7	MS-8	MS-9	MS-10
Total Metals (mg/Kg)											
Arsenic	9.79	ND	ND	ND	ND	ND	ND	ND	ND	5.84	ND
Barium	NE	59	99.6	153	84.8	200	139	51.4	93.1	49.8	55
Cadmium	0.99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	43.40	29.5	15.2	19	12.4	23.9	50.7	12.7	24.8	18.7	6.2
Copper	31.6	46.2	30.9	41.9	22.3	41.4	57.3	13.2	57.9	16.9	2.4
Iron	NE	9,530	11,400	15,600	8,810	22,800	37,000	6,840	15,100	11,400	6,440
Lead	35.8	277	118	135	47.80	78	318	61	339	121	ND
Magnesium	NE	1,520	1,300	1,900	1,060	1,960	4,430	1,230	1,900	912	985
Manganese	NE	124	755	1,290	798	3,290	1,410	497	305	317	224
Mercury	0.18	0.49	ND	ND	ND	ND	0.328	ND	0.352	0.129	ND
Nickel	22.7	16.6	12.2	17.4	9.75	17.9	36.5	7.54	17.9	11.3	4.5
Zinc	121	150	177	213	109	181	432	86.1	311	158	20

Analyte	Freshwater Sediment Threshold Effect Concentrations	Sampling Location									
		MS-11	MS-12	MS-13	MS-14	MS-15	WS-1	WS-2	WS-3	WS-4	WS-5
Total Metals (mg/Kg)											
Arsenic	9.79	ND	ND	ND	ND	7.65	ND	ND	ND	ND	ND
Barium	NE	88.5	114	99.6	57.8	88	59.2	48.2	91.7	82.5	107
Cadmium	0.99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	43.40	16.8	52.3	31	6.11	25.7	ND	4.81	ND	ND	12
Copper	31.6	27.5	54.7	40.60	6.9	29.8	17.9	8.08	21.4	13.4	35.9
Iron	NE	160,000	19,500	16,300	5,620	18,100	9,950	4,260	11,100	9,060	13,500
Lead	35.8	142.00	286	205	51.6	167	119	ND	ND	ND	130
Magnesium	NE	1,120	2,130	1,720	359	1,360	619	458	965	1,030	1,200
Manganese	NE	765	825	574	236	780	375	209	501	457	285
Mercury	0.18	ND	0.242	0.429	0.11	0.208	ND	ND	ND	ND	ND
Nickel	22.7	13.6	26.2	17	3.13	17.6	ND	ND	ND	ND	16.3
Zinc	121	179	306	225	61	265	86.1	31.4	77.7	62.1	215

All concentrations and standards given in milligrams per kilogram (mg/kg).
Highlighted values are above established TEC limits.
ND - not detected above minimum laboratory quantitation limits.

Total Metals

Metals are naturally occurring, and often released to the environment through industrial processes. Often, high concentrations of metals are often found in the runoff from industrial and urbanized areas. The runoff enters streams and ponds and the metals often accumulate in the sediments through precipitation and deposition processes.

Sediment samples from the Main and West Basins were analyzed for arsenic, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, and zinc. Sediment concentrations were compared to freshwater sediment screening TECs recognized by the DEP. Total metals concentrations are shown in Table 3, and metals concentrations above the applicable TECs are highlighted.

In summary, elevated levels of chromium, copper, lead, mercury, nickel, and zinc were noted in the Main Basin. The average concentrations of copper, lead, and zinc were higher than the associated TEC standards.

In the West Basin, elevated levels of copper, lead, and zinc were noted. The average concentration of lead was higher than the associated TEC standards.

Concentrations of arsenic in the Main and West Basins were below the established TEC standard, and cadmium was not detected in sediment samples from either basin. TEC standards do not currently exist for barium, iron, magnesium, and manganese. Iron and manganese are common in geologic formations of this region, and are therefore expected to be elevated.

Overall, average concentrations of total metals in the West Basin were significantly lower than those in the Main Basin. Concentrations of lead were detected above TEC standards in fourteen of the fifteen samples collected from the Main Basin.

Total Petroleum Hydrocarbons

Total petroleum hydrocarbons (TPH) are a family of several hundred chemical compounds that originally come from crude oil. Crude oil is used to make petroleum products, which can contaminate the environment. TPH is a mixture of chemicals, but they are all made mainly from hydrogen and carbon, called hydrocarbons. TPH may enter the environment through accidents, motor vehicle exhaust, industrial releases, or as byproducts from commercial or private uses. Some TPH fractions will float on the water and form surface films, while other TPH fractions will sink to the bottom sediments. TPH can enter Whitman's Pond primarily through storm water runoff.

Sediment samples from the Main and West Basins were analyzed for TPH. TPH concentrations in the Main Basin ranged from ND to 1,450 mg/kg, with an average concentration of 397 mg/kg. However, the average TPH concentration in the western portion of the Main Basin was only 90 mg/kg, whereas the TPH concentration in the rest of the Main Basin averaged 551 mg/kg, likely due to more stormwater discharge locations.

In the West Basin, TPH concentrations ranged from ND to 443 mg/kg, with an average concentration of 130 mg/kg. Three of the five samples had non-detectable concentrations, and the other two samples had concentrations of 209 and 443 mg/kg. While there is no TEC value for TPH, these values are consistent with those of a pond in an urban area.

Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs are usually found as a mixture containing two or more of these compounds, such as soot. Some PAHs are manufactured, and are found in coal tar, crude oil, creosote, and roofing materials. They enter Whitman's Pond primarily through storm water runoff. Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers. PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live due to bioaccumulation.

Sediment samples from the Main and West Basins were analyzed for polynuclear aromatic hydrocarbons (PAHs). Total PAH concentrations in the Main Basin ranged from ND to 44.85 mg/kg, with an average concentration of 5.86 mg/kg, higher than the TEC standard of 1.61 mg/kg. PAH analytes that were detected above the TEC standard included benzo(a)anthracene, chrysene, fluoranthene, phenanthrene, and pyrene. TEC standards do not currently exist for other PAH analytes which were detected in samples.

In the West Basin, PAH were not detected. The difference in PAH concentrations between the Main and West Basins is likely due to the fact that less stormwater drains from urban roads into the West Basin.

Total PAH and TPH concentrations are shown in Table 4 below. Concentrations above the applicable TECs are highlighted. As would be expected, PAH's are highest in the more developed or high traffic areas of MS-8, MS-11, MS-12 and MS-14.

Table 5 - Whitman's Pond Sediment Sampling – Polynuclear Aromatic Hydrocarbons (PAHs) and Total Petroleum Hydrocarbons (TPH)

Analyte	Freshwater Sediment Threshold Effect Concentrations	Sampling Location									
		MS-1	MS-2	MS-3	MS-4	MS-5	MS-6	MS-7	MS-8	MS-9	MS-10
Total PAHs	1.61	ND	ND	ND	ND	ND	ND	ND	44.85	1.02	ND
Benzo(a)anthracene	0.108	ND	ND	ND	ND	ND	ND	ND	3.37	ND	ND
Benzo(a)pyrene	NE	ND	ND	ND	ND	ND	ND	ND	4.10	ND	ND
Benzo(b)fluoranthene	NE	ND	ND	ND	ND	ND	ND	ND	4.47	ND	ND
Benzo(g,h,i)perylene	NE	ND	ND	ND	ND	ND	ND	ND	2.28	ND	ND
Benzo(k)fluoranthene	NE	ND	ND	ND	ND	ND	ND	ND	3.95	ND	ND
Chrysene	0.166	ND	ND	ND	ND	ND	ND	ND	4.70	ND	ND
Fluoranthene	0.423	ND	ND	ND	ND	ND	ND	ND	7.75	ND	ND
Phenanthrene	0.204	ND	ND	ND	ND	ND	ND	ND	3.93	ND	ND
Pyrene	0.195	ND	ND	ND	ND	ND	ND	ND	10.3	1.02	ND
TPH	NE	ND	ND	ND	ND	449	316	274	1,450	261	177

Analyte	Freshwater Sediment Threshold Effect Concentrations	Sampling Location									
		MS-11	MS-12	MS-13	MS-14	MS-15	WS-1	WS-2	WS-3	WS-4	WS-5
Total PAHs	1.61	18.64	7.34	ND	12.59	4.06	ND	ND	ND	ND	ND
Benzo(a)anthracene	0.108	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	NE	1.95	ND	ND	1.24	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	NE	2.56	2.05	ND	1.58	1.26	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	NE	1.83	ND	ND	1.19	ND	ND	ND	ND	ND	ND
Chrysene	0.166	2.32	ND	ND	1.43	ND	ND	ND	ND	ND	ND
Fluoranthene	0.423	3.94	2.50	ND	2.15	1.22	ND	ND	ND	ND	ND
Phenanthrene	0.204	2.04	ND	ND	1.54	ND	ND	ND	ND	ND	ND
Pyrene	0.195	4.00	2.79	ND	2.48	1.58	ND	ND	ND	ND	ND
TPH	NE	852	765	517	477	418	ND	ND	ND	209	443

All concentrations and standards given in milligrams per kilogram (mg/kg).
Highlighted values are above established TEC limits.
ND - not detected above minimum laboratory quantitation limits.

Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs, and they have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor. PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. Additionally, they were used as pesticide "carriers" to help pesticides stick to surfaces, including fruits and vegetables. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include fluorescent lighting fixtures and electrical devices containing PCB capacitors, transformers, and microscope and hydraulic oils.

PCBs can enter water and soil during their manufacture, use, and disposal, from accidental spills and leaks during their transport, and from leaks or fires in products containing PCBs. PCBs can still be released to the environment from hazardous waste sites, through illegal or improper disposal of industrial wastes and consumer products, through leaks from old electrical transformers containing PCBs, and through burning of some wastes in incinerators.

PCBs do not readily break down in the environment and thus may remain there for very long periods of time. In water, a very small amount of PCBs may become dissolved, but most stick to organic particles and bottom sediments. PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in the fat tissues of fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

Sediment samples from the Main, West, and South Basins were analyzed for PCBs. PCB concentrations of Arochlor 1260 were detected in the Main Basin, and ranged from ND to 0.749 mg/kg, with an average concentration of 0.133 mg/kg, higher than the TEC total PCB standard of .0598 mg/kg. PCB concentrations were found mainly in the southern portion of the Main Basin.

PCB concentrations were not detected in samples collected from the West and South Basins. This is especially important for the South Basin, which is used as a water supply.

Table 6 summarizes PCB concentrations from the three basins. PCB concentrations above the applicable TECs are highlighted.

Several properties of Aroclor 1260 warrant discussion. These include the following:

- Of all the PCB compounds, Aroclor 1260 is the least soluble in water. Therefore, leaching into the water is extremely limited.
- Of all PCB's, it has the highest rate of sorbtion to organic matter, making it bind strongly with sediments.
- It has the lowest rate of biodegradation of any PCB, meaning that it will exist in the sediment for many years.
- PCB's can accumulate in organisms, since they build up in fatty tissues.

As previously discussed, PCB's (only Aroclor-1254 and Aroclor-1260) were present in sediment and soils of the disposal area at the Naval Air Base adjacent to the Old Swamp River. Levels were generally <1 mg/kg, but reached levels up to 23 mg/kg. Coincidentally, sediment testing during this study revealed Aroclor 1260 throughout approximately half of the Main Basin, north of Washington Street. However, it was not detected in the South Cove, indicating it is likely from another source. Given the location where it was detected, a potential source of Aroclor 1260 could be a ruptured transformer on Washington Street, where the material would enter the Main Basin through the drainage system.

Table 6 – Whitman's Pond Sediment Sampling – Polychlorinated Biphenyls (PCB's)

Sampling Location	PCB Concentration (Aroclor 1260)
SS-1	ND
SS-2	ND
SS-3	ND
SS-4	ND
SS-5	ND
SS-6	ND
MS-1	ND
MS-2	ND
MS-3	ND
MS-4	ND
MS-5	ND
MS-6	ND
MS-7	ND
MS-8	0.378
MS-9	0.0797
MS-10	ND
MS-11	0.171
MS-12	0.213
MS-13	0.204
MS-14	0.749
MS-15	0.191
WS-1	ND
WS-2	ND
WS-3	ND
WS-4	ND
WS-5	ND

All concentrations and standards given in milligrams per kilogram (mg/kg).
The PCB TEC standard of 0.0598 mg/kg is based on total PCB concentrations.
Highlighted values are above established TEC limits.
ND - not detected above minimum laboratory quantitation limits.

Dredging and Disposal Options

The regulations for disposal of PCB-impacted soil at lined and un-lined landfills is <2.0 mg/l PCBs. (It is important to note that this limit is for soil and sediment). Therefore, if dredging of the Main Basin were pursued, technically the material would need to go to a landfill. However, dredging will cause the re-suspension of this material in the water column, resulting in a significant increase in exposure to fish and aquatic life. It is often preferred to leave the material in place to avoid environmental impacts. Dredging materials of the West or South Coves could possibly be mixed with yard waste to make compost for re-use elsewhere. This would save considerably in disposal costs.

<u>Sources of PCB's</u>

PCB's were only detected in the Main Basin. Given this location, it is suspected that a transformer may have historically ruptured in the vicinity of the Washington Street Pumping Station. The drainage system would carry the material away from the South Cove into the Main Basin and, because it is an oil, it would tend to spread out over time. The other alternative, though less likely, is that is the result of pesticide applications for the former apple orchard, as it was historically used as a pesticide "carrier". We were not successful in determining the definitive source of the material.

5.4 Fish Testing

On behalf of the Town, BETA requested that the Massachusetts Department of Public Health (DPH) conduct fish testing in the Pond under their testing program to determine whether bioaccumulation of PCBs and other pollutants is occurring in fish, and to what degree. The testing was performed by the DEP in December 2003 in conjunction with the DPH. While final results have not yet been released by the DEP, verbal draft results were issued to BETA. The results are detailed below:

Table 7-Whitman's Pond Fish Testing
DEP/DPH Fish Survey Results

Analysis	Fish Tested				
	Yellow Perch	Blue Gill	Eel	Pumpkin Seed	Black Crappie
Arsenic	*0.08*	*ND*	*0.10*	*ND*	*0.12*
Mercury	*0.12*	*0.07*	*0.01*	*0.09*	*0.17*
Selenium	*0.29*	*0.29*	*0.29*	*0.39*	*0.23*
					ND
BDE (a DDT Breakdown)	*0.01*	*ND*	*ND*	*ND*	*ND*
Total DDT and Breakdown Products	*ND*	*ND*	*0.19*	*ND*	*ND*
Total PCB Congeners	*ND*	*ND*	*0.24*	*ND*	*ND*

Notes:

All concentrations given in ppm.

ND - Not Detected.

PCB's were not detected in any fish other than the eel, where trace levels were detected. While BETA has yet to receive a hard copy of the results, verbal discussions with the DEP have indicated that there is not an issue with bio-accumulation in fish, and that no fish advisory would be issued for Whitman's Pond. The final decision will come from the EPA within the next few months.

5.5 Storm Drain Outfall Investigation

BETA attempted to locate and inspect 50 storm drain discharge pipes (outfalls) that discharge into Whitman's Pond. Of the 50 total reported outfalls, BETA was able to locate 46. Four of the 46 outfalls were noted to be present but buried, as dye testing efforts produced evidence of outflow in the vicinity of the estimated locations of the outfalls (see photograph below). Two outfalls were noted to have been disconnected (one was replaced), and two outfalls were never located. All outfalls were inspected during dry weather conditions, defined by the EPA as a prerequisite of three days without precipitation, prior to inspecting.

Of the 46 drains inspected during dry weather conditions, four were observed to be discharging to the pond. BETA collected water samples from four outfalls that exhibited dry weather flow. Of the four outfalls sampled, two discharge to the Main Basin, one discharges to the South Basin, and one discharges to the West Basin. Samples were analyzed for ammonia (as nitrogen), nitrate (as nitrogen), total phosphorous, total dissolved solids, surfactants, fluoride, fecal coliform, Enterococcus, Eschericia coli, and total metals. Due to small discharge volume in one of the outfalls (34B), the sample collected from that outfall was analyzed only for fecal coliform, Enterococcus, and Eschericia coli. The presence of any of these contaminants could indicate the presence of sewage or industrial contamination or illicit connections.

Analytical results were compared to the Massachusetts Maximum Contaminant Levels (MMCLs) and Secondary Maximum Contaminant Levels (SMCLs). Results of the outfall sampling activities are described in the narratives below. The Whitman's Pond drainage system and drainage watershed are illustrated in Figure 10, and outfall sampling locations are illustrated in Figure 11, and sampling results are tabulated in Tables 8 and 9.

Table 8-Whitman's Pond Outfall Investigation Log

	Original Weymouth Outfall ID #	Corresponding Town wide Stormwater ID #	Pipe Size and Type	Flow	Description	Picture
Dry:						
	13	**49-2**	12" reinforced concrete	no		yes
	15	**49-1**	12" concrete	no	**Dyed, buried and staked.*** **	yes
	16	**50-6**	10" concrete	no		yes
	17	**50-7**	8" concrete	no		yes
	17a	**50-8**	8" clay	no		yes
	18	**57-14**	8" concrete (broken up headwork)	no		yes
	19	**57-12**	10" corrugated metal	no		yes
	20	**57-11**	15" concrete (in headwork)	no		yes
	21	**57-10**	12" clay (in headwork)	no		yes
	22	**57-9**	6" cast iron	no		yes
	23	**57-8**	10" concrete (in stone headwall)	no		yes
	24b	**64-6**	15" concrete (in headwall)	no		yes
	24c	**64-5**	24" concrete (in headwall)	no		yes
	25	**64-3**	10" concrete	no		yes
	26	**64-2**	10" concrete	no		yes
	27	**64-1**	12" corrugated metal	no		yes
	28	**57-7**	n/a	no	**Dyed, buried and staked.**	yes
	29	**57-6**	18" concrete	no		yes
	30	**57-5**	12" concrete	no		yes
	31	**57-4**	10" clay	no		yes
	32	**57-3**	15" concrete (in headwall)	no	Part filled w/ moist soil and small plants.	yes
	33	**57-2**	12" concrete	no		yes
	35	**50-1**	10" concrete	no		yes
	36	**51-5**	10" concrete	no		yes
	37	**51-4**	10" concrete	no		yes
	38	**51-3**	10" concrete	no		yes
	38a	**51-2**	10" concrete	no		yes
	39	**51-1**	10" concrete	no		yes
	40	**51-6**	12" concrete	no		yes
	41	**50-2**	8" concrete	no	**Dyed, buried and staked (break in pipe).**	yes
	42	**50-3**	12" concrete	no		yes
	43	**50-4**	12" clay in headwork	no		yes
*	44	**50-5**	24" clay (in headwork)	no		yes
	45	**49-13**	10" concrete	no		yes
	46	**49-12**	10" concrete	no		yes
	47	**49-11**	10" corrugated metal	no		yes
	48	**49-10**	12" concrete	no	In culvert under Middle Street.	yes
	48a	**49-9**	12" concrete	no	In culvert under Middle Street.	yes
	48b	**49-5**	12" concrete	no		yes
	50	**49-3**	12" concrete	no		yes
	51	**49-8**	10" concrete	no		yes
	52	**49-4**	10" concrete	no	**Dyed, buried and staked.**	yes
	53	**49-7**	12" concrete	no		yes
Wet:						
*	24d	**64-4**	24" concrete (in headwall) (iron staining)	**yes**		yes
**	34b	**57-1**	10" concrete w/ plastic liner (in headwall)	**yes**		yes
*	49	**49-6**	24" concrete (in headwork)	**yes**		yes
Not Located:						
	24a	**64-9**	n/a		Under yard waste	
	24		15" concrete (in headwall)		Possibly destroyed.	
Disconnected:						
	34				**Blocked off and rerouted to 34b.**	
	17b	**50-9**	10" concrete	no	**Buried, blocked off and closed.**	

Ammonia (as nitrogen)
Ammonia is produced by bacteria during decomposition of proteins and other nitrogenous organic substances in the water and benthic sediments. Animal and human excrement may contribute an insignificant amount of ammonia. Household use of ammonia-containing cleaning products and improper disposal of ammonia products may contribute to non-point pollution. The presence of ammonia in outfalls discharging into Whitman's Pond could indicate an illicit private connection to the storm drainage system.

Dry weather samples collected from three of the four storm drain outfalls were analyzed for ammonia. Ammonia concentrations were detected in all three outfalls sampled, at concentrations of 0.57, 0.89, and 1.8 mg/l. These levels are within acceptable limits, and do not indicate illicit connections to the sewer system. There is no established MMCL for ammonia.

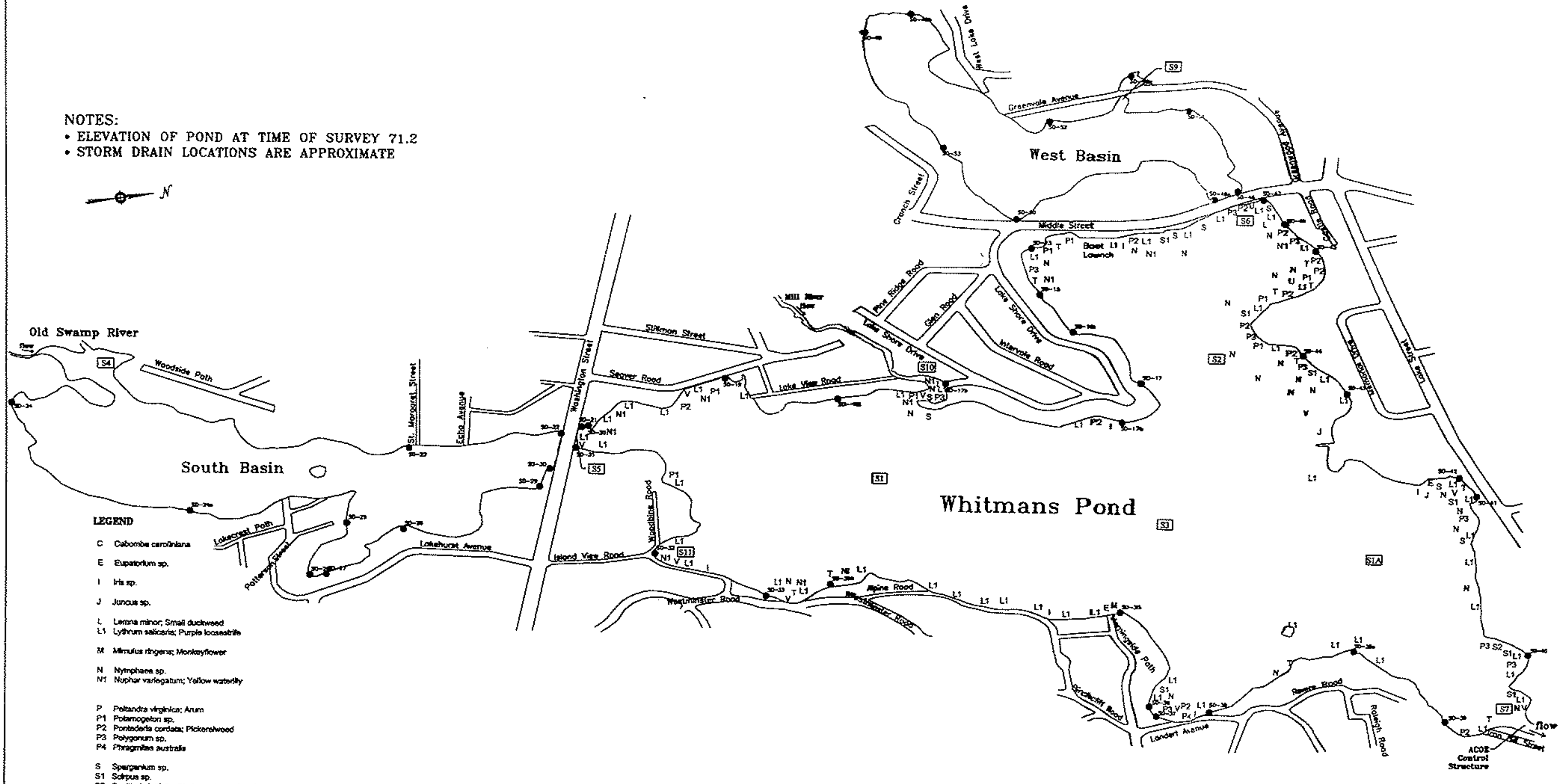
Nitrate (as nitrogen)
Nitrogen-containing compounds act as nutrients in streams and rivers. Nitrate reactions in fresh water can cause oxygen depletion. Thus, aquatic organisms depending on the supply of oxygen in the stream will often die in the presence of excessive nitrate. The major routes of entry of nitrogen into bodies of water are municipal and industrial wastewater, septic tanks, animal wastes (including birds and fish) and discharges from motor vehicle exhaust deposits carried by storm water.

Dry weather samples collected from three of the four storm drain outfalls were analyzed for nitrate (as nitrogen). Nitrate concentrations were detected in two of the three outfalls sampled, at concentrations of 0.2 and 0.26 mg/l. These concentrations are similar to those obtained in 1983, and are below the established MMCL of 10 mg/l. The levels detected do not indicate connections to the sanitary sewer system.

Total Phosphorous
Phosphorous occurs in nature and is critical to support plant life in aqueous environments. However, too much phosphorous causes an excessive growth of phytoplankton and other organisms, which deprive fish and other marine life, including plants, of oxygen. Phosphorous is present in human and animal waste, as well as in urban runoff. The presence of phosphorous in outfalls discharging into Whitman's Pond could indicate an illicit private connection to the storm drainage system.

Dry weather samples collected from three of the four storm drain outfalls were analyzed for total phosphorous. Phosphorous was detected in one of the three outfalls sampled, at a concentration of 0.1 mg/l. There is no established MMCL for phosphorous, but these results indicate that dry weather flows contribute negligible amounts of phosphorus to the Pond, and no illicit connections to the sanitary sewer system.

NOTES:
- ELEVATION OF POND AT TIME OF SURVEY 71.2
- STORM DRAIN LOCATIONS ARE APPROXIMATE



LEGEND

- C Cabomba caroliniana
- E Eupatorium sp.
- I Iris sp.
- J Juncus sp.
- L Lemna minor; Small duckweed
- L1 Lythrum salicaria; Purple loosestrife
- M Mimulus ringens; Monkeyflower
- N Nymphaea sp.
- N1 Nuphar variegatum; Yellow waterlily
- P Peltandra virginica; Arum
- P1 Potamogeton sp.
- P2 Pontederia cordata; Pickerelweed
- P3 Polygonum sp.
- P4 Phragmites australis
- S Sparganium sp.
- S1 Scirpus sp.
- S2 Sagittaria latifolia; Big-leaved arrowhead
- T Typha latifolia; Cattail
- U Utricularia sp.; Bladderwort
- ● SD-1 Storm Drains
- S4 2000 Sample Locations

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DRAWN BY	NW
DEPT. CHECK	RCH
PROJ. CHECK	SMS
SCALE:	1"=400'

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

Figure 2 - Site Plan
Whitman's Pond
Weymouth, MA

JOB NO.	1826-01
FILE	1826SitePlan
SHEET	1of1

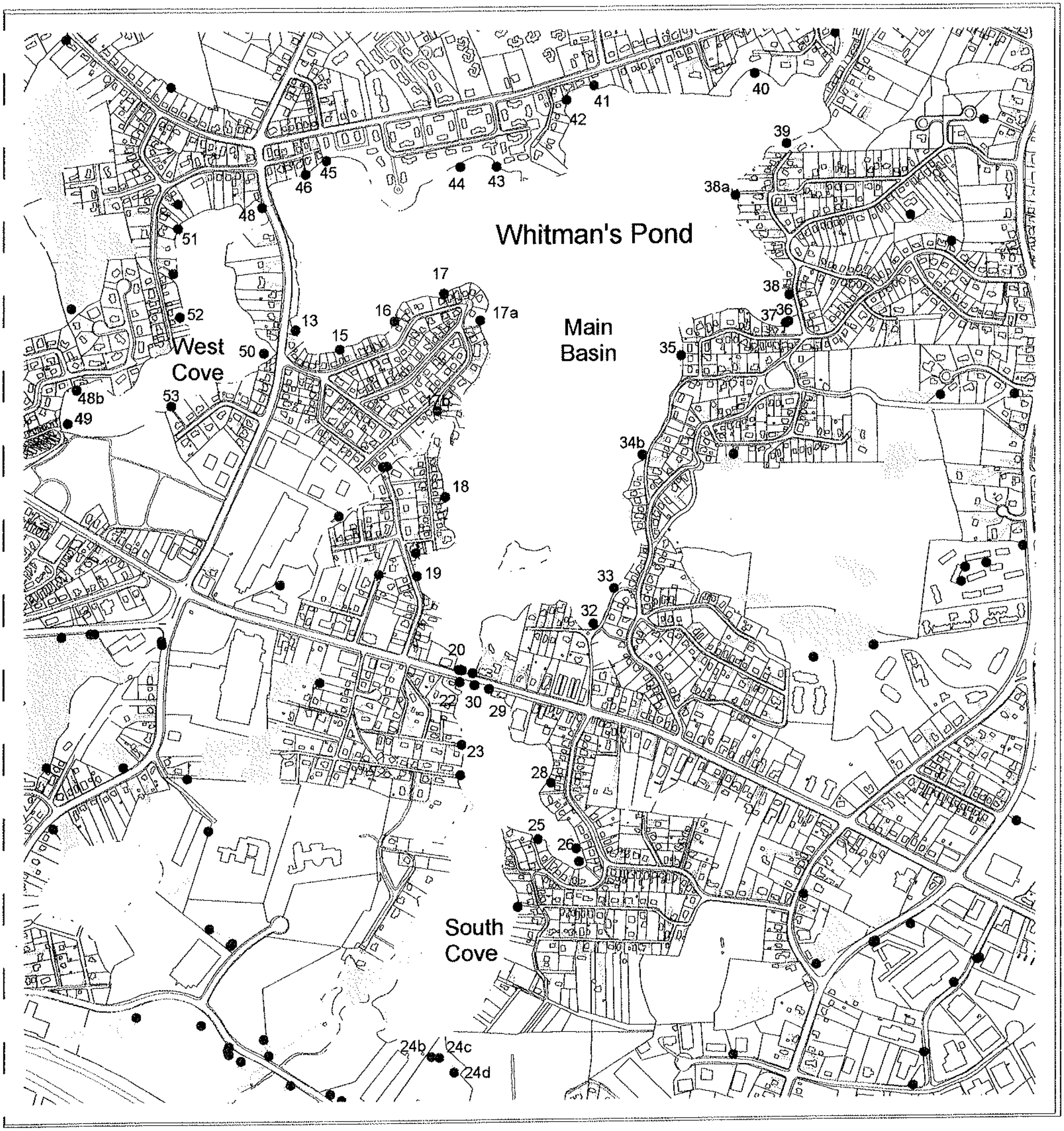

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Figure 11
Whitman's Pond
Drainage Outfalls

Total Dissolved Solids

Dissolved solids refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and some small amounts of organic matter that are dissolved in water. TDS originate from natural sources, road salt, sewage, urban run-off and industrial wastewater. An elevated TDS concentration is not a health hazard. The TDS standard is a secondary drinking water standard and therefore is regulated because it is more of an aesthetic threshold than a health hazard.

Dry weather samples collected from three of the four storm drain outfalls were analyzed for TDS. TDS concentrations were detected in all three outfalls sampled, at concentrations of 170, 210, and 350 mg/l. These concentrations are below the established SMCL of 500 mg/l, and consistent with background levels typical in groundwater.

Surfactants

Surfactants are chemical agents such as soap or synthetic detergents. Examples of surfactants include laundry detergent, dishwashing detergent, soaps, and shampoos. The presence of surfactants in outfalls discharging into Whitman's Pond could indicate an illicit private connection to the storm drainage system, such as sewage.

Dry weather samples collected from three of the four storm drain outfalls were analyzed for surfactants. Surfactants were not detected in any of the three outfalls sampled. There is no established MMCL for surfactants, but this indicates that surfactants are not of concern in dry weather flows.

Fluoride

Fluoride is naturally present in all water. Community water fluoridation is the addition of fluoride to adjust the natural fluoride concentration of a community's water supply to the level recommended for optimal dental health, approximately 1 part per million (ppm). The presence of fluoride in outfalls discharging into Whitman's Pond could indicate an illicit private connection to the storm drainage system, due to its presence in the drinking water supply.

Dry weather samples collected from three of the four storm drain outfalls were analyzed for fluoride. Fluoride was not detected in any of the three outfalls sampled. The established SMCL for fluoride is 2 mg/l. This indicates potable water or sewage is not flowing into the pond through storm drains.

Fecal Coliform

Fecal coliform bacteria are a group of bacteria that are passed through the fecal excrement of humans, livestock, and wildlife. They aid in the digestion of food. The bacteria can enter bodies of water through direct discharge of waste from mammals and birds, from agricultural and storm runoff, and from untreated human sewage. Individual home septic tanks can become overloaded during the rainy season and allow untreated human wastes to flow into drainage ditches and nearby waters. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Untreated fecal material, which contains fecal coliform adds excess organic material to water. The decay of this material depletes the water of oxygen. This lowered oxygen may kill fish and other aquatic life.

Dry weather samples collected from all four storm drain outfalls were analyzed for fecal coliform. Fecal coliform was detected in one of the four outfalls sampled, at a concentration of 250 colonies/100 ml. The outfall in which fecal coliform was detected discharges into the Main Basin. While the standard for Class A waters is 20 organisms/100 ml., the Main Basin is not used as a water supply. Additionally, levels over 20 would be expected given the excessive waterfowl and urban watershed. The limit for swimming is 200 colonies/100 ml.

Enterococcus

Enterococcus bacteria are a valuable indicator for determining the extent of fecal contamination of recreational surface waters. Studies have shown that swimming associated gastroenteritis is related directly to the quality of the bathing water and that enterococci are the most efficient bacterial indicator of water quality. Water quality guidelines have been proposed based on enterococcal density. Recreational fresh waters should have less than 33 enterococci/100ml.


Trailer Park Drain

Dry weather samples collected from all four storm drain outfalls were analyzed for enterococcus. Enterococcus was detected in one of the four outfalls sampled, at a concentration of 180 colonies/100 ml. The outfall in which enterococcus was detected discharges into the West Basin. There is no established number standard for enterococcus, but 180 is considered low with respect to water quality.

Eschericia Coli

The most common subgroup of the fecal coliform group is Eschericia coli (E. Coli). These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals.

Dry weather samples collected from all four storm drain outfalls were analyzed for E. coli. E. coli was not detected in any of the four outfalls sampled. There is no established number standard for E. coli.

Total Metals

Dry weather samples collected from three of the four storm drain outfalls were analyzed for total metals, including arsenic, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, and zinc.

Low concentrations of barium, iron, and zinc were detected in two of the three outfalls, and low concentrations of magnesium were detected in all three outfalls sampled. The concentrations of these metals were below MMCLs.

Concentrations of manganese were detected all three outfalls sampled. Concentrations in two of the three outfalls were above SMCLs. Since SMCLs are developed for aesthetic purposes, these concentrations are not considered to pose a problem to the pond's water quality.

Table 9 summarizes dry weather outfall sampling results. Concentrations above the applicable MMCLs or SMCLs are highlighted.

Table 9 - Whitman's Pond Dry Weather Outfall Sampling – Bacteria, Metals, and General Parameters

Analyte	Massachusetts Contaminant Level, Maximum(MMCL) or Secondary (SMCL)	Outfall Identification			
		24D	44	49	34B
		06/03/02	06/03/02	06/03/02	06/18/02
General Parameters (mg/l unless otherwise noted)					
Ammonia (as nitrogen)	NE	1.8	0.89	0.57	NA
Fluoride	4	ND	ND	ND	NA
Nitrate (as Nitrogen)	10	ND	2.6	0.2	NA
Surfactants	NE	ND	ND	ND	NA
Total Phosphorous	NE	0.1	ND	ND	NA
Total Dissolved Solids	500	170	210	350	NA
Bacteria (colonies/100 ml)					
Fecal Coliform	NE	<10	<10	<10	250
Eschericia Coliform	NE	<10	<10	<10	<10
Enterococcus	NE	<10	<10	180	<10
Metals (mg/l)*					
Arsenic	0.05	ND	ND	ND	NA
Barium	2	0.056	ND	0.23	NA
Cadmium	0.005	ND	ND	ND	NA
Chromium	0.1	ND	ND	ND	NA
Copper	1.3	ND	ND	ND	NA
Iron	0.3 (SMCL)	11	ND	6.6	NA
Lead	0.015	ND	ND	ND	NA
Magnesium	NE	2.9	3.4	3.9	NA
Manganese	0.05 (SMCL)	0.54	0.034	0.81	NA
Mercury	0.002	ND	ND	ND	NA
Nickel	NE	ND	ND	ND	NA
Zinc	5 (SMCL)	0.047	0.037	ND	NA

ND - not detected above minimum laboratory quantitation limits.
Highlighted values are above established MMCL or SMCL limits.
NE – standard not established.
NA – not analyzed.

Summary-Dry Weather Sampling

Dry weather samples collected from all four storm drain outfalls exhibited levels of bacteria, metals, and other parameters below applicable MMCLs and SMCLs, with the exception of iron and manganese, which were detected above SMCLs in two of the outfalls.

BETA followed up the dry weather sampling event with an investigation of the storm water drainage system upstream of the outfalls. In all four cases, when BETA traced the system back to the preceding drain manhole, the water level in the manhole was below the invert to the outgoing outfall pipe. Thus, this dry weather flow is likely attributed to groundwater infiltration into the drainage pipe between the manhole and the outfall, and not due to illicit discharges. This is supported by the laboratory analytical data, where levels of iron and manganese are above SMCLs, but all other parameters are within MMCL and SMCL limits. Elevated concentrations of iron and manganese are often associated with groundwater quality attributed to the regional geology.

Low concentrations of barium, iron, and zinc were detected in two of the three outfalls, and low concentrations of magnesium were detected in all three outfalls sampled. The concentrations of these metals were below MMCLs.

5.6 Base Map Preparation

Historically, no comprehensive maps have ever been developed for Whitman's Pond, the South Cove or West Cove. Additionally, an accurate map of the drainage system has never been developed. While a "Drain Atlas" exists, it was originally developed in the 1980's, and, based upon BETA's field inspections, many drainage system changes are not reflected in the Atlas.

Base Maps were developed in order to illustrate bathymetric data for the Pond, including all three basins. This included the thickness of sediment and bottom contours as well. This allows the volume of sediment to be determined, should dredging be pursued in the future. The survey was developed in strict accordance with the Massachusetts DEM's Bathymetric Survey Specifications. If dredging is pursued, these maps can be used to supplement federal and state Dredging Permit applications, as well as applications for state grant funding. Copies of the bathymetric survey maps are included as Appendix B.

In addition, mapping was developed for the drainage system location and components, septic system locations, and drainage outfall and sediment sampling locations. The base mapping provided an inventory of the existing watershed and drainage system in order to evaluate system deficiencies, analyze water quality and sediment quality, nutrient and pollutant inputs into the Pond, and to plan proposed improvements. Development of the GIS base mapping for the project was a critical element in the planning process, and represents the first accurate, comprehensive map of the drainage system of the Whitman's Pond Watershed.

The elements included in the base mapping effort are topographic/planimetric maps of the entire watershed at a scale of 1"=100' and existing drainage system mapping. All data collected and created in conjunction with the project was developed in GIS format for analysis purposes and for later use in the Town's overall GIS program.

5.7 Storm Drain Assessment

Approximately 800 catch basins within the Whitman's Pond sub-watershed were cleaned of sediments during this study. This equates to approximately 800 cubic yards of sediments and pollutants removed from the drainage system prior to discharging to Whitman's Pond. Elimination of nutrients and sediments to the pond is key to limiting eutrophication. Therefore, the catch basin cleaning program should continue on a regular basis.

The assessment included the physical inspection by BETA staff of approximately 1,200 drainage structures (both catch basins and manholes) for illegal connections to the sewer system. Other features, such as deficiencies, buried pipes, and crossing utilities, are also described in the inspection logs. No illegal connections were noted during the inspection program.

Of the 800 catch basins within the watershed, approximately 260 contribute either direct or indirect discharges to the three basins through drainage pipes, as detailed in Exhibit A. There are 46 known discharges to the three Basins. Thirty discharges flow into the Main Basin, five to West Cove and eleven into the South Cove. These discharges are shown in Exhibit A – Whitman's Pond Watershed Map.

This project included the purchase of a number of stencils to mark catch basins within the Whitman's Pond watershed "DUMP NO WASTE - DRAINS TO LAKE." These stencils have been used by volunteers to mark all basins within the watershed in an effort to reduce illegal dumping.

Structural Assessment

BETA performed a structural assessment of each catch basin, drainage manhole and drainage outfall that was inspected. This was done to identify the integrity of the existing storm water system and any problem areas. The inspection information was entered into an access database in order to be GIS compatible, and submitted to the Town as part of the town-wide Storm Water Management Plan (SWMP). Storm drain system deficiencies (buried outfalls, utilities installed through structures, maintenance problem areas, sedimentation problem areas, and water quality issues were included in the inspection reports, so that the Town DPW has an inventory of the drainage system. The inspection reports (hard copies) will be provided to the Town.

Hydrology Study

A watershed hydrology study was performed to identify drainage and sub-drainage watershed areas and the location of storm water outfalls associated with the determined watershed areas. This information was compared to land use data, soils data, and monitoring data in order to determine potential sources and targets for future water quality improvement efforts. The hydrology and watersheds are depicted in Exhibit A – Whitman's Pond Watershed Map.

5.8 Wet Weather Sampling

Wet weather sampling data was previously collected by Metcalf and Eddy (M&E) as part of a Feasibility Study conducted 1983. During that study, M&E collected wet weather samples from the two most densely developed areas contributing storm water to the pond, located on Lake Street and on Washington Street (Route 53). Results from the wet weather sampling events indicated that the concentrations of detrimental nutrients entering the pond via the storm water systems in these areas were not significantly higher than those levels already present in the pond, and therefore pollutant loading was not taking place. Since the M&E study, the Lake Street and Washington Street areas have changed little with regard to density and land use. Therefore, additional wet weather sampling was not deemed necessary. Efforts were focused on data that was lacking, and on coordinating restoration efforts. Available data indicates that storm water discharges during rain events are typical of those found in urban areas, and there are no apparent "hot-spots" or sources of contamination.

5.9 Additional Restoration Efforts

Additional Restoration Efforts associated with nuisance vegetation are discussed in detail in Section 6.0.

6.0 MACROPHYTIC VEGETATION

6.1 Background

In the early 1900s, portions of the West Basin and the (western portion) of the Main Basin of Whitman's Pond were used as an apple orchard. The orchard was flooded when a dam was constructed at the outlet of the pond, increasing the volume of the pond. The former orchard has since been recognized as part of Whitman's Pond. In addition, historic maps show a large portion of the West Basin was a swamp prior to construction of the dam. These portions of the pond are currently experiencing the majority of invasive weed plant growth. It is theorized that the erosion of enriched soil into the pond from former agricultural uses provided the necessary conditions for aquatic plants to grow and populate to nuisance proportions.

Whitman's Pond has seen an increase in macrophytic vegetation over the past several decades. Populations of several invasive species such as *Lithrum salicaria*, *Phragmites australis* (common reed), and *Cabomba caroliniana* (fanwort) have increased. The West Basin has seen the largest increase in macrophytic vegetation. In addition, areas along the perimeter of the Main Basin have seen an increase in populations of *Lythrum salicaria*, *Cabomba caroliniana*, *Polygonum sp* (buckwheat, smartweed), *and Nymphaea sp* (waterlillies). The depth in the north central area of the Main Basin appears to be decreasing since surveys were performed in the early 1980's. In this area stands of *Lythrum salicaria* are present.

The littoral region is the interface between the land of a drainage basin and the open water. The littoral flora contributes significantly to the productivity of the lake/pond ecosystem. Dense stands of macrophytic vegetation in this zone can alter the environmental conditions. Due to competition for light and nutrients, the population of phytoplankton decreases. Under floating vegetation the temperature increases and oxygen concentration decreases.

The littoral zone provides habitat and a diverse food source for fauna. However, mono-dominant stands of macrophytic vegetation are common due to the competitiveness of invasive and invasive exotic plants (Kusler, Kentula, 1990). The overabundance of these invasive species jeopardizes those fauna dependent on native vegetation. In addition, excessive aquatic vegetation can accelerate the eutrophication process by contributing to the organic matter. High levels of decaying organic matter along the bottom of the pond decreases dissolved oxygen levels which results in the loss of fish.

6.2 Weed Harvesting and Hydro-Raking

BETA supervised the services of Aquatic Control Technology, Inc. of Sutton, MA to remove a large portion of the invasive macrophytic vegetation from the West Basin, dominated by fanwort weeds. The weed removal was done using weed harvesting and hydro-raking technology. The weed harvester is mounted on a floating barge. It cuts the weeds below the surface of the water. The hydro-rake then follows behind and pulls the roots of the plants out of the sediment, minimizing future growth. Thus, along with the weed stems, the hydro-rake removes some of the root system and associated sediment. Harvested weeds are temporarily stored on a floating transport barge/harvester, which holds up to three to five cubic yards (3,000 pounds) of cuttings. Upon receiving a full load of cuttings, the barge is powered to the shore, where it unloads the cuttings to a loader for hauling to a compost facility. This process is repeated as needed to remove the desired volume of invasive weeds and plant growth.

BETA supervised a total of nine days of weed harvesting operations, during which a total of 150 tons of weeds, organic muck and other invasive organic material was removed. This represented an area of approximately seven acres of clearing in the West Basin, or approximately one-half of the Basin. The material was transported by the DPW to the compost facility on Wharf Street.

Because it is predominantly plant, root and organic matter, it can be mixed with yard waste to form a compost material. This eliminates the large costs of disposal associated with dredged material, which is regulated and often must be disposed of in a landfill.

The material which is removed, in particular the organic muck, results in a net loss of nutrients available to any future plant growth. Additionally, harvesting reduces the internal phosphate loading by limiting root uptake from the sediment and subsequent release to the open water.

BETA performed another round of hydro-raking in the western portion of the Main Basin in October of 2003. The area was in the vicinity of the new park on Middle Street, where West Cove flows into the Main Basin. Approximately 100 tons of weeds and organic muck were removed from this area over a seven day period.

6.3 Sonar AS (Fluridone) Chemical Treatment

In the summer of 2003, BETA supervised the chemical treatment of the West Cove with the USEPA/MA registered aquatic herbicide Sonar (fluridone). Sonar inhibits the plant's ability to make food. Specifically, it inhibits the synthesis of carotenoids. Carotenoids (yellow pigments) are a part of a plant's photosynthetic system. These yellow pigments protect the plant's chlorophyll (green pigments) from photodegradation. When carotenoids are destroyed, the plant's chlorophyll is exposed to photodegradation and gradually destroyed. When a plant's chlorophyll decreases, so does the plant's ability to produce carbohydrates through photosynthesis, and the plant slowly dies.

Sonar is the only herbicide that works effectively on fanwort. Sonar will not harm fish, wildlife, or humans when applied properly. Sonar has also been approved for use in drinking water reservoirs at low doses. Using Sonar to chemically treat the West and Main Basins of Whitman's Pond should provide at least two to three years of effective plant control.

Generally, chemical treatments alone are considered to have relatively short-term and localized effects. Chemical treatments are most effective when combined with other management practices, including weed harvesting and source removal of nutrients and pollutants.

6.4 Fish Habitat – Aeration

The Town applied for funding in 2002 and retained BETA to purchase three (3) aerators to increase the oxygen content of the water of the Main Basin. Portions of the Main Basin become anoxic (0 mg/l oxygen) during the year, and fish cannot survive. The aerators have been purchased, and the structural housing and electrical work has been completed. Hydro-raking of the areas where the aerators will be installed is planned to maximize their benefit. Hydro-raking must be done prior to their installation due the associated cables and hoses of the aerators. The aerators will provide sources of oxygen currently not available. Due to the cost and electrical constraints, they will be installed adjacent to the new park on Middle Street. This will significantly improve conditions for fishing at the park.

The herring and many of the other fish species need to lay their eggs on sand or gravel. The Cobomba infestation and algae restrict access to the bottom, and fish are unable to find a suitable spot to lay their eggs. The weed harvesting, herbicide applications and aerators will significantly improve conditions for spawning in these areas.

6.5 Phosphorus Reduction – Aeration

As previously discussed, a reduction in available phosphorus is one of the primary restoration goals for the Pond. The sediments of the Pond are enriched with phosphorus. A lack of oxygen, or anoxic conditions, causes a release of available phosphorus from the sediments. The aerators will provide the additional benefit of reducing the release of phosphorus, and therefore reduce eutrophication and production of nuisance weeds and algae as well.

7.0 WATERSHED MASTER PLAN

7.1 Summary

BETA has completed this study in an effort to identify nutrient and pollutant contributions to Whitman's Pond, and eliminate these contributions, to the greatest extent possible.

In addition to the investigations and studies, a number of pond restoration efforts have been previously performed for the pond, including:

- Construction of a sediment nutrient uptake pond
- Installation of two pond water quality "Restorers" (one in South Cove, one in West Cove)
- Several major sewer improvement projects

BETA has performed a number of investigations and studies, including:

- Whitman's Pond Habitat Study
- Storm water drainage outfall investigation
- Structural assessment of each drainage structure inspected
- Dry weather outfall sampling program
- Sediment testing in the Main Basin, both coves, and Old Swamp River
- Dry weather sampling of SNUP structure
- Bathymetric survey of all three basins

In addition to these studies, BETA has managed the following pond restoration efforts:

- Weed harvesting and hydro-raking (in West Cove and Main Basin)
- Herbicide treatments (in West Cove)

In total, all pond restoration efforts conducted by the Town, previous consultants, and BETA have a combined cost in the millions of dollars.

From BETA's sampling information and existing data, maximum pollutant and nutrient loads were determined in order to establish thresholds and water quality improvement goals for nutrient and pollutant loading into Whitman's Pond. Of these, the most significant input is that of phosphorus.

7.2 Recommendations

Nutrient and Pollutant Loading

Based on the storm drain inspections, sampling and hydrology study, storm water system improvements and modifications should be performed. Improvements include fitting new catch basins with hoods and updating existing catch basins with hoods when they are repaired or replaced. Additionally, all new catch basins should have deep sumps, to maintain the ability to collect more silt. Appropriate Best Management Practices (BMPs) should be implemented and include water quality enhancement structures, as detailed below:

Sediment Nutrient Uptake Pond (SNUP)

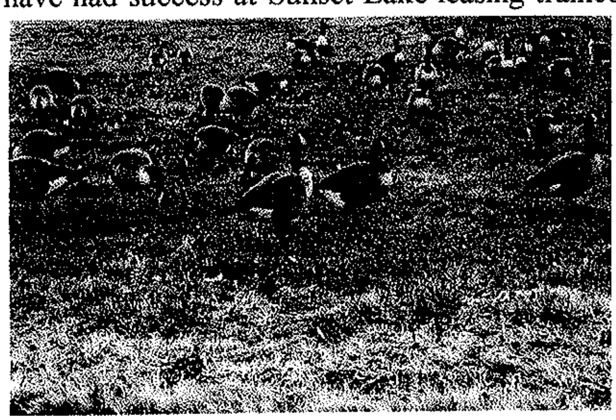
It is recommended that modifications to the weir structure of the sediment nutrient uptake pond (SNUP) be made to improve its efficiency. Many thousands of dollars were spent on this wetland system, which is now dysfunctional. Lowering the height of the structure slightly and keeping the sluice gate closed will allow dry weather flows to pass through the SNUP for nutrient uptake. Testing during this study revealed a 50% removal in phosphorus of Old Swamp River flows during dry weather. Since an estimated 60% of phosphorus loads upon Whitman's Pond come from the Old Swamp River (Metcalf and Eddy, 1983), this should be considered a priority. Periodic removal of vegetation (harvesting) will be required to ensure its efficiency. The DPW has indicated a willingness to perform this task, likely once or twice or year. Modifications and maintenance on the SNUP rank high with respect to environmental benefit, value to the Whitman's Pond watershed, and construction costs. These modifications rank slightly lower with respect to public support, as the SNUP is not in a high profile location, and the science behind the SNUP is not widely understood by most residents.

Septic to Sewer Conversions

Modifications to existing septic systems are recommended, based on our investigations. Homes with septic systems that potentially influence the water quality of Whitman's Pond (those within the Whitman's Pond watershed) should be connected to the municipal system, as shown on Figure 4. Grants and loans are available through the State Revolving Loan Fund (SRF) and the 319 Grant program to fund these sewer projects. Town funding is available in the form of 10-20 year low interest loans. The Town is also in the process of drafting rules and regulations for mandatory hookup to the Town sewer system when a home is sold. Septic system modifications rank high with respect to environmental benefit and value to the Whitman's Pond watershed. However, public support over conversion to sewer can be divided, as sewer conversion costs are a factor to those residents currently serviced by a septic system.

Feeding of Waterfowl

To reduce phosphorus and nutrient levels, the reduction of waterfowl in the vicinity of the Pond is recommended. Nearby Towns such as Braintree have had success at Sunset Lake leasing trained border collies to chase away waterfowl. The feeding of geese should strongly be discouraged through local ordinances, signage, and non-criminal citations. Discouraging the feeding waterfowl ranks high with respect to environmental benefit, value to the Whitman's Pond watershed, and construction costs. However, public support is not likely, as the feeding of waterfowl is considered an enjoyable leisure activity for many residents, especially children, in the vicinity of the pond.



Sewer System Improvements

Since 1960, spring precipitation in Weymouth exceeded 2003 in only five (5) years. This excessive precipitation results in flows which exceed the capacity of the municipal sewer system. The result is sewer overflows into the Old Swamp River and West Cove. As a result of excessive precipitation this year, the overflows were extraordinary, and algal blooms were as well. A reduction in these overflows through the planned sewer improvements (CIP) is critical for the restoration of Whitman's Pond. Since the Town is essentially built-out, with little room for new development, and significant projects over the years have reduced the amount of infiltration/inflow (I/I) into the sewer system, continued I/I reduction, along with the CIP sewer projects, should significantly reduce the overflows, and associated nutrient inputs into Whitman's Pond. Sewer improvements rank high with respect to environmental benefit, value to the Whitman's Pond watershed, and public support. However, construction costs to the Town are a factor.

Erosion and Sedimentation

An effective means of reducing sedimentation is increased rates of street sweeping and catch basin cleaning. A plan should be developed for the Whitman's Pond watershed which includes increased street sweeping and catch basin cleaning schedules. Additionally, the installation of end-of-pipe BMPs are recommended in several locations, including the following:

1. **Installation of oil/water separator at Middle Street drainage outfall where West Cove enters Main Basin.** The installation of an oil/water separator will remove oil and petroleum products, sand, sediment, trash, and other debris prior to discharge into the pond. Periodic Town maintenance will be required for this system.

2. **Relocation of drainage outfall on Washington Street to discharge into Main Basin, not South Cove, and installation of oil/water separator.** During a proposed development project on Washington Street, near the location of this outfall, the Town may request that the developer relocate this outfall so it discharges into the Main Basin, instead of South Cove, where it currently discharges. Additionally, the installation of an oil/water separator will remove oil and petroleum products, sand, sediment, trash, and other debris prior to discharge into the pond. Periodic Town maintenance will be required for this system.

These locations were selected based on high density of development, high traffic, and visual evidence of poor performance, including siltation and debris at the end of the pipe. Policies and ordinances should be developed and implemented by the Town to ensure that existing and future development within Whitman's Pond watershed addresses the goals of the restoration plan. This includes ensuring that maintenance of private drains and routine cleaning of catch basins is done on a regular basis. The installation of these BMPs rank high with respect to environmental benefit, value to the Whitman's Pond watershed, and public support. However, construction and maintenance costs and obligations to the Town are a factor as well.

Dredging

Dredging should be considered in specific areas of the pond, such as those used for recreation (new park on Middle Street), spawning areas for fish, and at inlets and outlets. While dredging is expensive, the focus should be on specific problem areas. Dredging costs, on average, about $30 per cubic yard, plus the cost for disposal. For example, dredging 2.5 feet of sediment from the approximately five (5) acres of the South or West Cove would cost approximately $300,000.00. Possible funding sources include the 319 Grant Program, since the Old Swamp River and Mill River are listed as impaired waters on the 303d list. Dredging in these specific areas ranks high with respect to environmental benefit, value to the Whitman's Pond watershed, and public support. However, project costs to the Town are a significant factor.

Additionally, the pipe connecting the Main Basin and West Cove should be lowered so there is a better hydraulic connection. In some years, during extremely dry periods, the water level in the West Cove and Main basin falls below the invert of the conduit pipe connecting the basins, and there is no hydraulic connection between the two basins. This impedes the migration of herring and other species. An adjustment of this culvert ranks high with respect to environmental benefit, value to the Whitman's Pond watershed, and public support. However, project costs to the Town are a factor, especially since several utilities pass through the culvert, increasing construction costs.

Aquatic Invasive Plant Species

An integrated management plan will be needed to continue to control existing invasive plant communities and potential introduction of other invasive communities. In most cases the implementation of one method does not produce long-term sustainable results. Therefore, an integrated approach is necessary. Available methods include biological, chemical and physical treatments.

Biological Management (introduction of insects, pathogens, fish, etc.)

Many aquatic invasive plant species can be controlled by introducing a predator, pathogen or other known biological control. Galerucella Pusilla (Golden loosestrife beetle) for example, is one promising option. This beetle feeds on the leaves and buds of purple loosestrife plants, defoliating the plant so severely that it often dies. While skeptical at first, after researching the issue, we found that this is being done all across the country, and has been successful. We have spoken with Integrated Weed Control, and provided information to the Town and Whitman's Pond Association on this issue. Information on this can be obtained at www.integratedweedcontrol.com/insects. They provide any state permits free of charge. A "release" of 105 beetles costs $75.00. Each female lays about 300 eggs per summer. In winter, they bury beneath the ground, as other beetles do. They are available every May, and are shipped overnight for release within the next several days. Simply dump the canister the insects are shipped in, and they begin consuming the loosestrife until no more foliage remains and the plants die. The introduction of natural predators ranks moderate with respect to environmental benefit and value to the Whitman's Pond watershed. Costs rank high, as this treatment is

Galerucella Pusilla

relatively inexpensive. Lack of public knowledge makes public support for this treatment rank low.

2000

2001

Before and After Release of Purple Loosestrife Beetle

Chemical Herbicide Treatments

Several aquatic herbicides are available for controlling invasive aquatic plants. The effectiveness of these chemicals is often determined by the application method and site-specific characteristics. In the West Cove, Fluoridone has been very successful in controlling fanwort, an invasive species. It is recommended that funding be appropriated as needed ($8,000 approximately every 3-4 years). Chemical herbicide treatment ranks high with respect to environmental benefit, value to the Whitman's Pond watershed, and cost. Public support for this treatment would likely be divided, as some residents living closest to the pond may express concern regarding exposure to herbicide treatments. Increased public awareness of the minimal risk of Fluoridone will increase public support.

Mechanical and Physical Management

Mechanical and physical management techniques include dredging/sediment removal, benthic barriers, nutrient inactivation, plant harvesting and hydro-raking, and de-watering. Many of these techniques are considered effective. However, if not done properly, they may have environmental impacts because of the non-selective nature. For example, physical removal of purple loosestrife can spread the plants seeds, and actually make the problem worse.

West Cove Prior to Hydro-raking/Fluridone

West Cove After Hydro-Raking/Fluridone

BETA feels that the most effective mechanical management tools for Whitman's Pond are weed harvesting and hydro-raking. Physical management of invasive aquatic species ranks high with respect to environmental benefit, value to the Whitman's Pond watershed, and public support. However, project costs to the Town are a somewhat of a factor, since annual appropriations are needed.

Some of the Material Removed During Hydro-Raking West Cove

It is recommended that the Town consider one of the following options:

- Annual appropriation of $10,000-$20,000 to hydro-rake nuisance vegetation in selected areas of the West, South and Main Basins
- Approach nearby communities about the joint purchasing of a weed harvester. This was done successfully by the Towns of Pembroke, Halifax and Hanson, who split the cost to purchase a harvester, and share it during the summer and fall months. The cost of an adequate harvester is roughly $40,000.00.

Monitoring Plan

In order to ensure efficiency of these proposed efforts, a monitoring plan should be developed. Monitoring of the storm drains, pond sediments, and aquatic vegetation should be performed on a determined basis to confirm efficacy of storm drain BMP's, sewer system modifications, and aquatic plant management, the standard of 0.04 – 0.05 mg/L for total phosphorus (P) for comparison and the establishment of watershed goals. Monitoring efforts can be performed by volunteer groups. Periodic inspection and effluent testing of the SNUP should be conducted routinely. Testing for total phosphorus for a sample costs roughly $15.00, and provides valuable information on the long-term efficiency of the SNUP.

The results of the fish testing by the DEP should be available in several months. These results should be used to determine what, if any, actions should be taken with respect to PCB's in the Pond sediment of the Main Basin.

The Pond should be monitored to determine target areas for restoration efforts such as hydro-raking and herbicide applications. These efforts can be conducted through volunteers.

Community Participation

Community participation is critical to the successful completion of any planning process. Informational meetings should include Town officials, the general public, local advocate groups, and local businesses to ensure comprehensive decision-making and planning. Educational handouts and signs can be developed and distributed. Public recreational areas such as the Lake Street beach, the new park and boat landing on Commercial Street, and fishing spots are an effective location for educational signs used to inform the general public on what they can do and the importance of their contribution.

A public hearing was held on November 20, 2002, at the Weymouth Department of Public Works facility on Winter Street. Over 100 citizens attended the meeting. At the meeting, information was handed out, a presentation was made by BETA, and questions from residents were addressed.

Public awareness efforts included science classroom field activities (with Bill McEckhern, Weymouth Public Schools – Science Program). A field trip was conducted with BETA and pollution and restoration efforts were studied. This is an effective and inexpensive means to educate students on water quality issues, and should continue in the future.

This project included the purchase of a number of stencils to mark catch basins within the Whitman's Pond watershed "DUMP NO WASTE – DRAINS TO LAKE." These stencils have been used by volunteers to mark basins within the watershed in an effort to reduce illegal dumping and increase public awareness.

The annual "Whitman's Pond Cleanup Day" is the most demonstrative example of widespread community participation, when hundreds of volunteers participate in removal of debris. Each year, tons of waste materials are removed form the Pond. Continuation of all of these efforts is essential in order for improvements to the Pond to be made. The next event is scheduled for March of 2004. The National Guard is apparently planning on participating in the cleanup as well.

7.3 Five Year Implementation Schedule

Task	Estimated Cost	Potential Funding Source	Year
Hydro-Rake West Cove	$18,000.00	Town	2004
Clean-Up Day	0	Volunteer	Annual
Storm Drain Stenciling	0	Town, Volunteer	Continuous
Herbicide Treatment	8,000.00	Town	2005
Catch Basin Cleaning	$8,000.00	Town	Annually
Street Sweeping	0 *	Town	Annually
Modifications to SNUP	$8,000.00	Town	2004
Purple Loosestrife Beetle Release	$300.00	Town	2004
Install Aerators	($30,000.00)	DEM**, Town	2004
Extend Sewers	Grants/Loans	SRF***, Town	2006
Sewer System Capital Improvements	$13,000,000.00	SRF, Town	2003-2008
Monitoring Plan	$500.00 (lab)	Town	Annual
Community Participation	0*	Town, Volunteer	Continuous
Street Sweeper/Vactor	($145,000.00)	Chap. 90, Town	Completed
Installation of BMP Structures	2 @ $25,000.00	DEM, Town, Private	2005
Septic to Sewer Conversion	Case by Case	SRF, Town	2006

( ) Task Complete
* Cost not including labor and operational and maintenance costs
**DEM-Massachusetts Department of Environmental Management
***SRF-State Revolving Loan Funds (DEP)

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7. "Habitat Study of Whitman's Pond" BETA Group, Inc. January 2001.

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10. Mass GIS-Online Mapping Data