CHAPTER XI FEASIBILITY OF RESTORATIVE ACTIONS

A. OVERVIEW

The subject of lake restoration and lake protection has been debated and researched extensively in the past two decades. Although the need to do something about our degraded lakes is beyond dispute, the science of lake restoration is still in its infancy. Often, a judgement must be made about feasible limits of expenditure and effort without the reassurance of a solid basis for predicting results.

Once a project for lake restoration is undertaken, the results of this effort must be carefully monitored, evaluated and recorded. Although lakes differ biologically, chemically, and physically, so that one method may bring gratifying results in one lake and not in another, permanent lake rehabilitation begins with halting the introduction of undesirable substances.

Most successful lake restoration projects are easily appreciated by people familiar with the "before". A lake restored to health and beauty is an irresistibly exhilarating sight.

The previous sections of this report constitute a diagnostic study of Great Pond and its watershed. They describe the water quality problems and the sources and levels of the nutrients causing those problems. This section deals with the feasibility of implementing a variety of techniques to help reduce the problems that do exist and to protect the lake in the future.

Techniques that are available for lake restoration and protection are commonly grouped into two basic types: those that attack the cause of the problem and those that attempt to mitigate the effects of the problem. While both approaches may sometimes have to be utilized, those that attack the cause of the problem are the only long-term solutions.

B. PROBLEM TREATMENT

1. Algicide Treatment

The use of the algicide copper sulfate in New Hampshire lakes was once quite common in relieving dense phytoplankton blooms. Although the method does not reverse the lake's eutrophication trend, it temporarily alleviates nuisance algal blooms and provides an acceptable recreational season. In recent years, the use of copper sulfate as an algicide has been limited, for the most part, to the treatment of municipal water supplies.

Historically, Great Pond has shown signs of stress. Summer hypolimnetic oxygen depletion and moderate productivity reveal to the limnologist that problems exist. Generally, Great Pond has exhibited moderate algae blooms, low transparency, abundant weed growth, obnoxious odors or poor aesthetic conditions.

Although application of copper sulfate is no longer widely used to reduce algal blooms in recreational ponds, copper sulfate is utilized as a pre-treatment for other restoration techniques. Because of the low acid neutralizing capacity of most New Hampshire lakes, the recommended dosage used for these lakes is 4.5 lb./acre/10ft.

If copper were to be utilized for pre-treatment of Great Pond, the effective calculated chemical dosage would be approximately 900 pounds. The price of copper sulfate may vary, but a reasonable current price for copper sulfate is approximately $0.80 per pound. At these prices, one could expect the chemical cost of copper to be in the $720.00 range. The labor for this application would require four field persons working eight hours at approximately $50.00 per hour or $1,600.00. Adding the costs of a site survey permit applications, equipment overhead and travel costs of those individuals treating the pond, the total cost to apply copper sulfate to Great Pond would probably be in the $5,000 to $6,000 range or approximately $75.00/ha. Cooke et al. (1993) has calculated costs for using $CuS0_4$ crystals in several lakes and found a range of $96 - $578/ha.

Although copper can be a highly effective algicide, the effects are always temporary (days), annual costs can be high, there are major negative impacts on nontarget organisms, and sediment copper contamination is possible.

2. Artificial Circulation

Artificial circulation and hypolimnetic aeration are management techniques for oxygenating lakes subject to water quality problems such as algal blooms and fishkills. Artificial circulation is achieved by injecting diffused air into the lower waters, by mechanically pumping water from one depth stratum to another, or by inducing turbulence at the surface using large axial-flow pumps. Complete mixing leads to homogenous conditions throughout the water column (Pastorak, et al., 1981).

Circulation, theoretically, can result in reduced phytoplankton biomass. The principal cause is light limitation, brought about by providing greater depth of mixing. Limitation occurs by mixing plankton cells deep enough in the water column so that the total light received while in the shallower photic zone is insufficient for net photosynthesis. The Kezar Lake study and work completed by Lorenzen and Fast (1977) confirm that by increasing the depth of mixing, the lake can potentially be returned to a winter condition when light is limiting.

Whole lake mixing may reduce regeneration of nutrients from profundal sediments, which may control blooms of blue-green algae. The elevation of epilimnetic CO_2 by destratification often causes a reduction in pH sufficient enough to shift algal communities from nuisance blue-green species to a mixed assemblage of green algae. While hypolimnetic treatment usually decreases phosphorus concentration in the bottom waters, the long term effects on internal loading of nutrients is unknown.

The New Hampshire Water Supply and Pollution Control Commission (NHWSPCC) installed and operated an artificial aeration system within Kezar Lake from July 1968 through August of 1974. The selected destratification system forced compressed air from four shore-located compressors through two-inch I.D., P.V.C. plastic piping to a terminal series of ceramic diffuses located on the bottom at the deepest point in the lake (8.0 meters) (Towne, 1970). Towne reported that Kezar Lake's visibility improved from one foot (0.3 m) to four feet (1.2 m), hypolimnetic dissolved oxygen increased, temperature increased, total plankton numbers declined, and blue-green algae populations declined. Destratification was therefore declared a success in its first season of operation. Destratification continued to operate successfully through the 1971 sampling season. However, the effectiveness of the destratification process was considered somewhat less successful during the 1972 summer season.

In 1974, Kezar Lake once again experienced a bloom of the blue-green alga *Aphanizomenon*, despite ongoing destratification processes. The *Aphanizomenon* bloom lasted nine weeks, increasing chlorophyll-a concentrations to over 100 mg/m^3, increasing cell counts to over 500,000 cells mL^{-1}, and decreasing transparency to 0.5 m.

By the end of the 1974 season, destratification was deemed by the biological investigators as no longer effective for improving water quality and transparency in Kezar Lake. Biologists speculated the blue-green algae had somehow adapted to the annual lake circulations, enabling them once again to aesthetically reduce the lake's recreational value.

Kezar Lake was destratified for seven consecutive summer seasons, at a cost of $27,000. This treatment procedure was instituted as a temporary measure to control the phytoplankton blooms until phosphorus removal facilities (tertiary treatment) could be constructed at the New London sewage treatment plant. It provided a limited relief for the first few years, but almost no effect on controlling the phytoplankton blooms the last two years of operation (NHWSPCC Staff Report No. 79, 1975).

In other applications of the technique, highly variable results from case to case have occurred. In most instances, problems with low dissolved oxygen have been solved. In about half the cases, and where very small temperature differences from top to bottom have been maintained all summer, algal blooms were reduced (Pastorak et al., 1981; Cooke et al., 1986). In other cases, phosphorus and turbidity have increased and transparency decreased.

Failure to achieve the desired objective is often due to an underpowered air compressor. Lorenzen and Fast (1977) concluded that there must be less than 2-3°C difference from top to bottom of the lake in order to achieve improvement in algal biomass. This requires an air flow of at least 30 ft^3 of air per thousand ft^2 (2.3 acres) of lake surface.

Artificial circulation has been recommended as an inexpensive, efficient restoration technique (Pastorak et al., 1981). Cost information on a project basis is scarce. The estimated annual cost to implement artificial circulation at Great Pond for two air compressors producing an air flow rate of 1200 CFM at standard conditions is $38,610 (1990 dollars). At the recommended rate of 9.2 m3/min/Km2, this represents a cost of $471/ha (for the first year of operation). Median values for initial and annual costs, respectively, were $718 and $320/ha (1990 dollars). Davis (1980) presented costs for one project that included a compressor, pipe, and 1-year operation of $41,000 or about $340/ha, including installation. In the shallow areas of Great Pond, iron may not be the controlling mechanism for phosphorus exchange. In that case, aerobic release through microbial decomposition or exchange of loosely sorbed phosphorus would become the principal mechanism for internal phosphorus loading. Under these conditions, a greater release of phosphorus may occur under circulation than before circulation.

3. Hypolimnetic Aeration

Depletion of oxygen in the hypolimnion of eutrophic lakes is one of the first signs of eutrophication. If enrichment becomes sufficient to exhaust all or a substantial portion of the hypolimnetic oxygen reserve before autumn destratification occurs, anoxia will result. Anoxia can produce several undesirable changes in lake quality, including accelerated internal recycling of nutrients, solubilization of metals and limitation of fisheries, especially coldwater species.

Hypolimnetic aeration is different than artificial circulation in objective and operation. Artificial circulation employs a curtain of bubbles to achieve complete mixing and isothermal conditions, while hypolimnetic aeration employs an airlift device to elevate cold hypolimnetic water to the surface of deep lakes. The water is aerated by atmospheric contact while carbon dioxide and methane are dispelled, and then the water is returned to the hypolimnion. Destratification is not achieved during this procedure (Olem and Flock, 1990). The objectives of hypolimnetic aeration are threefold:

- to raise the oxygen content of the hypolimnion,
- to provide an increased habitat and food supply for coldwater fish species, and
- to decrease the internal P load by establishing aerobic conditions at the sediment-water interface (Cooke et al., 1986).

There is, however, little documentation of its successful use to control nuisance algal blooms. Negative effects which have been observed are as follows:

- little increase in hypolimnetic dissolved oxygen if aerator is undersized,
- metalimnion oxygen depletion preventing the successful establishment of a cold water fishery, and
- aerators may partially destratify shallow lakes producing severe algal blooms.

Aqua Technique has reported the installation and operating costs for seven partial air-lift projects (Cooke et.al., 1993). At a power rate of \$0.09/kw/h, the average operating cost/Kg 0_2/d was \$0.072 $\pm$ \$0.026 (or 0.8 Kwh/Kg 0_2), and the average installed cost/d/Kg 0_2 was \$457 $\pm$ \$280 (1990 dollars). When the latter value is divided by 180d, the cost becomes \$2.50/Kg 0_2, which is probably the most useful cost indicator for hypolimnetic aeration since success depends on satisfying an oxygen demand. Not included in this cost would be electrical trenching and a small building to house the compressor. The estimated cost to operate the system would be $10 to $15 per day.

C. CAUSE TREATMENT

Phosphorus is the plant nutrient in New England lakes that most often determines the level of plankton growth. By reducing the phosphorus levels, the cause of the algal problems is attacked. The following methodologies describe ways to reduce the phosphorus levels currently in the lake and entering the lake, and to prevent increases in phosphorus discharged to the lake from future watershed development. These techniques involve both in-lake and watershed controls.

1. Sediment Removal

Dredging of organic lake-bottom sediments is generally implemented for the following purposes (Peterson, 1981): (1) deepening for improved recreational (boating) usage, (2) removal of eutrophying nutrients, (3) removal of toxic substances and, (4) removal and growth reduction of rooted macrophytes. Currently, Great Pond has adequate depth for boating and there have been no known discharges of potentially toxic material entering the lake. Macrophyte weed growth is abundant and is considered a nuisance in only some locations. Therefore, the only potential benefit of dredging the ponds would be the removal of nutrients which may be subject to release from the sediments. As discussed previously, Great Pond, like most waterbodies, acts as a net phosphorus sink on an annual basis (i.e., more phosphorus is deposited in the sediments from the lake than is released by the sediments to the lake). However, removal of phosphorus-enriched sediments could, conditions warranting, further retard the release of sediment phosphorus, thereby resulting in a greater net annual deposition of phosphorus. Additionally, dredging could increase the mean depth of the pond which might permit a greater tolerance to phosphorus loading as depicted by the Dillon/Rigler trophic model.

Unfortunately, adverse sediment characteristics and the physical limitations of standard dredges would severely limit the effectiveness of dredging to improve the trophic status of Great Pond.

The depth to which a standard dredge can operate is 15 feet below the lake surface, which would exclude the entire hypolimnetic bottom areas of Great Pond from its operation. However, recent advances in hydraulic dredging technology in the last decade has produced more effective cutter bars capable of removing sediment quicker and at deeper depths. The sediment map (Figure IV-6) verifies that most of the bottom areas contain a thick layer of organic detritus. Therefore, there is no advantage in decreasing internal phosphorus loading by the removal of the upper sediment layers. The release of sediment phosphorus to the water column would probably be similar because the sediments are only reactive to a shallow depth (approximately 10cm, Snow and DiGiano, 1976).

The Dillon/Rigler and other trophic models demonstrate that a lake's tolerance to phosphorus loading is highly dependent on its mean depth. Increasing the mean depth would result in an improvement of trophic status if the loading remained constant. However, phosphorus tolerance decreases with decreasing flushing rate. Dredging would increase the mean depth which would increase the lake volume and, hence, cause a decrease in flushing rate. These two factors thus counteract each other.

Suitable dredge spoils disposal site(s) of substantial size and location would have to be determined, designed and constructed with protective features such as diking to provide containment and prevent release of nutrients and suspended solids. An outlet structure and sedimentation pond downstream of the disposal area would probably also be necessary. Some treatment of the decant water may be required pending further analysis and characterization of the sediments. No areas proximal to Great Pond are topographically amenable to the construction of a disposal area without substantial earth moving and berm construction.

There are several noteworthy adverse effects associated with sediment removal (Peterson, 1981). Sediment solids are resuspended during dredging activities, thus causing high turbidity in the lake water. Toxicants (unknown) may be liberated to the water column and downstream waterbodies. An algal bloom may be triggered by dredging, due to the release of high concentrations of nutrients in the disturbed sediments and released interstitial water. Lake water oxygen depletion may occur due to increased exposure of the water to bacterial decomposition. The benthic community may be temporarily destroyed. Most of the above concerns are short-term impacts, however, and may be mitigated with a well designed sediment removal plan.

a. Project Costs

Sediment removal is costly, and the net dredging and disposal cost per unit volume removed varies widely from lake to lake. It is dependent on the equipment (dredges, barges, pumps, etc.), the sediment transport distance to the disposal site, the cost of acquiring and developing the disposal site, and manpower and permit (e.g., Federal Section 404) costs. Peterson (1981) tabulated essential data (including costs) for 64 dredging projects nationwide. Peterson reported a cost range of $0.40 per cubic yard and found that costs from $2.00 to 3.00 (1988 dollars) were common and were considered reasonable for hydraulic dredging.

The costs associated with a dredging project include:

- Supplementary investigation costs (containment site suitability, sediment analysis)
- Engineering and permitting costs
- Construction of containment areas
- Equipment purchases and operational costs
- Contract dredging costs
- Ultimate disposal costs

If contract dredging is the chosen approach, direct equipment purchases and operational costs are minimized. Conversely, there are no contract dredging costs if the Town or other entity chooses to purchase the necessary equipment and operate it under some internal arrangement to complete the project. Contracts for dredging and containment area construction are usually separate, although the same contractor may be able to provide the services needed under each. Likewise, contracts for containment area construction and ultimate disposal (which includes any required restoration of the containment area) are often kept separate.

Project costs are typically estimated by evaluating each element of the project separately and summing the expenses. Dividing this total cost by the quantity of material removed from the water body then provides a simple measure of the cost per unit volume removed. This number can be misleading, however, as it incorporates so many different factors that vary from project to project. It is a useful way of making general estimates and comparisons, however, and is widely used. From the experience of many professionals working in the northeastern United States, the range of costs per cubic yard of removed material is about $5-10. About $1-2/cy is attributable to supplementary studies, engineering and permitting, $3-5 is associated with actual dredging, and $1-3 is associated with the containment area and ultimate material disposal.

Recently, discussions have taken place with a company that offers a new solution for sediment spoils. Soloman Liquids is a technology group specializing in liquid/solid separation. Soloman has developed a proprietary system that efficiently remediates lakes at competitive costs, and at much faster rates with minimal impact to the body of water and surroundings.

The unique qualities of the Soloman separation process include:

- project completion can be scheduled in stages to accommodate budget and time considerations,
- trailer mounted system offers rapid mobilization,
- remote process location from site minimizes environmental impact,
- no secondary ponds needed for drying of solids,
- operation at 1200 g/m/unit, increasing reservoir space rapidly,
- removal of dry solids ranging in diameter from as large as 3 inches to less than 1 micron,
- recovered solids available for immediate recycling or removal, and
- cleansed water returned to the pond.

Soloman dredging costs are in the $10.00 per in-situ cubic yard range, but costs are decreased with an increase of dredged sediment. Soloman can also perform a nutrient supplementation study to establish a plan to reuse the fine sediments recovered as valuable soil amendment material. This would allow the sale of the spoils and recovery of some of the project costs.

Diagnostic feasibility studies at Kezar Lake (Connor and Martin, 1989) estimated the dredging cost at the lake to be in the range of $1,000,000 to $5,000,000 exclusive of spoils containment design and construction costs. A more recent study at Flints Pond (Bowser and Connor 1997) examined four options for dredging. The rough estimates of costs associated with each dredging option (Table XI-1) can be summarized as follows:

Table XI-1

Opinion of Probable Cost for Four Dredging Options

Approximate Costs, in Dollars

Expense Item	**136.000 CY**	**107,000 CY**	**50,000 CY**	**28,000 CY**
Survey Services for Topographic Maps	8,000	8,000	8,000	8,000
Additional Sediment Investigations	8,500	7,000	3,500	2,000
Engineering Design Services	60,000	55,000	45,000	35,000
Permit Application Support	15,000	15,000	10,000	10,000
Contract Administration	15,000	15,000	7,000	5,000
Containment Area Construction	150,000	125,000	75,000	50,000
Contract Hydraulic Dredging	550,000	430,000	200,000	112,000
Containment Area Restoration	35,000	30,000	20,000	15,000
Monitoring and Construction Observation	25,000	20,000	12,000	8,000
Miscellaneous Contingencies (Fencing, booster pumps, berm materials)	80,000	65,000	35,000	20,000
Total	946,500	770,000	415,500	265,000
Per Cubic Yard	6.96	7.2	8.31	9.46

In order to remove the potential of internal sediment phosphorus loading to Great Pond, the benthic areas that are anoxic during the summer months would have to be dredged. In this scenario, all the sediments contained within the 20 foot depth contour would have to be dredged and disposal of. Two sections of Great Pond would have to be considered for dredging: the north section (435,786 cy) and south section (582,017 cy). The total volume of sediment that would have to be removed and disposed of would be 1,017,803 cy.

Although many scenarios and dredging options are possible, depending on phosphorus reduction and model results that evaluate water quality impacts of dredging, only the worst case scenario will be presented here. Using the previously discussed estimated dredging costs of $5 to $10 per cubic yard removed, dredging the north and south basin of Great Pond would cost from $5,089,015 to $10,178,030.

Based on these calculations, it is evident that hydraulic sediment dredging at Great Pond as a restorative techniques would be extremely costly and of limited value.

b. Time and Cost Factors

Hydraulic dredging occurs only during non-freezing conditions, for reasons of both access by the dredge to target areas of the pond and transport of the liquid slurry. The normal maximum dredging season in New England is from April through November.

Dredging production rate is a function of pump size, transport capacity (pipeline size), and containment area restrictions on the rate at which material can be passed through with proper settling. Assuming that large enough containment areas are available to negate any problems with settling time (a reasonable assumption in this case), a typical inland pond dredge would be capable of pumping 2000 gallons per minute (gpd) at a solids concentration of 20%. This equates to 2 cy of bottom material per minute, or 120 cy/hr. Given an optimal 10 hour dredging day, 1200 cy could be removed each day. Realistically, however, actual dredging time of about 6 hours per day is more likely, yielding 720 cy/day.

With a 5 day work week and about 30 weeks of appropriate dredging conditions, an annual removal total of 108,000 cy is possible. Down time and weather complications usually reduce this total by at least 25%, however, and most reasonable dredging plans call for no more than 75,000 cy per year. Additional annual production is considered a bonus. Greater production is made possible by pumping at a greater percent solids or longer working hours, the latter depending upon equipment and weather conditions as well as personnel limitations. Use of a larger dredge can also increase production, but requires an oversized containment area to provide adequate detention and settling time.

Considering the potential amounts of material which might be removed from Great Pond, normal hydraulic dredging would require upwards of ten dredging season (years) to complete.

2. Phosphorus Inactivation

a. Literature Review

Phosphorus precipitation and sediment inactivation are lake restoration techniques that reduce phosphorus concentration and thereby limit the growth of phytoplankton. Sediment phosphorus inactivation results in longer term lake quality improvement when compared to water column precipitation. Sediment inactivation is particularly useful in accelerating lake improvement in those areas where internal phosphorus release represents a significant contribution to the phosphorus budget (Cooke et al, 1977; Larson, 1979).

The chemical and physical justification for utilizing aluminum as an inactivant is its ability to form complexes, chelates and insoluble precipitates with phosphorus. Aluminum complexes and polymers are inert to redox changes, are effective in entrapment and removal of inorganic and particulate phosphorus in the water column, and have been shown to have no toxicity at the pH and dose required to improve lake conditions (Cooke and Kennedy, 1981).

Removal of phosphorus by aluminum can occur by precipitation of $AlPO_4$ (Recht and Chassemi, 1970), sorption of phosphates to the surface of aluminum hydroxide polymers of floc(Eisenreich et al., 1977), and/or by entrapment/sedimentation of phosphorus-containing particulate by aluminum hydroxide floc.

Dissolved organic phosphates are less effectively removed by inactivation because of the complexity of their molecular structure. Failure to remove dissolved organic phosphorus could be of significance since certain blue-greens can produce phosphatase that removes inorganic phosphorus from any organic phosphates at rates sufficient to support elevated algae populations. Particulate phosphorus removal effectiveness is controlled by the quantity and quality of the aluminum hydroxide floc. The potential for particulate entrapment should occur in the 6 to 8 pH range.

Once deposited, aluminum hydroxide can provide a continuous control of phosphorus.

Kennedy (1978), under experimental conditions, demonstrated that treated sediments are active in retaining phosphorus. Low pH and high phosphorus concentrations in the interstitial water favor the formation of $AlPO_4$. The phosphorus-trapping effectiveness of the floc layer depends on aluminum concentration, pH, the phosphorus concentration and the rate at which phosphorus is supplied to the floc surface.

Within several months of the treatment, the floc consolidates with the sediments and is distinguishable as white-to-brown solid pellets.

A review of the literature provides us with a series of long-term inactivant projects that demonstrate the effectiveness of aluminum hydroxide floc in controlling internal phosphorus loading. The most successful phosphorus inactivation treatments are to continuously circulated lakes (polymictic). Weakly stratified dimictic lakes (Osgood Index <6) may also benefit. Even deeper lakes are likely to experience an improvement in late summer to fall surface lake quality after phosphorus inactivation because the treatment should eliminate the introduction of phosphorus-rich hypolimnetic waters to the surface as the lake begins autumn turnover. Cooke et al. (1993) warns that prospective users of phosphorus inactivation in dimictic lakes should consider whether summer algal blooms following phosphorus diversion are caused by phosphorus release from deep lake sediments, the traditional target of phosphorus inactivants.

Some of the important lake responses measured following the application of aluminum salts include decreases in lake phosphorus concentration, a sharp decrease in the accumulation of sediment-derived phosphorus to the hypolimnion, an increase in transparency, a reduction of phytoplankton populations and a shift in phytoplankton dominance from the more obnoxious Cyanobacteria to other less obnoxious classes.

Some potential negative impacts may be encountered if proper care is not exercised with regard to dose. The potential for toxicity responses is directly related to the acid neutralizing capacity (ANC) and pH of the lake water. Dosage rates, chemical ratios and responding decreases of ANC and pH must be determined under experimental laboratory conditions. Water ANC and pH decrease at a rate dictated by the initial buffering capacity of the water. In low ANC lakes, small doses of aluminum sulfate can exhaust the buffering capacity to a point that causes the pH to decrease below 6. At pH 6 and below, $Al(OH)_2$ and dissolved elemental aluminum (AL^{+3}) become the dominant forms. Both of these species can be toxic to the lake biota. Therefore, sodium aluminate along with aluminum sulfate is required in these lakes to prevent undesirable pH shifts, toxic aluminum concentrations and to generate adequate $Al(OH)_3$ for sediment phosphorus inactivation.

Phosphorus inactivation literature reviews indicate that prior to 1980, 28 surface water bodies had been treated to precipitate or inactivate phosphorus (Cooke and Kennedy, 1981). Within the last ten years, several phosphorus inactivation projects were completed just within New England. However, most of these projects were completed within the past five years and the final restoration prognosis is yet to be determined. West Twin Lake, Kent, Ohio (Cooke et al., 1978), Annabessacook Lake, Winthrop, Maine, (Dominie, 1980), Long Lake, Kitsap County, Washington, (Jacoby et al., 1982) and Kezar Lake (Connor and Martin, 1989) are of specific interest. Due to their similarity to Great Pond in criteria and/or treatment, a detailed discussion of these cases follows.

i. West Twin Lake, Kent, Ohio (Cooke et al., 1978)

In 1975, the hypolimnion of West Twin Lake was treated with alum. This treatment was directed primarily at covering the bottom sediments with a layer of aluminum hydroxide to absorb phosphorus molecules released from the sediments. West Twin Lake was classified as a eutrophic lake with an area of 34.02 hectares (ha), 4.3 m. in mean depth, and a maximum depth of 11.5 m. Liquid alum was added to the 5 m. contour, with 26 ha being treated in July of 1975. Dosage rates were based on ANC (102 - 149 mg/L $CaCO_3$) and the amount of aluminum sulfate (liquid alum) which could be added to the point at which pH began to decline and dissolved aluminum began to increase. The application of 91 metric tons was applied in three days at a dose of 27.6 mg Al/L to the hypolimnion. Phosphorus content fell precipitously and remained low through 1978. A small internal phosphorus release, calculated by a phosphorus budget method was not completely controlled, and was thought to be of littoral origin (Cooke and Kennedy, 1981). Cell volume and blue-green algae dominance decreased while transparency increased. There also was some indication of a decrease in microcrustacea diversity.

ii. Annabessacook Lake, Winthrop, Maine. (Dominie, 1980)

Annabessacook Lake has a surface area of 575 ha and a hypolimnetic area of 150 ha. It is a soft water eutrophic lake (ANC of 20 mg/L as $CaCO_3$), with a pH of 6-7, maximum depth of 14.9 m, and a mean depth of 5.4 m. Dominie calculated that 85% of summer phosphorus increase in the lake was due to internal phosphorus release, presumably from the sediments. The objective of the treatment was to control this phosphorus release. In order to maintain pH to near normal levels, and thereby also prevent the appearance of the toxic levels of dissolved aluminum, a mixture of aluminum sulfate (alum) and sodium aluminate was added to the hypolimnion of the lake in August, 1978. This hypolimnetic aluminum application was designed to accomplish two objectives: first, phosphorus precipitation and entrapment (which is most effective when done in mid to late summer when hypolimnetic phosphorus concentration is greatest) and second, chemical sealing of the sediment by aluminum floc which prevents future phosphorus release. Aluminum application dosages in the top meter of treated water were 25 mg/L for areas 7-10 m deep, and 34 mg/L in areas over 10 m deep. The aluminum application took approximately 18 days, averaging 10 hours per day, and was carried out where depths exceeded 8 m.

The results of aluminum application were at first very encouraging. However, post-monitoring data revealed increases in phosphorus, decreases in transparency and greater blue-green phytoplankton populations between the months of June and August.. There was no immediate reduction of phosphorus at Annabessacook, as was found at Horseshoe Lake (Peterson et al., 1973) and Medical Lakes (Gasperino and Saltero, 1978) after alum treatment. A large decline in the lake's phosphorus content was observed in September. From the time of treatment in 1977 to one year post treatment there was 65% reduction in maximum phosphorus mass in the lake.

iii. <u>Long Lake</u>, Kitsap County, Washington (Jacoby et al., 1982)

Long Lake is a shallow, unstratified lake, with a mean depth of only 2 m, and a maximum depth of 3.7 m. High pH levels (8 to 10) occur in the summer because of the lake's low buffering capacity (ANC from 10 to 40 mg/L as $CaCO_3$) and the high productivity rates. Internal phosphorus loading in Long Lake was identified as a major eutrophying factor. The sediments in the deeper parts of the lake were shown to be the immediate source of this internal phosphorus loading (Jacoby et al., 1982). In addition, contribution of phosphorus by a dense macrophyte crop was believed to be substantial. A drawdown in the summer of 1979 to control macrophyte growth was unsuccessful, with recolonization approaching pre-drawdown levels by the summer of 1981.

In September 1980, alum was applied to Long Lake at a rate of 5.5 mg Al^{3+}/L to provide a barrier to phosphorus release from the sediments. The alum floc remained well incorporated in the surficial sediments and served as an effective barrier to the vertical diffusion of soluble reactive phosphorus. Phosphorus control continued two years after treatment, in spite of a full macrophyte recovery. The alum may have continued to be effective by inactivating or complexing newly deposited phosphorus from macrophytes. One detrimental side effect was noted. The improved water column clarity resulted in increased density and distribution of *Potamogeton praelongus* and *P. pectinatus* in the deeper 3 m area of the lake, impacting boating and fishing activities. These areas of the lake previously had little macrophyte growth.

iv. <u>Kezar Lake</u>, North Sutton, New Hampshire (Connor and Martin, 1989)

Aluminum sulfate and sodium aluminate were utilized as sediment phosphorus inactivants to improve the water quality of a northeastern eutrophic lake. The treatment occurred during June of 1984 and utilized a 40 mg Al/m^2 concentration at a 2:1 ratio (AS:SA). A four-year monitoring program provided an extensive lake database utilized to evaluate the short-and long-term effectiveness of sediment phosphorus inactivation as a lake restoration technique. An immediate impact of treatment was a reduction in hypolimnetic BOD and dissolved oxygen deficit, lower chlorophyll-a and phosphorus concentrations, improved transparency, and the elimination of obnoxious blue-green phytoplankton blooms. For two to three years after treatment, these parameters continued to exhibit both less variability and improved values over the pre-treatment conditions. The improved water quality conditions warranted an upgrade of the lake trophic status from eutrophic to mesotrophic. Eighteen years after treatment, transparency values are still acceptable for recreation (ranging from a minimum of 1.8 m during the 1994 season to a maximum of 3.4 m during the 1992 season) while productivity was considered to be moderate (1994 chlorophyll ranged from 4.0 to 11.7 ug/L with a mean of 9.2) and internal phosphorus loading (mean epilimetic phosphorus concentration = 21 μg/L) was considered reasonable. A major benefit is an increase in the average attendance at the lake's State Park by almost 2,000 people per summer.

b. Environmental Effects of Phosphorus Inactivation Treatments

In order to assess the long-term environmental effects of phosphorus inactivation by treatment with aluminum, future research must be conducted to evaluate the effects on species diversity, fish populations, bioaccumulation of aluminum, potential impacts on human health, and related uses of lake water.

At this time, there is already some direct laboratory and field evidence concerning the short and long term effects of aluminum on aquatic biota and aquatic communities. Cooke, et al., (1982) observed few negative effects as a result of hypolimnetic alum treatment of West Twin lake (five years post-treatment) and Dollar Lake (six years post-treatment). Connor and Martin (1986) also observed few negative effects with an application of aluminum sulfate and sodium aluminate. Specific conductance, ANC, pH, sulfate, and dissolved aluminum were monitored regularly and no remarkable or excessive changes were noted. Residual dissolved aluminum (RDA), ANC, and pH all recovered rapidly after the treatment was completed. Transparency increased after aluminum application and remained high. These investigators report significant changes in species composition of phytoplankton and zooplankton following aluminum application. It appears that changes in this diversity may be attributable to increased clarity and decreased nutrient content, rather than toxicity. The decline in planktonic micro-crustacean diversity was apparently not due to aluminum toxicity in the water column, but to changes in the types of algal cells present, changes in pH, or perhaps RDA changes in the interstitial waters where resting stages of micro crustaceans might be found. Greatly increased transparency may enhance fish predation on zooplankton and contribute to reduced diversity.

Jacoby et al., (1982) also reported that increased water column clarity in alum treated Long Lake, Washington, resulted in an increase in the biomass of macrophytes in the deeper (3

m) area of the lake. Previously, this area had been relatively free of noticeable macrophytes, but had a dense algal biomass which decreased significantly after treatment. However, despite the overall improvement in lake quality and the lack of blue-green algal blooms, recreationists still complained of the impact of the macrophytes on boating and fishing activities on the lake.

Hypolimnetic aluminum sulfate treatment of Bullhead Lake, reported by Narf (1981), indicated that a reduction in phosphorus concentration apparently shifted the lake's microflora from a blue-green to a green dominant community.

Narf (1978) also reported an extensive evaluation of aluminum sulfate treatments on benthic insect communities. His study showed that the benthic insects suffered no toxic effects and generally increased the first year following the aluminum sulfate application. The presence of the aluminum flocculus did not appear to influence the species composition or numbers. Snake Lake, with one of the highest applied dosages of aluminum, produced the largest populations of benthic insects during the two years following treatment. At Long and Pickerel Lakes, the population shifts were less dramatic, but indicated no decline immediately after treatment, or for a number of years following.

The use of aluminum apparently enhances the lake quality for benthic organisms for a time period dependent on lake conditions. Narf also reported that benthic insect-burrowing activities may greatly contribute to phosphorus recycling of lake sediments. He observed that the apparent secondary toxicity in laboratory bioassays, using 93 and 140 g $A1_3/m^2$, can be explained by the probable change of the flocculus to a more cohesive precipitate layer. This was less pervious to biological and chemical diffusion, thus suffocating the insects. Dominie (pers. comm.) also noted the same phenomenon in his bioassay procedure.

Several investigators have reported an absence of negative effects on fish (Kennedy and Cooke, 1974; Buergel and Soltero, 1983; Connor and Martin, 1986) after a lake treatment. Everhart and Freeman (1973) used a constant flow bioassay to test toxicity to rainbow trout. At 52 ug A1/L, there were no obvious effects on growth or behavior, leading Kennedy and Cooke to adopt this value as an upper RDA limit for lake treatment. Peterson et al. (1974, 1976), using static bioassay, reported that Chinook Salmon survived an RDA of about 20 ug A1/L. Higher concentrations were not tested. Buergel and Soltero (1983) studied the possibility of bioaccumulation in stocked rainbow trout after a whole lake application of alum to Medical

Lake, Washington. This study was particularly pertinent because these trout and their prey were dependent upon habitat potentially higher in available aluminum than neighboring habitats. Trout tissue, plankton, and water were analyzed for total aluminum concentrations. Statistical comparisons revealed few overall differences in the level of aluminum in alum exposed and non-exposed fish, although significant differences existed among tissues within a given treatment and age class. Aluminum levels in plankton were approximately 10 times higher (dry weight comparison) than encountered in trout tissue, and may help to account for levels found in trout. The lack of aluminum in the muscle tissue suggests diminished vascularization or no metabolic means of storing aluminum. Further research is needed to study the impacts and fate of aluminum in tissues.

The modern phenomenon of acid precipitation, and the possible resultant mobilization of aluminum to the aquatic environment, warrants further research to study the potential biological impact of aluminum. Also, further study should be undertaken concerning the interactions of aluminum and the inherent environmental complexing agents of chelators and the subsequent toxicity potential. From the research performed thus far on the use of aluminum salts for phosphorus inactivation, it appears that increases in aluminum caused by these treatments do not deleteriously affect species diversity of fish populations, and do not lead to bioaccumulation of aluminum in the fish.

c. Cost Comparisons for Aluminum Salts Application

A comparison of labor, equipment and chemical costs between seven phosphorus inactivation projects on seven different lakes is summarized in Table XI-2. With the exception of Sluice Pond, the cost effectiveness of phosphorus inactivation has increased since earlier (late 1970) treatments. Although the cost of aluminum has increased, the chemical application techniques have become more efficient and less labor intensive.

The cost effectiveness of aluminum salts injection can best be demonstrated by comparing labor, chemical and equipment costs. Table XI-2 demonstrates the aluminum salts application effectiveness of the modified harvester (Connor and Smith, 1986), an older barge system, and a modified treatment barge recently developed by Sweetwater Technology.

A comparison of the person-days worked per hectare revealed that the harvester was much more effective than the barge method utilized at Annabessacook Lake. The modified harvester utilized at Kezar, Morey, and Cochnewagon Lakes saved an average of 0.63 person-days/ha when compared to the barge method utilized at Annabessacook Lake. However, it appears the cost-effectiveness of aluminum salts injection decreased with lake areas under 20 hectares. A computerized chemical distribution system developed by Sweetwater Technology has increased the efficiency of chemical application, and a portable LORAN navigational system has increased the path accuracy to 9 inch/0.5 mi (225 cm/0.8 km). This one-person operation is capable of applying up to 35,000 gallons (133,000 L) of liquids per day. These improvements increase the efficiency and economical application of aluminum salts. The computerized barge saved an average 0.43 person-days/ha and an average of $512.00 per hectare over both the old barge and modified harvester systems.

d. Application Feasibility for Sediment Phosphorus Inactivation.

The simultaneous application of two aluminum salts with either a specially modified aquatic weed harvester (Connor and Smith, 1986) or the new barge system (Sweetwater Technology) has proven to be an efficient method of treating stratified lakes for both reduction of hypolimnetic phosphorus and inactivation of sediment phosphorus (Connor and Martin, 1989).

Great Pond has adequate accessibility for launching the necessary equipment and for tanker truck dispersion of chemicals to the distribution mechanism. Several locations could be utilized as chemical refill stations so the barge has less distance to travel for refills. Before cost estimates can be made, three important factors must be determined. Each of these factors will determine the ultimate success of the project in sediment phosphorus inactivation and will determine the ultimate project cost.

- The treatment area of the lake must be determined by defining the areas of the lake that contribute to internal phosphorus loading. In some cases this area may be confined to the stratified anoxic hypolimnetic area of a lake. A more practical approach involves mapping the benthic sediments to their type and depth. A rich organic sediment will yield a greater phosphorus load to the lake than an inorganic sandy substrate. Over 70 percent of the Kezar Lake sediment was treated with aluminum salts.

Table XI-2
A Comparison of Aluminum Dose, Cost, and Work Production Data for Phosphorus Inactivation*

Lake	Year Treated	Area Treated (ha)	Aluminum Dose	Cost for Chemicals Labor and Equip.	Manday/ha	Cost/ha
Medical Lake, Washington[1]	1977	60	8.0 g Al/m^3 Aluminum Sulfate	$132,093	No data	$2,202
Annabessacook Lake, Maine[1]	1978	121	25 g Al/m^3 Aluminum Sulfate Sodium Aluminate	$234,000	1.12	$1,934
Kezar Lake, New Hampshire[2]	1984	48	40 g A1/m^3 Aluminum Sulfate Sodium Aluminate	$65,604	0.50	$1,367
Lake Morey, Vermont[2]	1986	133	45 g A1/m^2 Aluminum Sulfate Sodium Aluminate	$165,640	0.57	$1,245
Cochnewagon Lake, Maine[2]	1986	97	18 g A1/m^3 Aluminum Sulfate Sodium Aluminate	$81,840	0.41	$844
Sluice Pond Massachusetts[2]	1987	6	20 g A1/m^2 Aluminum Sulfate Sodium	$13,196	0.67	$2,199

			Aluminate			
3 Mile Pond, Maine[3]	1988	266	20 g A1/m^2 Aluminum Sulfate Sodium Aluminate	$170,240	0.06	$640

***Data from Connor and Smith, 1986; Gerald Smith, Aquatic Control Technology; and Richard H. Lepley, Sweetwater Technology Corp.**
[1] old barge system [2] modified harvester [3] new barge system

- Since New Hampshire lakes are low in ANC and are considered to be soft water, only small amounts of aluminum sulfate can be added before the pH falls below 6.0. In these lakes, sodium aluminate must also be added with aluminum sulfate. Sodium aluminate, which increases the pH of an aqueous solution, is utilized to maintain a pH above 6.0. The ratio of aluminum sulfate to sodium aluminate must be empirically determined. These ratios are determined by conducting jar tests utilizing water from the lake to be treated. Several tests including pH and aluminum are conducted to determine the proper ratio to be utilized during the treatment.
- The total aluminum dosage must be calculated for the lake. A basis for aluminum dose now exists. The Kennedy procedure (Kennedy & Cooke, 1980) is based on the assumption that as much aluminum as possible should be added, up to the pH where significant amounts of dissolved aluminum appear, since the goal is long term lake improvement. From our past experience with sediment phosphorus inactivation, we will assume an aluminum dose of 40 mg A1/m^2.

Great Pond has two basins in which anoxia occurs and internal phosphorus release to the hypolimnion will result. The north basin contains 11.1 ha within the 20 foot depth contour while the south basin contains 15 ha. within the 20 foot contour depth. Approximately 26 ha or 32 percent of the area of Great Pond is conducive to three layer stratification. The estimated cost for sediment phosphorus inactivation of 26 ha for Great Pond ranges from approximately $17,000 using the new barge system, to $36,600 (1990 dollars) using the modified harvester, similar to that used at Kezar Lake, New Hampshire. Figures are dependent upon the application methodology and include equipment, labor and chemical costs.

There is no apparent significant social impact of the phosphorus inactivation treatments of lakes. There will be minimal disruptions of the use of the lake and no restrictions placed on the subsequent water use. There are no disposal problems associated with the procedure, and no adverse impacts on docks, marinas, or other water structures.

3. Dilution and Flushing

Lake waters that exhibit low concentrations of phosphorus are unlikely to maintain algal blooms. While ideally it is more feasible to divert or treat phosphorus-rich waters before they empty into a lake, it is possible to lower the concentration of phosphorus within the lake and to flush out algal cells by adding sufficient quantities of phosphorus-poor water from some additional source. High amounts of additional water can also be used to flush algae cells from the lake faster than they grow.

Lakes with low flushing rates are poor candidates because in-lake concentration could increase unless dilution water is essentially devoid of phosphorus and sufficient water is added to gain a high flushing rate. Internal phosphorus release could further complicate the effect.

Flushing can control algal biomass by cell washout. The flushing rate must be near the cell growth rate to be effective. Flushing rates of 10-15 percent of the lake volume per day are believed to be sufficient (Cooke et al. 1986). Since Great Pond flushes only 3.7 times per year, this may not be a feasible means of restoration. Few case histories that document the effectiveness of dilution and flushing exist. The greatest problem is locating a dilution source that is low in phosphorus. Cooke et al. (1986) describe one successful case where low-phosphate Columbia River water was diverted through Moses Lake, Washington. Water exchange rates of 10 to 20 percent/day were achieved, and transparency and productivity dramatically improved. The advantages of using dilution water include (1) relatively low cost if low phosphorus water is available, (2) an immediate and proven effectiveness if phosphorus can be decreased, and (3) likely success if moderate phosphorus water is available.

Outlet structures must be capable of handling the added discharge, and increased volume released downstream may have water quality impacts to lakes and ponds located downstream. Also, a large volume of low phosphorus water is not easily accessible and/or close enough to make pumping and transporting cost-effective.

4. Sediment Oxidation

Riplox, a highly experimental procedure (Ripl, 1976) has only a few existing case histories. The objective of this procedure is to decrease phosphorus release from sediments, in much the same way as with phosphorus inactivation. The addition of ferric chloride to the sediments enhances phosphorus precipitation. Lime is then added to adjust the sediment pH for optimum denitrification. The final step promotes the oxidation of organic matter and denitrification through a calcium nitrate injection of the top 10 inches of sediment. The chemical solutions are applied by direct injection into the sediment with a "harrow", a 6 to 10 m wide device equipped with flexible tubes that penetrate the sediment. As the device is dragged along the lake bottom, sediment is disrupted to a depth of 20cm and the chemical solutions are injected.

Lake Lillesjon, a 10.5 acre Swedish lake with a mean depth of 6.6 feet was treated at a cost of $130,000. Only $7,000 of the total cost was for chemicals while the remaining costs were for equipment development and research (Olem and Flock, 1990). Cooke et al. (1993) noted that the principal impediment to the selection of Riplox over other inactivation treatments is the lack of documented overall successes. Lake Lillesjon is the only case where the experimentally required dose was applied, the lake phosphorus substantially declined, and the oxidized state of the sediment persisted. External phosphorus loading apparently remained too high for significant recovery to occur in Trekanten (Sweden) and Long Lakes (Minnesota); and, although expected results were observed in White Lough (Ireland), the lake was under-dosed.

Sediment oxidation (Riplox) is a sound technique and represents an alternative to alum treatment and dredging as a long term control of internal phosphorus loading from anaerobic sediment release.

The cost of an ideal dose (40 g N/m^2) of calcium nitrate to White Lough was compared with that of an earlier (1980) treatment of the lake with iron/alum. The total costs (1990) for calcium nitrate and iron/alum were $23,970 and $6,400, respectively. The estimated cost per treated hectare was $5,200 and $1,390, respectively.

If we treated the same area estimated for sediment inactivation (26 ha) the likely range of costs for sediment oxidation at Great Pond would be between $37,000 and $136,000. Riplox could be as much as four times the expense of sediment inactivation. However, it should be noted that the analyses of Great Pond sediments have revealed high iron concentrations distributed throughout the core depth. The high sediment iron content could aviod the need to add ferric chloride to the sediment and would save some expense.

5. Biomanipulation

Another highly experimental restoration technique utilizes zooplankton grazing for reducing plankton populations. Shapiro et al. (1975) proposed the term "biomanipulation" as a new lake management procedure. Shapiro (1990) defined biomanipulation as "a series of manipulations of the biota of lakes and their habitats to facilitate certain interactions and results which we as lake users consider beneficial -- namely reduction of algal biomass and, in particular, of blue-greens." Shapiro et al. (1975) used the term biomanipulation to include effects on algal biomass from both "top-down" biological processes (grazing), and "bottom-up" processes (nutrient cycling by fish). Shapiro et al. (1975) proposed that procedures or factors which significantly enhance and maintain the density of piscivorous fish should lead to a reduction in density of planktivorous fish, to an increase in survival of large-bodied zooplankton species, and to a reduction in algal biomass and/or an increase in water clarity. This biological approach to the improvement of lakes with pelagic algal blooms eventually may eliminate or reduce the need for mechanical or chemical controls. However, biological controls of algae biomass are still less precise than those methods. The type of plankton available as a food source to the herbivores and planktivores will have a direct effect on the project's outcome.

Knowledge of pelagic food webs and their interactions with littoral food webs is not at a level that permits prediction of responses to manipulation with a high degree of confidence.

A factor of importance to the successful use of zooplankton to reduce algal biomass involves palatability of phytoplankton. *Daphnia* not only are susceptible to fish predation, but also are severely affected by the presence of filamentous blue-green algae. Filaments and colonies may simply be unpalatable or too abundant, or toxic species of blue-greens may cause severe disruptions in the aquatic food chain through the release of antitoxins upon cell lysis. The palatability of algae, sources of blue-green algal blooms, and the roles of fish and birds are confounding factors in the trophic cascade idea. Other important elements include geographic limitations of large-bodied species of *Daphnia*, eutrophying effects through fish bioturbation and most notably, how to make biomanipulation last. Biomanipulation will not be successful in every lake, and particularly not in lakes that continue to receive high external phosphorus loading or water-bodies which have depressed hypolimnetic oxygen concentrations. Anoxic hypolimnions eliminate a particular refuge from sight-feeding planktivores and this enhances zooplankton mortality.

Food web management to improve lake trophic state is an experimental procedure at this time and many interactions are poorly understood. Costs for biomanipulation are not readily available. Fish poisons are expensive and clean-ups are costly. The cost of restructuring a food web through enhancement of a predatory fish population will be specific to each lake (Olem and Flock, 1990).

D. SUBWATERSHED MANAGEMENT

1. Introduction

Nonpoint loading of phosphorus can be a significant cause of eutrophication to New Hampshire lakes. Best Management Practices (BMPs) to control nonpoint sources are considered to be the primary methods of protecting lakes from this type of loading. The implementation of proper watershed management techniques within the Great Pond watershed will help mitigate the decline in water quality. Continued population growth and the associated growth in residential and commercial development, hobby farming, silviculture, and an increase in recreational use, combine to place a burden on the surface water resources within the region. Watershed management techniques designed to reduce this pressure include a variety of land use management, agricultural BMPs, stormwater management and public education of the permanent and transient population within the Great Pond watershed.

Each of these groups of management techniques plays a major role in the preservation of surface water quality within the watershed. The existing condition of the lake, and the nutrient supply sources identified by the study clearly point out the need to eliminate or reduce those factors that might contribute to the decline in water quality. While it is not possible to place specific values on each management practice in terms of potential reduced loads, it is clear that these practices, taken individually or in combination, will help to ensure that future development will be conducted in a manner that does not accelerate the decline in water quality.

The implementation of surface water quality protection and watershed management techniques within the Great Pond watershed will focus upon areas identified by the diagnostic/feasibility study that contributed the greatest negative environmental impact to the lake.

Several nonpoint management strategies will be developed for Great Pond to mitigate the effects of nonpoint source pollution and will involve several or all of the following strategies to achieve the desired results.

- Stormwater Management and Erosion Control
- Artificial Phosphorus Abatement Involving Individual Subsurface Disposal Systems
- Sawdust Waste Management
- Public Education
- Silviculture
- Agriculture
- Zoning Changes

2. Stormwater Management and Erosion Control

Development of residential areas around lakes and ponds has two main effects on stormwater. The first is the increase in the volume and rate of runoff as development takes place in a watershed. The second effect is the significant increase in the potential for degrading water quality not only for surface water but for groundwater as well (RCCD, 1992). In addition to promoting erosion and sedimentation, increased runoff acts as a medium for transporting pollutants which can contaminate surface waters and contribute to cultural eutrophication.

When development occurs, vegetation is removed and replaced with impervious surfaces in many instances. These surfaces include roads, streets, parking lots, roof tops, driveways, walks, etc., which reduce the amount of rainfall that can filtrate into the soil and therefore create more runoff into the surface water system. Natural drainage patterns are also modified as a result of development and runoff is transported via road ditches, drainage swales and constructed channels. These modifications increase the velocity of the runoff, which in effect decreases the time that it takes for runoff to travel through the watershed. The increase in flow and decreased travel time of runoff has an adverse impact on the natural stream channel. The increased runoff volumes caused by residential development cause flooding to occur more frequently which causes the stream channel to naturally widen and deepen to accommodate the increased flows. This natural process of stream channel erosion creates a sediment problem downstream. In addition to the pollution problem caused by the sediment, the stream bed ecosystem is adversely impacted not only in the downstream area by the lake but in the stream channel section being eroded. Erosional sediment deposits destroy vegetation and wildlife, impair aesthetic qualities, plug road culverts, and degrade water quality.

Stormwater runoff increases the pollution potential within a watershed. Several nonpoint pollution sources commonly associated with stormwater runoff are listed below, (RCCD,1992);

- The largest residential nonpoint pollution source is sediment and the nutrients and trace metals attached to it. In addition to this, the runoff from these areas may also carry bacteria, toxic chemicals, hydrocarbons and organic substances.
- Runoff from construction sites during residential development is the largest source of sediment. Sediment fills road ditches, streams, rivers, lakes and wetlands. A good erosion and sediment control plan can substantially decrease the amount of sediment being produced from residential areas and transported off site.
- Nutrients from residential areas are a major concern to surface water quality because of their effects on water bodies. The two major nutrients are nitrogen and phosphorus. Phosphorus is the limiting nutrient to New Hampshire lakes and even in small concentrations, increases algal growth. Nitrogen consumes oxygen in the nitrification process and is necessary for algal growth. Both conditions can

impair the use of our surface waters for water supply, recreation and fish and wildlife habitat.

- The main source of nutrients in developed areas can be related to improper use of fertilizers including over fertilization, and organic matter from lawn clippings and leaves.
- Bacteria levels can increase due to increased development. Most of this bacterial contamination is coliform bacteria which can be associated with animal wastes and from failed septic systems.
- Salt is used in large quantities in New Hampshire during the winter to melt ice from sidewalks, roads, streets, and parking lots. Salt is very soluble and therefore ends up in both the surface water and groundwater. In addition, contamination from salt and sand-salt stockpiles that are inadequately protected can cause water quality problems, particularly in the groundwater.

Uncontrolled runoff, accelerated soil erosion and the associated increase in pollution potential result in costly and unnecessary environmental degradation and damage. Well planned implementation of stormwater management BMPs can prevent or control much of this damage.

The following is a select list of stormwater management BMPs for New Hampshire:

- ***Detention and Retention Basins*** control the runoff from a given storm event and release the excess runoff in a way to reduce the impact on downstream systems. The basin releases the temporarily stored runoff over an extended period of time at a rate equal to or less than the pre-development conditions. The existing stream system will experience no greater flooding than would have occurred before development took place. However, longer duration flows may cause some stream degradation. It should be understood that detention and retention basins generally do not decrease the volume of runoff, but do decrease the rate of runoff. This practice applies to sites where the physical conditions are conducive to constructing an embankment, emergency spillway, a storage area and a structural outlet system.
- ***Diversions*** intercept and divert water from areas where it is in excess to sites

where it can be used or disposed of safely.

Diversion are used to:

- Divert runoff from highly erodible areas where the runoff is damaging property, causing erosion, or interfering with establishment of vegetation;
- Divert surface flow and subsurface flow away from steeply sloping land;

- An ***infiltration trench*** provides temporary storage of runoff in the void spaces around the stone and allows the stored runoff to infiltrate into the surrounding soil. This practice applies to sites where the soils are sufficiently permeable to provide a reasonable rate of infiltration. The water table and bedrock must be lower than the design depth of the trench. This practice is not recommended where runoff water contains a high percentage of suspended materials, oils and greases unless measures are taken to remove them before they reach the trench.
- An ***extended detention dry basin*** is used to reduce peak discharges from a given storm event by controlling the release rate and to improve water quality by removing pollutants from runoff. This practice applies to sites where the physical conditions are conducive to constructing an embankment, emergency spillway, a storage area, and a designed outlet system.
- A ***dry well*** is similar to an infiltration trench. It provides temporary storage of runoff in the constructed chamber and/or in the void spaces in the aggregate and allows the stored runoff to infiltrate into the soil. This practice applies to sites where the soils are sufficiently permeable to provide a reasonable rate of infiltration. Both the water table and bedrock must be lower than the design depth of the well. This practice is not recommended where runoff water contains high concentrations of sediment, oils, greases, and floatable organic materials unless measures are taken to remove them before they reach the well. Dry wells are generally used to store runoff from roof top areas; however they can be used to provide storage and infiltration from catch basins where conditions permit.
- A ***level spreader*** changes concentrated flow into sheet flow and then outlets it

onto stable areas without causing erosion. An example would be at the outlet of a diversion or a waterway. The level spreader is used where it can be constructed on undisturbed soils, where the area directly below the spreader is stabilized by existing vegetation, where the water will not re-concentrate immediately below the spreader, and where there is at least 100 feet of vegetated area between the spreader and surface water.

- ***Rock riprap*** protects soil from erosion due to concentrated runoff. It is used to stabilize slopes that are unstable due to seepage. It is also used to slow the velocity of concentrated runoff which in turn increases the potential for infiltration. Rock riprap can be used at the outlets of pipes and constructed channels where the velocity of flow from these structures exceeds the capacity of the downstream area to resist erosion. Rock riprap can be used for wave protection on lake shores and beaches. The practice can be used for storm drain outlets, in channels, in roadside ditches, on unstable slopes, at the toe of slopes, and for drop structures.
- A ***vegetated filter strip*** improves water quality by removing sediment and other pollutants from runoff as it flows through the filter strip. Some of the sediment and pollutants are removed by filtering, absorption, adsorption and settling as the velocity of flow is reduced. This practice applies to any site where adequate vegetation can be established and maintained. Vegetative filter strips can be used effectively:
    - surrounding stormwater management infiltration practices to reduce the sediment load delivered to the structures;
    - adjacent to all water courses such as waterways and diversions and water bodies such as streams, ponds, and lakes;
    - at the outlets of stormwater management structures; or
    - along the top of and at the base of slopes.
- ***Vegetated swales*** improve water quality by the treatment and removal of pollutants from stormwater runoff, increase infiltration, and reduce potential erosion from the discharge of runoff. This practice applies to all sites where a

dense stand of vegetation can be established and where either a stable outlet exists or can be constructed as a suitable conveyance system to safely dispose of the runoff flowing from the swale. The swale can be used by itself or in combination with other stormwater management and/or erosion and sediment control practices to achieve the water quality improvement or flood peak reduction desired.

- The ***Stormtreat System***^{TM} uses innovative stormwater treatment technology to selectively collect and treat the "first flush" of runoff and to efficiently handle runoff high in the watershed near its source. Stormtreat incorporates the proven technologies of sedimentation and filtration with a fringing constructed wetlands. By intergrating these techniques into a single unit, the ***Stormtreat System***^{TM} optimizes flow rates, maximizes sedimentation and provides filtration, adsorption, attenuation, and biochemical reaction within the wetlands.

3. Site Specific Management of Nonpoint Sources in the Great Pond Watershed.

a. Bank stabilization of Adirondack Shelter, Kingston State Park

i. Site background and Evaluation

The Adirondack Shelter is located within Kingston State Park along the shores of Great Pond. The area of concern is a rather steeply sloped (Figure XI-1), relatively unvegetated section of the state park. Much of the upper slope organic matter and lower sandy substrate has progessively eroded into the waters of Great Pond. If unchecked, this entire bank will continue to provide sedimentation and phosphorus to the pond. The area of concern is approximately 250 feet in length and contains some large tree stumps which are presently holding up some of the bank.

ii. Erosion Control Best Management Practice Design

Bioengineering for erosion control to reduce sedimentation and phosphorus inputs to waters is an expanding field. The placement of aquatic macrophytes and transitional aquatic/terrestrial plantings along this 500 foot

embankment should stabilize the unstablized bank and shoreline area from further erosion into the pond. This project will incorporate bioengineered fiber rolls and wetland plant pallets. Since we want to avoid the encouragement of ducks and geese in the beach area, we propose to use duck-resistant plantings. DES studies have shown that waterfowl that frequent public beaches increase the *E coli* bacteria levels which may result in the closing of public beaches.

The area will retain a siltation device during the entire construction phase and wetland permits must be obtained before any construction occurs.

iii. Materials and Estimated Construction Costs

Table XI-3 summarizes the materials necessary to stabilize 500 feet of shoreline at the Adirondack Shelter. Also included are estimated costs for the required plantings. Although the labor is intensive, no special equipment is required and no specialized personnel is necessary. Volunteers or park employees can carry the pallets to the waters edge and place them at the designated site. The water level must be lowered to facilitate the plantings and stakes must be hammered into the pallets to secure them in place when the water is brought back to full level. It may be necessary to level off the area where the pallets will be placed. If this is the case, a bucket loader or similar piece of heavy equipment may be required. Some terrestrial plantings and bank slope adjustments will also be required to decrease the velocity of runoff over the bank and to stabilize the unconsolidated sediments.Volunteer and park labor can be used as match, if funding is derived from a federal grant like the nonpoint source program.

Table XI-3
Materials and Costs and Bioengineering for Erosion Control

Description	Quantity	Unit Cost	Total
Arma Flor VF-500	50	15.40	770.00
Arma Flor VPO. 8x1.25 Plant pallet (sod) Size: 1.2 yds each proposed species selection: Blueflag Iris (*Iris versicolor*) Sweet Flag (*Acorus calamus*) Softstem Bulrush (*Scirpus validus*) Spargahium Spec. (*Bur reed*) Common Cattail (*Typha latifolia)*	23	33.60	772.80
Total			$1,542.80

b. Ball Road Erosion and Sedimentation BMPS

i. Site Background and Evaluation

The Ball Road Brook site is located approximately 0.25 miles from Rockrimmon Road. Erosional channels and sediment deposition were clearly evident at this station (Figure XI-2). The road is heavily sloped and crowned in such a way as to direct runoff into the upstream segment of the tributary. The adjacent area along the road is currently undeveloped and wooded. Typically, a road of this size will have a 20 foot perpetual maintenance easement off the center line of the road.

ii. Stormwater Management Design

This particular site would allow for the construction of a swale that would overlay a “French Drain” with a perforated PVC pipe extending the length of the swale, eventually discharging into a drop inlet or catch basin. Figures XI-3 through Figure XI-5 are plans adopted from the Rockingham County Conservation District to manage stormwater runoff into Beaver Lake, Derry, New Hampshire. This conceptual design is based upon success of stormwater BMP designs produced by NRCS and RCCD engineers and their subsequent installation and control of sstormwater in the Beaver Lake watershed.

iii. *Materials and Estimated Construction Costs*

The materials consist of perforated PVC pipe and coupling bands, rock rip-rap, woven geotextile fabric and concrete well tiles or a concrete drop inlet with a standard grate. The material costs associated with this design for approximately 700 feet of road-side drainage will be about $5,000.00; however, the length of road to be constructed for road-side drainage on Ball road will be less than Beaver Lake BMP. Additional engineering costs may be between $600.00 and $700.00 and will include site visits. The Town of Kingston Department of Public Works can provide the manpower and equipment to install the Stormwater Best Management Practices. The costs of construction will be used as the local soft match to complete this site specific project. In a similar BMP (See Table XI-4 for materials cost) project conducted at Beaver Lake, Derry, the town's D.P.W. cost for labor, supplies and construction equipment use was $5,900.00. The total estimated costs for materials and engineering will be $5,700.00.

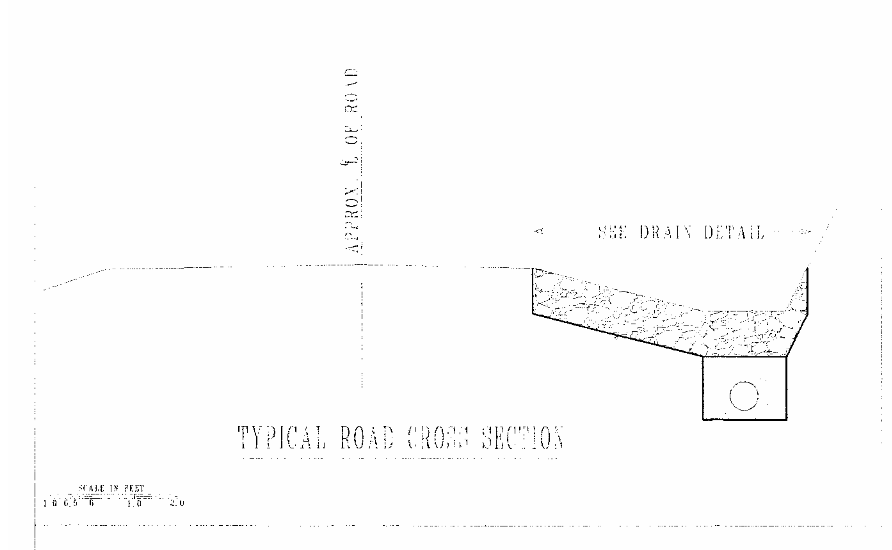
Table XI-4

Ever’s Road BMP Material Cost - Beaver Lake, Derry

Item	Area Description	Unit Price	Quantity	Item Price
Strip Loam	200' x 4' on left side	$4200.00/A	0.023 A	$97.00
Grade, Excavate Ditchline & Road	180' of ditchline, two diversion ditches & 500' of road super	$5.00/CY	118 CY	$590.00
Fabric for Ditch	180' x 5' wide	$1.10/SY	100 SY	$110.00
6 to 8" Riprap	180' x 5' x 1' deep	$30.00/CY	34 CY	$1,020.00
Recycled Asphalt	500' x 10' wide x 1.5" deep	$23.00/Ton	153 T	$3,519.00
Subtotal				$5,336.00

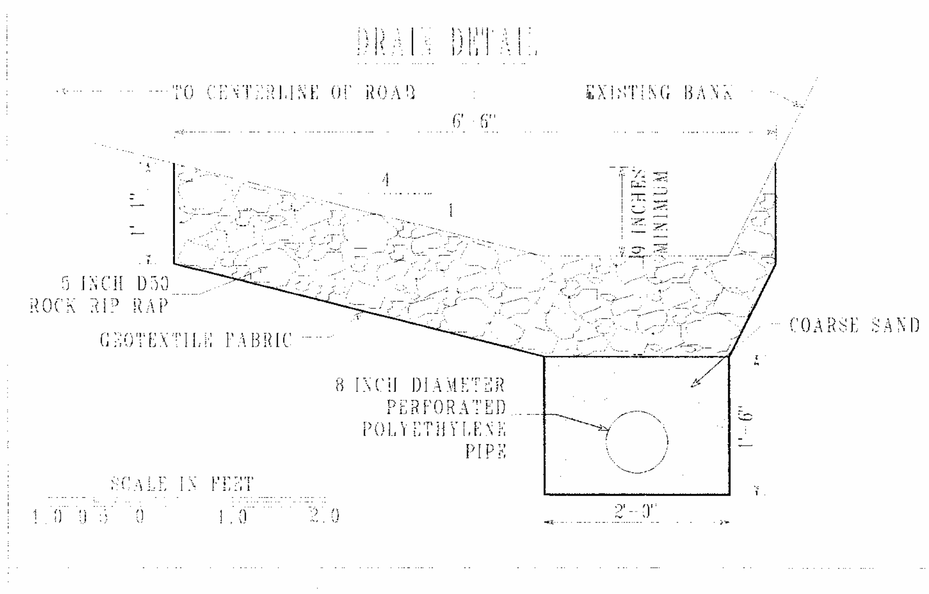
Ever’s Lane - Beaver Lake, Derry

Item	Area Description	Unit Price	Quantity	Item Price
Strip Loam	120' on left side	$4200.00/A	0.014 A	$59.00
Grade, Excavate Ditchline & Road	120' of ditchline & 20' x 20" of road	$5.00/CY	46 CY	$230.00
Fabric for Ditch	120' x 5' wide	$1.10/SY	67 SY	$74.00
6 to 8" Riprap	120' x 5' x 1' deep	$30.00/CY	23 CY	$690.00



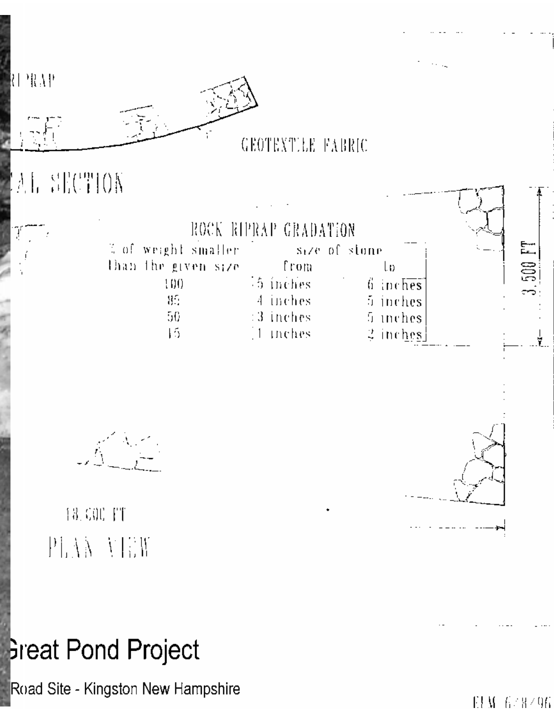
GREAT POND PROJECT

Ball Road Site - Kingston, New Hampshire



GREAT POND PROJECT

BALL ROAD SITE - KINGSTON, NEW HAMPSHIRE



c. Lincoln Brook Erosion and Sedimentation BMPs

i. Site Background and Evaluation

The Lincoln Brook site is located just before the entrance to Camp Lincoln. This site is a dirt surfaced road with erosional channels that transect Lincoln Brook and deliver a rich sediment load to the water. The Lincoln Brook site (Figure XI-6) has similar erosion problems to that of the Ball Road station.

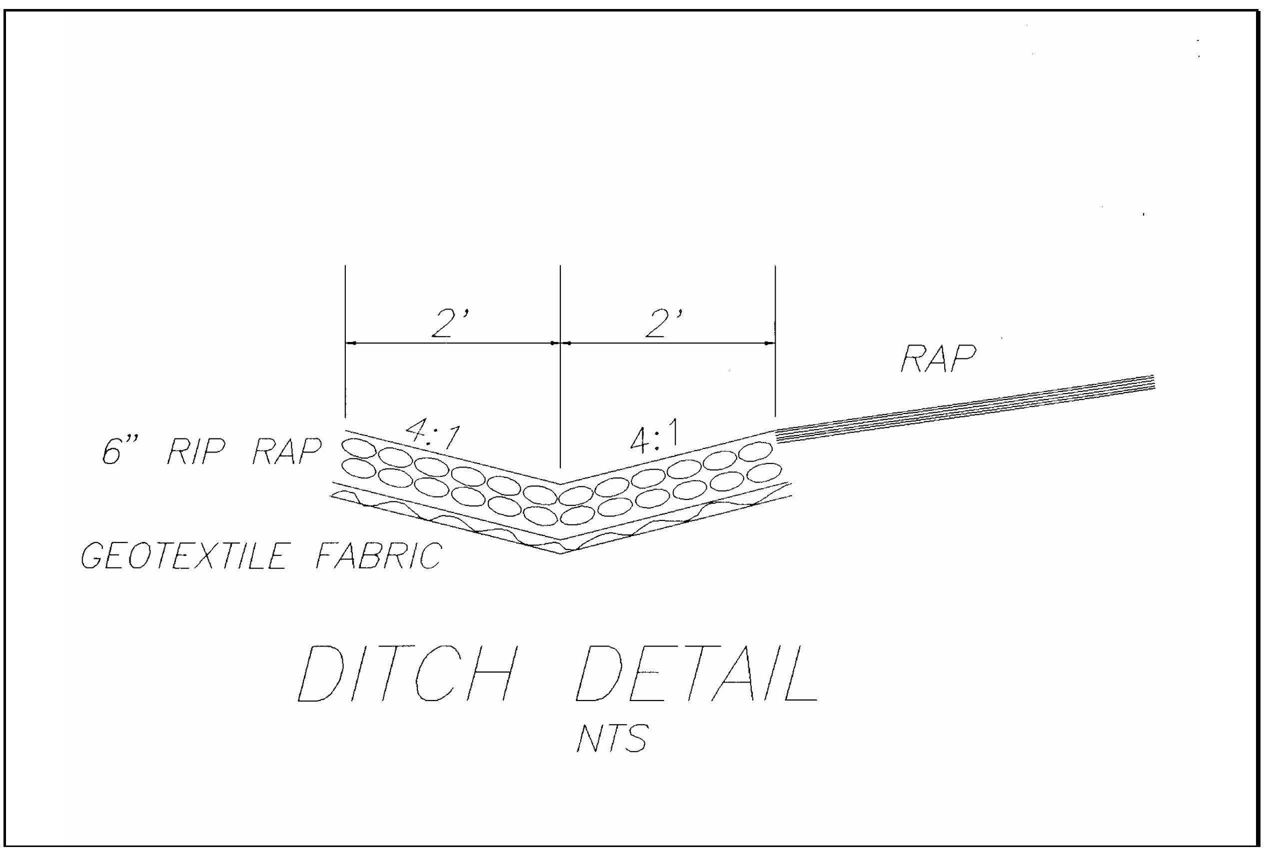
ii. Stormwater Management Design

This site would benefit from the application of Recycled Asphalt Product or RAP to eliminate the sedimentation of the tributary and to allow for crowning the new road surface to direct surface runoff into a management system. A sample rip-rap lined swale with geotextile fabric should be able to safely convey stormwater runoff to the tributary (Figure XI-7). A drop inlet or catch basin will be required to provide additional sump for solids. Alternatively, a culvert discharge into a rock rip-rap protected outlet structure or into a level spreader would also decrease the water velocity and settle out the particulate matter prior to its discharge into Lincoln Brook.

The key to the successful performance of stormwater practice is maintenance. The Town of Kingston must make a long term commitment to a maintenance program for the proposed Best Management Practices. Long term maintenance programs are the only means to ensure their performance over time. Many towns have an annual catch basin inspection and clean-out programs. In some cases, smaller towns may have to rent special equipment to provide annual service to catch basins.

iii. Materials and Estimated Construction Costs

Material costs for the project should be similar to Ever's Road in Derry (TableXI-5). Actual costs for this project will be derived from on-site plan prepared prior to construction. Figure XI-7 is a conceptual ditch design to be placed at the Ball Road site.



d. Sawdust Waste Management at the Cheney Mill

i. Site Background and Evaluation

The Cheney Mill is a historical presence in Kingston. This old saw mill is located in close proximity to Kelly Brook and on Cheney Mill Road. The saw mill is still run by power derived from the water flowing within Kelly Brook. A diesel engine is also located onsite as an alternative power source. Figure XI-8 portrays the sawdust mill and sawdust transport mechanism. As the trees are cut, the waste products are transported away from the sawmill. The sawdust is transported across Kelly Brook through a wooden structure. The sawdust falls to the ground and collects in a pile.

Sawdust is classified by DES as a waste product. Several site inspections have revealed that the Kelly Brook bottom is composed of sawdust waste. Much of the sawdust waste observed in the brook is probably a result of wind and surface water runoff from the sawdust pile to the brook.

The introduction of this waste to Class B waters is a violation of our states water quality standards. The sawdust waste smothers the benthic community, creates a demand on the oxygen in the water and provides an additional source of phosphorus to Great Pond.

ii. Sawdust Waste Management

Although there is no specialized Best Management Practice to control this waste, there are probably many techniques that could be applied. A common sense approach would be to construct a simple four sided building without a roof. The bottom of the structure could be non pervious or pervious to wetfall. If a non pervious floor is chosen, structures should be built into the building to facilitate drainage. The roadside section of the building could be open or fitted with a garage door so that waste products could easily be picked up for use or disposal.

iii. *Materials and Estimated Construction Costs*

Since we are dealing with a saw mill, the wood for this project should be inexpensive. The building dimensions can be based upon the maximum amount of waste stored over time. This can best be estimated by the owners themselves. Sawdust waste management practices would also be eligible for nonpoint source funding. The total cost of the project should be minimal and can only be estimated through contact and cooperation of the sawmill owners.

e. *Kingston State Park*

i. *Site Background and Evaluation*

The Kingston park manager has documented an erosion problem in the area where the stabilized grassed area intersects the sandy beach (Figure XI-9). The poor drainage results in moderate to high hydraulic intensity to the park beach. The combination of flow velocity being distributed to a concentrated area results in the erosion of beach sand to the pond.

ii. *Stormwater Management Design*

The lengthwise ditch running parallel to the lake should be cleaned out regularly to facilitate the flow of water. This site would also be conducive to a shallow trapezoidal grassed swale or a grassed ditch. The additional surface area of the swale would allow for some infiltration of surface water. The addition of one or more stone check dams along the grassed swale would allow for some settling out of particulate matter before the water flows onto the beach.

The eroded drainage section of the beach should be lined with geotextile fabric and covered by rock rip-rap.

iii. Materials and Estimated Construction Costs

Plans for trapezoidal grassed swales can be derived from NRCS. The estimated cost for a 120 foot ditch are included on Table XI-5. Stone check dams are easy to construct once an area is dug out. The bottom is lined with geotextile fiber and rocks are placed over the fiber material.

Table XI-5
Estimated Costs for Erosion Control
Practices at Kingston State Park

Item	Area Description	Unit Price	Quantity	Item Price
Grade, excavate swale	120 feet of swale	$5.00/CY	46 CY	$230.00
Frabic for Beach Ditch	100' x 5' wide	$1.10/SY	56 SY	$62.00
6 to 8 in riprap	100' x 5' x 1'	$30.00/CY	20 CY	$600.00
Subtotal				$892.00

Nonpoint source money may be available to help pay for this project. As we discussed previously, nonpoint source funding requires a 60-40 match. Any work done be volunteers and state park employees are considered match.

4. Zoning

The Zoning Ordinance and Building Code Regulations for the Town of Kingston were amended in 1995. The purpose of a zoning ordinance is to regulate the use of land in a manner that promotes the health and welfare of a municipality. It includes requirements to lessen congestion in the streets, secure safety from fires, panic and other dangers, to provide adequate light and air, to prevent overcrowding to land and to avoid undue concentrations of populations. The ordinance should be designed to facilitate adequate provision of an infrastructure to meet municipal needs for such services as transportation, solid waste facilities, water, sewerage, schools and parks.

a. Introduction.

RSA 674:16 authorizes the local legislative body of a city or town to adopt and amend a zoning ordinance for the purpose of promoting the health, safety or general welfare of the community. Such ordinances are designed to regulate and restrict the use of land within the municipality. They often include maximum limitations for the density, height, number of stories and sizes of buildings and other structures. They specify areas, or zones, within the municipality where land and structures can be used for business, industrial, residential and other purposes. A listing of land uses that are permitted and prohibited, or permitted by special exception, is usually included for each zone within the community. A variety of zoning techniques are available for lake management and protection; some are listed in Table XI-6.

b. Environmental Characteristics Zoning.

It is common for municipalities to recognize the importance of critical resource areas by adding protective overlay districts to their town-wide zoning ordinances. An overlay zone is so called because it adds special protective requirements or higher standards within an area that is delineated as a special resource. The boundaries of that resource usually do not coincide with those of the regular zoning districts. Where the requirements of the districts differ, the more stringent of the two apply. This type of zoning has traditionally been used to protect wetlands, floodplains, watersheds, aquifers, steep slopes and shorelines. Table XI-7 presents a summary of the types of requirements that are likely to be found in overlay zoning ordinances to address

Table XI-6
A Variety of Zoning Techniques

Topic	Definition
Zoning	The regulation of building types, densities, and uses permitted in districts established by law.

Special Permits/ Special Exceptions/ Conditional Use Permits	Administrative permits for uses that are generally compatible within a particular use zone, but that are permitted only if certain specified standards and conditions are met.
Variances	Administrative permits for uses that are generally compatible within a particular use zone, but that are permitted only if certain specified standards and conditions are met.
Floating Zones	Use zones established in the text of a zoning ordinance, mapped until a developer proposes and the legislative body adopts such a zone for a particular site.
Conditional Zoning	An arrangement whereby a jurisdiction extracts promises to limit the future use of land, dedicate property, or meet any other conditions. The arrangement is either stated in general terms in the zoning ordinance or imposed on a case-by-case basis by the legislative or administrative body, prior to considering a request for a rezoning.
Contract Zoning	An arrangement whereby a jurisdiction agrees to rezone specified land parcels subject to the landowner's execution of restrictive covenants or other restrictions to dedicate property or meet other conditions stated in the zoning ordinance or imposed by the legislative or administrative body.
Cyclical Rezoning	The periodic, concurrent consideration of all pending rezoning applications, generally as part of an ongoing rezoning program, focusing upon one district at a time.
Comprehensive Plan Consistency Requirement	Provisions that require all zoning actions, and all other government actions authorizing development, be consistent with an independently adopted comprehensive plan.
Zoning Referendum	Ratification of legislatively approved land use changes before such changes become law.
Prohibitory Zoning	The exclusion of all multifamily, mobile, modular, industrialized, prefabricated, or other "undesirable" housing types from an entire jurisdiction, or from most of the jurisdiction.

Table XI-6 (cont.)

A Variety of Zoning Techniques

Topic	Definition
Agricultural Zoning/Large Lot Zoning Open Space Zoning	The establishment of "permanent" zones with large (that is multiacre) minimum lot sizes and/or a prohibition against all nonagricultural development of single-family residences and, possibly, selected other uses).
Phased Zoning/ Holding Zones/ Short-Term Service Area	The division of an area into (1) temporary holding zones closed to most nonagricultural uses and/or with large minimum lot sizes, and (2) service areas provided with urban services and open for development in the near term (for example 5 years).
Performance Zoning/Performance Standards	An arrangement whereby all or selected uses are permitted in a district if they are in compliance with stated performance standards; that is, if they meet stated community and environmental criteria on pollution, hazards, public service demands, etc.
Flexible Zoning/ Cluster Zoning/ Density Zoning	Freedom from minimum lot size, width, and yardage regulations, enabling a developer to distribute dwelling units over individual lots in any manner the developer desires, provided (usually) that the overall density of the entire subdivision remains constant.

From the Lake and Reservoir Restoration Guidance Manual, Second Edition, EPA, 1990.

these resources.

Delineation of the environmental overlay zoning districts usually depends on existing maps and data prepared by federal agencies such as the Natural Resources Conservation Service, United States Geological Survey, Federal Emergency Management Agency and others. Although such maps provide the planning board with a general idea of the extent of the resource in question, they are generally not sufficient in detail to identify a precise location of the district boundary. Where this is the case, it is important that the overlay zoning ordinance allows applicants to provide the planning board with more technical, site specific information to delineate the boundary. It is helpful to both the planning board and applicants if that section of the ordinance clearly defines the methodology or options for methodologies to be used to delineate the district in the field. The ordinance may provide for an independent review of the

Table XI-7

Overlay Zoning Techniques: Key Characteristics

Wetlands	Floodplains	Watershed	Aquifer	Steep Slopes	Shoreline
Permitted and prohibited uses*	Permitted and prohibited uses*	Permitted and prohibited uses*	Permitted and prohibited uses*	Requirements for location or prohibition of septic systems vs. roads and structures*	Buffers, setbacks and rationale*
Setbacks for septic tanks/leachfields*	Setbacks for septic tanks/leachfields*	Performance standards more stringent than generally required by zoning*	Definition and methodology for delineation of district	Site specific data requirement option	BMPs for lawn management natural vegetative buffers, etc.*
Setbacks for roads and structures*	Setbacks for wells, structures, roads*	Site specific data requirement option	More stringent performance standards than watershed*		Requirements for shoreline structures*
Buffers*	Zero increase in peak flood elevation		Limitations or percent coverage by impervious materials*		Site specific data requirement option
Definition of wetlands and methodology for delineation*	Site specific data option		Site specific data requirement option		
Site specific data requirement option					

Note: *Need to examine scientific basis.		Source: NH Office of State Planning, Water Protection Assistance Program, 1990.

data which has been provided by the applicant, or by a qualified consultant hired by the planning board at the applicant's expense. This type of review and professional consultation assists the planning board in making an informed decision based on technical information about the sensitive resource that the ordinance aims to protect. The ordinance may also spell out conditions under which the planning board may require site specific investigations.

c. Wetlands Zoning

Many municipalities adopt wetlands overlay zoning regulations to protect the natural functions or values which make wetlands a critical resource within a watershed. These important functions include flood protection and flow stabilization, wildlife habitat, filtration of nutrients, trapping of sediments, and ecological productivity. Such ordinances need to define or delineate the extent of the overlay district boundary. There are a number of ways to establish the extent of wetland boundaries. Wetland overlay ordinances typically have requirements for setbacks from wetlands for the location of septic system tanks and leachfields, roads and structures. Some ordinances establish buffers around wetlands within which land uses are either restricted or required to adhere to performance standards. It is common for wetland ordinances to allow the planning board to require that site specific information relative to the location of the wetland boundary be supplied by the applicant. This is usually for sites where considerable acreage of wetlands is proposed for alteration, or the wetlands exhibit particular resource values that are significant to the municipality.

The Town of Kingston has adopted a Wetlands Conservation District. The Following description is taken from Article III of the Zoning Ordinance and Building Code Regulations.

4.70 WETLANDS CONSERVATION DISTRICT (Adopted 3-9-82)

4.71 Purpose (Amended 3-8-83, 3-14-89 & 3-12-91)

In the interest of public health, convenience, safety and welfare, this ordinance is intended to guide the use of wetland areas which are identified and delineated as poorly and very poorly drained soils.

a. To maintain the quality and level of the groundwater table and water re-charge areas for existing or potential water supplies,

b. To insure uses that can be safely and appropriately located in wetlands areas in order to prevent pollution of surface and groundwater necessary to supply domestic water needs,

c. To prevent the Town from incurring unnecessary and excessive expenses to provide and maintain essential. services and utilities which arise because of unwise use of wetlands.

d. To protect persons and property against the hazards of flood water inundation by assuring the continuation of the natural flow pattern of streams and other water courses within the Town and by preserving natural flood water storage.

6. To protect presently existing natural wetland wildlife habitats.

4.72 Definition

a. The Wetlands Conservation District of Kingston shall consist of those areas within the Town which contain fresh water marshes, ponds and lakes, perennial streams and soils classified as poorly and very poorly drained as defined by the National Cooperative Soil Survey conducted by the U.S. Department of Agriculture Soil Conservation Service for the Town of Kingston through field mapping surveys completed in 1977 and published in the "Soil Survey Report of the Town of Kingston".

b. Where the Wetlands Conservation District is superimposed over another zoning district in the Town of Kingston, that district which is more restrictive shall govern.

4.73 Wetlands Conservation District Map

The Wetlands Conservation District as herein defined is shown on a map designated as

"Town of Kingston Wetlands Conservation District" and is a supplement to the zoning map of the town. Wetland boundaries indicated on the zoning map supplement shall be determined from soil survey field sheets which show the results of the soil survey referenced in Section 4.72 and from the on-site soils investigation of a certified soils scientist when required. Soil survey field sheets are available from the U.S. Soil Conservation Service in Exeter, N.H., and are on file with the Planning Board, Town Clerk and Conservation Commission. The results of any on-site soils investigation will be on file with the Planning Board and Conservation Commission. A certified soil scientist is a person qualified in soil classification and mapping who is certified by the State of New Hampshire Board of Natural Scientists.

4.74 Appeal

In the event that an area is alleged to be incorrectly designated on the soil survey field sheets, any person aggrieved by such a designation may present adequate evidence of such to the Planning Board. Adequate evidence shall include a written report of on-site soils investigation and analysis conducted by a certified soils scientist.

4.75 Permitted Uses

In designated wetland areas permitted uses are those which are compatible with the purposes specified in Section 4.71 of this ordinance and do not involve significant alteration of the wetland. Such uses include:

- *a. Forestry tree farming*
- *b. Agriculture*
- *c. Water impoundments and well supplies*
- *d. Maintenance of existing drainage ways—streams, creeks, or other paths of normal water runoff*
- *e. Wildlife refuge*
- *f. Parks and such recreational uses which are consistent with the purpose and intent of Section 4.71*
- *g. Conservation areas and nature trails*
- *h. Open space as permitted by subdivision regulations and other sections of this ordinance*

4.76 Uses Permitted Subject to Review

a. Easements and Rights of Way Streets, roads and other access ways and utility rights of way or easements may be permitted provided that evidence of the following be accepted by the appropriate Board:

1) The street, road, access way or utility right-of-way or easements are essential to the productive use of land. not zoned under the provisions of this ordinance.

2) The street, road, access way or utility right-of-way or easement is so located and constructed as to minimize any detrimental impact of such uses upon the wetland.

3) Such location and construction be compatible with the intents and purposes of this ordinance.

b. Underlying Districts

In cases where The Wetlands Conservation District overlays another zoning district, the proposed use shall be permitted (providing said use is allowed in the underlying district) subject to review by the appropriate Board providing that:

1) Uses are consistent with the purpose and- intent in Section 4.71.

2) The appropriate procedure for review as delineated in Section 4.77 be followed.

4.77 Proceedure for Review (Amended 3-14-98)

a. Building Permits for Individual Lots: Upon receiving a request for a building permit within the Wetlands Conservation District, the Board of Selectmen shall notify the Planning Board and Conservation Commission of said request. The Planning Board and Conservation Commission may submit a written report. If the Board of Selectmen determines from these reports that the proposed activity may have a significant negative impact on the wetlands as described in Section 4.71, they may request the applicant to submit a drainage report and calculations describing the extent of that impact.

b. Subdivision and Site Plan Review (Amended 3-14-89): Any person who desires to subdivide land or propose construction that would be subject to site plan review *within the wetlands Conservation District shall submit to the Planning Board, in addition to all other requirements stipulated in the Subdivision Regulations, five (5) copies (copies are given to the Board of Selectmen, Conservation Commission, Town Engineer, and two retained by the Planning Board) of a drainage report and calculations prepared by a Registered Professional Engineer describing the extent of impact on the wetlands. The topographic map should include soil typing according to Section 4.72 of this ordinance. The Board of Selectmen and Conservation Commission may submit a written report for consideration.*

c. Issuance of Conditions

If after review of all submitted data the appropriate Board determines that the area on which the proposed work is to be done is in conflict with Section 4.71 of this ordinance, the Board shall:

1) Grant preliminary approval subject to an order of conditions it deems necessary for compliance and subsequent final approval, or

2) deny the request and give the reason thereto.

d. Amended 3-14-89

The appropriate Board shall be entitled to review, regulate and prohibit development proposals within one hundred (100) feet of a wetland when it is determined that such developuent may have a significant negative impact on the wetland not consistent with the purposes and intent of Section 4.71.

4.76 Special Exceptions

Special exceptions for the undertaking of a use not otherwise permitted in the Wetlands Conservation District, which may include erection of a structure, dredging, filling, draining, or otherwise altering the surface configutation of the land, may be granted by the Board of Adjustment, if it can be shown that such proposed use will not conflict with the purpose and intent of Section 4.71. Proper evidence to this effect shall be submitted in writing to the Board of Adjustment and may be accompanied by the findings of a review of the Rockingham County Conservation District of the environmental effects of such proposed use upon the wetlands in question.

In 1995 the Office of State Planning (OSP) reviewed the Town of Kingston's ordinances as part of the EPA funded Wetlands Project. The OSP made several valuable recommendations for changes to Kingston's Wetlands Conservation District, they are as follows:

2. Section 2.20, 12, the definition of wetlands should be updated to reference the updated

Rockingham County Soil Survey, which has recently been published by the Natural Resources Conservation Service.

Town Of Kingston, Wetlands Conservation District, Revised 1991

3. *Section 4.71, entitled Purpose for the wetlands conservation district, states that wetlands are "identified and delineated as poorly and very poorly drained soils." However, Section 2.02, 12 and Section 4.72 also define wetlands as fresh water marshes, ponds, lakes and streams. These definitions should all be consistent.*

4. *Section 4.72 refers to the 1977 Soil Survey Report of the Town of Kingston. This should be updated to reflect the recently released update of the Rockingham County Soil Survey.*

5. *Section 4.74, entitled Appeal, allows areas that are alleged to be incorrectly designated on the soils maps to be reconsidered based upon a written report of on-site soils investigation and analysis conducted by a certified soil scientist. The planning board may wish to consider a delineation requirement that is consistent with the requirements of the New Hampshire Wetlands Board's administrative rules Wt 301.01, which states that*

   "Wetlands shall be delineated on the basis of hydrophytic vegetation, hydric soils, and wetlands hydrology, in accordance with the techniques outlined in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, (January 10, 1989)".

   The rules allow for a delineation based on hydrophytic vegetation or hydric soils alone for minimum impact projects.

6. *Section 4.76 is entitled "Uses Permitted Subject to Review". The planning board may wish to consider using the term "special exception" as is referenced in RSA 674:33, IV. Another option could be to require a conditional or special use permit as part of an innovative land use control under RSA 674:21,II.*

7. *Section 4.77 outlines the procedure for the review. It includes a written report from the planning board and conservation commission and authorizes the board of selectmen to request the applicant to submit a "drainage report and calculations". The ordinance should*

include specifications for what should be detailed in this report. We suggest that a wetland evaluation and/or delineation may be more appropriate than a drainage report.

The ordinance requires that the drainage report be prepared by a Registered Professional Engineer, yet the map requires "soil typing". A certified soil scientist is required to make a soil map in New Hampshire.

If classification and mapping of the soil is what the planning board wishes for site specific information, it would be helpful to reference the recently developed soil map standards included in the publication entitled <u>Order 1 Soil Mapping Standards for New Hampshire</u>, Society of Soil Scientists of Northern New England Publication Number 2, 1993.

8. *Section 4.77, (c) authorizes the "appropriate board" to issue conditions. The ordinance should specify what the "appropriate board" is. An innovative land use control, in accordance with RSA 674:21 would be required to designate administration of the ordinance to other than the planning board.*

   The ordinance should also specify the type of "conditions" that can be required so that it is clear to both applicants and members of the planning board.

9. *Section 4.77, (d) authorizes the "appropriate board" to prohibit development proposals within 100 feet of a wetland. The ordinance should specify conditions under which development can be prohibited, so that it is clear to both applicants and members of the planning board.*

10. *Section 4.78 allows for special exceptions. It should specify the conditions under which special exceptions will be granted.*

11. *Section 6.17 prohibits septic systems within 75 feet of wetlands and water bodies. This requirement is more stringent than Env-Ws 1014.01, (2), which allows for leachfields to be located within 50 feet of hydric B, poorly drained soils.*

12. *Section 6.30 should be updated to reflect the current agency name Water Supply and Pollution Control Division. It could also cite RSA 485-A, 29-44 and the state rules for*

subsurface wastewater disposal systems NH Code of Administrative Rules Env-Ws 1000.

13. *Section 8.10 should cite the enforcement procedures in RSA 676:17, 17-a and 17-b, which authorize fines and penalties, cease and desist orders and local land use citations.*

14. *Relative to drainage, it may be useful to add a section which references the state's requirements for erosion and sediment control and stormwater management for disturbance of land greater than 100,000 square feet. A site specific permit for such disturbances is required by the DES-WSPCD in accordance with RSA 485-A:17 and NH Code of Administrative Rules Env-Ws 415.*

    The planning board may also wish to include the specifications of the 1992 publication entitled Stormwater Management and Erosion and Sediment Control for Urban and Developing Areas in New Hampshire, DES and RCCD. In addition to this publication, the NHACD Urban Development and Water Quality Committee is working on a model stormwater management regulation that will also address long term, on-going maintenance of permanent stormwater management measures once they are in place. This should be available in the spring of 1995.

15. *The planning board may wish to consider lot sizing by soil type as an alternative to an across the board 80,000 square foot minimum lot size. The original concept of determining lot sizes by soil type was developed in New Hampshire for groundwater protection purposes. This approach has been used by the Department of Environmental Services in their administrative rules for subsurface wastewater disposal systems. It is based upon the natural capabilities of the receiving soils to treat wastewater in unsewered areas with private individual wells. The rationale behind this approach has gained acceptance and many municipalities have adopted soil based lot size requirements in their local zoning ordinances.*

    Within the recent past an Ad Hoc Committee of New Hampshire experts was formed to research and document the technical basis for the soil based lot sizing concept. Their findings were summarized in a document entitled Environmental Planning for on-site Wastewater Treatment in New Hampshire: Technical Report of the Ad Hoc Committee for Soil Based Lot Size, NH DES and Rockingham County Conservation District, June

1991. The Committee used a state of the art computer model described in the technical report to generate lot sizes by soil type for New Hampshire soils. The results are presented in a second document entitled Model Subdivision Regulations for Soil-Based Lot Size, Report of the Ad Hoc Committee for Soil Based Lot Size, NH DES and Rockingham County Conservation District, June 1991. In general these two recent documents corroborate the earlier work that was done by DES. Although the lot sizes in the model regulations are not exactly the same as those in the DES subsurface rules, they are comparable. Both schemes are considered to be within the realm of reasonableness.

If the Town of Kingston has not already addressed these recommendations, they should do so as soon as possible.

d. Floodplain Zoning

Floodplains are sensitive resources that are often protected by local zoning. Their values include their ability to protect adjacent properties from damage by assimilating flood waters during storm events. Many also serve as critical wildlife areas, and either are wetlands or are associated with wetland habitats. Communities are required by the Federal Emergency Management Agency (FEMA) to pass certain minimal zoning restrictions for floodplain development in order to be eligible for the federal flood insurance program. Many communities choose to adopt floodplain requirements in their zoning ordinances which are more stringent than the minimum required by the FEMA program. The FEMA program allows construction within sensitive floodplain areas if the structures are "floodproofed." Filling in or paving over floodplains decreases the peak flow capacity of the riverine system. The cumulative impacts of filling or paving, over time, can have a significant impact on downstream properties. Municipalities can adopt more stringent overlay zoning requirements than FEMA's to provide protection measures for floodplain areas. Floodplain ordinances can include setbacks and site specific data requirements that are similar to those found in wetlands ordinances. Requirements for maximum or no increases in peak flood levels are often considered in floodplain zoning ordinances.

The Town of Kingston has a Floodplain Development ordinance in its zoning codes, which applies to all lands designated as flood hazard areas by FEMA. It requires that new and replacement water supplies and wastewater disposal systems are located, constructed and designed to minimize and/or avoid destruction caused by flood events.

The article, taken from the Zoning Ordinances of the Town of Kingston appears here.

Kingston Floodplain Development Ordinance
Adopted March 10, 1992, Amended March 8, 1994

This ordinance, adopted pursuant to the authority of RSA 674:16, shall be known as the Town of Kingston Floodplain Development Ordinance. The regulations in this ordinance shall overlay and supplement the regulations in the Town of Kingston Zoning ordinance, and shall be considered part of the Zoning Ordinance for purposes of administration and appeals under state law. If any provision of this ordinance differs or appears to conflict with any provision of the Zoning Ordinance or other ordinance or regulation, the provision imposing the greater restriction or more stringent standard shall be controlling.

The following regulations in this ordinance shall apply to all lands designated as special flood hazard areas by the Federal Emergency Management Agency (FEMA) in its "Flood Insurance Study for the Town of Kingston, N.H." together with the associated Flood Insurance Rate Maps with an effective date of April 15, 1992, which are declared to be a part of this ordinance and are hereby incorporated by reference.

Item I Definition of Terms: The following definitions shall apply only to this Floodplain Development Ordinance, and shall not be affected by the provisions of any other ordinance of the Town of Kingston.

> *"Area of Shallow Flooding" means a designated AO, AH, or VO zone on the Flood lnsurance Rate Map (FIRM) with a one percent or greater annual possibility of flooding to an average depth of one to three feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and where velocity flow may be evident. Such flooding is characterized by ponding or sheet-flow.*
> *"Area of Special Flood Hazard" is the land in the floodplain within the Town of Kingston subject to a one-percent or greater possibility of flooding in any given year. The area is designated as zone A on the FHBM and is designated on the FIRM as zones A and AE.*

“Base Flood” means the flood having a one-percent possibility of being equalled or exceeded in any given year.

“Basement” means any area of a building having its floor subgrade on all sides.

“Building” - see “structure”.

“Breakaway wall” means a wall that is not part of the structural support of the building and is intended through its design and construction to collapse under specific lateral loading forces without causing damage to the elevated portion of the building or supporting foundation.

“Development” means any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operation.

“FEMA “ means the Federal Emergency Management Agency.

“Flood” or “Flooding” means a general and temporary condition of partial or complete inundation of normally dry land areas from:

(1)the overflow of inland or tidal waters.
(2)the unusual and rapid accumulation or runoff of surface waters from any source.

“Flood Elevation Study” means an examination, evaluation, and determination of flood hazards and if appropriate, corresponding water surface elevations, or an examination and determination of mudslide or flood - related erosion hazards.

“Flood Hazard Boundary Map” (FHBM) means an initial insurance map issued by FEMA that identifies, based on approximate analyses, areas of 100-year flood hazard within a community.

"Flood Insurance Rate Map" (FIRM) means an official map incorporated with this ordinance, on which FEMA has delineated both the special flood hazard areas and the risk premium zones applicable to the Town of Kingston.

"Flood Insurance Study" - see "Flood elevation study".

"Floodplain" or "Flood-prone area" means any land area susceptible to being inundated by water from any source (see definition of "Flooding").

"Flood proofing" means any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitation facilities, structures and their contents.

"Floodway" - see "Regulatory Floodway".

"Functionally dependent use" means a use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking and port facilities that are necessary for the loading/unloading of cargo or passengers, and ship building/repair facilities but does not include long-term storage or related manufacturing facilities.

"Highest adjacent grade" means the highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

"Historic structure" means any structure that is:

(a) Listed individually in the National Register of Historic Places (a listing maintained by the Department of Interior) or preliminarily determined by the secretary of the Interior as meeting the requirements for individual listing on the National Register;

(b) Certified or preliminarily determined by the secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the secretary to qualify as a registered

historic district;

(c) *Individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the secretary of the Interior or*

(d) *Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either:*

1) *By an approved state program as determined by the secretary of the Interior, or*

2) *Directly by the Secretary of the Interior in states without approved programs.*

"Lowest Floor" means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided, that such an enclosure is not built so as to render the structure in violation of the applicable non—elevation design requirements of this ordinance.

"Manufactured Home" means a structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For floodplain management purposes the term "manufactured home" includes park trailers, travel trailers, and other similar vehicles placed on site for greater than 180 days.

"Mean sea level" means the National Geodetic vertical Datum (NGVD) of 1929 or other datum, to which base flood elevations shown on a communities Flood Insurance Rate Map are referenced.

"l00-year flood" - see "base flood"

"Recreational vehicle" means a vehicle which is (a) built on a single chassis; (b)

four hundred (400) square feet or less when measured at the largest horizontal projection; (c) designed to be self propelled or permanently towable by a light duty truck; and (d) designed not primarily for use as a permanent dwelling but as temporary living quarters for recreational camping, travel or seasonal use.

"Regulatory floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without increasing the water surface elevation. These areas are designated as floodways on the Flood Boundary and Floodway Map.

*"Special flood hazard area" means an area having flood, mudslide, and/or flood-related erosion hazards, and shown on an FHBM or FIRM as zone A, AO, Al-3D, AE A99***,** *All, VO, Vl-30, VE, V, M or E. (See - "Area of Special Flood Hazard")*

"Structure" means for floodplain management purposes, a walled and roofed building, including a gas or liquid storage tank, that is principally above ground, as well as a manufactured home.

"Start of Construction" includes substantial improvements, and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, placement, or other improvement was within 180 days of the permit date. The actual start means either the first placement of permanent construction of a structure on site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of manufactured home on a foundation. Permanent construction does riot include land preparation, such as clearing, grading and filling ; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or part of the main structure.

"Substantial damage" means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would

equal or exceed 50 percent of the market value of the structure before the damage occurred.
"Substantial Improvement" means any combination of repairs, reconstruction, alteration, or improvements to a structure in which the cumulative cost equals or exceeds fifty percent of the market value of the structure. The market value of the structure should equal: (1) the appraised value prior to the start of the initial repair or improvement, or (2) in the case of damage, the value of the structure prior to the damage occurring. For the purposes of this definition, "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. This term includes structures which have incurred substantial damage, regardless of actual repair work performed. The term does not, however, include any project for improvement of a structure required to comply with existing health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions or any alteration of a "historic structure", provided that the alteration will not preclude the structure's continued designation as a "historic structure".

"Water surface elevation" means the height, in relation to the National Geodetic Vertical Datum (NGVD) of 1929, (or other datum, where specified) of floods of various magnitudes and frequencies in the floodplains.

Item II.
All proposed development in any special flood hazard areas shall require a permit.

Item III.
The building inspector shall review all building permit applications for new construction or substantial improvements to determine whether proposed building sites will be reasonably safe from flooding. If a proposed building site is located in a special flood hazard area, all new construction or substantial improvements shall:

(I) be designed (or modified) and adequately anchored to prevent floatation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy,

(ii) *be constructed with materials resistant to flood damage,*

(iii) *be constructed by methods and practices that minimize flood damages,*

(iv) *be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment, and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.*

Item IV.

Where new or replacement water and sewer systems (including on-site systems) are proposed in a special flood hazard area the applicant shall provide the Health Inspector with assurance that these systems will be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters, and on-site waste disposal systems will be located to avoid impairment to them or contamination from them during periods of flooding.

Item V.

For all new or substantially improved structures located in Zones A, Al-AO, AE, AH or AO, the applicant shall furnish the following information to the building inspector:

(a) *the as-built elevation (in relation to NGVD) of the lowest floor (including basement) and include whether or not such structures contain a basement.*

(b) *if the structure has been floodproofed, the as-built elevation (in relation to NGVD) to which the structure was floodproofed.*

(c) *any certification of floodproofing.*

The Building Inspector shall maintain for public inspection, and shall furnish such information upon request.

<u>Item VI</u>.
The Building Inspector shall not grant a building permit until the applicant certifies that all necessary permits have been received from those governmental agencies from which approval is required by federal or state law, including section 404 of the Federal Water Pollution Control Act Amendments of 1972, 33 U. S. C. 1334.

<u>Item VII</u>.

1. In riverine situations, prior to the alteration or relocation of a watercourse the applicant for such authorization shall notify the Wetlands Board of the New Hampshire Environmental Services Department and submit copies of such notification to the Building Inspector, in addition to the copies required by the RSA 483-A:1-b. Further, the applicant shall be required to submit copies of said notification to those adjacent communities as determined by the Building Inspector, including notice of all scheduled hearings before the Wetlands Board. In addition construction within wetland areas requires notification of the Kingston Conservation Commission and the Planning Board.

2. The applicant shall submit to the Building Inspector, certification provided by a registered professional engineer, assuring that the flood carrying capacity of an altered or relocated watercourse can and will be maintained.

3. The Building Inspector shall obtain, review, and reasonably utilize any floodway data available from Federal, State, or other sources as criteria for requiring that all development located Zone A meet the following floodway requirement:

"No encroachments, including fill, new construction, substantial improvements, and other development are allowed within the floodway that would result in any increase in flood levels within the community during the base flood discharge.

4. Along watercourses that have not had a Regulatory Floodway designated or determined by a federal, State or other source; no new construction, substantial improvements, or other development (including fill) shall be permitted within zones Al—30 and AE on the FIRM, unless *it is demonstrated by the applicant that the cumulative effect of the proposed development, when combined with all existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.*

Item VIII.

1. In special flood hazard areas the Building Inspector in conjunction with the Kingston Town Engineer shall determine the 100 year flood elevation in the following order of precedence according to the data available:

a. In zones A and AE, refer to the elevation data provided in the community's Flood Insurance Study and accompanying FIRM or FHBM.

b. In unnumbered A zones the Building Inspector shall obtain, review, and reasonably utilize any 100 year flood elevation data available from any federal, state or other source including data submitted for development proposals submitted to the community (i.e. subdivisions, site approvals).

c. In zone A0 the flood elevation is determined by adding the elevation of the highest adjacent grade to the depth number specified on the FIRM or if no depth number is specified on the FIRM at least 2 feet.

2. The Building Inspector's 100 year flood elevation determination will be used as criteria for requiring in zones A and AE that:

a. all new construction or substantial improvement of residential structures have the lowest floor (including basement) elevated to or above the 100 year flood elevation;

b. that all new construction or substantial improvements of non—residential structures have the lowest floor (including basement) elevated to or above the 100 year flood level; or together with attendant utility and sanitary facilities, shall:

(I) be floodproofed so that below the 100 year flood elevation the structure is watertight with walls substantially impermeable to the passage of water;

(ii) have structural components capable of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy; and

(iii) be certified by a registered professional engineer or architect that the design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of this section;

c. recreational vehicles placed on sites within Zones Al—BO, All, and AB shall either (I) be on the site for fewer than 180 consecutive days, (ii) be fully licensed and ready for highway use, or (iii) meet all standards of Section 60.3 (b) (1) of the National Flood Insurance Program Regulations and the elevation and anchoring requirements for manufactured homes in paragraph (c) (6) of Section 60.3.

d. all manufactured homes to be placed or substantially improved within special flood hazard areas shall be elevated on a permanent foundation such that the lowest floor of the manufactured home is at or above the base flood level; and be securely anchored to resist floatation, collapse, or lateral movement. Methods of anchoring may include, but are not limited to, use of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable state and local anchoring requirements for resisting wind forces;

e. for all new construction and substantial improvements, fully enclosed areas below the lowest floor that are subject to flooding are permitted provided they meet the following requirements: (1) the enclosed area is unfinished or flood resistant, usable solely for the parking of vehicles, building access or storage; (2) the area is not a basement; (3) shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwater. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or must meet or exceed the following minimum criteria: A minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided. The bottom of all openings shall be no higher than one foot above grade. Openings may be equipped with screens, louvers, or other coverings or devices provided that they permit the automatic entry and exit of floodwater.

f. proposed structures to be located on slopes in special flood hazard areas, zones AU and AO shall include adequate drainage paths to guide flood waters around and away from the proposed structures.

<u>Item IX Variances and Appeals</u>:

1. Any order, requirement, decision or determination of the building inspector or health officer made under this ordinance may be appealed to the Zoning Board of Adjustment as set forth in RSA 676:5.

2. If the applicant, upon appeal, requests a variance as authorized by RSA 674:33, 1(b), the applicant shall have the burden of showing in addition to the usual variance standards under state law:

> *(a) that the variance will not result in increased flood heights, additional threats to public safety, or extraordinary public expense.*
>
> *(b) that if the requested variance is for activity within a designated regulatory floodway, no increase in flood levels during the base flood discharge will result.*
>
> *(c) that the variance is the minimum necessary, considering the flood hazard, to afford relief.*

3. The Zoning Board of Adjustment shall notify the applicant in writing that: (I) the issuance of a variance to construct below the base flood level will result in increased premium rates for flood insurance up to amounts as high as $25 for $100 of insurance coverage and (ii) such construction below the base flood level increases risks to life and property. Such notification shall be maintained with a record of all variance actions.

4. The community shall (I) maintain a record of all variance actions, including their justification for their issuance, and (ii) report such variances issued in its annual or biennial report submitted to FEMA's Federal Insurance Administrator.

e. Watershed Zoning

Some communities have recognized the importance of particular watersheds by adopting watershed protection overlay districts. This is common where there is either a public surface water supply or a particular watershed contributing recharge to a groundwater supply. It is also common for watershed zoning to be used to protect a surface waterbody that is considered a critical resource for reasons other than drinking water supply. Such ordinances usually specify land-uses which are permitted or prohibited within the watershed. With outright prohibition of land uses within an entire watershed, the potential for a "taking" issue may come into play. The emphasis, therefore, is usually on performance standards that are somewhat more specific or stringent than those required for the rest of the community. Such standards should be designed to address protection of the specific watershed resource values which the town considers important. In many instances the land of a significant watershed may lie within a number of municipalities. In these cases it may be appropriate for each community to adopt the same performance standards for the portion of the watershed that is within their town. This is one way to assure consistent protection throughout the entire hydrologic system.

The watershed zoning approach should be considered by the Town of Kingston.

f. Aquifer Zoning.

There has been an increased interest in local groundwater protection, stemming from a growing public awareness about groundwater contamination occurrences. The State-USGS cooperative aquifer mapping program is making available improved information about stratified sand and gravel aquifers on a statewide basis. In order to protect these areas for future use as potential water supplies, many municipalities have adopted aquifer zoning districts. These ordinances generally list permitted and prohibited uses. To a large extent, they also rely on performance standards for future land uses to minimize the chances of aquifer contamination resulting from new development. Such standards often include provisions that require containment structures for uses involving the presence of dangerous materials. Treatment swales to control stormwater flows and ensure infiltration for groundwater recharge are also common. Due to their high rates of transmissivity and permeability, aquifer areas that may serve as existing or future water supplies are sensitive to potential pollutants. This is generally considered to be justification for more stringent performance standards than are imposed throughout the municipality.

At the present time there are no surface waters within Kingston which are utilized as water supplies. Consumers in Kingston utilize a mixture of shallow dug wells, drilled wells and fractured bedrock wells for water supply.

A detailed investigation into the geohydrology and water quality of stratified drift aquifers in the Lower Merrimack and Coastal River Basins was revised in 1992 by the U.S. Geological Survey in Cooperation with the New Hampshire Department of Environmental Services, Water

Resources Division. Information from this report (Water-Resources Investigations Report 91-4025) was used to determine the number, size and feasibility of aquifers located in the Kingston area. One stratified-drift aquifer of high yield (transmissivity > 4000 ft^2/day) is located in the vicinity of Great Pond. No municipal or high yield wells tap this aquifer at the present time, therefore this aquifer has potential for development as the demand for water in the area grows.

The Town of Kingston has adopted an Aquifer Conservation District in its zoning ordinance.

Kingston Aquifer Protection Ordinance

ADOPTED MARCH 14, 1989 and AMENDED MARCH 13, 1990; March 10, 1992 and March 8, 1994

1. <u>AUTHORITY AND PURPOSE</u>

Pursuant to RSA 674: 16-21, the Town of Kingston hereby adopts an Aquifer Protection District and accompanying regulations in order to protect, preserve and maintain potential groundwater supplies and related groundwater recharge areas within a known aquifer identified by the United States Geologigal Survey. The objectives of the aquifer protection district are:

-- *to protect the public health and general welfare of the citizens of Kingston;*

-- *to prevent development and land use practices that would contaminate or reduce the re-charge of the identified aquifer;*

-- *to promote future growth and development of the Town*, *in accordance with the Master Plan, by ensuring the future availability of public and private water supplies;*

-- *to encourage uses that can appropriately and safely be located in the aquifer recharge areas.*

2. <u>DEFINITIONS</u>

<u>Animal Feedlot</u>: A commercial agricultural establishment consisting of confined feeding

areas and related structures used f or the raising of livestock. An animal feedlot shall be considered one on which more than five (5) animals are raised simultaneously.

Aquifer: For the purpose of this Ordinance, aquifer means a geologic formation, group of formations, or part of a formation that is capable of yielding quantities of groundwater usable for municipal or private water supplies.

Dwelling Unit: A building or that portion of a building consisting of one or mare rooms designed for living or sleeping purposes, including kitchen and sanitary facilities and intended for occupancy by not more than one family or household.

Groundwater: All the water below the land surface in the zone of saturation or in rock fractures capable of yielding water to a well.

Groundwater Recharge: The infiltration of precipitation through surface soil materials into groundwater. Recharge may also occur from surface waters, including lakes, streams and wetlands.

Leachable Wastes: Waste materials, including solid wastes, sludge and agricultural wastes that are capable of releasing contaminants to the surrounding environment.

Mining of Land: The removal of geologic materials such as topsoil, sand and gravel, metallic ores, or bedrock to be crushed or used as building stone.

Non-Conforrning Use: Any lawful use of buildings, structures, premises, land or parts thereof existing as of the effective date of this Ordinance, or amendment thereto, and not in conformance with the provisions of this Ordinance, shall be considered to be a non-conforming use.

Non-Municipal Well: Any well not owned and operated by the Town of Kingston or its agent.

Recharge Area: The land surface area from which groundwater recharge occurs.

Sludge: Residual materials produced by the sewage treatment process.

Solid Waste: Any discarded or abandoned material including refuse, putrescible material, septage, or sludge, as defined by New Hampshire Solid Waste Rules He-P 1901.03. Solid waste includes solid, liquid, semi—solid, or certain gaseous waste material resulting from residential, industrial, commercial, mining, and agricultural operations.
Structure: Anything constructed or erected, except a boundary wall or fence, the use of which requires location on the ground or attachment to something on the ground. For the purposes of this Ordinance, buildings are structures.

Toxic or Hazardous Materials: Any substance or mixture of such physical, chemical, or infectious characteristics as to pose a significant, actual or potential hazard to water supplies, or other hazard to human health, if such substance or mixture were discharged to land or waters of this Town. Toxic or hazardous materials include, without limitation, volatile organic chemicals, petroleum products, heavy metals, radioactive or infectious wastes, acids and alkalies, and include products such as pesticides, herbicides, solvents and thinners, and such other substances as defined in New Hampshire Water Supply and Pollution Control Rules, Section Ws 410.04 (1), in New Hampshire Solid Waste Rules He-P 1901.03 (v), and in the Code of Federal Regulations 40 CFR 261. Wastes generated by the following commercial activities are presumed to be toxic or hazardous, unless and except to the extent that anyone engaging in such an activity can demonstrate the contrary to the satisfaction of the Planning Board.

Airplane, boat and motor vehicle service and repair;
Chemical and bacteriological laboratory operation;
Dry Cleaning;
Electronic circuit manufacturing;
Metal plating, finishing and polishing;
Motor and machinery service and assembly;
Painting, wood preserving and furniture stripping;
Pesticide and herbicide application;
Photographic processing;
Printing.

3. *DISTRICT BOUNDARIES*

a. *Location*

The boundaries of the Aquifer Protection District are those areas designated as 'Stratified Drift Aquifer' and Stratified Drift Aquifer over Glacio-Estuarine Silts and Clays as found on the map entitled Saturated Thickness and Transmissivity of Stratified Drift in the Exeter, Lamprey, and Oyster River Basins, Southeastern New Hampshire, (Study entitled Geohydrology and Water Quality of Stratified-Drift Aquifers in the Exeter, Lamprey and Oyster River Basins, Southeastern New Hampshire, WRI 88-4128, published in 1990); and areas designated as Fine-Grained Stratified Drift, Coarse-Grained Stratified Drift, as found on the map entitled Saturated Thickness, Transmissivity, and Materials of Stratified Drift Aquifers in the Lower Merrimack and Coastal Basins, Southeastern New Hampshire, (Study entitled Geohydrology and Water Quality of Stratified Drift Aquifers in the Lower Merrimack and Coastal River Basins, Southeastern New Hampshire, WRI 91—4025, published in 1992).

The Aquifer Protection District is a zoning overlay district which imposes additional requirements and restrictions to those of the underlying, base district zoning. In all cases, the more restrictive requirement(s) shall apply.

b. *Recharge Areas*

For the purpose of this Ordinance, the primary recharge area for the identified aquifer is considered to be co-terminous with that aquifer.
No secondary recharge area has been identified at the tine of enactment.

c. *Appeals*

Where the bounds of the identified aquifer or recharge area, as delineated, are in doubt or dispute, any landowner aggrieved by such delineation may appeal the boundary location to the Planning Board. Upon receipt of such appeal, the Planning Board shall *suspend further action on development plans related to the area under appeal and shall engage, at the landowner's expense, a qualified hydrogeologist to prepare a report determining the proper location and extent of the aquifer and recharge area relative to the property in question. The aquifer delineation shall be modified by such determination subject to review and approval by the Planning Board.*

4. USE REGULATIONS

a. Minimum Lot Size

The minimum lot size within the Aquifer Protection District for each dwelling unit if a residential use, or each principal building if a non-residential use, shall be three acres, or 130,680 square feet.

b. Hydrogeologic Study

For development proposals within the Aquifer Protection District, a hydrogeologic study shall be required for the following:

1) *subdivisions of ten (10) lots or greater;*
2) *any septic system or series of septic systems designed for 2,400 gallons per day or greater contained within one lot.*

For residential subdivisions of ten (10) lots or less the Planning Board shall determine, on a case-by-case basis, the need for a hydrogeologic study. Particularly sensitive sites may include areas that have septic systems in close proximity to wells, or may contain excessively drained soils or steep slopes.

Hydrogeologic studies shall be performed by a qualified hydrogeologist registered in the State of New Hampshire. This study shall be sufficiently detailed to evaluate the development's impacts to groundwater within both the parcel to be developed and the surrounding land. All hydrogeologic studies shall include at least the following:

1) *Multi-level monitoring wells (to evaluate soil stratigraphy);*
2) *Cumulative impact nitrogen loading analysis employing a saturation build-out model. The analysis shall include verification that the development will not cause the nitrate-nitrogen (N03-N) concentration in groundwater beyond the site to exceed 5 mg/l;*
3) *Permeability testing;*

4) *Water quality sampling analysis;*

5) *Water table contours and groundwater flow direction.*

c. *<u>Maximum Lot Coverage</u>*

Within the Aquifer Protection District, no more than 20 percent of a single lot may be rendered impervious to groundwater infiltration for residential uses, and no more than 35 percent for commercial uses.

d. *<u>Septic System Design Installation</u>*

In addition to meeting all local and state septic system siting requirements, all new on-lot waste water disposal systems installed in the Aquifer Protection District shall be designed by a Sanitary Engineer licensed in New Hampshire. These systems shall be Installed under the supervision of said engineer.

A designated engineer of the Town shall Inspect the installation of each new system prior to covering, and shall certify that the system has been installed as designed.

Septic systems are to be constructed in accordance with the most recent edition of the "Guide for the Design, Operation and Maintenance of Small Sewage Disposal System" as published by the New Hampshire Water Supply and Pollution Control Division.

In the case where a failed septic system located on an existing non-conforming lot of record must be replaced within the Aquifer Protection District, the Kingston Health Inspector shall be responsible for final approval of the location of the installation of the replacement system.

However, the following more stringent requirements shall apply to all septic system construction:

1. *At least 24 inches of natural permeable soil above the seasonal high water table must exist prior to constructing a leach bed. The leach bed bottom must be at least six feet above the seasonal high water table.*
2. *The leach bed bottom is required to be at least eight feet above bedrock and must include at least four feet of natural permeable soil.*
3. *The leach bed bottom is required to be at least eight feet above any impermeable subsoil and must include at least three feet of natural permeable soil.*
4. *There will be no filling of wetlands allowed to provide the minimum distance of septic to wetlands.*
5. *A receiving layer which must be under and extend one hundred feet laterally from the proposed system.*
6. *Standards for fill material: Fill material consisting of organic soils or other organic materials such as tree stumps, sawdust, wood chips and bark, even with a soil matrix, shall not be used.*

The in-place fill should have less than 15% organic soil by volume.

The in-place fill should not contain more than 25% by volume of cobble (6 inch diameter)

The in-place fill should not have more than 15% by weight of clay size (0.002 mm and smaller) particles.

The fill should be essentially homogeneous. If bedding planes and other discontinuities are present, detailed analysis is necessary.

e. Prohibited Uses

The following uses are prohibited in the Aquifer Protection Zone except where permitted to continue as a non-conf orming use. Such uses shall include, but not be limited to:

1. *Disposal of solid waste (as defined by NHRSA 149:M) other than brush or stumps generated on the property on which they are to be disposed.*
2. *Storage and disposal of hazardous waste.*
3. *Disposal of liquid or leachable wastes except that from one or two-family residential subsurface disposal systems, or as otherwise permitted as a conditional use.*
4. *Subsurface storage of petroleum and other refined petroleum products.*
5. *Industrial uses which discharge contact type process waters on-site. Non-contact cooling water is permitted.*
6. *Outdoor storage of road salt or other de-icing chemicals.*
7. *Dumping of snow containing de-icing chemicals brought from outside the district.*
8. *Commercial animal feedlots.*
9. *Dry cleaning establishments.*
10. *Automotive service and repair shops, junk and salvage yards.*
11. *Laundry and car wash establishments not served by a central municipal sewer.*
12. *All on site handling, disposal, storage, processing or recycling of hazardous or toxic materials.*

f. Permitted Uses

The following activities may be permitted provided they are conducted in accordance with the purposes and intent of this Ordinance:

1. *Any use permitted by Article IV VII of the Town of Kingston Zoning Ordinance, except as prohibited in Section 4 of this article.*

2. *Activities designed for conservation of soil, water, plants and wildlife.*

3. *Outdoor recreation, nature study, boating, fishing and hunting where otherwise legally permitted.*

4. *Normal operation and maintenance of existing water bodies and dams, splash boards and other water control, supply and conservation devices.*

5. *Foot, bicycle, and/or horse paths and bridges.*

6. *Maintenance, repair of any existing structure, provided there is no increase in impermeable surface above the limit established in Section 4.c. of this Article.*

7. *Farming, gardening, nursery, forestry, harvesting and grazing, provided that fertilizers, herbicides, pesticides, manure and other leachables are used appropriately at levels that will not cause groundwater contamination and are stored under shelter.*

g. *<u>Conditional Uses</u>*

The following uses, if allowed in the underlying zoning district, are permitted only after a Conditional Use Permit is granted by the Kingston Planning Board:

1. Industrial and commercial uses not otherwise prohibited in Section 4 of this Article;

2. Multi-family residential development;

3 Sand and gravel excavation and other mining provided that such excavation or mining is not carried out within eight (8) vertical feet of the seasonal high water table and that periodic inspections are made by the Planning Board or its agent to determine compliance.

The Planning board may grant a Conditional Use Permit for those uses listed above only after written findings of fact are made that all of the following conditions are met:

I. the proposed use will not detrimentally affect the quality of the groundwater contained in the aquifer by directly contributing to pollution or by increasing the long term susceptibility of the aquifer to potential pollutants;

ii. the proposed use will not cause a significant reduction in the long-term volume of water contained in the aquifer or in the storage capacity of the aquifer;

iii. the proposed use will discharge no waste water on site other than that typically discharged by domestic waste water disposal systems and will not involve on-site storage or disposal of toxic or hazardous waste as herein defined;

iv. the proposed use complies with all other applicable sections of this Article;

v. a hydrogeologic study shall he submitted for uses whose septic system is designed for more than 2,400 g.p.d.

The Planning Board may require that the applicant provide data or reports prepared by a qualified hydrogeologist to assess any potential damage to the aquifer that may result from the proposed use. The Planning Board shall engage such professional assistance as it requires to adequately evaluate such reports and to evaluate, in general, the proposed use in light of the above criteria.

5. <u>SPECIAL EXCEPTION FOR LOTS OF RECORD</u>

Upon application to the Board of Adjustment, a special exception shall be granted to permit the erection of a structure on a non-conforming lot within the Aquifer Protection District provided that all of the following conditions are met:

a. The lot upon which an exception is sought was an official lot of record, as recorded in the Rockingham County Register of Deeds, prior to the date on which this amendment was posted and published in the Town.

b. The use for which an exception is sought cannot feasibly be carried out on a portion or portions of the lot which are outside the Aquifer Protection District.

c. Due to the provisions of the Aquifer Protection District, no reasonable and economically viable use of the lot can be made without the exception.

d. The design and construction of the proposed use will, to the extent practical, be consistent with the purpose and intent of this Section.

6. <u>DESIGN AND OPERATIONS GUIDELINES</u>

Where applicable the following design and operation guidelines shall be observed within the Aquifer Protection District:

a. Nitrate loading. No development shall cause the nitrate-nitrogen (NO3-N) concentration to exceed 5 mg/l in the groundwater beyond the site.

b. Safeguards. Provision shall be made to protect against toxic or hazardous materials discharge or loss resulting from corrosion, accidental damage, spillage, or vandalism through measures such as: spill control provisions in the vicinity of chemical or fuel delivery points; secured storage areas for toxic or hazardous materials; and indoor storage provisions for corrodible or dissolvable materials. For operations which allow the evaporation of toxic or hazardous materials into the interiors of any structures, a closed vapor recovery system shall be provided for each such structure to prevent discharge of contaminated condensate into the groundwater.

c. Location. Where the premises are partially outside of the Aquifer Protection Overlay Zone, potential pollution sources such as on-site waste disposal systems shall be located outside the Zone to the extent feasible.

d. Drainage. All runoff from impervious surfaces shall be recharged on the site, and diverted toward areas covered with vegetation for surface infiltration to the extent possible. Dry wells shall be used only where other methods are not feasible, and shall be preceded by oil, grease, and sediment traps to facilitate removal of contaminants.

e. Inspection. All conditional uses granted under Section 4.g. of this Article shall be subject to twice annual inspections by the Building Inspector or other agent designated by the Selectmen. The purpose of these inspections is to ensure continued compliance with the conditions under which approvals were granted. A fee for inspection shall be charged to the owner according to a fee schedule determined by the Selectmen.

7. NON-CONFORMING USES:

Any non-conforming use may continue and may be maintained, repaired and improved, unless such use is determined to be an imminent hazard to public health and safety. No nonconforming use may be expanded, changed to another non-conforming use, or renewed after it has been discontinued for a period of 12 months or more.

8. ADMINISTRATION

a. General: The provisions of the Aquifer Protection District shall be administered by the Planning Board. All development proposals, other than single or two-family residential construction not involving the subdivision of land, shall be subject to subdivision and/or site plan review and approval in accordance with Planning Board rules and regulations. Such review and approval shall precede the issuance of any building permit by the Town.

b. Enforcement: The Board of Selectmen shall be responsible for the enforcement of the provisions and conditions of the Aquifer Protection District.

9. EFFECTIVE DATE

This Article shall become effective upon date of passage.

OSP has made several recommendations for changes in Kingston’s Aquifer Protection Ordinance, they are as follows:

Town Of Kingston, Aquifer Protection Ordinance, Revised 1994

16. Section 3, (c) states that “any landowner” may appeal the boundary location. It further *states that the planning board will engage a qualified hydrogeologist to prepare a report at the landowner's expense. Would the landowner still be responsible for the expense if the aggrieved party was an abutter? A certified soil scientist would also be qualified to delineate the extent of stratified drift.*

17. *Section 4, (b), (2) requires a hydrogeologic study for septic systems designed for 2,400 gpd or greater. What is the rationale for this loading rate threshold? Also, I am not aware of a registration requirement for hydrogeologists in New Hampshire.*

18. *Section 4, (b), (2) requires a limit of nitrate-nitrogen concentration in the groundwater of 5 mg per liter. Does the planning board have a well documented rationale for this requirement? The EPA standard, which was also used by the Ad Hoc Soil Based Lot Size Committee, is 10 mg per liter.*

19. *Section 4, (d) requires septic systems to be designed by a licensed sanitary engineer. There are licensed designers and installers in New Hampshire that are not sanitary engineers. They should not be excluded by the zoning ordinance from designing subsurface wastewater disposal systems.*

20. *Section 4, (d), (1) requires the leach bed bottom of septic systems to be at least six feet above the water table. This is more stringent than NH Code of Administrative Rules Env-Ws 1014.04, which requires a four foot separation distance.*

21. *Section 4, (e), (4) prohibits subsurface storage of petroleum and Section 4, (e), (10) prohibits automotive service and repair shops. This may be construed as overly prohibitive. The NH Wellhead Protection Program takes a management approach and requires best management practices to be followed in accordance with NH Code of Administrative Rules Env-Ws 421.*

22. *Section 4, (f), (4) permits agricultural activities. This could require that such activities be performed in accordance with best management practices developed by the NH Department of Agriculture.*

23. *Section 4, (g), (3) requires sand and gravel excavation to be carried out above eight vertical feet of the seasonal high water table. Does the planning board have a scientific rationale for this requirement, clearly documented in the municipal master plan?*

24. *Section 4, (g), (ii) requires a proposed use to ". . .not cause a significant reduction in the long-term volume of water contained in the aquifer..." for a conditional use permit to be granted. It should indicate how the applicant is to demonstrate this.*

25. *Section 4, (g), (v) requires a hydrogeologic study for septic systems designed for 2,400 gpd or greater. Again, what is the rationale for this loading rate threshold?*

26. *Section 6, (a) requires a limit of nitrate-nitrogen concentration in the groundwater of 5 mg per liter. Comment 18 also applies here.*

27. *Section 6, (d) includes drainage requirements. The planning board may also wish to include the specifications of the 1992 publication entitled Stormwater Management and Erosion and Sediment Control for Urban and Developing Areas in New Hampshire, DES and RCCD and the state requirements for stormwater management in accordance with RSA 485-A:17 and NH Code of Administrative Rules Env-Ws 415.*

If the Town of Kingston has not already addressed these recommendations, they should do so as soon as possible.

g. Shoreland Zoning

A concern about disturbance of natural shorelands arose from the increase in demand for and the value of waterfront property. Unvegetated, exposed shorelands are subject to erosion from increased wave action due to storm and boating pressures. Further removal of natural shore vegetation leaves the land vulnerable to storm event related erosion. The installation of lawns along the shore often leads to the introduction of fertilizers and pesticides. Many municipalities with lake and river shorelands are responding to this concern by developing overlay zoning ordinances that address specific lacustrine (lake) and riverine habitat problems. The waterbodies of Kingston are protected at the present time by a comprehensive Shoreland Protection ordinance adopted in 1991, which is described as follows;

SHORELAND PROTECTION ORDINANCE

ADOPTED MARCH 12, 1991

AMENDED MARCH 10, 1992

A. AUTHORITY AND PURPOSE

Pursuant to RSA 674: 16-21 the Town of Kingston hereby adopts the Shoreland Protection District and accompanying regulations in order to protect and promote public health, resource conservation and the general welfare and to:

1. *Protect, maintain and enhance the water quality of the Great Ponds, the Little River and its tributaries, and the Pow Wow River and its tributaries in the Town of Kingston, and to ensure their continued availability as public water supplies;*

2. *Conserve and protect aquatic and terrestrial habitat associated with Shoreland areas;*

3. *Preserve and enhance those recreational and aesthetic values associated with the natural shoreline and river environment;*

4. *Encourage those uses that can be appropriately located adjacent to shorelines.*

B. DEFINITIONS

1. *Bulk Storage. Storage of materials intended for wholesale distribution or used in a manufacturing facility.*

2. *Hazardous and toxic materials, includes but is not limited to volatile organic chemicals, petroleum products, heavy metals, radioactive or infectious wastes, acids and alkalies, pesticides, herbicides, solvents and thinners, and such other substances as defined in N.H. Water Supply and Pollution Control Rules, Section Ws 410.04(1), in N.H. Solid Waste Rules He-P 1901.03(v), and in the code of Federal Regulations 40 CER 261.*

3. *Great Ponds. All natural inland bodies of water with a surface area of ten acres or more.*

4. *Perennial brooks and streams. Brooks and streams that appear on U.S. Geological Survey quadrangle maps (7.5”, scale l”:24,000”) covering the Town of Kingston.*

5. *Residential accessory building. A subordinate building located on the same lot as the main building, the use of which is incidental to the main building, and discharges no sewage or other wastes.*

6. *Seasonal High Water Level. The average annual high water elevation of a pond, stream, brook or river, including contiguous wetlands and floodplains.*

7. *Shoreline. The water’s edge at seasonal high water level.*

C. DISTRICT BOUNDARIES

The Shoreland Protection District in the Town of Kingston La defined as:

1. *The areas of land within 300 feet horizontal distance of the seasonal high water level of the Great Ponds of Kingston, the Exeter River and its major tributaries, and of the Pow Wow River and its major tributaries within the Town of Kingston are defined to be the following: Little River (in the north side of town), and the Pow Wow River (in the central and the south side of town). The Great Ponds are Great Pond (also known as Kingston Lake); Country Pond; Pow Wow Pond; Greenwood Pond; Mill Pond; and Bayberry Pond.*

2. *In addition, the areas of land within 150 feet horizontal distance of the seasonal high water level of all perennial brooks and streams within the Exeter River Watershed and*

the Pow Wow River Watershed which appear on U.S.G.S. quadrangle maps (7.5" scale 1":24,000") covering the Town of Kingston, as revised.

D. USE REGULATIONS

1. *Minimum Lot Size: The minimum lot size within the Shoreland Protection District shall be the same as required in the underlying Zoning District and by applicable subdivision regulations for the Town.*

2. *Maximum Lot Coverage: Structures, including pavement, shall not cover more than 20% of any lot or portion thereof within the Shoreland Protection District.*

3. *Building Setbacks No building, (except any accessory building permitted as a Conditional Use), septic system or septic system leeching field shall be constructed on or moved to a site within 150 feet from the shoreline of the Great Ponds, the Little River, or the Pow Wow River or their major tributaries as herein defined, or within 100 feet from the shoreline of perennial brooks and streams located within the Shoreland Protection District. In the case where a failed septic system located on an existing non-conforming lot of record must be replaced within the Shoreland Protection District, the Kingston Health Inspector shall be responsible for final approval of the location of the installation of the replacement system.*

4. *Surface Alterations: Alteration of the surface configuration of land by the addition of fill or by dredging shall be permitted within 150 feet of the shoreline of the Great Ponds, the Little River, and the Pow Wow River and their major tributaries only to the extent necessitated by a permitted or conditionally permitted use, or for the construction of transmission lines and access ways, including driveways.*

5. *Vegetative Buffer: Alteration of natural vegetation or managed woodland within 75 feet of the shoreline of the Great Ponds, of the Little River and of the Pow Wow River and their major tributaries shall be permitted only to the extent necessitated by a permitted or conditionally permitted use, or by the construction of transmission lines and access ways, including driveways.*

6. *Prohibited Uses: The following uses shall not be permitted within the Shoreland Protection District:*

   a. *Disposal of solid waste (as defined by the N.H. RSA 149-M) other than brush.*
   b. *On site handling, disposal, bulk storage, processing or recycling of hazardous or toxic materials.*
   c. *Disposal of liquid or leachable wastes, except from residential subsurface disposal systems, and approved commercial or industrial systems that are otherwise permitted by this section.*
   d. *Buried storage of petroleum fuel and other refined petroleum products except as regulated by the NH Water Supply and Pollution Control Division (Ws 411 Control of Non- residential Underground Storage and Handling of Oil and Petroleum Liquids). Storage tanks for petroleum products, if contained within basements, are permitted.*
   e. *Outdoor unenclosed or uncovered storage of road salt and other deicing chemicals.*
   f. *Dumping of snow containing road salt and other deicing chemicals.*
   g. *Commercial animal feedlots.*
   h. *Automotive service and repair shops; junk and salvage yards.*
   I. *Dry cleaning establishments.*

j. Laundry and car wash establishments not served by a central municipal sewer system.

k. Earth excavation as defined by RSA 155:E, within 300 feet of the Great Ponds, of the Little River, or of the Pow Wow River or their major tributaries. It is prohibited to conduct any excavation within eight feet of the Seasonal High Water Table.

7. <u>Conditional Uses</u>:

a. The following uses, if allowed in the underlying zoning district, are permitted only after a Conditional Use Permit is granted by the Kingston Planning Board.

1. Industrial and commercial uses not otherwise prohibited in Section D.6 of these regulations.

2. Multi-family residential development.

3. The clearing of natural vegetation for the creation of new agricultural land not closer than 20 feet to a shoreline, provided that all agricultural activities comply with Best Management Practices as prescribed by the Rockingham County Conservation District.

4. Residential accessory buildings or additions, of less than 400 square feet in the first floor area, within 150 feet of the Great Ponds, or of the Little River or of the Pow Wow River or their major tributaries, or within 100 feet of perennial brooks and streams located within the Shoreland Protection District.

5. Beach maintenance and creation, subject to Wetlands Board Regulations.

b. The Planning Board may grant a Conditional Use Permit for those uses listed above only after written findings of fact are made that all of the following are true:

1. The proposed use will not detrimentally affect the surface water quality of the adjacent Great Pond, river or tributary, or otherwise result in unhealthful conditions.

2. The proposed use will discharge no waste water on site other than that normally discharged by domestic waste water disposal systems and will not involve on-site storage or disposal of hazardous or toxic wastes as herein defined.

3. The proposed use will not result in undue damage to spawning ground and other wildlife habitat.

4. The proposed use complies with the use regulations identified in Section D and all other applicable sections of this article.

5. The design and construction of the proposed use will be consistent with the intent of the purposes set forth in Section A.

8. Special Exception for Lots of Record. A special exception shall he granted by the Board of Adjustment to permit the erection of a structure within the Shoreland Protection District provided that all of the following conditions are found to exist:

a. The lot upon which an exception is sought was an official lot of record, as recorded in the Rockingham County Registry of Deeds, prior to the date on which this amendment was posted and published in the Town.

b. The use for which the exception is sought cannot feasibly be carried out on a portion or portions of the lot which are outside the Shoreland Protection District.

c. Due to the provisions of the Shoreland Protection District, no reasonable and economically viable use of the lot can be made without the exception.

d. The design and construction of the proposed use will, to the extent practical, be consistent with the purpose and intent of this Section.

9. Permitted Uses: The following uses are permitted within the Shoreland Protection District provided they are conducted in accordance with the purpose and intent of this Ordinance.

a. Agriculture, including grazing, hay production, truck gardening and silage production, provided that such use will not cause increases in surface or groundwater contamination by pesticides, fertilizers, or other hazardous or toxic substances and that such use will not cause or contribute to substantial soil erosion and stream sedimentation. However, no clearing of natural vegetation within the vegetated buffer (as defined in Section D.5 above) shall be permitted for the purpose of establishing new tilled and cultivated farmland without a Conditional Use Permit (7.d). All pesticide applications shall be conducted in strict accordance with the requirements set forth in N.H. RSA 430:28 et seq.

b. Forest Management, including the construction of access ways for said purpose. The cutting of trees shall be limited to fifty percent (50%) of the basal area of all live trees two (2) inches in diameter (as measured four and one-half feet above the ground) and over, before any trees were removed from specified area, in a 20-year period. The remaining uncut trees shall be left well distributed throughout the harvested area. On slopes greater than fifteen percent (15%), tree cutting as described above shall be limited to 25%.

c. Uses permitted in the underlying district of the Zoning Ordinance, except for those listed as conditional uses in Section D.7 and those prohibited in Section 0.6.

10. Non-conforming Uses:

a. Non-conforming uses in existence prior to the enactment of this Ordinance may be continued, maintained, repaired and improved, unless and until such use becomes an imminent hazard to public health and safety. Non-conforming uses may not be expanded or changed to other non-conforming uses.

b. Non-conforming use may be renewed after being discontinued for a period of 12 months or more.

E. ADMINISTRATION

General: The provisions of the Shoreland Protection District Ordinance shall be administered by the following:

a. Building Inspector for building permits;

b. Planning Board for subdivision, site plan review, and conditional use approval; and

c. Zoning Board of Adjustment for special exception approval of existing lots.

2. Enforcement: The Board of Selectmen shall be responsible for the enforcement of the provisions and conditions of the Shoreland Protection District Ordinance.

EFFECTIVE DATE

This Article shall become effective upon the date of passage.

OSP has made several recommendations for changes in Kingston's Shoreland Protection Ordinance, they are as follows:

Town of Kingston, Shoreland Protection Ordinance, Revised 1992

28. Section D, (3) has building, septic system and leachfield setbacks of 150 and 100 feet, depending upon the water body. This is more stringent than the 50 foot setback for primary structures and the 75, 100 and 125 foot septic system setbacks in the comprehensive shoreland protection act. Is the rationale for these more stringent requirements clearly documented in the municipal master plan?

29. Section D, (4) restricts surface alterations within 150 feet of the shoreline of certain waters. The comprehensive shoreland protection act regulates alterations of terrain greater than 50,000 square feet within 250 feet of the reference line in accordance with RSA 485-A:17 and NH Code of Administrative Rules Env-Ws 415.

30. Section D, (5) requires a vegetative buffer within 75 feet of certain waters. The comprehensive shoreland protection act requires a 150 foot vegetative buffer.

31. Section D, (6), (k) prohibits sand and gravel excavation within eight vertical feet of the seasonal high water table. Does the planning board have a scientific rationale for this requirement, clearly documented in the municipal master plan?

If the Town of Kingston has not already addressed these recommendations, they should do so as soon as possible.

The adoption of the State's Shoreland Protection Act (presented in Appendix XI-2) is a great benefit to protecting the town's waterbodies.

The Shoreland Protection Act was passed in 1991 and it became effective, in its entirety, on July l1, 1994. With the concern that the protection of this state's waterbodies is a primary goal, the general court found:

- The shorelands of the state are among its most valuable and fragile natural resources and that their protection is essential to maintain the integrity of public waters.
- The public waters of New Hampshire are valuable resources held in trust by the state and the state has an interest in preserving those waters and has the jurisdiction to control the use of the public waters and the adjacent shoreland for the greatest public benefit.
- There is great concern throughout the state relating to the utilization, protection, restoration and preservation of shorelands because of their effect on state waters.
- Under current law the potential exists for uncoordinated, unplanned and piecemeal development along the state's shorelines, which could result in significant negative impacts on the public waters of New Hampshire.

To fulfill the state's role as trustee of its waters and to promote public health, safety, and the general welfare, the General Court declared that the public interest requires the establishment of standards for the subdivision, use and development of the shorelands of the state's public waters. The development standards provided in this Chapter shall be the minimum standards necessary to protect the public waters of the State of New Hampshire. These standards shall serve to:

- Further the maintenance of safe and healthful conditions.
- Provide for the wise utilization of water and related land resources.
- Prevent and control water pollution.
- Protect fish spawning grounds, aquatic life, bird and other wildlife habitats.
- Protect buildings and lands from flooding and accelerated erosion.
- Protect archeological and historic resources.
- Protect commercial fishing and maritime industries.
- Protect freshwater and coastal wetlands.
- Control building sites, placement of structures and land uses.
- Conserve shore cover, and visual as well as actual points of access to inland and coastal waters.
- Preserve the state's rivers, lakes, estuaries and coastal waters in their natural state.

- Promote wildlife habitat, scenic beauty, and scientific study.
- Protect public use of waters, including recreation.
- Conserve natural beauty and open spaces.
- Anticipate and respond to the impacts of development in shoreland areas.
- Provide for economic development in proximity to waters.

The Shoreland Protection Standards are designed to minimize shoreland disturbance so as to protect the public waters, while still accommodating reasonable levels of development in the protected shoreland. Development outside the protected shoreland shall conform to local zoning and local ordinances and shall not be subject to standards established in this chapter.

The minimum Shoreland Protection Standards are listed below and summarized in Figure XI-10. Within the protected shoreland the following restrictions shall apply:

- The establishment or expansion of salt storage yards, automobile junk yards, and solid or hazardous waste facilities shall be prohibited.
- Primary structures shall be set back behind the primary building line. This line shall initially be set back 50 feet from the reference line. Upon the establishment of a shoreland building setback by a municipality, that standard, whether greater or lesser than 50 feet, shall define the primary building line in that municipality.
- A water dependent structure, meaning one which is a dock, wharf, pier, breakwater, or other similar structure, or any part thereof, built over, on, or in the waters of the state, shall be constructed only as approved by the wetlands board pursuant to RSA 482-A.
- No fertilizer, except lime and wood ash, shall be used on lawns or areas with grass on residential properties.

The following minimum standards shall apply to the protected shoreland provided that forestry, involving water supply reservoir water management or agriculture conducted in accordance with BMPs, shall be exempted from the provisions of this chapter:

- Where existing, a natural woodland buffer shall be maintained to protect the quality of public waters by minimizing erosion, preventing siltation and turbidity, stabilizing soils, preventing excess nutrients and chemical pollution, maintaining natural water temperatures, maintaining a healthy tree canopy and under story, preserving fish and wildlife habitat, and respecting the overall natural condition of the protected shoreland.
- Within the natural woodland buffer of the protected shoreland under conditions defined in RSA 483-B:9, V the following prohibitions and limitations shall apply:
- Not more than a maximum of 50 percent of the basal area of trees, and a maximum of 50 percent of the total number of saplings shall be removed for any purpose in a 20-year period. A healthy, well-distributed stand of trees, saplings, shrubs and ground covers and

their living, undamaged root systems shall be left in place. Replacement planting with native or naturalized species may be permitted to maintain the 50 percent level.

- Stumps and their root systems which are located within 50 feet of the reference line shall be left intact in the ground.

Septic Systems

- All new lots, including those in excess of 5 acres, created within the protected shoreland are subject to subdivision approval by the Water Division, Subsurface Systems Bureau under RSA 485-A:29.

- The following conditions, based on the characteristics of the receiving soil as they relate to U.S. Department of Agriculture, soil conservation service drainage classes, shall dictate the setback requirements for all new leaching portions of new septic systems, as follows:
- Where the receiving soil down gradient of the leaching portions of a septic system is a porous sand and gravel material with a percolation rate faster than 2 minutes per inch, the setback shall be at least 125 feet from the reference line;
- For soils with restrictive layers within 18 inches of the natural soil surface, the setback shall be at least 100 feet from the reference line; and
- For all other soil conditions, the setback shall be at least 75 feet from the reference line.

Erosion and Siltation

All new structures within protected shoreland shall be designed and constructed in accordance with rules adopted by the department pursuant to 541-A, relative to terrain alteration under RSA 485-A:17, for controlling erosion and siltation of public waters, during and after construction.

Minimum lots and residential development. In the protected shoreland:

- The minimum size for new lots in areas dependent upon on-site septic systems shall be determined by soil type lot size determinations, as established by the Department of Environmental Services.
- For projects in areas dependent upon on-site sewage and septic systems, the total number of residential units in the protected shoreland, whether built on individual lots or grouped as cluster or condominium development, shall not exceed one unit per 150 feet of shoreland frontage.

5. Land Management and State Government

As we have stressed throughout this chapter, the manner in which man uses the land (or its resources) within the watershed will play a major role in the maintenance or degradation of water quality standards. Each of the major categories of management practices is reviewed in the following sections and recommendations made relative to the proper application of each, along with a notation of applicable state laws which regulate the manner in which these practices are carried out.

a. Agriculture

A variety of management practices, implemented at individual farm sites, can reduce or eliminate the potential for adverse water quality impacts.

These include:

- Manure Storage and Spreading - Manure should be stored in a facility which reduces or eliminates the potential for runoff or leaching of nutrients into watercourses. Manure spreading should be conducted only when the ground is not frozen or wet. In those instances where plowing is anticipated, such action should commence as near to the date of spreading as possible.
- Land clearing - In all instances where land areas are cleared for the purpose of providing additional cropland or pasture land, the clearing operation should be conducted in a manner that reduces the potential for erosion and sedimentation. (See Silvicultural Activities.)
- Alteration of drainage courses, pond construction and filling of wetlands - Management practices designed to increase the amount of land utilized for cultivation, unless conducted in a manner acceptable to the appropriate state agencies and their established guidelines, can significantly affect the level of water quality within the watershed. Existing and altered drainage courses must be managed so that the potential for stream bank erosion is eliminated. Strict guidelines relative to pond construction, which reduce or eliminate sedimentation and erosion during construction and eliminate the potential for dam failure or improper overflow during peak flow periods, should be followed. Wetlands and marsh areas, especially near stream systems, should be protected as a means of reducing flow velocities, thereby reducing erosion potential and dispersing and reducing sediments and nutrient loading.
- Access to running water - In all cases, direct access to running water (streams, rivers, etc.) by farm animals should be eliminated. Water supply to farm animals should be provided from a tank or alternate system which is located at a reasonable distance from all sources of surface water.
- Chemical fertilization - pesticide, herbicide and fungicide - In those instances where chemical fertilizers or pesticides are used, the application of such should be conducted in a manner which limits the potential for runoff and/or contamination of water systems. This can be achieved by tilling the soil immediately following the application of fertilizer and reducing the use of fertilizers and pesticides within a 125 foot distance of standing or running water.

Each of these recommended management practices relies almost entirely upon the individual landowner for compliance. Some will require capital outlays to achieve these goals. Financial assistance from U.S.D.A. agencies and educational programs directed toward landowners should be made available whenever possible. Existing state laws that govern specific agricultural practices are included in Table XI-8.

Table XI-8
State Laws Governing Agricultural Practices

Revised Statute Annotate	**Subject**	**Governing Agency**
RSA 482-A	Dredge and Fill	DES, WD
RSA 485-A:17	Significant alteration of the terrain	DES, WD
RSA 224:44-a	Cutting near public water or highways	Forest and Lands
RSA 485-A:12-15	Limiting disposal of waste	DES, WMD
RSA 79:10	Notice of intent to cut	NH Dept. of Revenue
RSA 430:28-48	Pesticide control act	Pesticide Control Division
RSA 430:2848	Economic Poisons Act	Pesticide Control Division
RSA 431:33	Regulation of handling of Manure, Agricultural Compost and Chemical Fertilizers	Dept of Agriculture

An educational program should be made available on BMPs for those people in the watershed who practice animal husbandry or manage "hobby farms".

Hobby farms, with one or more animals, may have poor grazing practices, too many animals per acre, unrestricted access to streams, poor waste management practices and poorly drained soils. Such farms have limited space and capital with which to construct facilities for animal management. They have not traditionally been eligible for cost-sharing grants from federal or state programs.

Since small farms contribute to non-point sources of phosphorus and may even contribute more phosphorus than larger farms that practice BMPs , an educational program is needed on BMPs for waste and pasture management.

b. Silvicultural Activities

Timber harvest and silviculture practices, if conducted in an improper manner, can contribute significantly to stream sediment and nutrient levels, thereby affecting the level of water quality within the watershed. The following management practices are recommended as a means of reducing adverse impacts from theses activities.

- Road Construction - Properly designed skid roads, which do not exceed a gradient of 10% and incorporate the use of water bars for drainage purposes, substantially reduce the potential for erosion and sedimentation. In those instances where stream crossings are required, construction of a log bridge and proper attention to stream bank alteration should be implemented by the logger.
- Clear Cutting - In areas of thin soil cover or shallow to bedrock soil characteristics, clear cutting should be minimized to reduce the potential for erosion and nutrient release. In addition, in all areas in which clear cutting practices are conducted, a vegetation buffer area in excess of 100 feet should be maintained around all surface water areas.

The statutes which regulate silviculture practices and timber harvesting are included in Table XI-9.

Table XI-9
State Laws Governing Silviculture Practices

Revised Statute Annotated	Subject	Governing Agency
RSA 224:44-a	Cutting near public water or highway	Forest and Lands
RSA 224:44-6	Care of slash or mill wastes	Forest and Lands
RSA 79:10	Notice of intent to cut	NH Dept of Revenue
RSA 485-A:17	Significant alteration of the terrain	DES, WD
RSA 482-A	Dredge and fill	DES, WD

Siviculture activities in the Great Pond watershed must be strictly enforced and regulated. Frequent inspections of silviculture activities may detect a potential water quality problem before it is too late for remedial action.

Forests and public recreational lands are the most common type of land-use cover in the Great Pond watershed. As such, there is potential for water quality impacts due to silvicultural activities. Performance standards and plan review for silvicultural activities are regulated by the state through timber harvesting and water quality protection laws. Regulation prohibits the placement of slash and mill waste in or near waterways, and limits clear-cutting near great ponds and streams. These requirements may mitigate to some degree water quality impacts associated with timber harvesting. More stringent local regulations could increase the setback requirements for disposal of slash.

A major cause of water quality degradation associated with forestry activities is soil erosion caused or aggravated by logging and skidder roads. Disruption of the vegetative cover, disturbance by heavy equipment, and the often steep slopes on which cutting is carried out, combine to create conditions favoring rapid and severe erosion. Where access to harvest areas involves crossing a waterway, eroded material can rapidly impact downstream waterbodies. The New Hampshire Department of Environmental Services responds to complaints of poor logging practices that impact water quality. The development of local forestry bylaws, under the administration of the Conservation Commission or Planning Board, would provide additional protection to the water resources in the Town of Kingston.

c. Construction Practices

Construction operations, whether it be a single family home or a major industrial expansion, can place a severe burden on water quality within the watershed unless closely monitored. Standard practices which reduce the level of erosion and sedimentation should be incorporated at all times. These practices can be enforced by the building inspector of the local municipality as well as by state officials to ensure conformity. These practices include:

- Building Permits - Included within a standard building permit application should be a provision which requires the contractor to incorporate management practices which reduce the potential for soil erosion and sedimentation. Nonconformity to these practices should result in the revocation of such a permit and the issuance of a cease and desist order.
- Site Work - During actual construction, care should be taken to reduce erosion through such control measures as mulching of disturbed soils surfaces and excessive gradients, construction of sediment retention ponds in those instances where surface water is disrupted and phasing of construction when possible to reduce the gross land area which may be exposed or disturbed at any one point in time. Site preparation, such as clearing or grading, should be monitored and practices incorporated similar to those outlined under Timber Harvest and Silviculture Practices.
- Road Construction - Construction of new roadways and the alteration of existing roadways should be conducted so as to eliminate erosion problems. Roadway lane surfaces (dirt roads) and shoulders should be constructed so as to reduce erosion. Roadside gradients should be no more than 3:1 and mulched as soon after construction as possible. Proper drainage should be provided through use of appropriately designed

culverts and ditching alongside roadways. Drainage should be designed such that stormwater runoff from roads and other impervious surfaces is minimal. Construct areas that allow for infiltration of the stormwater.

The incorporation of these broad construction practices can produce substantial results. However, it cannot be left solely to the contractor to ensure the implementation of such practices. While local municipalities can enforce proper practices through the building permit program, assistance and support from the state is available through the enforcement of the statutes listed in Table XI-10.

Table XI-10
State Laws Governing Construction Practices

Revised Statute Annotated	Subject	Governing Agency
RSA 79:10	Notice to intent to cut	NH Dept of Revenue
RSA 36:19-29 & 34	Local subdivision regulation	Municipality
RSA 485-A:29-35	Subdivision regulations	DES, WD
RSA 482-A:21	Excavation & dredging	DES, WD
RSA 485-A:17	Significant alteration of the terrain	DES, WD
RSA 224:44-a	Cutting near public water or highways	Forest and Lands

OSP has made several recommendations for changes in Kingston's Ordinances pertaining to constructions practices, they are as follows:

Town Of Kingston, NH: Subdivision Regulations, Revised 1993

1. *Section 1.1 refers to RSA 36:19 as amended in 1974. The planning and land use statutes have since been recodified. The statute which authorizes subdivision regulations is now RSA 674:35 and 36.*

2. *Section 2.9, entitled Soil Survey Report, requires a High Intensity Soil report. The planning board should change the term "registered" to "certified' soil scientist to be consistent with the statute.*

The planning board may wish to update this to include more recent soil map standards that were developed by the state soil scientist in cooperation with the Society of Soil Scientists of Northern New England (SSSNNE) Order 1 Soil Mapping Standards for New Hampshire, SSSNNE Publication Number 2, 1993.

3. *In Section 3.12, entitled Boundary Line Changes, the planning board should change the term "registered" to "licensed" land surveyor to be consistent with the statute.*

4. *Section 3.24 should be updated to reference the recently published Rockingham County Soil Survey.*

5. *Section 3.25 should also include a reference to the state wetlands permit process outlined in RSA 482-A and NH Code of Administrative Rules Wt 100-800.*

6. *Section 3.31 refers to RSA 36:21. The planning and land use statutes have been recodified. The statute which authorizes additional area requirements for on-site sanitary facilities is now RSA 674: 36, II, (I).*

   The planning board may wish to update the subdivision regulations to be consistent with the more recent documents entitled Environmental Planning for on-site Wastewater Treatment in New Hampshire: Technical Report of the Ad Hoc Committee for Soil Based Lot Size, NH DES and Rockingham County Conservation District, June 1991 and Model Subdivision Regulations for Soil-Based Lot Size, Report of the Ad Hoc Committee for Soil Based Lot Size, NH DES and Rockingham County Conservation District, June 1991 and RSA 485-A, 29-44 and NH Code of Administrative Rules Env-Ws 1000.

7. *In Section 3.5, entitled Engineering and Layout, the planning board should change the term "registered" to "licensed" land surveyor to be consistent with the statute.*

8. *In Section 3.6, the planning board should change the term "Sewage" to "Wastewater" to be consistent with DES administrative rules.*

9. *In Section 3.62, the planning board should cite the requirements for subsurface wastewater disposal systems in RSA 485-A, 29-44 and NH Code of Administrative Rules Env-Ws 1000.*

This section also should be updated to reflect the current agency name Water Supply and Pollution Control Division.

10. *Section 3.63 requires that the 4,000 square feet acceptable for installation of an approved septic system be at least 100 feet from any wetland. This is more stringent than Env-Ws 1014.01, (2), which allows for leachfields to be located within 50 feet of hydric B, poorly drained soils. It is also inconsistent with Section 6.17 in the zoning ordinance, which prohibits septic systems within 15 feet of wetlands and water bodies.*

11. *Section 3.71 requires streets to have adequate provisions to control drainage and an adequate stormwater system. To assure continued effectiveness of stormwater management measures, the planning board may wish to require the specifications of the 1992 publication entitled <u>Stormwater Management and Erosion and Sediment Control for Urban and Developing Areas in New Hampshire</u>, DES and RCCD and DES rules for significant alteration of terrain, RSA 485-A:17 and NH Code of Administrative Rules Env-Ws 415.*

    The planning board should also consider requiring that all long term maintenance plan be submitted along with the detailed stormwater management plan. By including this type of requirement as part of the plan any violation of the stormwater management requirements could be enforced under RSA 674:16, 17, 17-a or 17-b.

12. *In Section 4.33, (1), wetlands should also be required to be delineated and shown on the plan in accordance with a methodology that is consistent with that required by the zoning ordinance and site plan review regulations.*

13. *Section 4.41, (5), entitled Storm Drainage Design and Section 5.33, entitled Drainage, should require the standards referenced in comment 11. Section 5.33,(2) should note that a state permit in accordance with RSA 482-A and NH Code of Administrative Rules Wt 100-800 is required to provide "proper drainage of swampy areas".*

14. *Section IX refers to RSA 36:27. The planning and land use statutes have been recodified. The statute which provides for penalties for transferring lots in unapproved subdivisions is now RSA 676:16. Section IX should also cite RSA 676:17 and RSA 676:17, (a) and (b), which authorize the municipality to issue cease and desist orders and local land use citations.*

Town of Kingston, NH: Site Plan Review Regulations, Revised 1993

1. *Section V, entitled Required Exhibits and Data, requires that water courses and water bodies be shown on the site plan. Wetlands should also be required to be delineated and shown on the plan in accordance with a methodology that is consistent with that required by the zoning ordinance and the subdivision regulations.*

2. *Section VI contains the general standards for a site plan. There is a reference to disturbed areas in (1). The regulations could require the applicant to submit a detailed construction schedule with phased disturbance to minimize the extent of exposed soil at any given time during the development process.*

3. *Section VII requires an erosion and sedimentation plan. To assure continued effectiveness of stormwater management measures, the planning board may wish to require the specifications of the 1992 publication entitled <u>Stormwater Management and Erosion and Sediment Control for Urban and Developing Areas in New Hampshire</u>, DES and RCCD. The planning board should consider requiring that a long term maintenance plan be submitted along with the detailed stormwater management plan. By including this type of requirement as part of the plan any violation could be enforced under RSA 674:16, 17, 17-a or 17-b.*

It may also be useful to reference to the state's requirements for erosion and sediment control and stormwater management for disturbance of land greater than 100,000 square feet. A site specific permit for such disturbances is required by the DES-WSPCD in accordance with RSA 485-A:17 and NI-I Code of Administrative Rules Env-Ws 415.

4. *Section IX requires water supply and sewage disposal to meet the requirements of the Water Supply and Pollution Control Commission. This should be updated to reflect the current agency name Water Supply and Pollution Control Division. The planning board may wish to reference the requirements of the water supply rules NH Code of Administrative Rules Env-Ws 378 and RSA 485-A, 29-44 and subsurface wastewater disposal system rules, NH Code of Administrative Rules Env-Ws 1000.*

If the Town of Kingston has not already addressed these recommendations, they should do so as soon as possible.

d. Lawn Fertilizers

The practice of lawn fertilization in areas adjacent to surface waters has the potential of increasing nutrient loading to the water. The Shoreland Protection Act restricts the use of fertilizers, except lime on lawns and grass areas within 25 feet of any surface water. The Shoreland Protection Act also requires that only low phosphate and time released nutrients are to be used within the 25 to 250 foot protective area. This sort of ordinance requires close monitoring by the local municipality and area lake associations during the spring and summer months.

e. Gravel Pits

The location of gravel pits and the manner in which the material is removed from the site should be closely monitored by local officials. Gravel pits should not be permitted in any location where increased runoff will result in sedimentation of surface waters due to erosion. Where possible, inactive pits should be graded to reduce excessive slopes, thereby reducing the potential for runoff and sedimentation.

RSA 155-E governs the excavation of earth. This law places the burden upon the landowner to obtain a permit from the municipality within which the proposed excavation is planned. In this manner control over excavation of material is retained by the municipality.

6. Watershed Management Summary

Development within the watershed of a lake that fails to take into account the carrying capacity of the land will serve to lessen the value of the lakes. Management of the watershed, which ensures the maintenance of adequate water quality standards and prevents future degradation of water quality, is of obvious importance to the local municipalities from both an economic and environmental standpoint.

Each of the recommended management practices outlined above will require incentives to ensure conformity to, and implementation of, these recommendations. Management practices are more difficult to monitor and enforce than regulatory controls and therefore require alternative means of implementation.

In order to provide for proper management, specific regulatory controls should be incorporated at the local level. Controls should include the determination of lot sizing according to the soil and slope characteristics, enforcement of shoreline setbacks and the control of seasonal cottage conversions to year round residences. Existing state laws lend support to the incorporation of these specific practices. Land management practices relative to agriculture, timber harvest, construction and gravel pit operation require more of a commitment by individual landowners and operators. Enforcement of specific regulations relative to management practices exists primarily at the state level. However, local municipal officials should play a major role in the identification and documentation of potential violations. Local ordinances can be adopted which conform closely to existing state regulations. In this manner, local ordinances supplement state regulations and provide support for existing state laws. Each recommendation will involve some degree of personal sacrifice. However, this price is small in comparison to the economic, environmental and aesthetic values to be realized by a watershed with a high level of water quality.

Most other management practices require monitoring by local officials who can then notify state authorities when violations of state regulations are documented. This review by the municipal officials is the most effective manner in which these laws can be monitored and enforced.

Programs currently exist at the federal level, through the United States Department of Agriculture (U.S.D.A.) which provide for cost sharing of certain conservation projects. Educational methods can be incorporated by the Natural Resources Conservation Service and can help to point out practices which benefit the farmer as well as reduce the potential for water quality degradation.

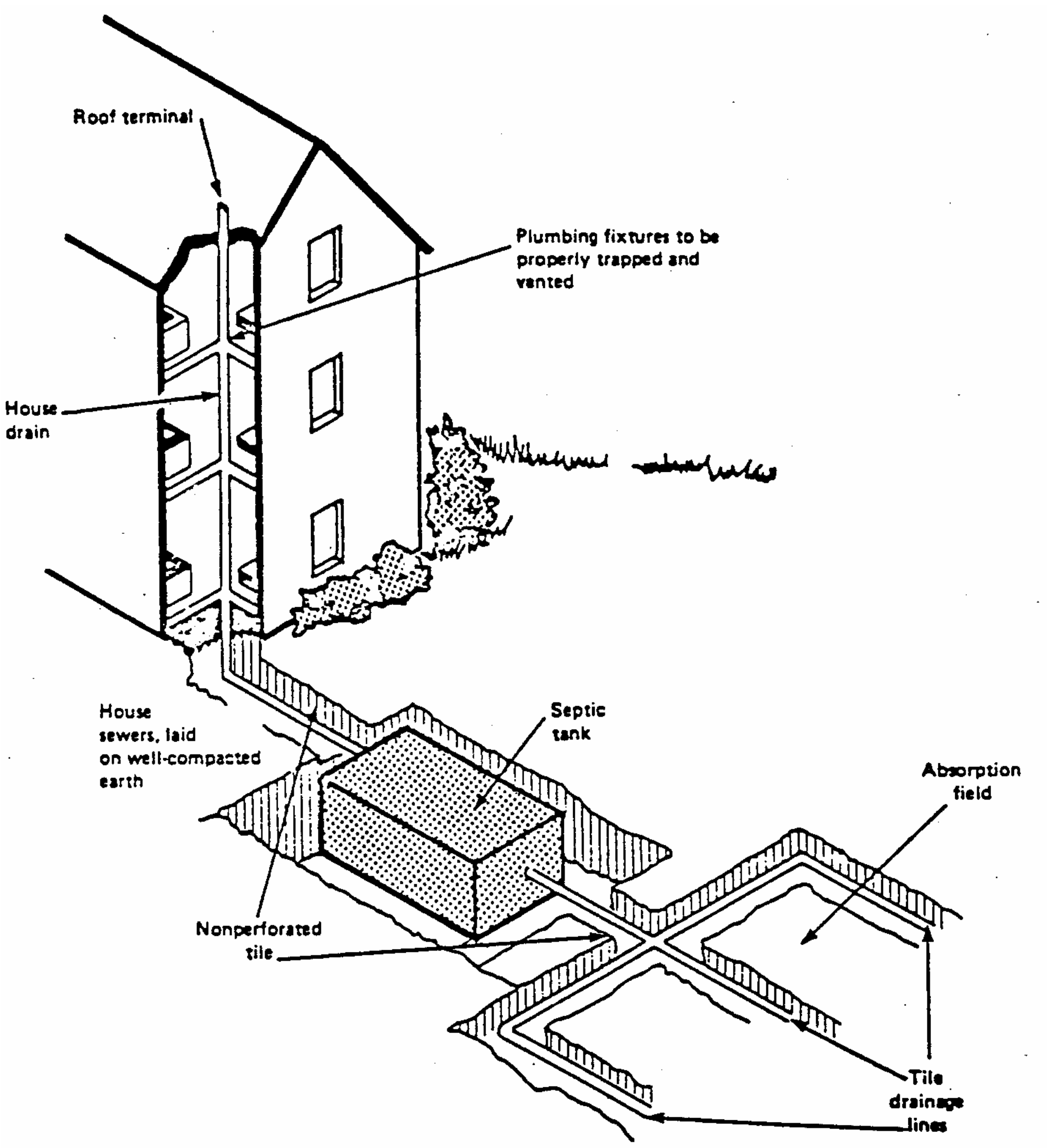
E. ARTIFICIAL PHOSPHORUS ABATEMENT

1. General Discussion

Several studies (Jones and Lee, 1977; NHWSPCD, 1975) have indicated that a properly designed, constructed, and maintained septic system will not generally contribute significant amounts of phosphorus to surface waters or cause extensive fertilization. However, because of their use in unsuitable areas or because of improper design, construction, or maintenance, it is estimated that over one-half of the systems in use today fail before their designed life of fifteen to twenty years is completed (Scalf et al., 1977).

The most common type of individual disposal system is the septic tank - leach field system (Figure XI-11). The septic tank functions to separate the solids, both floating and settleable, from the liquid material. Most systems should have the accumulated sludge pumped out every three to five years, but many systems at Great Pond should be pumped yearly because of the high water table. The liquid is discharged from the tank through piping material and distributed over the leaching area, which is designed to absorb the effluent and to remove the impurities before it percolates to the groundwater.

In 1967, the New Hampshire legislature enacted a law to protect water supplies from pollution by subsurface disposal systems, and directed the Water Supply and Pollution Control Division to establish minimum, state-wide requirements for properly designed systems. However, this law provided no control over existing systems. The requirements most pertinent to the prevention of surface water contamination by phosphorus are:


Roof terminal
Plumbing fixtures to be properly trapped and vented
House drain
House sewers, laid on well-compacted earth
Septic tank
Absorption field
Nonperforated tile
Tile drainage lines

- Location of the system with respect to the surface water body,
- Soil permeability: the rate of water transmission through saturated soil, of which estimated soil retention coefficients varied with different lake sections,
- Land slope: steep slopes may cause erosion problems when associated with low permeability soils,
- System age: soils have only a finite capacity for phosphorus absorption,
- Per capita occupancy: (household population based on sanitary survey),
- Fraction of year system is in use: (i.e., summer cottages or year-round dwellings), and
- Additional water utilizing machinery: (i.e., washing machines, dish washers, or garbage disposals).

2. Great Pond Sanitary Survey Results

A sanitary survey of the Great Pond shoreline was conducted during the study period (Appendix VIII-2). A sanitary survey typically consists of a visual inspection of the property, interviews with residents to discuss various problems and the compilation of information regarding the system, such as type of system, age, maintenance schedule, depth to groundwater etc. This is an extremely time consuming task, often requiring numerous visits to find people home, and the information obtained is questionable at best. In 1995, a sanitary survey questionnaire was distributed to the homeowners around Great Pond in an effort to gather more information about septic systems. The questionnaires received from Great Pond residents accounted for 38% of the residences on the pond. The remaining systems were evaluated by examining town records that identify systems along the pond.

The sanitary survey of Great Pond revealed that out of the 115 completed surveys, 84 systems (73%) were perceived to be functioning properly, 18 systems (16%) were suspected failures. A suspected failure was assigned if a system exhibited overflows, blocking, or foul odors. No data was available for 13 systems (11%).

Many of the systems around Great Pond predate the 1967 rules and regulations establishing design and installation criteria. In fact, the mean system age of those surveyed during the 1995 study year was 15.8 years. This indicates that although systems were perceived to be functioning properly in 1995, a large portion of these systems are now older than twenty years and have passed their expected design lives and may be considered potential problems. The upgrading of septic systems could occur through four channels:

- Voluntary replacement;
- Proven failure and subsequent order to replace from the health officer or the DES

Subsurface Bureau;

- Conversion from seasonal to year round use or addition of bedrooms; or
- Engineering study conducted prior to the house sale showing evidence that the septic system was in need of repairs or replacement.

The pollution abatement alternatives of no action, regional treatment, group or cluster systems, and upgrading of individual systems were evaluated.

The estimated impact of phosphorus from groundwater was measured directly. Approximately 20% of the phosphorus loading from the groundwater phosphorus budget can be attributed to septic system leachate. Groundwater seepage, which included septic system phosphorus loading to the pond, contributed 41 percent of the total phosphorus budget.

3. Wastewater Treatment Alternatives

a. No Action. One option is to take no action to abate the identified and suspected pollution. The impact of this alternative would be continued degradation of the water quality of Great Pond although the extent is not known.

When septic systems fail, they present a potential health hazard associated with the presence of untreated human wastes above ground and in surface waters. Groundwater contamination and subsequent pollution of drinking water is probable in many areas. Many older systems will leach phosphorus into the groundwater and lake, accelerating the eutrophication process in Great Pond.

Many of the housing lots are less than 0.5 acres in size and very few could meet the design requirements needed to replace failed systems. Additionally, soils in the area are considered severely limited for leach field systems because of depth to bedrock and/or high water table.

b. Regional Waste Treatment. There is no feasible regional waste treatment alternative for Great Pond at this time. The closest municipal wastewater treatment facility to Great Pond is located in Exeter, New Hampshire which is approximately 11 miles from the pond.

c. Cluster Systems. Cluster systems are innovative systems that collect and treat sewage for many homes or groups of homes around a lake. First tier development around Great Pond could elect the alternative of subsurface treatment systems with conventional collection from clusters or groups of individual homes. These cluster systems are usually simple and a cost effective alternative for the secondary treatment of small flows. Installations range from 500 gpd to 300,000 gpd. One company has developed a system that removes nitrogen and phosphorus. This system was developed especially for areas that are environmentally sensitive.

Cluster systems are becoming more popular as alternative systems and research conducted on these units show that more nutrients are trapped so less enter the waterbody. There are several cluster systems that are now operational in New England and the Great Pond community could benefit from this type of waste treatment technology.

i. *State Water Quality Standards and Permits*. Some form of land application or soil absorption appears to be the sole means of acceptable discharge for treated effluent from the Great Pond community. Such disposal will require a groundwater discharge permit under RSA 485:A:BVI and ENV-WS 430 of the New Hampshire Code of Administrative Rules.

ii. *Treatment Plant Design Criteria.* Septic tank-soil absorption systems are by far the least costly alternative for providing for adequate disposal of sewage. Design of such systems is based upon a design flow of 150 gallons per day per bedroom for the community served. Sites around the pond must be evaluated for conventional septic tank-soil absorption and areas eliminated that are inadequate for a system of the required size.

Estimating the design flow for application of active treatment is the most critical element in the design process. For the residents that responded to the sanitary survey, the total number of people is determined to be approximately 3.7 people per dwelling unit. The State has required that 70 gallons per capita per day be used to size typical active treatment systems with gravity sewers not including infiltration/inflow and industrial commercial flows. Latest guidelines for design of pressure sewers indicates that typical design flows should be in the 40 to 60 gallons per day per capita range with peak flows calculated as follows:

$$Q = 15 + 0.5D$$

where: Q = peak flow in gallons per minute
D = number of dwellings

Seventy gallons per capita per day has been used here as a conservative design flow for treatment plant design. Peak flows are expected to be 38 gallons per minute for a community of 46 dwellings. Table XI-11 shows design criteria used for the two sites evaluated for Flints Pond, Hollis, New Hampshire.

Domestic waste can be treated to various degrees which include: preliminary/primary treatment, secondary treatment, tertiary treatment, and disinfection, followed by effluent disposal.

Preliminary and primary treatment consist of removing large solids, debris, floating material, grease and oil, and other heavy solids. Septic tanks perform this function by mechanically removing gross solids by flotation and sedimentation, breakdown or conversion of solids to liquids, and finally providing storage of solids that are not amenable to decomposition. These solids eventually fill the tank and must be removed (pumped) periodically and disposed of separately. Septic tanks are anticipated to remove 30 to 50% of the BOD_5 and total suspended solids from the incoming waste.

Table XI-11
Data Sheet - Flint Pond

Site ‘‘A’’ Criteria	
Number of Lots Served	46
Gallons Per Capita Per Day	70
Number of People Per Lot	3*
Estimated I/I	None
Design Flow	9,660 gpd
Site ‘‘B’’ Criteria	
Number of Lots Served	58
Gallons Per Capita Per Day	70
Number of People Per Lot	3*
Estimated I/I	None
Design Flow	12,180 gpd

Wastewater Characteristics**	
BOD (5 day)	250 mg/L
TSS	250 mg/L
NH_3 - Nitrogen	12 mg/L
Total Phosphorus	25 mg/L

Based on Flint Pond Sewerage Committee Survey
Typical of Domestic Waste Based on EPA Criteria

Secondary treatment serves to remove the soluble organic load from the waste stream, usually by biochemical means. Treatment units such as rotating biological contractors, intermittent sand filters, and aeration tanks are typical of these processes for small treatment plants. The first two processes were considered here because of low power consumption and relative ease of operation and maintenance. Secondary treatment includes solids removal using a sedimentation basin and sludge removal for final disposal. Secondary treatment is expected to remove 90% of the BOD_5 and total suspended solids.

iii. *Collection System and Treatment Costs*. This analysis assumes that the collection system will consist of grinder pumps and pressurized sewers. This configuration may be considered innovative. If so, it may be eligible for some level of federal funding, but this is an extremely competitive process and chances of success are very small.

Costs which have been estimated for the pressure collection system are presented in Table XI-12. The total cost shown here does not include the leach field ($110,000) or the septic tanks ($10,500) which were considered previously. Cost for these facilities will be added separately for clarity.

Table XI-12
Estimated Capital Cost: Pressure Collection Sewers

Cost of Each Residence	
Grinder Pump and Basin	1,500
Electrical	500
Yard Piping (100 ft. per yard)	1,500
Miscellaneous Expense	500
Subtotal	4,000
Pressure Sewer Costs	
Sewer Pipe (2,600 ft.)	39,000
Spare Pumping Equipment	9,000
Subtotal	48,000
Total Costs	
$4,000 X 46 Residences + $48,000	$232,000

Treatment has been evaluated for secondary and tertiary treatment. This is for comparative purposes although tertiary treatment may be a requirement if groundwater rights cannot be secured. Any site will require preliminary/primary treatment for removal of solids and floating material. This will be accomplished by using septic tanks upstream of the treatment units. Ultimate disposal of treated effluent will be by subsurface discharge which will not require disinfection. In any event, it is likely that a groundwater monitoring program will be required by the State to evaluate conditions in the soil/groundwater as affected by treatment plant discharge. Tertiary treatment performs removal of nutrients.

Generally, the objective here is to remove nitrogen by anaerobic processes. It is expected that the State may require compliance with drinking water standards achievement of which will require tertiary treatment. Costs for secondary treatment have also been developed in the event this level of treatment is acceptable.

Table XI-13
Unit Treatment Processes and Estimated Costs

Treatment Function	Unit Process	Degree of Treatment	Estimated Capital Cost	Estimated Annual Operation and Maintenance
Preliminary and Primary Treatment	Septic Tank	30-60% Removal of BOD_5, TSS	$20,000	$2,000
Secondary Treatment	Rotating Biological Contractor	90% Removal of BOD_5, TSS	$305,000	$10,000
	Intermittent Sand Filters	90% Removal of BOD_5, TSS	$202,500	$5,000
Tertiary Treatment	Anaerobic Filter	50 - 80 % Total Phosphorus and Total Nitrogen Removal	$50,000	$5,000
Groundwater Disposal (includes groundwater monitoring)	Soil Absorption Field	Some Nitrogen Removal Some BOD_5 Removal	**$35,000	***$3,000

* Based on a design wastewater flow of 14,000 gpd.
** Includes cost of hydrogeological study.
*** Includes cost of annual sampling of monitoring wells.

Table XI-14

Estimated Total Capital and Operation and Maintenance Costs for Treatment at Site A

	Treatment Plant			Collection System		Estimated Total Costs	
Type of Treatment	Degree of Treatment	Estimated Construction Cost	Estimated Annual Operation & Maintenance Cost	Estimated Construction Cost	Estimated Annual Operation & Maintenance Cost	Capital	Operation & Maintenance
Sand Filters	Secondary	$232,500	$10,000	$232,000	$2,000	$464,500	$12,000
	Tertiary	$282,500	$15,000	$232,000	$2,000	$514,500	$17,000
Rotating Biological Contractors	Secondary	$335,000	$15,000	$232,000	$2,000	$567,000	$17,000
	Tertiary	$385,000	$20,000	$232,000	$2,000	$617,000	$22,000

Groundwater discharge can be accomplished by using an absorption field similar to those used in conjunction with septic tank systems. If secondary treatment is performed prior to discharge, requirements for absorption bed area can probably be reduced. This is due to reduction of pollutant mass due to active treatment. It has been estimated that a hydraulic loading rate of about 1.2 gallons per day per square foot would be acceptable. Various unit treatment processes are shown in Table XI-13. Cost estimates for achieving treatment at a typical site for both secondary and tertiary treatment are shown in Table XI-14.

Acquisition of funds by the Town of Kingston through the State's Revolving Loan Fund (SRF) would be the most cost-effective method of constructing cluster systems around the Great Pond shoreline. SRF funds are loaned to communities at a low rate of interest for eligible non-point source pollution control management programs. These funds cover one hundred percent of the project costs and may be paid back to the state over a five to twenty year period depending on the town budget and loan agreement. Although a user fee would be required of all involved homes around the lake, the environmental and economic benefits greatly outweigh the option of individual subsurface system upgrades which can cost up to $16,000. Information on SRF loans can be found in the NHDES Technical Bulletin number WSPCD-WEB-1994-3.

d. Upgrading of Individual Systems.

A wide range of individual treatment systems has been explored in the last few years due to a renewed interest in on-site disposal systems. The Federal Environmental Protection Agency has a thorough review system in their draft report "Innovative and Alternative Technology Assessment Manual." The fact sheets from that manual give a good outline of available alternatives. A discussion of many of these alternatives will follow.

i. *Septic Tank and Leaching Field.* Individual treatment systems installed in recent years normally consist of a septic tank for solids separation and degradation, and a soil absorption system or leach field to aid liquid percolation into the soil. The size of the tank is proportional to the expected usage and the leaching field is sized according to both usage and soil characteristics. When soils are poor (i.e., low permeability) or flows are high, the leaching field must be large. Unfortunately for many of the residences on Great

Pond septic tanks and leaching fields are impractical or impossible due to lot restrictions and/or soil and groundwater conditions.

ii. *Compost Toilets.* A reduction in wastewater volume entering the leaching field is possible by the use of a waterless toilet of the composting type. A discussion of this alternative requires an understanding of domestic wastewater composition. Wastewater is the by-product of all water used within the home including toilet facilities, cleaning, cooking and personal hygiene. The wastewater associated with toilet and urinal usage is considered concentrated human waste and classified as black water. Gray water comprises the remainder of the domestic wastewater such as water from baths, showers, sinks and clothes washers. By eliminating toilet and urinal usage (black water) about a 40% reduction in total flow can be achieved. Compost toilets decompose human wastes by a natural biological process. With the aid of air and/or some heat, human waste will degrade itself over an extended period of time. This process is similar to the compost process in composting leaves and manure piles used for garden and agricultural crop enrichment. Basically, there are two types of compost systems. One utilizes a large compost chamber that must be installed in the basement or underground, and is called an external unit. The larger external units rely completely on natural processes. They have no external heat addition or composting aids as in the smaller internal units. The addition of heat and compost aids (such as a starter bed or enzymes) speeds the degradation process thereby decreasing the required volume. The treatment process is the same in each. Toilet wastes enter through a toilet chute and accumulate in the compost chamber. Here, with air supplied through ventilation, warm temperatures and humidity, the waste begins to decompose. The process should create no odor since released gases and water are removed by outside ventilation and evaporation. Organic material such as food wastes should be introduced into the chamber to aid in the composting process. The total decomposition time ranges from 1-1/2 to 2 years initially, and from 3 to 12 months thereafter. At the end of this time, the wastes have been reduced to a rich, odorless humus that can be removed and used as garden soil. This is the only required maintenance except for the occasional addition of enzymes for certain internal units. For the internal units, electricity is required for heating and a ventilation fan, while some external units utilize convection currents for ventilation. The amount of humus produced varies with the system and ranges from 15 to 60 pounds per year per person.

Composting toilets would provide an excellent alternative to some residences along Great *iii.* *Individual Treatment and Recycle.* The recycle system is a self-contained, package treatment unit specifically designed to treat black water. Wastes are transported in about 2 quarts of water per flush, by means of vacuum, to the self-contained unit where the black water is treated by a combination of anaerobic and aerobic decomposition, settling, filtering, and purification by ultraviolet light. This treatment and purification process operates efficiently at temperatures between 55°F and 120°F and must be protected against freezing. The recycled water is returned to a flush holding tank. The recycle toilet operates on 110 volts AC and consumes from 300 to 500 KWH of electricity per month of operation. The system requires regular maintenance. Since the recycle toilet uses cultured bacteria to accelerate digestion of solids, the bacteria must be added periodically in the form of dry packets. The water level should be checked every two weeks. Periodic replacement of some parts is required. Activated carbon, used in the filtering system, needs annual replacement as does the ultraviolet lamp bulb used in purification, the air filter cartridges on the vacuum and aeration pumps and the three-way solenoid valve regulating vacuum and aeration.

iv. *Low Water Flush Toilets.* Several low water flush toilets are available which utilize from one quart to two gallons of water instead of the average five to eight gallons used by a standard flush toilet. A limited capacity self-contained tank controls the volume of flushing water. Air in the tank is compressed as it is filled with water. When flushed, the compressed air forces the water through the toilet bowl at a faster rate thereby requiring a lower volume to empty the bowl.

Other low water flush toilets involve mechanical equipment and use either vacuum or pressure to empty the toilet bowl. Basically, the components for a one toilet vacuum system are the toilet, vacuum pump, and plumbing. The vacuum pump maintains a vacuum in the plumbing at all times. A valve separates the toilet bowl and the plumbing. When activated, the valve opens allowing the contents of the toilet bowl to be drawn into the plumbing. These wastes remain under vacuum until they reach the holding or discharge tank. The maintenance required is minimal, but mechanical equipment is involved to maintain the pressure or vacuum. Although the water content is lowered, the amount of organics, solids, toxics, etc. is still the same as the conventional flush toilet.

v. *Gray Water Flow Reduction.* Unlike concentrated human waste, gray water cannot be completely eliminated as domestic wastewater by recycling or composting.

However, many devices are available for water conservation that greatly reduce gray water quantities. Flow restrictors and regulators can be placed on faucets and shower heads. The average person showering will use 6 gallons of water per minute for 7.5 minutes with a standard shower head. Should a 3-gallon per minute flow reduction be installed, an average family of four persons could save 90 gallons of water per day, assuming each took one shower a day.

Water conservation and wastewater treatment methods described above may result in significant flow reduction to the ultimate treatment and disposal system. Assuming the average family produced 75 gallons per day per person, an estimated flow for their household is about 300 gallons/day. Table XI-15 displays estimated resulting flows.

Table XI-15
Household Wastewater Flow Quantities With Water Conservation and Separation

Item	Design Criteria	Percentage Flow Reduction	Reduced Wastewater Flow*
1. Compost incinerator or recycle toilet	Flow-300 gpd for average dwelling	3.5%	195
2. Low water gravity flush toilet	Flow-300 gpd limited to 3½ gallons per cycle	7.5%	278
3. Low water vacuum flush toilet	Flow-300 gpd, limited to 3½ gallons per cycle	7.5%	278
4. Shower flow control device	Limited to 2 gpm	4.0%	288
5. Combination of 1 and 4 above		7.5%	483
6. Combination of 2 or 3 and 4		11.5%	566

*Per Day

vi. *Aerobic Wastewater Treatment Unit.* Many alternative individual systems utilize an aerobic process. The operating principle of aerobic treatment units is the same as that used in many conventional municipal wastewater treatment plants of the activated sludge type. In essence, these household/on-site systems are miniature models of the larger municipal plants. Some units are complex while others are simply an aeration chamber.

This process of aeration and subsequent settling is called secondary treatment. It is a biological process that removes organics which cannot be settled out in primary treatment such as the septic tank. The incoming wastewater is initially treated in order to make it acceptable for aeration. This primary treatment is accomplished by various methods including settling of heavy solids, grinding of large particles or rough filtering. The wastewater then enters the aeration chamber where it undergoes aerobic decomposition. Solids formed by the aerobic degradation process are subsequently allowed to settle out in the settling chamber. After the settling chamber, the effluent is discharged to the ground. The end product, though better quality than septic tank effluent, does contain substantial amounts of pollutants which must be removed by the soil.

The biological secondary treatment process utilized in these units is a sensitive one. This, in addition to the mechanical equipment involved, requires that a unit be monitored and maintained on a continual basis. If this equipment is purchased, it is highly recommended that the home owner obtain a service contract with a reliable repair service and set up a schedule of maintenance calls (at least four times a year). Alarms can also be supplied which are wired into the house and activate when malfunctions occur.

vii. *Wastewater Treatment Alternatives Summary.* A variety of alternatives is possible for the upgrading of individual treatment systems. Each alternative has limitations for proper operation including difficult climate, terrain, soils and/or groundwater conditions, personal acceptance, technical and administrative problems.

A summary of advantages and disadvantages is shown in Table XI-16 for all alternatives previously discussed.

e. Septage Handling Alternatives.

The cluster system alternative includes large septic tanks that require pumping every other year. One septage handling alternative would involve pumping of the septage by a tank truck, owned and operated by a management district for Great Pond or the Town of Kingston. Septage would be hauled to the nearest approved disposal site or wastewater treatment plant for further treatment. Hauling of raw septage to an existing wastewater treatment plant would only require the payment of a tipping fee. Wastewater treatment facilities in New Hampshire presently charge a septage disposal fee of approximately seventy-five cents per gallon. Disposal at a land treatment site owned and operated by a town or district may be less costly once site development costs are met.

Another septage handling alternative would include contracting with a private septage hauler to periodically pump all septic tanks and be responsible for disposal. Contracting

Table XI-16

Individual Innovative/Alternative Treatment Systems

TREATMENT METHOD	ADVANTAGES	DISADVANTAGES
1. Septic tank and field	Simple operation and maintenance. Good public acceptance.	Dependent on soil and site conditions - percolation rate, depth to ledge, seasonal high water level, distance to well or surface water.
2. Compost toilets.	Eliminates black water flow.	Gray water still requires septic tank and soil absorption system. Potential for breeding of flies, odors and hydraulic overload. Problem with public acceptance.
3. Individual treatment and recycle.	Reduces flow from home.	Still requires septic tank and soil absorption system. High cost and high maintenance.
4. Low water flush	Reduces black water flows.	Concentration of organic loading still high. Gray water still requires treatment and disposal.
5. Gray water flow	Reduces volume of wastewater requiring treatment.	Concentration of organic loading still high. Treatment and disposal still required.
6. Aerobic treatment absorption bed.	Achieves higher BOD removals than conventional septic tank systems.	Variable effluent quality, semiskilled operation and maintenance required. Requires conventional soil absorption system. Does not, in general, remove phosphorus.
7. Aerobic treatment surface discharge with disinfection.	Achieves higher BOD removals than conventional septic tank systems. Avoids need of soil absorption system.	Variable effluent quality requires semiskilled O&M. Requires surface stream discharge. Does not, in general, remove phosphorus.

cost-estimates recently solicited from local private haulers averaged eight cents per gallon.

f. Environmental Assessment of Alternatives.

The environmental effects for the various sanitary pollution abatement alternatives were evaluated. Potential environmental impacts may be summarized as follows:

i. Water Quality. The alternatives of regional and/or cluster treatment would meet present State and Federal regulations regarding acceptable treatment levels of sewage. A beneficial effect of treatment on the aquatic habitat is increased dissolved oxygen content of the water because of a reduction of organic matter and phosphorus presently flowing into the pond.

During construction of a selected alternative, the contractor will be required to provide a means to minimize both siltation and erosion. All appropriate areas of construction will be sufficiently seeded and mulched, upon completion, to prevent erosion. Where necessary, drainage swales and culverted trenches will direct surface runoff. Siltation basins will be used to intercept silt and eroded material before they enter any watercourses. Construction and implementation of the project should not appreciably affect the hydraulics of any stream.

ii. *Wetlands.* All wetlands around Great Pond have been mapped. Although no significant environmental impact is expected, the regional treatment alternatives considered would include collection systems that must pass through wetland areas. Adequate precautions and permits will be required to minimize the primary impact of construction, with special emphasis on control of sedimentation and siltation due to erosion. Regional treatment alternatives were determined to be unfeasible and cost prohibitive at the present time which eliminates the possibility of any negative environmental impacts from occurring in wetlands around Great Pond.

iii. *Historical and Cultural Value.* It is not anticipated that the proposed alternatives will affect areas designated as having historical or cultural value. Facilities proposed for collection and treatment would be constructed below ground level, with those areas of construction being returned essentially to their original state. If treatment facilities are to be constructed in previously undisturbed areas, an archaeological study would be required.

iv. *Hydrologic Impacts.* The hydrologic areas of concern include increased rates of runoff, transfer of water to another watershed, modification to the water table, and transportation of groundwater contaminants. Modification of any of these factors could adversely affect the hydrologic cycle.

Increased runoff would be minimized by proper design and control during construction. If a subsurface treatment alternative is selected, a study of the transport of groundwater contaminants would be required. No other adverse impacts are anticipated.

v. *Air Quality.* There are no anticipated problems that would arise from the operation of the alternatives relative to air quality. Any pumping stations will be completely enclosed below ground with only a hatch for access. Any odors that may occur would only be detectable in the immediate vicinity of the pumps during maintenance.

vi. *Noise.* The only noise generated by the alternatives would be from pumping units. Since the pumps are located below ground in the pump station enclosure, little or no noise will be discernible outside. During construction, noise will be generated by a variety of equipment used to excavate, grade and backfill. Construction noise is, for the most part, unavoidable. It will be necessary for the contractor to comply with existing regulations to minimize noise by employing mufflers and other devices that limit noise levels.

vii. *Secondary Effects.* It is not anticipated that secondary effects induced by the proposed alternatives will be significant. The proposed alternatives will service all problem areas of existing development around the pond.

Implementation of watershed management techniques will help to mitigate the decline in water quality and potential secondary effects. Management techniques include a variety of land-use and land-management practices, involving regulatory controls and BMPs.

4. State and Town Regulation for Individual Subsurface Disposal Systems

A septic system inspection program for lake residents as well as those who live on tributaries to the lake should be initiated. A rotating three year inspection program will prompt those who have inadequate systems to get them replaced.

RSA 485-A Revised Statutes Annotated of the State of New Hampshire is specifically intended to prevent pollution of surface water by “inadequate sewage or waste disposal systems”. Under the power of this chapter, the New Hampshire Water Division regulates the design standards and construction of subsurface disposal systems. Generally, local ordinances in the Great Pond Watershed conform to the state regulations. Regardless of state approval, the Planning Board should state that it may require changes and additions to a proposed sewage disposal system. Most town health officers, through the power of the Planning Board may issue a cease and desist order if the system becomes non-functional. The Town of Kingston may want to consider local regulations concerning septic system approvals that would allow the town additional control in several areas. Building permits for home conversions from seasonal to permanent use are now covered under state law.

Of particular concern at Great Pond is the large proportion of residences along the western shore area. Sewage disposal systems which may be adequate for temporary use are often overloaded when conversion of a residence to year-round use occurs.

Effective January 1989, a new state law, RSA 485-A, requires landowners of all developed property to obtain state approval to increase the load on a sewage disposal system. RSA 485-A states that prior to expanding any structure or occupying any existing structure on a full time basis, which would increase the load on a sewage disposal system, the owner of such structure shall submit an application for approval of the sewage system to the Water Division.

The state also requires a site assessment study on all pending property sales on water frontage or Great Ponds. RSA 485-A states that prior to offering for sale any developed waterfront property using a sewage system, the owner of the property shall, at his expense, engage a licensed sewage disposal system designer to perform a site assessment study to determine if the site meets the current standards for sewage disposal systems established by the Division. This law protects potential waterfront property owners from purchasing inadequate and outdated septic systems.

An amendment to Kingston’s zoning bylaws should define seasonal and permanent use and should alert residents to state law RSA 485-A. These laws should help the Zoning and Planning Boards regulate pond shore and other conversions. The latter restrictions are particularly appropriate since they provide some control over existing sewage disposal systems.

Although not always specifically designed for protection of surface and groundwater quality, zoning bylaws concerning lot sizes may influence local water quality, particularly where on-site subsurface disposal systems are used.

The following technical assistance is provided by the Office of State Planning, and are listed here to help the Town of Kingston improve on the town’s ordinances concerning sewage disposal systems.

Town Of Kingston, NH: Rules And Regulations Of The Board Of Health, Revised 1984 And 1989

Installation of Wells and Septic Systems

1. *This section should cite the state's new well siting rules NH Code of Administrative Rules Env-Ws 378 and RSA 485-A, 29-44 and the subsurface wastewater disposal rules Env-Ws 1000.*
2. *RSA 149-E: 5 and 6 were repealed in 1989. They have been recodified to RSA 485-A:41 and 42. The current statutes governing subsurface wastewater disposal systems is RSA 485-A 29-44.*
3. *The section entitled "Installation of Wells and Septic Systems" requires applications for installation of wells and septic systems be submitted to the Board of Selectmen, yet the section entitled "Installation of New Sewage Disposal Systems" (2) requires plans and specifications for sewage disposal systems to be submitted to the health officer. The procedures should be consistent.*

Installation of New Sewage Disposal Systems

4. *This section of the ordinance should cite RSA 485-A, 29-44 and the state's subsurface wastewater disposal rules NH Code of Administrative Rules Env-Ws 1000.*
5. *Section (5), (a) restricts submission of plans to a "site review season" of between April 1 and November 30. Is there a reason why the plans could not be submitted during the other months, with the inspection to be scheduled during the site review season?*
6. *Section (6), (b) requires a 100 foot protective radius for proposed wells. This is more stringent than the 75 foot protective well radius required by Env-Ws 1008.04.*
7. *Section (6), (c)requires the plans to show all wetlands within 100 feet of the proposed septic system. The methodology for delineation of the wetlands should be specified.*
8. *Section (7), the Water Supply and Pollution Control Commission should be updated to reflect the current agency name, Water Supply and Pollution Control Division.*

   Also all of RSA 149-E was repealed in 1989. It has been recodified to RSA 485-A:29-44.

9. *Section (12) should cite the public health statutes for enforcement. RSA 147:4 authorizes the health officer to issue removal notices, RSA l47-a provides the detailed requirements for a notice to an owner and RSA 147-b authorizes collection of nuisance abatement costs by the health officer.*

Repair and/or Replacement of Existing Sewage Disposal Systems

10. *Section (1), (a) requires an application to the Kingston Board of Health for repair and/ or replacement of existing sewage disposal systems. This is not consistent with the previous two sections of the health ordinance.*
11. *Section (1), (a), (5)requires surface waters to be located on a sketch. The location of wetlands should also be required. The methodology for delineation of the wetlands should be specified.*

Well Protection and Placement

12. *Section (2), (a) requires a 100 foot setback of new wells from leachfields and/or septic tanks. This is more stringent than the 75 foot protective well radius required by Env-Ws 1008.04. It is also inconsistent with Section 6.17 in the zoning ordinance, which prohibits septic systems within 75 feet of wetlands and water bodies.*
13. *This section should cite the state's new well siting rules NH Code of Administrative Rules Env-Ws 378.*

F. PUBLIC EDUCATION

The Great Pond Association (GPA) should initiate an education program aimed at educating lake residents, transient lake recreationists and private/public beach users. This educational program should be designed to incorporate residents within the entire watershed but specifically targeting developed areas adjacent to surface waters. The ultimate goal of this type of program is to reduce the amount of nonpoint source pollution within the watershed and to eliminate the effects of cultural eutrophication upon Great Pond.

Given a choice and a better understanding of the consequences of their actions, most people will opt to improve their environment. If all residents of the Great Pond watershed could enjoy the benefits of a choice recreational facility, they would likely take a greater interest in protecting water quality. The GPA has been aggressive in the implementation of public education programs for several years. In 1995, the Town of Kingston purchased the Interactive Lake Ecology Program to introduce school aged children to the study of lakes.

The GPA can be a valuable and effective vehicle for conveying information to the residents and transient population of Great Pond and its watershed. The existing infrastructure and long term goals of the GPA will coincide with the recommendations for public education outlined in this study and should include the following:

- Continuation of GPA sponsored activities revolving around public education as it pertains to shoreland protection, watershed management and lake ecology.
- Construct an educational kiosk at the public launch to educate transient recreationists on lake preservation, safety and watershed management issues.
- Continued participation in the New Hampshire Volunteer Lake Assessment Program.
- The GPA with support from NHDES, New Hampshire Department of Agriculture and Natural Resources Conservation Services should develop an educational program or workshop on BMPs for those people in the watershed who practice animal husbandry or manage “hobby-farms”. Since small farms contribute to nonpoint sources of phosphorus and may even contribute more phosphorus than larger farms that practice BMPs, an educational program is needed on BMPs for manure handling and pasture management.
- The Town of Kingston should support the NHDES Interactive Lake Ecology Program in their elementary and secondary schools. This program is designed to educate the young on principles of lake ecology and preservation of these resources, ensuring that the future residents of the area have the necessary education to be the safeguards of their water resources.
- The GPA or the Kingston Conservation Commission should adopt the inovative Landscaping Lakeshore Properties program that the Lake Sunapee Protection Association (LSPA) developed.

The frequency of seasonal to year-round residence conversions on Great Pond coupled with the large scale development of the watershed and public boat access utilization emphasize the necessity of a comprehensive educational program within the Great Pond watershed. Implementation of the recommendations listed above will act to mitigate nonpoint source pollution around Great Pond and reduce the impacts of cultural eutrophication.

1. Workshops and Kiosk

a. Problem and Need

An information kiosk (sign) and series of workshops will address the public's general lack of knowledge regarding nonpoint source pollution in the Great Pond Watershed. Removal of trees and shrubs along the shore, creation of unstable beaches, and the advantages of maintaining or restoring the natural shoreland will be addressed by the Native Vegetation/Erosion Workshop. The Nonpoint Source: Stormwater Workshop is needed to educate homeowners and city road agents in the maintenance and repair of storm water drainage. The message of the workshop is directed at removing the pollutants that tend to be retained, and accumulate at specific locations in the stormwater system, i.e. catch basins. Great Pond Quality and Monitoring Workshop deals with the effects of nonpoint source pollution on the lake quality and how GPA is monitoring the pond. The final workshop in this series, Homeowners in the Watershed, encourages proper use and disposal of materials by homeowners. The contaminants addressed by this control activity include materials such as fertilizers, pesticides and herbicides, oil and antifreeze, paints and solvents.

b. Project purpose and objective

The educational component of this project is two-fold. GPA will design and construct an informational kiosk at the public beach. Educational materials and water quality results will be regularly displayed. And, GPA will hold a series of four hands-on workshops for the public. The workshop topics will coincide with the watershed projects also under this project. Homeowners in the Watershed workshop will encourage proper use and disposal of materials by homeowners. The workshop will coincide with a Town of Kingston Household Hazardous Waste Disposal Day. Other topics for this workshop include septic system maintenance, use of fertilizers and pesticides, and the harmful effects of these hazards on lake plants and animals. The Nonpoint Source: Stormwater workshop will feature a speaker from the NH Nonpoint Source Program and will address town personnel associated with road maintenance and the general public. This workshop will coincide with the Storm Drain Stenciling program. The Native Vegetation Workshop may be presented by the Rockingham Natural Resources Conservation Services staff. In addition to educating residents how to plant and what to plant along the shoreline, the staff member will teach erosion control techniques for residential lots. A local nursery may be interested in offering native plants for sale at this workshop for a reduced price. Great Pond Quality and Monitoring Workshop will be presented by the NH Volunteer Lake Assessment Program coordinator. GPA members participate in this program and will assist with the demonstration of lake monitoring equipment. Workshop participants will have a chance to use the equipment and learn how to interpret basic water quality data.

c. Project Plan

After obtaining the proper permits, GPA members will design the kiosk and purchase supplies. In cooperation with the Parks & Recreation Department, volunteers will construct the kiosk at the public beach. The responsibilities of the Correspondence Committee of GPA include the periodic updating of materials in the kiosk.

GPA will advertise in local and state papers, through flyers, and in a GPA newsletter for the series of workshops. Workshops will be held outdoors at the public beach picnic area for anyone interested. Organization of the workshops will occur under a chairperson for each workshop. The chairperson is responsible for assisting the guest speaker in forming the contents of the workshop and in confirming the speakers attendance prior to the scheduled day. Emphasis will be placed on hands-on activities and how the topic relates to the Great Pond Watershed. Each chairperson will recruit a committee to help with advertising and the workshop. Participants will be requested to evaluate the workshops through a written evaluation form.

d. Budget

The budget category and cost breakdown is provided in Table XI-17, showing the federal funds (319), non-federal match, and total costs.

Table XI-17
Workshops and Kiosk Budget Catagory and Costs

Budget Category	319 Cost	NFM Cost	Total Cost
Contract		$110	$110
Monitor 2 fall storm events		$616	$616
Fall sweeping and catch basin cleaning	$1,000		$1,000
Monitor 2 spring storm events		$616	$616
Spring sweeping and catch basin cleaning	$1,000		$1,000
Town sweeping and catch basin cleaning (fall and spring)		$1,000	$1,000
Laboratory Costs Fall	$1,624		$1,624
Laboratory Costs Spring	$1,624		$1,624
Total	$5,248	$2,342	$7,590

2. Landscaping Lakeshore Properties

Bringing all shorefront lots into compliance with the Shoreland Portection Act would help preserve Great Pond's water quality; however it would be inappropriate for any government or association to mandate SPA compliance of any grandfathered lot.

The Lake Sunapee Protective Association (LSPA) developed an innovative education program to aid in shoreland protection. LSPA produced a brochure (Figure XI-12) that explains the benefits of a lakefront buffer zone and landscaping techniques that minimize shoreland erosion. On the reverse side of the borchure is a list of plants appropriate for shoreland areas. The LSPA combined the brochure with an incentive program that promotes replanting shrubs in shoreland areas. In the first year of the program the LSPA purchased hundreds of blueberry bushes, and sponsored a sales drive in surrounding areas of Lake Sunapee. The sales drive was spearheaded by an advertizing campaign in the local media. The campaign was a success as LSPA sold all of the shrubs, while maintaining their budget. In subsequent years the LSPA has partnered with local nurseries in the advertizing campaign and in exchange the nurseries have donated a portion of the profits from the recommended shrub species back to LSPA. This has allowed the LSPA to avoid the financial risk of purchasing plants themselves. The GPA or the Kingston Conservation Commission should consider a similar program to promote the planting of shoreland buffer strips around Great Pond.

3. New Hampshire Volunteer Lake Assessment Program

The Volunteer Lake Assessment Program (VLAP) should continue to monitor both in-lake and subwatershed tributaries for water quality. Those that have participated in VLAP and the Diagnostic/Feasibility study understand the importance of collecting samples, analyzing the samples and evaluating the trends.

VLAP along with the Town of Kingston should be the focal points for advancing the implementation projects defined within this report. Since any future projects will require a non-federal match, volunteers can use their time as part of this match.

Volunteers will also be asked to monitor any lake restoration projects, watershed management, Best Management Practices and will have to lead any education efforts adopted from the recommendations.

Although the costs for participation in VLAP is only approximately $300.00 per year, the possible match for future watershed projects will be in the thousands.

4. Interactive Lake Ecology

The Town of Kingston should continue the Interactive Lake Ecology (ILE) curriculum in their school system. Educating the kids who live in the watershed and around the lake is a key component in protecting our waters for future generations.

The costs to the town for new ILE workbooks and teacher guides will be less than $200.00.

Principles of Lakeshore Landscape Design

The best landscape design near a body of fresh water is one which interrupts any potential flow of surface water directly into the lake, pond or stream. Existing trees, new plantings, and ground covers all can trap runoff water from rain and snow melt, and allow it to settle into the soil. It can then be filtered by the soil before it reaches the lake through underground routes.

Runoff from rain contains *phosphorus,* and silt which is also a major source of phosphorus. Phosphorus is a nutrient which feeds algae in the water; algae "blooms" kill fish, turn the water green and ugly, and smell awful!

Silt carried into the lake not only brings phosphorus, it will settle on the bottom, creating a fertile bed for unwanted weed growth. Sediment fills stream beds, inhibiting water flow, destroying fish spawning areas, and suffocating all organisms living on the bottom.

Keep a Green Buffer Zone

State and local regulations call for a "buffer zone" where as much native vegetation as possible is to be retained in an area near the shore, in order to limit runoff. (See LSPA's brochure

Minimize the Area of Lawn

Plants trap runoff better than manicured lawns. Groundcovers and rock gardens can substitute well for grass. Views over shrubs can be maintained with careful pruning. Any lawn should be minimal and as far from the lake as possible, with a good buffer zone of shrubs and trees. Lawns should be of low maintenance varieties, as they should not be fertilized.

Grade for Erosion Control

Grading surfaces flattens small irregularities that naturally exist on the surface of land; these dips are beneficial in their ability to trap and store water so it can seep down into the soil. Include depressions in your landscape planning. Plan drainage and grading so that water flows away from the shore and can settle naturally. Be sure runoff from surfaces such as driveways and roofs has opportunity to settle into the soil of vegetated areas. Steep slopes need dense vegetation cover to control erosion.

Landscaping of a lakeshore prop siderations, so that the lake is m human impact.

Ground covers, shrubs and trees function in trapping sediment a

This pamphlet explains why lak buffer area, and suggests landsc for both established and new pr

Included are lists of both native non-native species for different erations.

LSPA thanks the Lake Sunapee area La sionals who have contributed to this pa Nancy Fleming.

Lake Sunapee Protectiv

72 Main Street, PC
Sunapee, NH

Plants for Shoreland A

Shrubs

The list which follows is a good selection of plants which are native to the Sunapee area, or which are appropriate non-native species hardy in this climate. Native plants and the non-natives listed are accustomed to weather and soil conditions in the area, and do not need high concentrations of fertilizer. (Fertilizer runoff is harmful to the lake.)

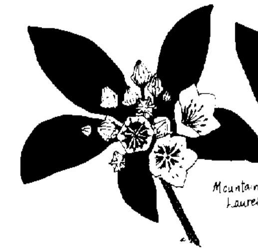
A well balanced landscape design will include trees, shrubs and ground covers. There are local and state regulations about cutting trees; see LSPA's zoning brochure or your town offices. Although larger trees are not listed in this brochure, they are available from local landscapers and nurseries who can advise you as to appropriateness of specific species.

Full Sun, Dry Soil

American Hazelnut *(Corylus americana)*
Will tolerate poor dry soil
Blackhaw *(Viburnum prunifolium)*
Sun to dense shade * #
Meadowsweet *(Spirea latifolia)*
Mugo pine *(Pinus mugo)* Needs good drainage
Potentilla *(Potentilla fruticosa)*
Spiraea *(Spiraea species)*
Sweet Gale *(Myrica gale)*
Will tolerate poor dry soil

Full Sun, Average Soil

Forsythia *(Forsythia intermedia)*
Gray dogwood *(Cornus racemosa)*
Honeysuckle *(Lonicera tatarica)*
Lilac *(Syringa species)*



Partially Shaded, Sometin

American cranberry *(Viburnum tril*
Arrowwood *(Viburnum dentatum,*
Quick growing * #
Inkberry *(Ilex glabra)* Protect from
Large Fothergilla *(Fothergilla major*
Mountain laurel *(Kalmia latifolia)*
Well drained soil. Cannot
Protect from wind #
Rosebay rhododendron or great la
(Rhododendron maximum)
shade but must be well d
Protect from wind #
Serviceberry or shadbush *(Amelan*
Spicebush *(Lindera benzoin)*
Swamp azalea *(Rhododendron visco*
Sun or shade, wet or ave
Sweet pepperbush or summer swe
alnifolia) Heavy shade to
Winterberry or black alder *(Ilex ve*
Tolerates very wet soil *

5. Storm Drain Stenciling

a. Problem and need

The 1994 Great Pond Diagnostic/Feasibility Report states that approximately 7 percent of the phosphorus contribution to the lake is from direct runoff. Other contaminants were also measured during this study. Anecdotal information concerning the dumping of oil down storm drains and other actions by residents demonstrate a lack of understanding that storm water drains into the lake without treatment. Household hazardous wastes are finding their way into our waterways and creating havoc for aquatic organisms. The Stenciling Project will educate residents about the connection of the storm water drains to the lake. An accompanying flyer, delivered to neighborhood residents, alerts the residents to the Stenciling Project and educates them about storm water pollution.

b. Nonpoint Sources of Pollution Categories

The Stenciling Project addresses source control of nonpoint source pollution. In particular, it excludes inappropriate dumping into storm drains. The stencil and accompanying flyer encourage proper use and disposal of materials by homeowners. The contaminants addressed by this control activity include materials such as fertilizers, pesticides and herbicides, oil and antifreeze, paints, and solvents. Specific actions for preventing the discharge of household contaminants include the following:

i. Educate watershed residents regarding the proper storage and use of fertilizers, herbicides and pesticides and the potential environmental damage that can be caused by these materials. Identify alternative methods for controlling insects and weeds;

ii. Educate watershed residents regarding the need to keep oils, paints and similar contaminants out of storm drains, the potential environmental damage that can be caused by these materials, and acceptable disposal methods;

iii. Educate watershed residents regarding annual Household Hazardous Waste Collection Day in Kingston and encourage all residents to take advantage of this opportunity to safely dispose of toxic household wastes; and

iv. Label storm drain inlets and provide a flyer to local residents explaining the environmental impacts of dumping wastes.

c. Purpose

It is clear that many people who live in the Great Pond watershed fail to understand nonpoint source pollution. The Stenciling Project raises the awareness of residents regarding the flow of pollutants from storm water drains to Great Pond. Labeling of the storm drains and an informational flyer educate residents and involve them in protecting their Lake.

d. *General Project Plan*

Beginning in May 2000, the Great Pond Association (GPA) will hold a contest for the design of a stencil by advertising in local businesses, newspapers, and schools, interest will be generated and the Great Pond Association will become a recognized organization in the community. After the winning entry is chosen, the design will be sent out for stencil fabrication. GPA will develop an accompanying flyer explaining storm water drainage in the watershed, safe household hazardous waste disposal, and the city-wide leaf & yard waste composting program. In addition to contacting local and statewide newspapers about the stenciling project, organizers will obtain permission from the Town and will notify the local police of the scheduled painting. The actual painting will occur in September to coincide with the Storm Water Workshop.

e. *Tasks, Schedules, and Outputs:*

Table XI-18 lists the tasks, schedules, and outputs of this project.

Table XI-18

Tasks, Schedules, and Outputs:

	Description	Output	Schedule
Task 1	Contest	Design for Stencil	2 months
Task 2	Stencil Fabrication	Stencil	4 months
Task 3	Media Blitz	Signage, Articles, etc.	5 months
Task 4	Painting and Flyer Distribution	40 Storm Drains Painted	5 months
Task 5	Final Report of Activities	Final Report	7 months

f. *Interagency Coordination, Roles and Responsibilities*

GPA committees will access the technical assistance and informational materials produced by NH Department of Environmental Services' Nonpoint Source Program and the Household Hazardous Waste Program. The Town of Kingston will cooperate by allowing the painting of the stencil near storm drains on city streets.

g. *Public Participation*

Participation by the public is three fold. People, especially children, submit entries to the stencil design contest. Others will actually paint the stencils around the watershed. And residents will use more care when disposing of hazardous wastes, car maintenance, and lawn care after educating themselves with the storm water flyer.

h. *Budget*

Table XI-19 presents the project budget.

Table XI-19
Storm Drain Stenciling Budget

Budget Category	319 Cost	NFM Cost	Total Cost
Advertising	$200	$220	$420
Stencil Fabrication	$500	$55	$555
Media Blitz	$475	$330	$805
Paints, Kits, Painting, and Flyer Distribution	$700	$1,045	$1,745
Total	$1,875	$1,650	$3,525

6. Street Sweeping/Storm Water Quality

a. Problem and Need

Since a portion of the nutrient loading entering Great Pond occurs via direct runoff, storm water is an obvious target for reducing pond pollutants. Advanced Street Cleaning and Catch Basin Flushing can be an important non-structural practice to reduce stormwater runoff pollutants to Great Pond. The intent of these practices is to remove the pollutants before they reach the pond. GPA needs to demonstrate to the Town of Kingston and watershed residents that periodic street sweeping provides worthwhile environmental benefits. Storm event monitoring, before and after street sweeping and catch basin maintenance, will measure the effectiveness of these Best Management Practices.

b. Purpose and Objective

The purpose and objective of this project is to demonstrate watershed management strategies recommended by an intensive Clean Lakes Study on Great Pond that will mitigate nonpoint source pollution which has accelerated the eutrophication process.

c. General Project Plan

Advanced sweeping (street cleaning with broom and vacuum) removes a greater portion of the fine solids fraction of the street surface contaminants. It is estimated that removal efficiencies of street cleaning are approximately: solids, 90%; PO4-P, 85%, and heavy metals, 85% (Wanielista, 1978) M.P. The Durham, NH Urban Runoff Program, 1983, showed that parking lot vacuum control removals of 58%, 53%, and 96% for BOD, non-filterable residue, and fecal streptococci bacteria, respectively. Removal rates for phosphorus, nitrogen, and metals were lower, in the 16-50% range. Catch basin flushing involves high water pressure cleaning during dry weather flow. This best management practice reduces pollutant loading by removing solid waste materials before discharge to receiving water bodies. Monitoring of storm water after the flow passes through the catch basins should reveal if moderate cleaning frequencies have a measurable impact on storm water quality.

GPA will contract with a sweeping service for spring and fall service. Town street cleaning services may by limited to a maximum of twice yearly and additional services are not available. GPA will collect wet condition samples from the 4 storm drains that immediately enter the lake. During storm events, occurring before and after sweeping and catch basin flushing, storm water will be collected and analyzed for lead, zinc, copper, phosphorus, *E.coli*, volatile organics, total suspended solids, and turbidity. Two fall storms and two spring storms will be sampled for pollutants resulting from surface runoff.

d. Tasks, Schedules, and Outputs:

Table XI-20 demonstrates the tasks, schedule, and outputs of the street sweeping project.

Table XI-20
Tasks, Schedules, and Outputs:

	Description	Output	Schedule
Task 1	Develop and negotiate contract for cleaning	Contract	3 months
Task 2	Fall Storm sampling	Stormwater analysis	5 months
Task 3	3 sweeping and catch basin cleanings	Clean streets	6 months
Task 4	Fall storm sampling	Stormwater analysis	7 months
Task 5	Spring storm sampling	Stormwater analysis	10 months
Task 6	Spring sweeping and catch basin cleaning	Clean streets	11 months
Task 7	Spring storm sampling	Stormwater analysis	12 months
Task 8	Report writing	Report	17 months

e. Interagency Cooperation/Public Participation

The Town of Kingston will perform street sweeping services once during the fall and once during spring for the Great Pond Watershed. The NH Department of Environmental Services' chemistry laboratory will analyze samples collected during the storm events.

f. Measure of Performance or Success

Laboratory results from pre- and post-street sweeping, storm event sampling will be analyzed for statistically significant differences in pollutant composition. Results determine if moderate street maintenance has an impact on the nonpoint source pollutants reaching a waterbody.

G. PROJECT SCHEDULE AND MONITORING PROGRAM

Watershed management, Lake Protection zoning ordinance revisions, education and possible in-lake sediment inactivation, comprise the basis of the Great Pond restoration program. Only through phosphorus reduction in the watershed would in-lake sediment inactivation be considered feasible and cost effective.

Table XI-21 provides a suggested and preliminary project implementation schedule. A preliminary monitoring program and schedule, designed to gauge the effectiveness of the different watershed management strategies is shown in Table XI -22.

The extent to which restoration or watershed management strategies developed for Great Pond are eventually implemented will largely depend on the continued availability of local, state and federal funds. The Clean Lakes Program (section 314 of Clean Water Act) has been unfunded since 1995. It is the Clean Lakes Program that has typically funded in-lake restoration. Nonpoint source funding (section 319 of the Clean Water Act) has typically provided funding for watershed management and education implementation. It has recently been determined that nonpoint source funding can be used for most lake restoration implementation. The following interpretation has been made:

Lake protection and restoration activities are eligible for funding under Section 319(h) to the same extent, and subject to the same criteria, as activities to protect and restore other types of waterbodies from nonpoint source pollution. States are encouraged to use Section 319 funding for eligible activities that might have been funded in previous years under Section 314 of the Clean Water Act. However, Section 319 funds should not be used for in-lake work such as aquatic macrophyte harvesting or dredging, unless the sources of pollution have been addressed *sufficiently to assure that the pollution being remediated will not recur*.” [emphasis added]

Assuming through a combination of federal, state, and local sources, sufficient funds will be made available, watershed management planning and development is proposed to begin in the fall of 2000 while implementation is scheduled for the fall of 2001.

Possible phosphorus inactivation of the sediments of Great Pond to limit internal phosphorus loading will not begin until the watershed management phase is completed and the pond’s internal phosphorus loading has been evaluated. Phosphorus inactivation is not scheduled to begin until the summer of 2002.

Table XI-21
Preliminary Project Implementation Schedule

Task Year (EPA fiscal year)	**2000**				**2001**				**2002**			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Watershed and Lake Protection Zoning Ordinances												
Review and Possible Revision of Zoning Ordinances	✸	✸	✸	❑	❑							
Adopt BMP Ordinances for Silviculture, Agriculture, and Hobby Farms	✸	✸	❑	❑	❑							
Watershed												
Upgrade watershed monitoring	✸	✸	❑	❑	❑	❑	❑	❑				
Subsurface System Upgrade Program/Innovative Systems	✸	✸	✸	✸	◆	❑	❑	❑				
Alternative On-site Treatment	✸	✸	✸	✸	✸	❑	❑	❑				
Adirondack Shelter Bank Stabilization	✸	✸	◆	◆	❑	❑	❑	M	M	M	M	M
Lincoln Brook Erosion Control BMPs	✸	✸	◆	◆	❑	❑	❑	❑	M	M	M	M
Ball Road Brook Erosion Control BMPs	✸	✸	◆	◆	❑	❑	❑	❑	M	M	M	M
Kingston State Park Erosion Control BMPs	✸	✸	◆	◆	❑	❑	❑	❑	M	M	M	M
Sawdust Waste Management	✸	✸	◆	◆	❑	❑	❑	M				
Education												
Workshops and Kiosk	✸	✸	◆	◆	❑	❑	❑					
Stormwater Pollution Project	✸	✸	◆	◆	❑	❑	M		M		M	
Street sweeping/stormwater	✸	✸	◆	◆	✸	❑	M	✸	✸	❑	M	
In-Lake												

Dose and Ration Determinations						✸	✸	❑				
Sediment Inactivation Experiment						✸	✸	❑				
Phosphorus Inactivation (If necessary)	M		M	M			M	M	◆		❑	M

◆	Grant Application Submittal, Review, Award and Procure Local Match
✸	Evaluation/Design
❑	Implementation
M	Monitoring/Inspection

Table XI-22
Recommendation Summary For Great Pond

Watershed and Lake Protection Zoning Ordinances

- Restricted and Permitted users
- Review and Revisions
- BMP Ordinances

Watershed Management

- Watershed Monitoring/Volunteer Lake Assessment Program
- Subsurface System Upgrade Program
- Innovative System Research and Implementation
- Alternative On-Site Treatment
- Adirondack Shelter Bank Stabilization
- Lincoln Brook Erosion Control BMPs
- Ball Road Brook Erosion Control BMPs
- Kingston State Park Erosion Control BMPs
- Sawdust Waste Management

Education

- Workshops and Kiosk
- Stormwater Pollution Project
- Street Sweeping/Stormwater
- Interactive Lake Ecology Program

In-Lake

- Sediment Inactivation

Recommendations like: adopting stricter shoreline protection ordinances; creating education programs for lake users and school children; adopting BMP's for hobby farms, agriculture and silviculture; and continuing with a volunteer monitoring program for the lake and the watershed can begin immediately.

Programs will also have to be devised to monitor the efficiency of the proposed stormwater management program. This monitoring program will help scientists evaluate how these practices reduce sedimentation and pollutants to the lake. Great Pond will be monitored by both DES aquatic biologists and by volunteers from the lake association. The Great Pond Volunteer Monitoring Program will be initiated before watershed management construction occurs and will continue through 2002. Monthly or bi-weekly sampling of Great Pond and Lincoln and Ball Road Brooks will occur to ascertain any change in trophic status resulting from watershed management practices and possible sediment inactivation. Depth integrated sampling within the lake and analyses for phosphorus and other lake quality and biologic parameters will be continued. A summer vascular plant (macrophyton) survey of the lake and sampling of the macro invertebrates and fish communities should also be performed. Rooted submergent macrophytes, although presently abundant in many parts of the pond, may extend their distribution into deeper waters as the lake clarity improves. Benthic macroinvertebrates are useful indicators to assess any long-term toxic effects of the possible aluminum treatment. Fish tissue should be tested for whole tissue aluminum before and after any pond treatment.