The SOUTH WATUPPA POND and its WATERSHED

This document is extracted from a 1990 report prepared by Whitman & Howard Engineers for the City of Fall River, and was edited for this web page. It presents an overview of the pond and watershed in 1990. It discusses possible remedial steps for the South Watuppa Pond, but some of the site-specific data is outdated. Much of the information regarding watershed stewardship is useful for residents of the watersheds of both the South and North Watuppa Ponds, today.

A. DESCRIPTION OF WATER SOURCE AREA

1. WATERSHED CHARACTERISTICS

The South Pond watershed covers about 11,775 acres (18.4 square miles). This includes roughly one-fourth of the watershed runoff to North Watuppa Pond which was diverted to South Pond via the interceptor drain shortly after 1915. The interceptor drain is a concrete open channel which collects over land runoff and some storm drain outfalls on the eastern side of the Pond for ultimate discharge to the South Pond east of the narrows. The watershed falls within three municipal boundaries. Their approximate breakdowns follow: 35 percent in the City of Fall River, Massachusetts, 25 percent in the Town of Westport, Massachusetts, and 40 percent in the Town of Tiverton, Rhode Island. The municipal boundaries infer different management practices and capabilities (e.g., monetary, regulatory) within the watershed.

The topography of the South Pond watershed is predominantly flat to gently rolling with little relative relief. The watershed is located in the seaboard lowland physiographic unit. Elevations in the watershed range from approximately 130 feet to 300 feet above mean sea level. The watershed is primarily delineated by the topography around the pond. However, the interceptor drain and its western counterpart, the North Pond Diverter, as described in a subsequent section, drain regions beyond the natural topographic limit off the watershed.

South Pond is a very shallow water body encompassing approximately 1,792 acres (2.8 square miles). There are numerous inlets to South Pond including natural tributaries and interceptor drains. Sucker Brook is a major inlet to the pond. Situated in a northwest cove, this Brook originates from the outlet of Stafford Pond. The outlet of South Pond is the Quequechan River. The River flows in a northwesterly direction and through the center of Fall River before its confluence with the Taunton River.

Due to the proximity of Sucker Brook to the Quequechan River outlet, it has been theorized that a certain amount of short-circuiting occurs. This theory is important to pond water quality because, if true, the impact of Sucker Brook on the pond is diminished.

2. ZONING AND LAND USE

The portion of the watershed within the City of Fall River, is zoned almost entirely residential. Approximately one-tenth of this area, located adjacent to the outlet of South Pond, is zoned industrial. The industrial district also encompasses Sucker Brook and Bleachery Ponds. Less than 5 percent of the watershed area within Fall River is zoned commercial. These areas are scattered

in small parcels throughout the watershed. The largest commercial district is adjacent to Interstate Route 195 near the state line.

The portion of the watershed located in the Town of Westport is almost exclusively zoned for residential use. A very small portion, approximately 5 percent, is zoned for commercial and "unrestricted" use. These areas are found along Route 177 and adjacent to the Narrows.

In the Town of Tiverton, residential zoning also predominates in the watershed, covering roughly three-quarters of the area. The land surrounding and including Stafford Pond is classified as a Watershed Protection Overlay District (WPOD) in addition to its residential designation. The following restrictions apply to the WPOD:

- No building is allowed within 200 feet of the Pond
- No brush removal is allowed within 100 feet of the Pond
- Construction must be permitted by the Planning Board
- Three-acre lots are required for any subdivision

Approximately one-fifth of the watershed in the Town of Tiverton is industrially zoned. This zoning area has a particularly important location in the watershed as it encompasses the Pocasset Cedar Swamp. Sucker Brook flows through this zoning district. Commercial zoning comprises less than 5 percent of the watershed area in Tiverton. Commercial areas are found along Route 81 and east of Sucker Brook adjacent to the state line.

Land use in the watershed is typically urban in Fall River and becomes increasingly rural in the Towns of Tiverton and Westport. Table 8-1 presents the approximate percentage breakdown of the various land uses within each of the three municipalities. Although Fall River has a definite urban character, approximately one-third of its South Pond watershed area is comprised of wetlands, woodlands, and open land. The South Pond watershed has 63 percent of its land area in these three land-use categories.

Whereas this may appear to present a favorable use of land in the watershed, it must not be overlooked that the existing land-use profile is not static. When comparing allowable zoning to current land uses, the true implications can be seen. There is a latent potential for undeveloped lands to become developed. The greatest potential for development is in Tiverton and Westport.

A review of historical changes in land use in Westport highlights the non-static nature of land usage. From 1951 to 1985, a decrease of 2,195 acres in forest land was documented.(1) During this same period, a concurrent increase of 2,410 acres in residential land use was observed. It is probable that population pressures will cause these trends in land-use patterns to continue.

The predominant land use along the shoreline of South Pond is residential. The residences are largely maintained in a wooded setting. A trailer park is south of Fedora Point on the western shore of the pond. Agricultural land use (a piggery) is located adjacent to Fedora Point.

(1)Data from the Cape Cod Regional Planning and Development Commission.

In addition to private boat docks, ramps, and beaches, recreational land use is limited to: (1) the boat ramp along the northwest shore of the Pond and (2) the Westport/Fall River Rod and Gun Club on the eastern shore of the Pond. The latter parcel is extensively preserved as undeveloped land. Additional undeveloped lands are located adjacent to the gun club and at the southernmost tip of the pond. Both of these areas encompass tributaries to the pond and are bordered by vegetated wetlands.

TABLE 8-1
LAND USE WITHIN THE SOUTH WATUPPA POND WATERSHED[1]

Land-Use[2] Category	Westport (%)	Fall River (%)	Tiverton (%)	Entire Watershed (%)
Wetlands	28	5	21	20
Woodlands	33	16	40	31
Open Land[3]	13	15	9	12
Residential/ Commercial	26	56	29	5
Industrial[4]	0	8	1	2
TOTAL	100	100	100	100

1 Percentages were obtained by the interpretation of the following USGS quadrangles: Fall River, Tiverton, and Westport.
2 In calculating percentages, water bodies were not included in the data analysis.
3 This category includes agricultural land, recreational land, and cemeteries.
4 This category includes transportation and land uses.

A significant commercial/industrial presence is situated along the northern and northwestern shoreline. The commercial component is comprised of small business establishments (e.g., diners, gas stations, convenience stores). The industrial component is comprised of factories, mills, transportation facilities (State Route 24, Interstate Route 195, U.S. Route 6, and Conrail), and energy transmission facilities. Potential contamination from these and other land uses is discussed in the following section.

Considering the land use characteristics and the physical features of the South Pond shoreline, there is considerable potential for access by the public to the watershed and the water body itself. Many summer cottages and public roads are set 50 to 100 feet from the water body. Little, if any, land buffer exists between public roads and the water body. In the vicinity of the Narrows, for example, it is easily possible for the general public to have direct access and contact with the Pond. Considerable effort at significant cost would be required to effectively restrict public access to the Pond.

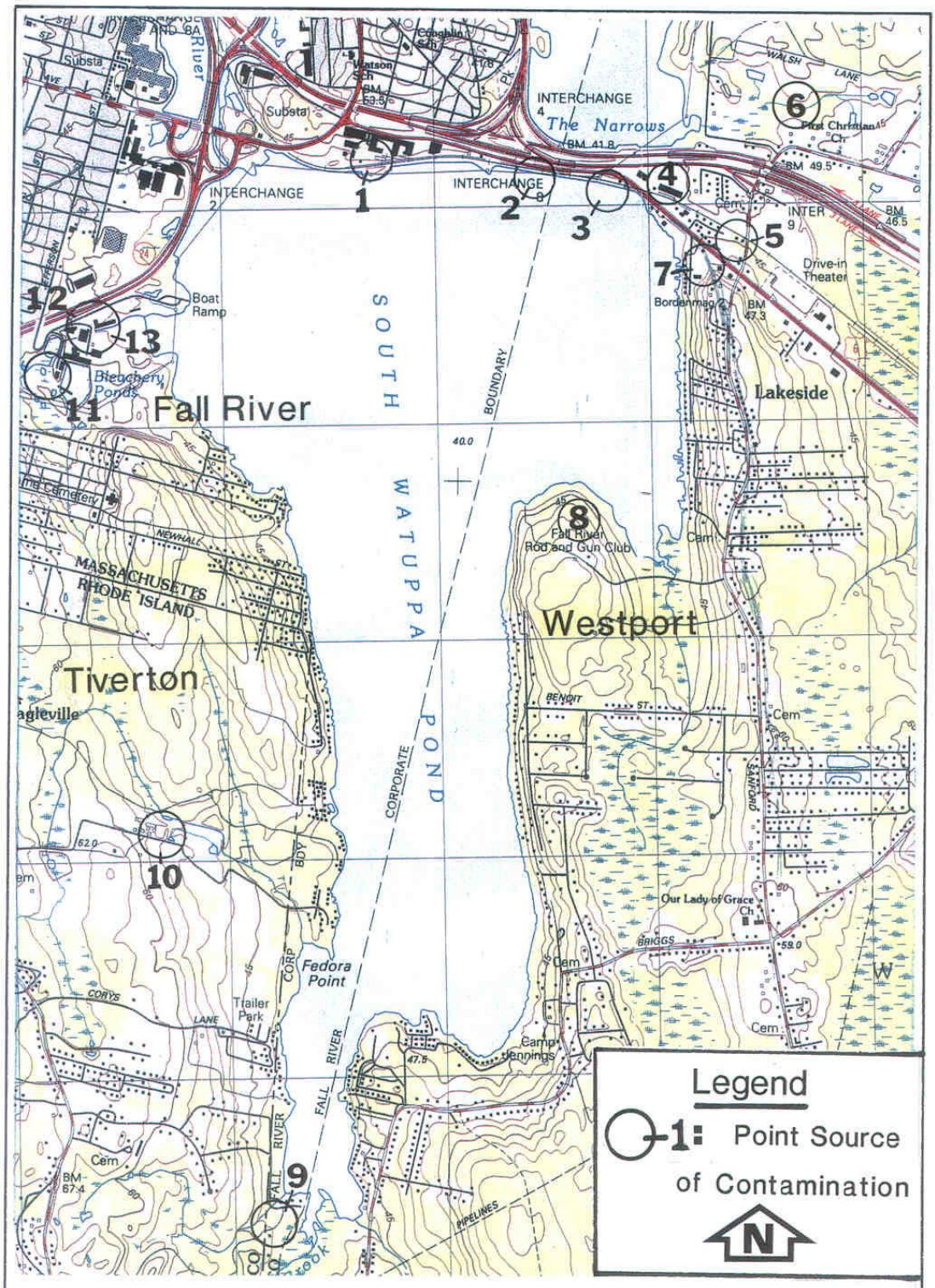

Figure 8-1
Point Sources of Contamination
to South Watuppa Pond

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B. SOURCES OF CONTAMINATION

1. INTRODUCTION

Sources of contamination to South Pond can be divided into two categories: point sources and nonpoint sources. Point sources are generally the more discernible and more easily controllable sources of pollution than are nonpoint sources.

2. POINT SOURCES

There are several known point sources of contamination to South Pond (Figure 8-1). Information on point sources was obtained during a visit to South Pond Watershed conducted by Whitman & Howard, Inc. in the company of Mr. Gerard Blais, Director of Water Treatment/Resources in Fall River. The following describes the contamination sites identified during the site visit in more detail.

Site No. 1 refers to the Kerr Mill site. At this location, a metal plating facility once operated, but has since burned down. On-site, there is evidence of oil contamination, as well as the presence of PCB's and cyanide. Partial remediation efforts have been made, including the removal of 27 cubic yards of cyanide-contaminated soils. As of July 1989, the DEP classified the site as "non-priority" and granted a waiver of its approvals of five documents that must be submitted to DEP as part of a response action, in accordance with Massachusetts Contingency Plan. The site is currently undergoing a Phase II Comprehensive Site Assessment.

Sites No. 2 and 3 designate the respective discharge locations of the North Watuppa Pond Diverter (NWPD) and the interceptor drain on the easterly side of the Narrows. The NWPD carries stormwater effluent draining from about one-fourth of the North Watuppa Pond watershed.

White's Restaurant (Site No. 4) is situated on Old Bedford Road in the Town of Westport. Although it is the only sewered establishment in Westport, leaking fuel tanks have been cited as a source of contamination. A "Notice of Responsibility" was issued in September 1988 by the DEP to the liable party. The notice concerns "the existence of volatile organic compounds" and the "release and a continuing threat of release of oil or hazardous materials at and from the site." As of March 1989 contaminated soils have been excavated and stockpiled. Transportation of the stockpiled material has also been approved by the state. However, the DEP still requires a Phase II Comprehensive Site Assessment. Whereas a scope of work for the site assessment was submitted to the DEP, it was not approved by them as of March 1989.

At the intersection of Route 6 and Sanford Road (Site No. 5), a source of pollution has been attributed to petrochemical wastes held in dry wells. These wastes, associated with adjacent gasoline stations, impact the Hebert Terrace area to the extent that fumes are noticeable within adjacent homes.

Leakage of the insecticide "Temik" (a trademark of Union Carbide) was reported as originating from the potato farm at Site No. 6. This chemical was applied to the potato crop to control grub

and beetle pests. The soluble powder Temik eventually infiltrated a large number of local wells for which Union Carbide had to supply activated carbon filters. Since groundwater flows in a south to southeasterly direction from the potato farm, the continued use of and leaching of this insecticide could contaminate South Pond via the interceptor drain.

A tractor/trailer garage on Borden Street (Site No. 7) has been cited as the source of oil and gasoline contamination to the pond. The site has been targeted for future investigation.

The Westport/Fall River Rod and Gun Club (Site No. 8) reportedly has potential discharges of septage. To the south of the club, there is a known burn and dump site (Site No. 9). The dumping has resulted in the covert filling of wetlands, which has two negative aspects: (1) leachate from the dump site is potentially detrimental to the pond, and (2) filling of the wetlands diminishes their capacity to act as natural filters of storm runoff. Wetlands remove and/or detain sediments, nutrients, and toxic substances that occur in runoff.

A piggery and associated farm lagoons are located along Stafford Road (Site No. 10). During storm events, the stabilization lagoons at the pig farm surcharge, thereby allowing effluent to flow into Fedora Brook, which is tributary to South Pond at Fedora Cove. Chesebrough (1977) documents that Fedora Brook is a substantial point source discharge of nutrients. Subsequently, Fedora Cove acts as a large settling basin for lagoon-derived effluent. Although the piggery is located in Rhode Island, the Massachusetts Department of Environmental Management has asked the owner to correct this source of pollution. As of this writing, the pollution problem still exists.

Sucker Brook and the Bleachery Ponds (collectively called Site No. 11) were the focus of a study conducted by Durfee High School's Environmental Control Committee (ECC) during 1981. The ECC monitored 61 sites along the Brook and Ponds and concluded that the main sources of pollution originate from the careless upkeep of these water resources. The ECC described the watercourse and Ponds as fouled with rubbish, oil scums, algae, and decomposing organic matter. At one location, the concrete foundation of a demolished mill has been converted into a dumpsite containing, discarded vehicles and empty drums (some having contained cyanide). Leachings from these and other wastes enter the Brook and eventually South Pond.

Whereas the brook is considered a point source discharge of pollution, two industrial discharges along it must also be mentioned. They include; (1) Site No. 12, the Fall River Tool and Dye Company (NPDES MA 003107) and (2) Site No. 13, the Fall River Plating Company (NPDES MA 0022471). These point source discharges, at a minimum, impact Sucker Brook's values of pH, hardness, nitrogen, phosphorus, and aluminum.

The ECC (1981) discovered that the used cyanide drums, previously mentioned, originated from the Fall River Tool and Dye Company. Cyanide is also a by-product of the metal cleaning and electroplating processes practiced by the Fall River Plating Company. The ECC measured cyanide levels during their study and found readings as high as 0.65 mg/L. A proposed maximum contaminant level (MCL) for cyanide has not yet been proposed under the 1986 Amendments to the Safe Drinking Water Act. However, the 1962 U.S. Public Health Service Drinking Water Standards recommend a limit of 0.10 mg/L.

3. NONPOINT SOURCES

In addition to point sources, South Pond is susceptible to nonpoint sources of pollution arising from various land use activities. Sediments, organic matter, and nutrients have many origins including:

- Road runoff
- Shoreline erosion
- Garden/agricultural fertilizers and pesticides
- Gasoline and oil from power boats
- Septic systems
- Household wastes and detergents
- Construction sites
- Burial grounds

These factors, especially overland runoff and septic systems, may potentially be significant sources of sediment deposition and nutrient enrichment. As discussed previously, the characteristics of road runoff can be particularly detrimental, whether entering South Pond as a point source or nonpoint source, the major difference being the difficulty in quantifying and qualifying the nonpoint source. It is widely recognized that urban runoff has many detrimental characteristics which impair the water quality of the receiving water body or watercourse. The U.S. EPA conducted a Nationwide Urban Runoff Program (NURP) which was designed to examine: (1) the quality characteristics of urban runoff and (2) the extent to which urban runoff is a significant contributor to water quality problems. Table 8-2 presents the major conclusions of the NURP study. Of important note is the finding that heavy metals (particularly copper, lead, and zinc) are the most prevalent priority pollutants in urban runoff. In many instances, concentrations exceed EPA water quality criteria and drinking water standards. Therefore, the potential impact of stormwater flow entering South Pond should not be underestimated.

One in-pond source of potential water contamination is algae. This source is not easily classified as point or nonpoint but nonetheless deserves mention because of its importance. Algae population in South Pond are largely sustained by the sources of nutrients previously mentioned. Algal growth is so profuse in South Pond that it presents a real and present threat to water quality of the pond. In particular, the blue-green algae, Aphanizomenon, maintains a sizeable population in the pond.

Aphanizomenon lie in parallel bundles of macroscopic proportion. Their cells contain gas vacuols which give them great buoyancy. This fact accounts for their becoming concentrated at the surface where floating scums result.

Cell deterioration causes a release of cell contents, including endotoxins in certain species. This leads to increased bacterial action and either directly or indirectly, Anphanizomenon can become a spoiler of water for both drinking and recreational purposes. A bloom of endotoxin-producing Anphanizomenon can be responsible for catastrophic fish kills or death of animals which drink infested water. Occasional fish kills have been reported in South Pond when the algal blooms are

most prolific. Besides the production of endotoxins, algae are also associated with poor taste, and odor and the production of tribhalomethane (TFl~1) precursors. Chlorination of waters containing THM precursors leads to the formation of THMs which currently have a regulated MCL of 0.1 mg/L. Proposed regulations call for a reduction in the THM MCL to 0.25-0.50 mg/L. The algal problem in the pond must clearly be dealt with in addition to the causal agents which promote algal growth.

TABLE 8-2
MAJOR CONCLUSIONS OF NATIONWIDE URBAN RUNOFF PROGRAM (NURP)

A. GENERAL CONCLUSIONS

- Heavy metals (especially copper, lead, and zinc) are by far the most prevalent priority pollutant constituents found in urban runoff. End-of-pipe concentrations exceed EPA **e**ffluent water quality criteria and drinking water standards in many instances. Sane of the metals are present often enough and in high enough concentrations to be potential threats to beneficial uses.

- The organic priority pollutants were detected less frequently and at tower concentrations than the heavy metals.

- Coliform bacteria are present at high levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in many surface waters, even those providing high degrees of dilution.

- Nutrients are generally present in urban runoff, but with a few individual site exceptions, concentrations do not appear to be high in comparison with other possible discharges to receiving water bodies.

- Oxygen demand substances are present in urban runoff at concentrations approximately those in secondary treatment plant discharges. If dissolved oxygen problems are present in receiving waters of interest consideration of urban runoff controls as wet I as advance waste treatment appears to be warranted.

- Total suspended solids concentrations in urban runoff are fairly high in comparison with treatment plant discharges. Urban runoff control is strongly indicated where water quality problems associated with TSS, including buildup of contaminated sediments, exist.

B. RIVERS AND STREAMS

- Frequent exceedances of heavy metals ambient water quality criteria for freshwater aquatic life are prohibited by urban runoff.

- Although a significant number of problem situations could result frau heavy materials in

urban runoff, levels of freshwater aquatic life use impairment suggested by the magnitude and frequency of ambient criteria exceedances were not observed.

- Copper, lead, and zinc appear to pose a significant threat to aquatic Life uses in some areas of the country. Copper is suggested to be the most significant of the three.

- Organic priority pollutants in urban runoff do not appear to pose a general threat to freshwater aquatic life.

- The physical aspects of urban runoff, e.g., erosion and scour, can be a significant cause of habitat disruption and can affect the type of fishery present. However, this area was studied only incidentally by several of the projects under the NURP program and more concentrated study is necessary.

- Several projects identified possible problems in the sediments because of the buildup of priority pollutants contributed wholly or in part by urban runoff. However, the NURP studies in this area were few in number and limited in scope, and the findings gust be considered only indicative of the need for further study, particularly as to long-term impacts.

- Coliform bacteria are present at high Levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in most rivers and streams.

- Domestic water supply systems with intakes Located on streams in close proximity to urban runoff discharges are encouraged to check for priority pollutants which have been detected in urban runoff, particularly those in the organic category.

C. LAKES

- Nutrients in urban runoff may accelerate eutrophication problems and severely limit recreational uses, especially in lakes. However, NURP's lake projects indicate that the degree of beneficial use impairment varies widely, as does the significance of the urban runoff component.

- Coliform bacteria discharges in urban runoff have a significant negative impact on the recreational uses of lakes.

C. REMEDIAL SOLUTIONS TO SOURCES OF CONTAMINATION

1. INTRODUCTION

Once sources of contamination have been identified, there are various means by which to protect or restore the water resource. Remedial actions fall into two basic categories including: (1) watershed management techniques, and (2) in-pond restoration techniques, both of which will be addressed in this section.

The effectiveness of a given remedial action, however, should be assessed with regard to the hydrologic and nutrient budgets of the pond. These models can be used to predict pond responses to selected actions. This gives the water supply manager the ability to discern: (1) the magnitude of influence, and (2) the relative importance of various sources of pollution. With these budgets, the water supply manager can prioritize management/restoration techniques to achieve productive improvements in water quality. Specific watershed management and in-pond restoration techniques are presented below.

2. WATERSHED MANAGEMENT TECHNIQUES

a. Introduction

The condition of South Pond is greatly influenced by the quality of watershed drainage. Pollutant loads are contributed from the watershed as either point sources or nonpoint sources. Some of the point sources have been addressed previously in Section VIII. B. Wastewaters from industrial and municipal sources can be highly enriched in organic matter, bacteria, and nutrients. Such pollutants can be extremely harmful to the water quality of the pond, even when toxic substances or pathogens are not involved.

Non-point sources include other types of pollutant loads that originate from lawns, driveways, subdivision roads, construction sites, agricultural areas, and other widespread sources. Although individual contributions may be viewed as insignificant, the cumulative effect can be severe.

This section will focus on management practices and remedial solutions that can be implemented throughout the watershed to help restore and protect the water quality of the South Pond. The following areas will be addressed:

- Improvement of wastewater flow
    - On-site treatment of wastewater
    - Sewage treatment facilities
    - Small-scale sewage treatment
    - Pretreatment of industrial/commercial discharges
- Reduction of wastewater flow

- Water conservation
- Industrial/commercial discharges

- Best management practices (BMP5)

  - Street sweeping and catch basin cleaning
  - Mitigation of soil erosion

- Land-use regulation

- Regulation of Recreational Use

- Public awareness/education program

b. Direct Discharges

A seemingly obvious way to improve the water quality of South Pond is to reduce or eliminate identified discharges to the Pond or its tributaries. The Chesebrough report (1977) identified three recommendations which are listed below:

- Eliminate or divert all industrial discharges to Sucker Brook.

- Eliminate or divert nutrients entering "Piggery Brook."

- Investigate and eliminate nutrient sources entering the "White's Restaurant culvert" and North Watuppa Pond Diverter.

The Chesebrough Report (1977) found Sucker Brook to be a definite source of nutrients to South Pond. However, the apparent short-circuiting of the Brook to the outlet may significantly diminish the overall impact of the Brook on South Pond water quality. Short-circuiting should be confirmed by a dye tracer study under various weather conditions. Additionally, if point source discharges were reduced or eliminated, assessments of South Pond hydrologic and nutrient budgets could be used to predict water quality improvements.

c. Domestic Wastewater Treatment

Household sources of wastewater, while technically point sources of pollution, are discussed here in the collective sense of a single pollution source. A major portion of residences in the watershed are on septic systems and are located in the Towns of Tiverton and Westport. It is essential to identify problematic or failing systems to minimize contamination from the source. Systems could be identified by contacting local or state health departments or water pollution control agencies. Improperly operating systems can then be modified to improve the quality of the wastewater flow.

It is not unusual for waterfront homes to have problems with waste disposal. Conditions that prevent or interfere with proper septic system function include:

- Unstable soils
- High water tables
- Steep slopes
- Underdesign or improper use

Alternative on-site treatment options for wastewater are listed in Table 8-4. Of these, mound systems and sand filters are often the most suitable for lakeside properties. These systems represent only minor modifications to the typical septic system. Generally, they do not require major construction or involve substantial cost. However, effluent of marginally better water quality still enters the water body.

If existing public sewage treatment facilities are adequate, one solution is simply to tie residences into the public sewer system. However, conventional sewers are a major capital cost. Therefore, examination of alternative designs for sewer systems is often warranted.

TABLE 8-4
ALTERNATIVE ON-SITE AND SMALL-SCALE WASTEWATER TREATMENT DESIGNS

Example	Remarks
Septic rank	A septic tank followed by a soil absorption bed is the traditional on-site system for the treatment and disposal of domestic waste-water from individual households or establishments. The system Consists of a buried tank where wastewater is collected and scull, grease, and settleable solids are removed by gravity and a sub-surface drainage system where wastewater percolates into the soil.
Septic Tank Mound System	Can be used as an alternative to the conventional septic tank - soil absorption system in areas where problen soil conditions preclude the use of subsurface trenches or seepage beds.
Septic rank - Sand Filter	Surface discharge of septic tank effluent. Can be used as an al-ternative to the conventional soil absorption system in areas where subsurface disposal contain an intermediate layer of sand as fil-tering material and underdrains for carrying off the filtered sewage.
Faculative Lagoon	An intermediate depth (3 to 8 feet) pond in which the wastewater is stratified into three zones. These zones consist of an anaerobic bottom Layer, and aerobic surface layer, and an intermediate zone.
Oxidation Ditch	An activated sludge biological treatment process. Typical oxidation ditch treatment systems consist of a single or closed loop channel 4 to 6 feet deep, with 45° sloping sidewalk. Some form of

	preliminary treatment such as screening, comminution, or grit removal normally precedes the process. After pretreatment, the wastewater is aerated in the ditch using mechanical aerators that are mounted across the channel.
Trickling Filter	The process consists of a fixed bed of rock media over which wastewater is applied for aerobic biological treatment. Slime forms on the rocks and treat the wastewater. The bed is dosed by a distributor system, and the treated wastewater is collected by an underdrain system.
Overland Flow Treatment	Wastewater is applied by gravity flow to vegetated soils that are slow to moderate in permeability and is treated as it travels through the soil matrix by filtration, adsorption, ion exchange, precipitation, microbial action and also by plant uptake. An underdrainage system serves to recover the effluent, to control groundwater, or to minimize trespass of wastewater onto adjoining property by horizontal subsurface flow.

Source: North American Lake Management Society, Lake and Reservoir Restoration Guidance Manual, Washington, D.C.: U.S. Environiientat Protection Agency. 1988.

The applicability of alternative system designs should be assessed with regard to the constraints of the physical watershed, receiving waste-water treatment facility, and monetary budget. A brief description of three alternative sewer systems is presented in Table 8-5.

TABLE 8-5
ALTERNATIVE SEWER SYSTEMS

Sewer System	Characteristics
Small diameter gravity sewers	Carries effluent away from home. Pipes usually plastic and generally small in diameter.Lowoperation and maintenance requirements.
Pressure sewer system	Uses small pump at each house to move wastewater under pressure to treatment facility or interceptor sewer.
Vacuum sewer system	Draws wastewater from each home through small collector pipes to a central collection station by vacuum. At collection station, sewage is pumped to treatment facility or interceptor sewer.

In addition to on-site modifications of individual septic systems or the use of existing treatment facilities, communities also have the option of small-scale treatment. If soil conditions are unsuitable for the proper functioning of on-site systems, a cluster system can be used. By this method, wastewater is conveyed to a neighborhood drain field, mound, or sand filter. Other small-scale treatment systems that are well-suited to small community situations include:

- Ponds
- Lagoons
- Trickling filters
- Oxidation ditches
- Overland flow treatment

d. Wastewater Minimization

In addition to improving the quality of wastewater flow, water conservation measures reduce the quantity of flow. Water-saving devices (e.g., flow-reducing showerheads and water-saving toilets) can cut household wastewater flows by as much as 25 percent (EPA, 1981 in NALMS, 1988). Table 8-6 lists several water conservation procedures. Whereas these procedures may seem simple or obvious, the water they conserve can permit smaller wastewater treatment facilities. This is particularly appropriate where existing treatment capacity is limited or near the maximum.

TABLE 8-6
WATER CONSERVATION TECHNIQUES

- Inspect the plumbing system for leaks.

- Install flow control devices in showers.

- Turn off all water during vacations or long periods of absence.

- Check the frequency with which home water softening equipment regenerates and backwashes. It can use as much as 100 gallons of water each time it does this.

- Insulate hot water pipes to avoid having to clear the “hot” line of cold water during use.

- Check all faucets, inside and out, for drips. Make repairs prompt1y. These problems get worse - never better.

- Reduce the volume of water in the toilet flush tank with a quart plastic bottle filled with water (bricks lose particles, which can damage the valve).

- Never use the toilet as a trash bucket for facial tissues, etc. Each flush uses 5 to 7 gallons of water. Items carelessly thrown in could clog the problems.

- Accumulate a full laundry load before washing, or use a lower water level setting.

- Take showers instead of baths.

- Turn off shower water while soaping body, lathering hair, and massaging scalp.

- Bottle and refrigerate water to avoid running excess water from the lines to get cold water for meals. Shake bottle before serving to incorporate air in the water so that it doesn't taste flat.

- To get warm water, turn hot water on first; then add cold water as needed. This is quicker this way and saves water, too.

- Wash only full loads of dishes. A dishwasher uses about 9 to 13 gallons to water per cycle.

- When washing dishes by hand, use one pan of soapy water for washing and a second pan of hot water for rinsing. Rinsing in a pan requires less water than rinsing under a running faucet.

- Use rinse water "gray water" - saved from bathing or c'othes washing to water indoor plants. Do not use soapy water on indoor plants. It could damage them.

- Vegetables requiring more water should be grouped together in the garden to make maximum use of water applications.

- Mulch shrubs and other plants to retain moisture in the soil longer.

  Spread leaves, lawn clippings, chopped bark or cobs, or plastic around the plants. Mulching also controls weeds that compete with garden plants for water.

  Mulches should permit water to soak into the soil.

- Try "trickle" or "drip" irrigation systems in outdoor gardens. These methods use 25 to 50 percent less water than hose or sprinkle methods. The tube for the trickle system has many tiny holes to water closely spaced plants. The drip system tubing contains holes or openings at strategic places for tomatoes and other plants that are more widely spaced.

- Less frequent but heavier lawn watering encourages a deeper root system to withstand dry weather bet t e r.

- Plan landscaping and gardening to minimize watering requirements.

- When building or remodeling, consider:
  - installing smaller than standard bath tubs to save water.
  - locating the water heater near area where hottest water is needed usually in the kitchen/laundry area.

Source: North American Lake Management Society, Lake and Reservoir Restoration Guidance Manual, Washington, D.C.: Environmental Protection Agency. 1988.

e. Best Management Practices

A set of restoration techniques can be collectively categorized as "best management practices" or BMPs. The focus of EMPs is to control four primary, interactive processes:

- Erosion
- Runoff
- Nutrient enrichment
- Pesticide or toxic loading

Table 8-7 lists BMPs applicable to various land uses. Street sweeping and catch basin cleaning may be particularly appropriate for the urban area of the watershed located in Fall River. Based on the Nationwide Urban Runoff Program studies by EPA, pollutant loading can be reduced by two to eleven percent by effective street sweeping (EPA, 1983). Similarly, routine catch basin cleaning can reduce sediment loading by as much as 30 percent. The removal of phosphorus, heavy metals, oil and grease would enhance the water quality of South Pond.

TABLE 8-7
BEST MANAGEMENT PRACTICES

Agriculture

Conservation Tillage
Contour farming
Contour Stripcropping
Integrated Pest Management
Crop Rotation
Terraces
Animal Waste Management
Fertilizer Management
Livestock Exclusion

Urban

Porous Pavements
Flood Storage
Street Cleaning

Construction

Nonvegetative Soil Stabilization
Disturbed Area Limits
Surface Roughening

Multicatepory

Streamside Management Zones
Grassed Waterways
Interception or Diversion Practices
Streambank Stabilization
Detention/Sedimentation Basins
Vegetative Stabilization

Silviculture

Ground Cover Maintenance
Road and Skid Trail Management
Riparian Zone Management
Pesticide/Herbicide Management

In addition to Street sweeping and catch basin cleaning, another external source of sediment comes from soil erosion. Areas of the shoreline around South Pond that are particularly susceptible to erosion could be protected by the installation of gabion retainers. A gabion system could prevent further erosion and could also filter runoff from land surfaces. Figure 8-2 depicts the typical construction of a gabion retainer designed for both stabilization and filtration.

Land-use regulation is another means by which a water supply manager can exercise control over the quality of surface runoff reaching South Pond. The following suggestions could be implemented on a watershed basis. It is acknowledged that limitations due to political boundaries may be experienced. Coordination between the three municipalities is encouraged.

Currently, Tiverton, RI, imposes zoning regulations in a Watershed Protection Overlay District (WPOD). It is suggested that similar districts be designated in both Fall River and Westport. At a minimum, the following requirements could be established for a WPOD:

- Invoke a 200-foot buffer requirement for all areas adjacent to wetland and water resources
- Increase minimum lot size requirements to three acres
- Impose strict drainage requirements for commercial properties
- Require low or no road salt usage
- Require oil and grease traps for storm drains in parking lots
- Disallow the storage of materials (including disintegratible or putrescible matter) or equipment within any wetland resource or its buffer zone (200 feet) or in the buffer zone of any water resources
- Enforcement of Code of Massachusetts Regulation 310.22.20, Drinking Water Regulations - Surface Water Supplies, which regulates activities within potable supply watershed

In addition, “erosion-sensitive areas” could be designated within all three municipalities. “Erosion-sensitive areas” could be defined as areas that have highly erodible soils and severe slope conditions. The purpose of this designation would be to control the effects of siltation throughout the watershed.

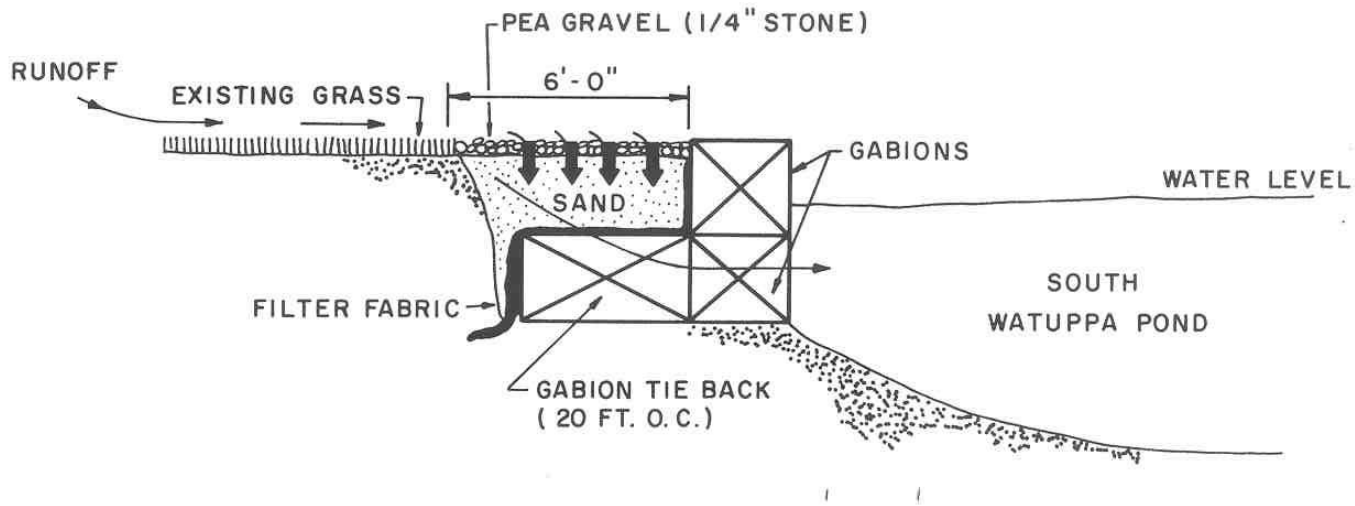

FIGURE 8-2

TYPICAL GABION RETAINER

W&H

Within Massachusetts, the local Conservation Commission has jurisdiction over activities within a 100-foot buffer zone of wetland resources. However, sediment can enter storm drains from distances greater that 100 feet and can still discharge into a wetland or water resource. Review of site plans in "erosion sensitive areas' would enable each municipality to enforce proper sedimentation control practices at such sites regardless of existing regulatory jurisdiction. These sites should require a "land disturbance permit" to be issued and enforced by the managing body of the water supply. Applicants would be required to invoke BMPs during the construction process.

f. Recreational Uses

Currently, South Pond is used extensively for recreational activities including swimming, boating and fishing. These activities pose a contamination risk to the water body in the form of human feces, gasoline and motor oil, and common waste products of human activity such as paper, plastics and metal wastes.

South Pond water quality would be most improved by limiting recreational use to the highest degree compatible with public acceptance.

g. Public Awareness

Another aspect of watershed management could include a public awareness program aimed at informing residents of the value of their water resources (including both South Pond and its tributaries). This program should incorporate the publication of a brochure including such topics as: (1) the ecosystem of the pond, (2) human activities and how they impact the pond, (3) mitigation measures that protect water quality, and (4) any proposed restoration efforts to be undertaken (if applicable).

3. IN-POND RESTORATION TECHNIQUES

In-pond management options are very limited for South Pond due mainly to its morphometry. Dredging, for example, would be cost prohibitive. Also, based on the water quality studies done in 1977, it does not appear that sediments are a source of nutrient release. Therefore, sediment removal, while increasing potential pond volume, would not affect the nutrient supply which promotes excessive algal growth.

The Chesebrough report did mention that a nutrient inactivation would provide a viable means of restoring the water quality" of the pond (Chesebrough et. al., 1977). Nutrient inactivation is a commonly practiced procedure for the immediate improvement of water quality. The use of aluminum sulfate (alum) in conjunction with other chemicals can reduce algal populations by removing soluble phosphorus from the water column. The resultant floc settles to the bottom. Immediate results of phosphorus precipitation include decreased turbidity, increased water clarity, and decreased algal growth (NALMS, 1988). Overall, the use of alum to produce these changes may be a viable option for South Pond, but requires additional evaluation before

implementation.

As discussed previously, algae bloom conditions on the South Pond deteriorate water quality and impair pond aesthetics. Through implementation of the watershed management options and the best management practices previously presented, it should be possible to reduce the organic loading on the pond. This, in turn, may decrease the frequency, duration and intensity of incipient algae blooms.

In the meantime, however, algae in South Pond may be controlled through the development and implementation of an aggressive algae control program. The 1987 American Water Works Association (AWWA) publication entitled "Current Methodology for the Control of Algae in Surface Reservoirs" reviewed current algae control techniques. Among other things, the document presents the results of a survey of about 120 water utilities experiencing algae-related taste and odor problems. Overall, the survey found that the majority of utilities were able to mitigate algae-related problems through some type of control program.

Some of the conclusions of the study applicable to South Pond are presented below:

- Several algae control methods are available including:
    - Reservoir treatment with copper sulfate pentahydrate
    - Chlorination of reservoirs
    - Lime and quicklime treatment of reservoirs
    - Reservoir treatment with iron sulfate, aluminum salts, zinc salts and trace elements
    - Application of algicides and herbicides
    - Nutrient inflow control
    - Aeration, circulation, and mixing of reservoirs

- Copper sulfate penthydrate is the most common algicide used in the U.S. since 1904.

- The chemical mechanism of copper sulfate toxicity to algae is not well understood.

- Little information is available concerning actual concentrations of copper sulfate applied, depth of copper penetration in the water column, etc.

- Economic treatment methodology using copper sulfate varies among reservoirs requiring trial and error experimentation.

- Annual cost of algae control programs ranged from $1,000 to $25,000 for the water utilities surveyed.

In order to economically control algae in South Pond, we recommend that a comprehensive algae monitoring and control program be implemented. The key features of such a program include maintenance of accurate records of algae levels, chemical application locations and doses. Ideally, determination of algae levels can aid in the determination of the actual need for treatment, and the degree of treatment required. Eventually, maintenance of algae levels and

treatment history records over a period of time may aid in refining treatment techniques and ultimately allow some degree of prediction of algae bloom severity, duration, and treatment effectiveness.

As mentioned previously, several treatment techniques are possible. Due to the shallow nature of South Pond and the lack of stratification, aeration and mixing control methods would likely have only marginal affects.

One algae control technique with significant potential impact is nutrient influent control. This involves limiting the entry of nutrients into the pond which algae require for growth. These types of control techniques were discussed previously in the section on watershed management.

The last control technique considered is chemical application. It is not possible to predict the optimum chemical or combination of chemicals most suitable to South Pond without extensive experimentation. However, since copper sulfate has been used in the past on South Pond, the experience gained in its past use could prove valuable in developing an effective algae control program.

4. SPECIFIC RECOMMENDATIONS

Table 8-8 presents specific recommendations for remedial solutions to sources of contamination. The table lists sources of contamination, possible remedial actions, and the potential effect of the remedial action on South Pond water quality.

We recommend elimination and/or control of these contamination sources as part of a watershed management and control program.

TABLE 8-8
REMEDIAL SOLUTIONS TO SOURCES OF CONTAMINATION

Sources		Remedial Action	Impact on Water Quality (Contaminants Affected)
Point Sources			
#1	Kerr Mill site	Excavate and Dispose of Contaminated Soils	Cyanide, Hydrocarbons
#2	North Watuppa Pond Diverter (NWPD) - west	Divert To Quequechan River	Lead, Zinc, Copper, salts
#3	NWPD - east	Divert to Quequechan River	Lead, Zinc, Copper, salts
#4	Westport restaurant	Repair Leaking Fuel Tank, Excavate and Dispose of Contaminated Soils	Hydrocarbons
#5	Sandford Road and Rte 6	Remove and Dispose of Waste	Hydrocarbons Route 6
#6	Potato Farm	Pump and Treat Groundwater	Temik

#7	Borden Street Garage	Implement Revised Operational Methods	Hydrocarbons
#8	Rod and Gun Club	Install Septic System	Organics, Coliforms
#9	Burn and Dump Site	Remove and Dispose of Debris	Organics
#10	Fedora Point Piggery	Faculative Lagoons, Oxidation Ditches	Organics, Coliforms
#11	Sucker Brook/Bleachery Pond	Implement Brook Watershed Control	Organics, Metals Coliforms
#12	Tool & Die co.	Pre-treat waste, Discharge to sewer	pH, hardness, Nitrogen Phosphorus, Aluminum
#13	Plating co.	Pre-treat waste, Discharge to sewer	pH, hardness, Nitrogen Phosphorus, Aluminum

Nonpoint Sources

#1	Shoreline Erosion	Gabion Retainers	Organcis
#2	Runoff	Storwater Control	Lead, Zinc, Copper, Salts
#3	Septic Systems	Improved Waste Treatment	Organics, Coliforms