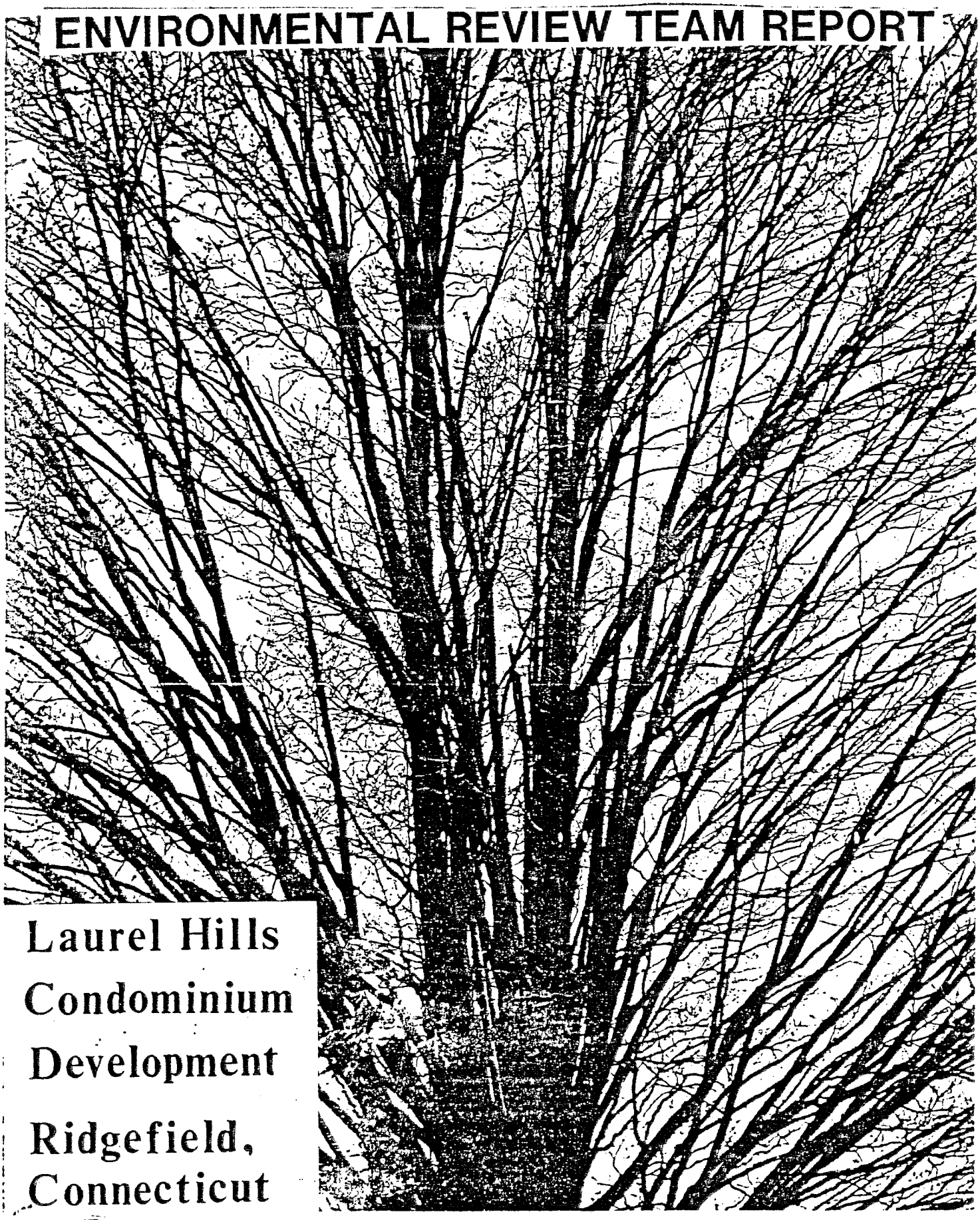
ENVIRONMENTAL REVIEW TEAM REPORT



Laurel Hills Condominium Development

Ridgefield, Connecticut

KING'S MARK RESOURCE CONSERVATION AND DEVELOPMENT AREA, INC.

LAUREL HILLS CONDOMINIUM DEVELOPMENT

RIDGEFIELD, CONNECTICUT

Environmental Review Team Report

Prepared by the King's Mark Environmental Review Team
of the King's Mark Resource Conservation
and Development Area, Inc.

Wallingford, Connecticut

for the

Ridgefield Planning and Zonning Commission

This report is not meant to compete with private consultants by supplying site designs or detailed solutions to development problems. This report identifies the existing resource base and evaluates its signficance to the proposed development and also suggests considerations that should be of concern to the developer and the Town of Ridgefield. The results of the Team action are oriented toward the development of a better environmental quality and long-term economics of the land use. The opinions contained herein are those of the individual Team members and do not necessarily represent the views of any regulatory agency with which they may be employed.

DECEMBER 1986

ACKNOWLEDGEMENTS

The King's Mark Environmental Review Team Coordinator, Keane Callahan, would like to thank and gratefully acknowledge the following Team Members whose professionalism and expertise were invaluable to the completion of this study:

* William Warzecha, Geohydrologist
  Department of Environmental Protection

* Richard M. Lynn, Senior Planner
  Housatonic Valley Council of Elected Officials

* Frank Homiski, Senior Environmental Engineer
  Department of Health Services

* Timothy Barry, Fishery Biologist
  Department of Environmental Protection

* Jerry Milne, Forester
  Department of Environmental Protection

* Nancy Marin, Lake Specialist
  Department of Environmental Protection

I would also like to thank Laverne Mendela, Secretary and Janet Jerolman, Cartographer, of the King's Mark Environmental Review Team, and Joan Froble, District Executive Manager of the New Haven County Soil and Water Conservation District for assisting in the completion of this report.

Finally, special thanks to Mr. Oswald Inglese, Director of Planning for the Town of Ridgefield and Mr. George Bakes of George Bakes Associates for their cooperation and assistance during this environmental review.

EXECUTIVE SUMMARY

The Ridgefield Planning and Zoning Commission requested that the King's Mark Environmental Team conduct an environmental review on a site proposed for condominium development. The site, approximately 106 acres, is located south of Laurel Lane and east of the junction of Routes 7 and 35 and adjacent to Great Pond, a 22-acre waterbody.

The proposed development encompasses approximately 265 condominium units. Most of the development is proposed in the upland areas north and west of Great Pond and existing wetland communities. A wetland crossing is proposed to provide access to the northeast section of the site. On-site water and public sewers are proposed to serve the site.

The site is characterized by woodland, open woodland, wetland, and pond habitats. Former camp buildings occupy the wooded upland areas of the site. A series of three connected wetlands occur north of Great Pond and are primarily forested. Slopes are moderate to very steep. The southern portions of Great Pond is presently used for swimming and fishing.

* *

The Ridgefield Planning and Zoning Commission was specifically requested the ERT to: (1) assess the hydrology of the site; (2) inventory and assess existing forest, wildlife, and fishery resources; (3) discuss the potential effects of the development on the open space and recreational uses of Great Pond; and (4) discuss planning and land use considerations.

Through the inventory and assesment process, specific resources, areas of concern and opportunities were determined. They fall into the following categories: (1) Physical Characteristics; (2) Water Resources; (3) Biological Resources; and (4) Land Use and Planning Conosiderations. They are summarized below.

* *

PHYSICAL CHARACTERISTICS

Topography

The site is characterized by gentle and very steep slopes. These areas are associated with numerous rock ledges and shallow to bedrock soils. It appears that these excessively sloping areas will be a major hindrance to the construction of condominium units and access roads. Maximum and minimum elevations on the site are about 660 feet and 510 feet above mean sea level, respectively.

Bedrock Blasting

The proposed road system and several condominium units in the southern half of the parcel will be located on shallow to bedrock soils or in areas of rock outcrops which may result in significant blasting of the bedrock in order to install sewer lines, water lines, foundations, or roads on the site.

It seems likely that most blasting will be far removed from existing structures. Any blasting activity which takes place on the site should be under the strict supervision of persons experienced with state-of-the-art blasting techniques. This will hopefully reduce the chance of unnecessary seismic shock or possible damage claims.

Every effort should be made to keep blasted rock from coming in contact with surface water, particularly tributaries to Great Pond and any of its tributaries.

Surficial Geology

Two surficial geologic deposits occur in the proposed development site: (1) till which consists of ground up rock material; (2) post-glacial sediments called swamp deposits which consist of sand, silt, and clay mixed with organic material and deposited in poorly-drained areas.

Watershed Boundary

The watershed boundary for the site tends to follow the crests of local hills and ridges and lies within the headwater region of the Norwalk River. Surface runoff from the site can be divided nearly in half. The western half of the site drains downslope towards Routes 35 and 7. Storm drainage systems along these state highways will intercept and route the stormwater into the Norwalk River. The eastern half of the site drains downslope to the linear wetland bisecting the parcel, which transports the water directly to Great Pond.

Stormwater Drainage and Runoff Potential

Stormwater drainage for the development will be divided into two areas. Stormwater emanating from the western parts of the development will be intercepted by drainage pipes and routed to a retention basin located near the entrance to the proposed development. The basin will hopefully allow peak flow increases for the outlet stream to be mitigated and reduce the chance for flooding along Route 7 and to other downstream points. Stormwater from the eastern parts of the development will be piped to the upper parts of linear wetlands on the site.

Increases in runoff would be caused mainly by removal of vegetation, compaction of soil, and creation of impervious surfaces such as paved access roads and parking areas, rooftops, tennis courts, etc. This additional runoff could lead to increases to peak flood flows of streams which drain the site, and may also cause increased overland erosion. Peak flows arising from increased runoff from the eastern portions will be attenuated in the generally flat wetland area in the east central parts of the site. It seems likely that Great Pond can also serve as a retention basin for peak flow increases, if necessary.

Erosion and Sedimentation Concerns

It appears that some construction activity would occur near the very steep slopes in the southern parts of the watershed. The removal of vegetation and construction activities on these slopes, without careful planning, could lead to the deposition of silt into drainageways on the site and, ultimately be

carried to Great Pond or Norwalk River and its tributaries. As a result, it seems likely that sediment trapping will be most important in order to protect Great Pond, the Norwalk River, and its tributaries.

In order to minimize the impact of increased and/or concentrated runoff, a stormwater management plan which incorporates a sound erosion and sediment control plan should be submitted to the Town for review by all appropriate officials. The plan should include pre- and post-development hydrologic computations, sediment detention or retention basin designs, inland wetland crossings, and any other engineering structures where needed, either before or during land grading.

Water Supply

The site is proposed to be served by three existing drilled wells. These wells derive their water from the underlying bedrock aquifer. The natural quality of groundwater in this area should be satisfactory. However, due to the mineralogy of the rock types underlying the site, there may be a chance that elevated iron and manganese levels could affect well water quality. As a result, it may be necessary to install an appropriate water treatment filtration system.

Based on some assumptions, the Team's Geologist was able to calculate the potential yield of a well or wells would need to be in order to serve the proposed 265 unit condominium complex. If each resident needed 75 gallons of water per day to meet his/her needs, a total of 59,625 gallons per day would be needed for the approximately 800 residents occupying the complex. A single bedrock well yielding about 55 gpm continously would be required to adequately serve the complex.

If more than one well is needed to fulfill the needs of the residents of the condominium complex, the wells should each be conservatively separated if possible. This will hopefully help to prevent the chance of mutual interference of one well with another during pumping periods.

* *

WATER RESOURCES

Great Pond

Land use in the watershed is currently dominated by wetlands and woodlands. Characteristically, these two land uses contribute fewer nutrients to lake and pond waters than any other. The alterations of these land uses to residential use generally results in an increased nutrient loading to lake and pond waters; however, this impact can be minimized through proper watershed management. Since the proposed development will be served by sanitary sewers, the nutrient contribution from additional septic systems will not be a concern.

The 150-foot setback from the pond should serve to minimize most of the short and long term impacts of the development if left in its present state. It is encouraged that the appropriate local agencies strictly enforce zoning ordinances dealing with erosion and sedimentation. It is further advised that the area of stormwater runoff be addressed.

With very little water quality data on Great Pond, it is impossible to comment on existing conditions in the pond. If this type of information is desired by the town, the DEP - Water Compliance Unit can supply a listing of qualified biological consulting firms which could perform a diagnostic study of pond conditions. This study could then serve as a baseline for future lake or pond studies to assess trends in water quality.

Public Health Considerations

Water quality data provided by the Ridgefield Health Department for the past five years (1982-1986) from samples collected at the public and private beaches on Great Pond indicate that the level of total coliform organisms were moderately elevated for the August samplings. The Department of Health Services recommends that bathing not be allowed in surface waters with a total coliform concentration greater than 1,000 per 100 ml using the membrane filter technique. In August of 1986, sample results indicated 760 and 810 total coliform organisms for the public and private beaches respectively. While in June 1986, the results were 120 at the public beach and 130 at the private beach.

Conditions which may be contributing to elevated bacterial levels during the month of August are: (1) Reduction in available dilution water through the bathing areas; (2) Elevated water and ambient air temperatures; (3) Increased bather loading due to #2 above; and (4) Proliferation of bacterial growth and introduction into the bathing area due to all of the above.

Information provided during the field review indicated that on a hot sunny summer weekend day it would not be uncommon for as many as 1500 to 1800 people to visit the public beach and several hundred to utilize the private beach.

Based on these figures it appears that the bathing areas are over-utilized at certain times which can lead to localized bacterial pollution in the crowded bathing areas. Limiting the number of people using the bathing areas on any one day may reduce, to some extent, the total coliform organisms in the bathing areas.

* *

BIOLOGICAL RESOURCES

Forest Resources

There are five vegetation cover types on the proposed development site. They are: old field, conifer plantation, hardwood swamp, oak ridge, and oak/mixed hardwoods

Careful pre-construction planning is necessary to minimize disturbance of the forest. Each of the proposed lots should be examined by a professional forester to identify trees to be retained in active construction areas. These trees should be clearly marked and their root zones flagged. Equipment operators should be advised to avoid these zones.

After the rough grading and excavation is completed, the extent of damage to the remaining trees should be evaluated. Severely damaged trees should be removed, while slightly injured trees may be improved by pruning, fertilizing, or other arboricultural measures.

Fishery Resources

Bluegill sunfish, largemouth bass, brown bullhead, yellow perch, golden shiner and chain pickerel should be present in Great Pond. This pond appears to be well suited for family and/or children's recreation fishing.

The wetland north of the pond serves as an important spawning site for pickerel and largemouth bass during the spring, provides suitable substrate over which they could lay their eggs, and provides diversity of aquatic habitats. Any increase in nutrient inputs as a result of disturbance to the wetland or surrounding forested area would increase the fertility of the pond and thus increase the fishery.

The presence of an outlet structure (i.e., surface water gate and deep-water outlet) for pond level control is a considerable advantage in this pond. If used properly this mechanism could serve a dual function, to both control the development of aquatic macrophytes and enhance the existing fishery. Winter drawdowns of several feet every 3 to 4 years might be dvisable if a weed problem begins to develop.

* *

PLANNING CONSIDERATIONS

Land Use

The site is currently zoned for restricted corporate development (RCDD) on the western half of the site and two-acre residential (RAA) on the eastern half. The applicant is proposing a rezoning of the entire site to a new one, entitled special multi-family development distirct (SMFDD) to allow multi-family dwelling structures at a density not greater than 2.5 units per acre overall. Along with a rezoning of this parcel, amendments to both the zoning regulations and the Town Plan are being requested by the applicant to accommodate his development proposal.

In general, the proposed project is not consistent with the HVCEO's regional land use plan which calls for more limited growth at the site. Nor is the proposed project consistent with the comprehensive Town Plan map which calls for office development and open space use of the site. Nevertheless, with the proximity of the site to Route 7, its location directly adjacent to an area proposed for urban growth by the HVCEO, and the availability of sewers, the proposed project is not viewed as completely inappropriate. In addition, a section of the Ridgefield Town Plan speaks to the need for developing additional multi-family units in town. Specifically, the plan states that "...where suitable sewage treatment can be achieved, it is recommended that the town permit additional multi-family housing." In the final analysis, a judgement decision is required by the town as to whether the proposed residential project is preferable on this particular site to an office development constructed under existing town regulations.

Traffic and Access Considerations

Access to the site is proposed to be provided through the construction of a new driveway on Route 7 approximately 450 feet south of where Laurel Lane intersects Route 7. Sight line distances are good in both directions at the

proposed access point. A traffic signal and left turn lane at the project's driveway has nevertheless been recommended by the applicant's traffic consultant to improve traffic safety. The proposed project would increase existing traffic flows on Route 7 by six percent.

Design Considerations

The proposed project promises the construction of an attractive complex characterized by a New England style of architecture with a single-family home appearance. Both passive and active recreational amenities are proposed together with ample areas of open space. The 100-foot buffer around the central wetland on the site and the 150-foot buffer around Great Pond will serve to protect these important natural resources.

A major concern raised during the field review was the visual impact of the project on surrounding land uses. On-site inspection shows that the proposed project is generally well screened from surrounding land uses. Three surrounding areas where the project will likely be visible to a limited degree include the land along Laurel Lane, homesites to the south and west of the proposed project, and the beaches on the southern shore of Great Pond. The visual impact on these surrounding areas can be mitigated through careful landscaping. Hemlock or white pine could be planted in selected areas of the site to help screen the new structure from surrounding land uses. This would be particularly valuable during the winter months when the leaves are off the trees.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

EXECUTIVE SUMMARY iii

LIST OF FIGURES x

INTRODUCTION

Introduction 1
Goals of the Environmental Review Team. 2

PHYSICAL CHARACTERISTICS

Topography 5
Bedrock Geology 7
Surficial Geology 10
Hydrology 12
Water Supply 19

WATER RESOURCES

Great Pond 23
Public Health Considerations 26

BIOTA

Description of Forestry Resources 28
Fishery Resources 32

LAND USE AND PLANNING CONSIDERATIONS

Planning Considerations 34

APPENDIX A: WATER QUALITY AND MANAGEMENT REPORTS 42

LIST OF FIGURES

1. Location of Study Site 3
2. Preliminary Site Plan 4
3. Topography 7
4. Bedrock Geology 8
5. Surficial Geology 13
6. Watershed Boundary 16
7. Forest Cover Types 31

INTRODUCTION

forested. Species include red maple, American elm, ash, and yellow birch. The shrub layer is dominated by sweet peeperbush. Slopes are moderate to very steep.

GOALS OF THE ENVIRONMENTAL REVIEW TEAM

The Town of Ridgefield was specifically concerned with the capacity of this site to adequately support the proposed development. Therefore, the town requested the ERT to:

(1) Assess the hydrology of the site, including water supply and quality, stormwater runoff, and impacts to surrounding watershed.

(2) Inventory and assess existing forest, wildlife, and fishery resources.

(3) Discuss the potential effects of the development on the open space and recreational uses of Great Pond.

(4) Discuss planning and land use considerations such as site design compatibilty, traffic and access, noise, and consistency with existing plans and zoning regulations.

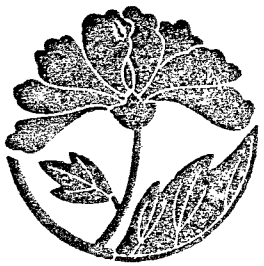


Figure 1

LOCATION OF STUDY SITE

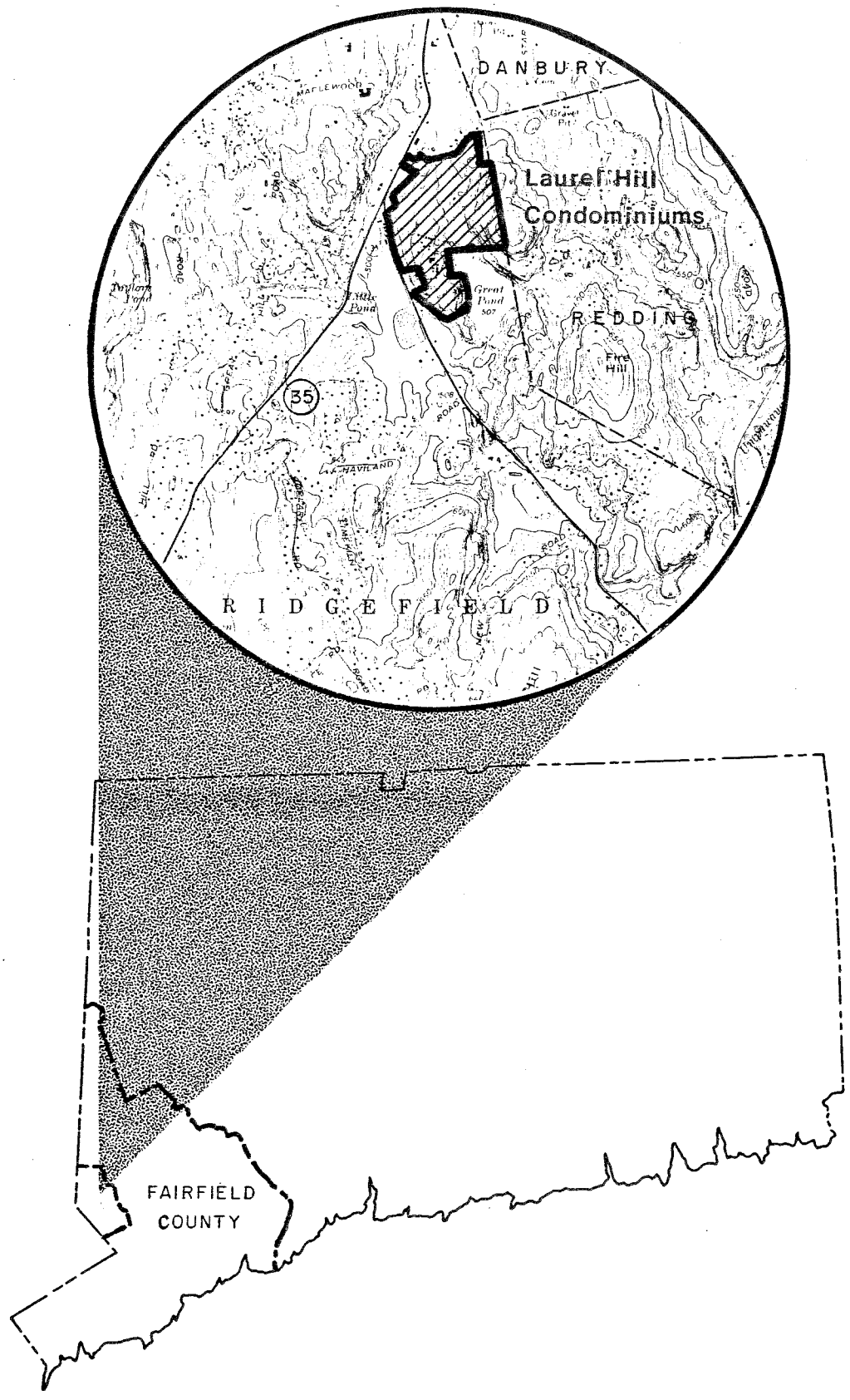
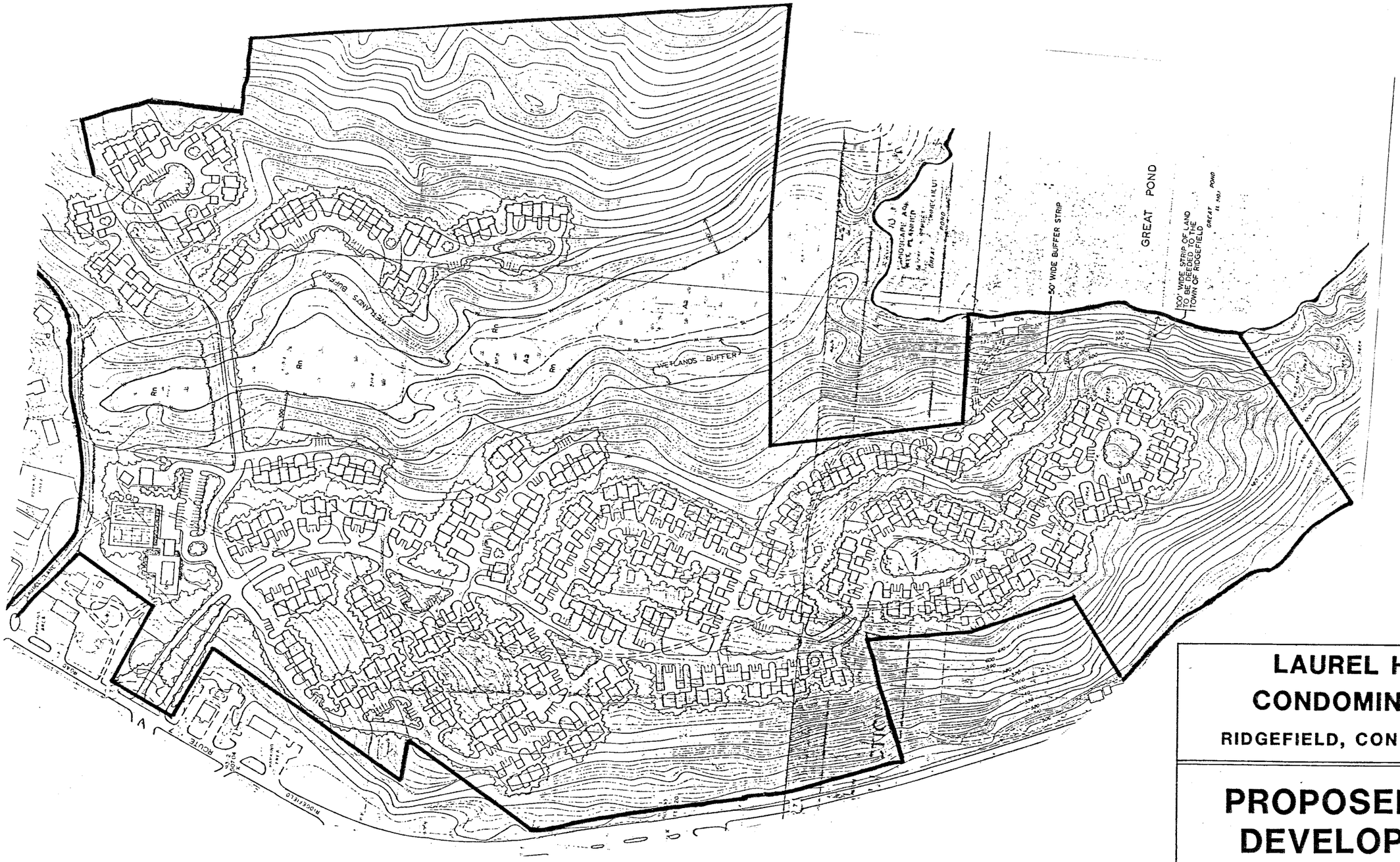


Figure 2



LAUREL HILL CONDOMINIUMS

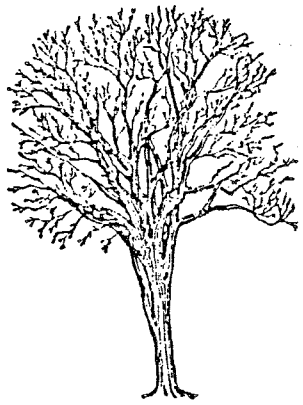
RIDGEFIELD, CONNECTICUT

PROPOSED SITE DEVELOPMENT PLAN

King's Mark Environmental Review Team

NOT DRAWN TO SCALE

PHYSICAL CHARACTERISTICS



TOPOGRAPHY

The 106 acre parcel of land is located northeast of Great Pond in eastern Ridgefield. It consists of the former Camp Arden property. The land is comprised largely of forest with some softwood stands along the access road to Camp Arden in the northern parts. There are some open areas also along the access road to the camp which appears to have been former athletic fields. Numerous out buildings which served the camp area are still standing on the site.

The site is characterized by slopes which range between gentle and very steep. The flat to gentle slopes are found mainly in the area of the former camp buildings on the site, on the east and west side of the access road to the camp in the northern parts, and throughout the north/south trending wetland in the eastcentral parts. Moderate to very steep slopes characterize the remaining parts of the parcel. The very steep slopes flank the east and west side of the rock-cored hill mainly in the southern parts on which the former camp is located. These slopes also characterize the terrain in the eastern parts of the site. These areas are associated with numerous rock ledges and shallow to bedrock soils. It appears that these excessively sloping areas will be a major hindrance to the construction of condominium units and access roads. Maximum and minimum elevations on the site are about 660 feet and 510 feet above mean sea level, respectively (Figure 3).

The major watercourse on the site flows through the wetland in the eastcentral parts. This streamcourse also appears to be the major feeder stream to Great Pond.

BEDROCK GEOLOGY

The proposed Laurel Hill Condominums site is located within the Bethel topographic quadrangle. Neither a bedrock or surficial geologic map has been published for the quadrangle to date. The Team's geologist referenced John Rodgers Bedrock Geological Map of Connecticut (1985) and the Soil Survey of Fairfield County, Connecticut for the purpose of the following section.

Bedrock ledges or outcrops are extensive throughout the southern and eastern portions of the site. Rodgers classifies the bedrock under the site as very old metamorphic rocks (i.e., rocks geologically altered by great heat and pressure within the earth's crust) comprised of granitic gneisses, gneisses and schists (Figure 4). These are among the oldest rocks in the state, probably 1.1 billion years old.

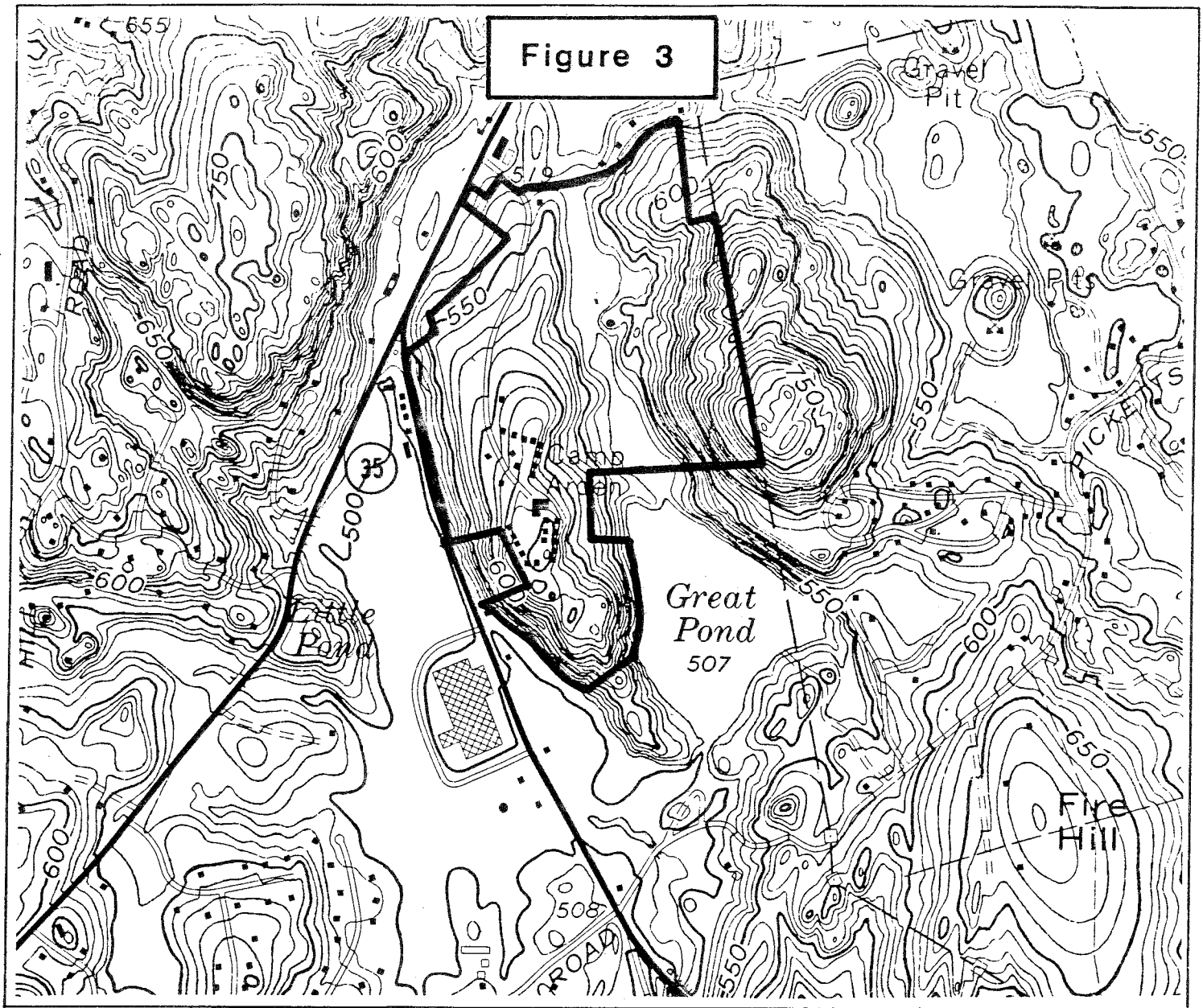
Bedrock Blasting

Based on proposed plans and observations made during the field review, the proposed road system and several condominium units in the southern half of the parcel will be located on shallow to bedrock soils or in areas of rock outcrops. As a result, it seems likely that significant blasting of the bedrock will be required in order to install sewer lines, water lines, foundations, or roads on the site.

If proper precautions are not taken, there is a chance that blasting could lead to:

(1) Increased turbidity levels in surface water and groundwater, at least in the immediate vicinity.

(2) Increase the number of fractures or openings in the solid bedrock at least in the immediate vicinity, which may or may not impact nearby wells which rely on the underlying bedrock as a water source (it should be pointed out that water stored in fractures



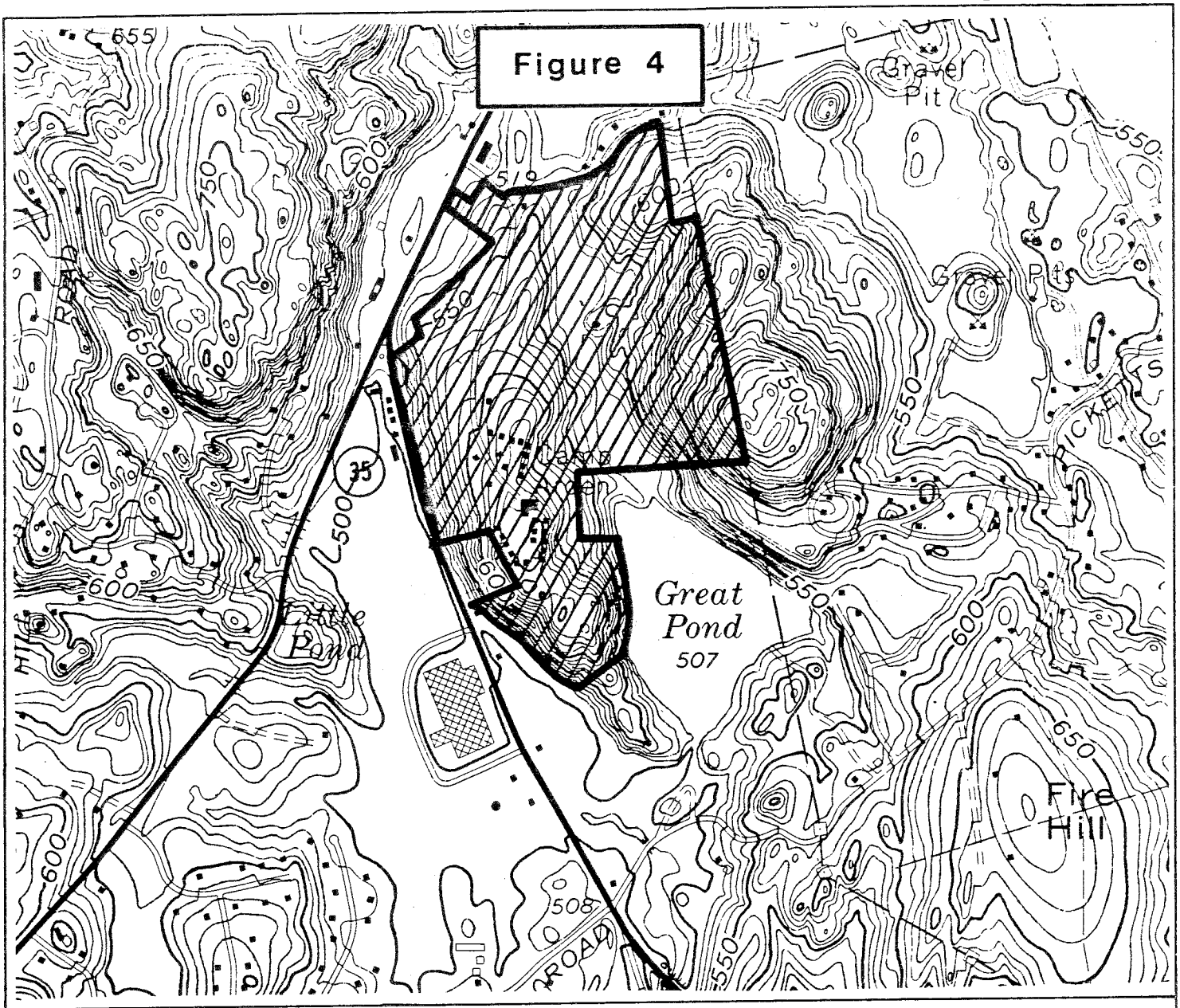
LAUREL HILL CONDOMINIUMS

RIDGEFIELD, CONNECTICUT

TOPOGRAPHY

King's Mark Environmental Review Team

0 1000'



GNEISS OF HIGHLAND MASSIF - GRANITIC GNEISSES AND SCHISTS (Rogers, 1985)

LAUREL HILL CONDOMINIUMS

RIDGEFIELD, CONNECTICUT

BEDROCK GEOLOGY

King's Mark Environmental Review Team

0 1000'

N

and openings in the underlying bedrock is the source of groundwater to wells which tap the bedrock).

(3) Possibly cause damage to nearby structures and foundations.

In regard to the last comment, a pre-blasting survey of surrounding properties should probably be considered to reduce unwarranted damage claims. It seems likely that most blasting will be far removed from existing structures. Any blasting activity which takes place on the site should be under the strict supervision of persons experienced with state-of-the-art blasting techniques. This will hopefully reduce the chance of unnecessary seismic shock or possible damage claims.

From a water quality standpoint, there is a chance that minor amounts of nitrate may be released from explosives into the surrounding soils, ultimately percolating into the groundwater or directly to surface water. This undoubtedly would be a short-term effect occurring mainly during initial blasting. Nevertheless, every effort should be made to protect any streamcourses from potential nitrate contamination. Because of the site's close proximity to Great Pond, streamcourses and drainageways leading to Great Pond, this will be of great concern.

Another water quality concern associated with blasting of bedrock on the site is the presence of very steep slopes, most of which occur in areas where blasting will most likely be necessary. Because blasting may mobilize fine grained soil particles into drainageways and ultimately Great Pond, a detailed soil erosion and sediment control plan should be developed for this construction phase. Consideration should probably be given to constructing at least a temporary sediment basin to remove potential silty material from runoff prior to discharging to Great Pond or any of its tributaries. Conventional

measures, such as silt fence and hay bale silt barriers on very steep slopes, will probably not function adequately as velocities and volumes will destroy the barriers during the first substantial rainfall. (See Hydrology section).

A final water quality concern associated with bedrock blasting on the site is the potential for the leaching of certain iron or manganese bearing minerals from freshly blasted bedrock surfaces when it comes in contact with water. Chemically active rock may also alter the pH of the water as well as its appearance. As a precaution, every effort should be made to keep blasted rock from coming in contact with surface water, particularly tributaries to Great Pond and any of its tributaries.

Bedrock-based Wells

The three existing wells located on the property derive their water from the fractures, cracks and openings in the underlying metamorphic bedrock. According to the Fuss & O'Neill report submitted to Team members on the field review day, it is believed that the wells yield 5, 15 and 50 gallons per minute. According to the applicant, all three wells will be pump tested to determine their yields in accordance with State Health Department and Department of Public Utility Control regulations as they pertain to community water supplies.

SURFICIAL GEOLOGY

A glacial sediment called till was plastered by moving glacial ice onto the crystalline bedrock underlying the site. Till consists of ground up rock material which may range in size from clay to boulders or any combination of these intermediate sizes. Because the ice moved the particles without regard

to their sizes or shapes, till textures may be locally quite variable. Two types of till have been identified in Connecticut. One is fairly loose and medium- to coarse-grained, while the other is typically finer-grained, crudely layered, and compact. The coarser, looser till is most common in surface exposures and in shallow to bedrock areas. Based on soils mapping information supplied to Team members, it appears that the coarser, looser variety of till covers most of the site (Figure 5). Soil testing would be required to substantiate this, however.

Thicknesses of the till varies throughout the site. Based on visual observations, soil mapping, and geologic maps, till is thickest in the northern parts, probably not much more than 10 feet. It becomes much thinner in the southwestern and eastern parts. The bedrock breaks ground surface in many areas throughout these areas.

Overlying glacial till along the unnamed streamcourse in east central parts are post-glacial sediments called swamp deposits (see Figure 5). Swamp deposits consist of sand, silt, and clay mixed with organic material and deposited in poorly-drained areas. Based on the soil scientist's report, these sediments are quite mucky in the southern parts of the linear wetland on the site.

Proposed Wetland Crossing

According to conceptual development plans, an approximately 90-foot section of a proposed access road will need to cross the northcentral parts of the wetland north of Great Pond. The crossing will occur outside of the soils delineated as mucky (Aa), where stability problems may arise if proper precautions (e.g., removal of organic material), are not taken. The wetland soils to be crossed do not appear to contain a high percentage of organic material.

The proposed wetland road crossing will need to be properly engineered. The road should be constructed adequately above the surface elevation of the wetlands. This will allow for better drainage of the road and also decrease the frost heaving potential of the road. Road construction through wetlands should preferably be done during the dry time of the year and should include provisions for effective erosion and sediment control. Finally, culverts(s) should be property sized and located so not to alter the water levels in the wetland and cause flooding problems. A detailed cross-section of the proposed road crossing, which includes information on the amount of fill to be used should be included on the final site plan.

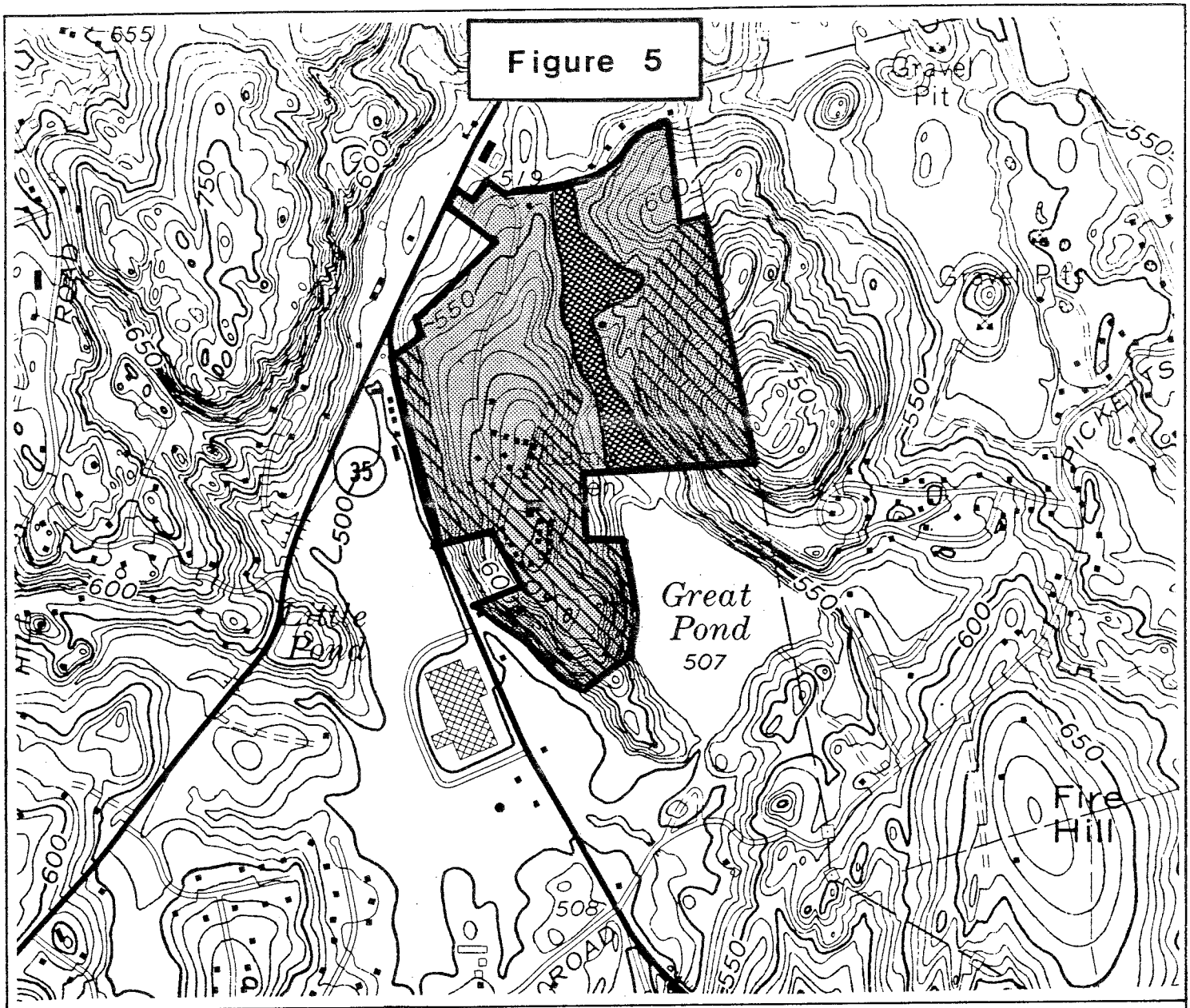
The proposed 100-foot setback from regulated wetland soils will help protect valuable hydrologic and ecologic functions that wetlands are capable of performing.

HYDROLOGY

Watershed Boundary

The site lies within the headwater region of the Norwalk River. Surface runoff from the site can be divided nearly in half. The western half of the site drains downslope towards Routes 35 and 7. Storm drainage systems along these state highways will intercept and route the stormwater into the Norwalk River. The eastern half of the site drains downslope to the linear wetland bisecting the parcel, which transports the water directly to Great Pond. The watershed boundary for Great Pond is delineated in Figure 6.

By definition, the watershed of Great Pond comprises all land areas from which ground or surface water may ultimately enter the pond. A raindrop falling from the watershed boundary would have a 50 percent chance of passing



TILL

TILL (thin)

SWAMP SEDIMENTS

LAUREL HILL CONDOMINIUMS

RIDGEFIELD, CONNECTICUT

SURFICIAL GEOLOGY

King's Mark Environmental Review Team

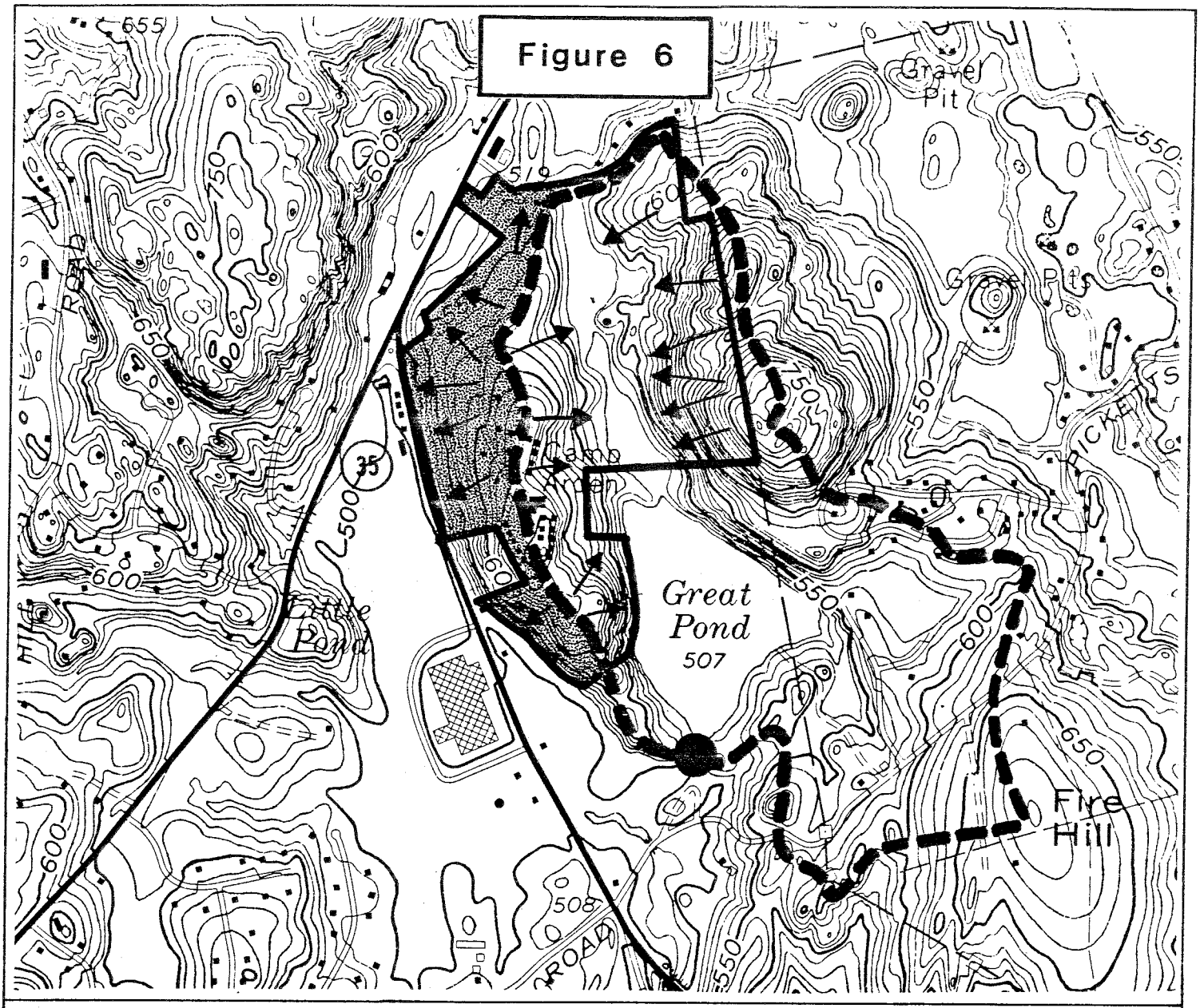
0 1000'

other downstream points. Stormwater from the eastern parts of the development will be piped to the upper parts of linear wetlands on the site.

Hydrologic computations were not available to Team members on the review day. As a matter of policy, it is encouraged that a detailed engineering study, including pre- and post-development data, be computed for the proposed development. These plans should also include detailed information on the proposed retention basin. A careful look at all downstream culverts is also suggested, particularly along the state highways. In this regard, the western district of Connecticut Department of Transportation (DOT) should be contacted.

It is expected that the proposed condominium will lead to increases in amount of runoff shed from the site. The increases in runoff would be caused mainly by removal of vegetation, compaction of soil, and creation of impervious surfaces. The major runoff increases would be expected from the paved access roads and parking areas, rooftops, tennis courts, etc. The increases in additional runoff could lead to increases to peak flood flows of streams which drain the site, and may also cause increased overland erosion. The latter is a major concern especially for portions of the site which are characterized by moderate to very steep slopes. If silt-laden water reaches Great Pond it will undoubtedly have an adverse impact on water quality from both a recreation standpoint and for Gilbert and Bennett's use of the water, especially process water intake.

A likely resolution for mitigating peak flows arising from increased runoff would be the installation of one or more retention basins. As mentioned earlier, a retention basin for the western parts of the development is presently being considered near the entrance of the proposed access road. Detailed information on this detention basin should be made available to the Town Engineer. Peak flows arising from increased runoff from the eastern



PORTION OF PROPERTY WHICH DRAINS TO ROUTES 7 AND 35 AND ULTIMATELY INTO NORWALK RIVER

WATERSHED BOUNDARY AND POINT OF OUTFLOW FOR GREAT POND

DIRECTION OF SURFACE FLOW

NOTE: The watershed boundary shown below may not account for possible drainage re-routing due to road drainage

LAUREL HILL CONDOMINIUMS

RIDGEFIELD, CONNECTICUT

WATERSHED BOUNDARY

King's Mark Environmental Review Team

0 1000'

N

In order to minimize the impact of increased and/or concentrated runoff, a stormwater management plan which incorporates a sound erosion and sediment control plan should be submitted to the Town for review by all appropriate officials. The plan should include pre- and post-development hydrologic computations, sediment detention or retention basin designs, inland wetland crossings, and any other engineering structures where needed, either before or during land grading.

Water Level of Great Pond

Another water-related concern, expressed by a member of the Great Pond Club, is the potential affect of the three bedrock wells during pumping periods on the water level of Great Pond. A major consideration to take into mind is that the proposed project will be tied into public sewers, which will pipe the effluent out of the Great Pond watershed into another watershed. As a result, water withdrawn from the underlying bedrock for domestic use will be lost via the public sewer. If the bedrock fracture system is recharging the pond, it seems likely that pumping wells may ultimately effect the water level of the pond. It is beyond the scope of the Team's Geologist to determine the potential affect, especially since the exact yield of the wells on the site were not known during the ERT field review and bathymetric data for the pond is lacking. It is suggested, however, that a study be conducted to determine the affects of the three bedrock wells during pumping periods on the water level of the pond. Areas of concern that should be addressed include the following:

(1) If water levels are reduced, what affects will this have on bathing load requirements? Based on the Department of Health Service's swimmer capacity formula, it seems likely that if the level was reduced significantly, it may lead to a reduction in the number of bathers that could use Great Pond. This would be of most concern during the dry time of year when bathing is at its peak.

(2) If water levels are reduced, how will it affect Gilbert and Bennett's use of the water for fire protection and process water intake? As mentioned earlier, Gilbert and Bennett own the surface water rights on Great Pond. The company should be contacted and informed about the proposed development.

(3) Will the outlet stream for Great Pond be reduced so as to affect fish and wildlife, especially during low flow periods?.

(4) Will there be any interference between the wells on the site and neighboring wells during pumping periods?

It should be pointed out that, if the withdrawal rate of the wells, in combination, exceeds 50,000 gallons in a 24-hour period, a diversion permit will be required from the DEP - Water Resources Unit in Hartford (Telephone 566-7220). According to the Fuss & O'Neill report, the applicant's well driller reported yields of 5, 15 and 50 gallons per minute. The combined yield of three wells in a 24-hour period would have a withdrawal rate of almost 101,000 gallons of water in a 24-hour period. All of the aforementioned concerns would need to be addressed in detail as part of the application for the diversion permit, which will probably be required based on preliminary information.

WATER SUPPLY

Proposed development plans indicated that the project would be served by three existing drilled wells on the site. These wells derive their water from the underlying bedrock aquifer. The exact yield of a bedrock-based well is a function of many geologic factors including the number and size of fractures present in the bedrock.

Since the fractures in bedrock are irregular, there is no practical way of predicting the yield of a bedrock well drilled in a specific location. Even with geophysical exploration, it is extremely difficult to predict such yields. Nevertheless, wells drilled in bedrock are generally capable of supplying small but reliable yields.

Another important type of aquifer found primarily in major valleys of the state is sand and gravel. However, no extensive sand and gravel deposits exist within the site. If sand and gravel deposits are thick enough, coarse-grained, and saturated, they can generally yield water at a high rate compared to wells tapping crystalline bedrock. Based on the Groundwater Availability in Connecticut (Meade, 1978), the area north of Laurel Lane is underlain by deposits known or inferred to be capable of yielding moderate to very large amounts of water (50 to 2,000 gallons per minute). Although this area is off the property, it may be a possible alternate site for a well or wells, if the existing bedrock wells on the site are not productive enough to meet the demands of the proposed project.

An assessment of existing bedrock-based wells has been conducted for the southwestern coastal basin, which includes the subject site. (Source: Connecticut Water Resources Bulletin No. 17). All of the 725 wells surveyed in Bulletin No. 17 tap crystalline bedrock, which is the same as the bedrock underlying the proposed development site. This assessment allows one to predict the chances for any new well to achieve certain minimum yields. Based on Bulletin No. 17, 90 percent of the wells drilled through 350 feet or less of uncased saturated bedrock yielded one gallon per minute (gpm) or more and only 29 percent of the wells drilled through 350 feet or less of uncased saturated bedrock had a yield of 10 gpm or more. Most of the bedrock wells in the basin were capable of yielding about three gpm.

Based on some assumptions, the Team's Geologist was able to calculate the potential yield of a well or wells would need to be in order to serve the proposed 265 unit condominium complex. If it is assumed that each housing unit contained two bedrooms and three residents, a total of 795 residents would have to be served by the arrangement.

If each resident needed 75 gallons of water per day* to meet his/her needs, a total of 59,625 gallons per day would be needed. A single bedrock well yielding about 55 gpm continously would be required to adequately serve the complex. Of course, the peak demand on any given day may be greater than 55 gallons per minute; therefore, a storage system of some kind would have to be provided. This can be accomplished by the installation of a single water storage tank or an individual tank in each building. Storage tanks are sized based on the "peak hour demand." The "peak hour demand" occurs during the hour in which the largest volume of water is consumed and shall be considered one-third of the average daily consumption.

For example, under the 265 condominium unit scheme, where the average daily consumption is estimated to be 58,625 gallons, approximately 20,000 gallons of usable storage would be required for the total project.

It should be pointed out that the above mentioned design criteria does not include requirements for fire protection. It is the responsibility of the design engineer and the water supply owner to insure that the applicable federal, state and local fire protection requirements are satisfied.

* Community Water Supply Design Criteria for Water Systems Serving less than 1,000 People. (DRAFT) by Connecticut Department of Health Service, Public Water Supply Sections, Part 2.

In addition, water supply systems serving over 100 people will require a minimum of two distinct well sources. Each well must be capable of meeting the average daily consumption demands plus usable storage.

Based on statistical information regarding minimum yields reported in Connecticut Water Resources Bulletin No. 17, it appears that the chances of obtaining a yield of 44 gallons per minute on the site would be low. In this regard, would it be possible to connect to an existing public water supply line such as the Ridgefield Water Company.

If more than one well is needed to fulfill the needs of the residents of the condominium complex, the wells should each be conservatively separated if possible. This will hopefully help to prevent the chance of mutual interference of one well with another during pumping periods.

Since the Public Water Supply section of the Department of Health Services and the Department of Public Utility Control reviews and approves community water supplies, they should be contacted as soon as possible in order to discuss the following: (1) projected needs of the development in terms of water quantity; (2) location of the community well or wells on the site; (3) water quality testing requirements; and (4) plans for pumpage, storage, treatment (if necessary), and the distribution system.

The natural quality of groundwater in this area should be satisfactory. However, due to the mineralogy of the rock types underlying the site, there may be a chance that elevated iron and manganese levels could affect well water quality. As a result, it may be necessary to install an appropriate water treatment filtration system.

WATER RESOURCES

Construction Site Erosion

Research has shown that soil erosion from construction sites may be 10 to 100 times greater than erosion from agricultural land of the same size, slope, and soil type. Construction site erosion must therefore be regarded as a major causative factor in the lake or pond eutrophication process.

Methods for controlling construction site erosion and sedimentation are described in Guidelines for Soil Erosion and Sediment Control, (Connecticut Council on Soil and Water Conservation, January 1985). This document can be obtained from the DEP - Natural Resources Center. This publication is a technical handbook which was developed to assist government officials, developers, engineers, contractors and others to minimize erosion and sedimentation from sites undergoing development. Among the erosion control topics which are discussed in detail are site planning, vegetative controls such as seeding, sodding and tree planting, non-structural controls such as hay bale checks, mulching, land grading and traffic control, and structural controls such as diversions, rip rap, and sediment basins. This handbook should be used as the basic guidance manual for controlling construction site erosion in lake watersheds.

Erosion and Sediment Control Regulations

Excessive sedimentation from construction activities can be reduced when erosion and sedimentation (E&S) control needs are recognized and BMP,s are defined and E&S control management is a shared responsibility. Municipal government through its Inland Wetlands Agency, Zoning Commission, or General Site Plan Review procedures, are required by State Statues to evaluate E&S control needs. The Connecticut Council on Soil and Water Conservation, the Soil and Water Conservation Districts, and Regional Planning Agencies routinely

promote the need for thorough municipal E&S control programs and are available to provide technical assistance.

Similarly, DEP's role is to encourage the development of municipal programs. Furthermore, DEP - Water Resources Unit is the E&S control plan reviewer and regulator for State-sponsored projects requiring Inland Wetlands permits and manager of local Inland Wetland Permit Programs where municipalities have not assumed such authority.

In 1983, major E&S control legislation was passed (P.A. 83-388) to strengthen this program in Connecticut. Key provisions of this statute require:

(1) Development of E&S control guidelines and model regulations for municipalities by the Connecticut Council on Soil and Water Conservation (completed in 1985).

(2) Mandatory adoption of municipal E&S control programs by July 1, 1985.

This law was amended in 1985 to defer mandatory municipal adoption to June 30, 1986.

Mitigative Measures

The 150-foot setback from the pond should serve to minimize most of the short and long term impacts of the development if left in its present state. It is encouraged that the appropriate local agencies strictly enforce zoning ordinances dealing with erosion and sedimentation. It is further advised that the area of stormwater runoff be addressed.

PUBLIC HEALTH CONSIDERATIONS

Introduction

The proposed condominiums are to be served by public sanitary sewers and on-site wells. It is proposed that the wells will be incorporated with the Ridgefield Water Supply Company and therefore become a part of the public water supply which serve areas of Ridgefield.

The developer will first have to make an application to the Department of Public Utility Control (DPUC) for a Certificate of Public Convenience and Necessity per Public Act 84-330. This will initiate the procedure for turning the well water supply over to the local water company if approval is granted by the DPUC and Public Water Supply section of the Department of Health Services.

The drilled well which was used as the drinking water supply for Camp Arden, which formerly occupied the site, will now have to be abandoned in accordance with Article 4, Part 3, Section 25-128-56 and 25-128-57 of the Rules and Regulations of the Well Drilling Board.

Great Pond Water Quality

Water quality data provided by the Ridgefield Health Department for the past five years (1982-1986) from samples collected at the public and private beaches on Great Pond indicate that the level of total coliform organisms were moderately elevated for the August samplings. The Department of Health Services recommends that bathing not be allowed in surface waters with a total coliform concentration greater than 1,000 per 100 ml using the membrane filter technique. In August of 1986, sample results indicated 760 and 810 total coliform organisms for the public and private beaches respectively. While in June 1986, the results were 120 at the public beach and 130 at the private beach.

Conditions which may be contributing to elevated bacterial levels during the month of August are:

(1) Reduction in available dilution water through the bathing areas.

(2) Elevated water and ambient air temperatures.

(3) Increased bather loading due to #2 above.

(4) Proliferation of bacterial growth and introduction into the bathing area due to all of the above.

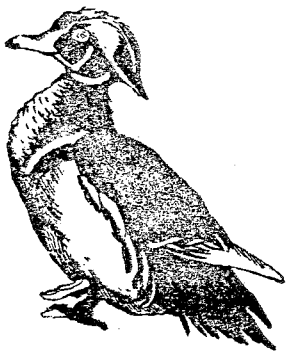
Bathymetic information concerning Great Pond was not available. Therefore the Team's Geologist could only estimate the pond's volume and inflow. By inserting these figures into a formula used by the Department of Health Services to determine available dilution water, it was calculated that approximately 1,000 bathers theoretically could utilize the pond daily.

Information provided during the field review indicated that on a hot sunny summer weekend day it would not be uncommon for as many as 1500 to 1800 people to visit the public beach and several hundred to utilize the private beach.

Based on these figures it appears that the bathing areas are over-utilized at certain times which can lead to localized bacterial pollution in the crowded bathing areas. Limiting the number of people using the bathing areas on any one day may reduce, to some extent, the total coliform organisms in the bathing areas.

Because the proposed Laurel Hill Condominium development will be served by public sanitary sewers and not by on-site subsurface sewage disposal systems, the possibility of raw sewage entering the pond from failing or malfunctioning on-site systems does not become a factor as a potential source of pollution to the pond.

As for the question of discharging surface water runoff from paved roads and driveways into the wetlands drainage system and what impact that may have to the water quality of Great Pond is beyond the scope of this review. Reference could be made to consultants reports furnished by the developer which seem to indicate minimal impact if recommended precautions are followed.



BIOTA

Oak ridge (2 acres)

Pole to sawtimber size chestnut oak and black oak. Understory consists of mountain laurel, low bush blueberry, maple-leaved viburnum, and club moss. There are numerous ledge outcrops. Windthrow of trees is a potential hazard because of shallow soils.

Oak/Mixed hardwoods (90 acres)

Sawtimber red oak, hickory, white ash, red maple, beech. Understory is sugar maple, flowering dogwood, black birch, beech, maple-leaved viburnum, and mountain laurel.

The developer indicated that he would like to retain as much of the woodland as possible in his landscape design. Therefore it is of the utmost importance that:

(1) The vigor and health of the forest be maintained.

(2) The remaining trees should be protected from all potentially damaging construction activity.

Construction can damage trees in a number of ways, including the following:

(1) Wounding of the trunk by machinery.

(2) Breaking of branches by other falling trees.

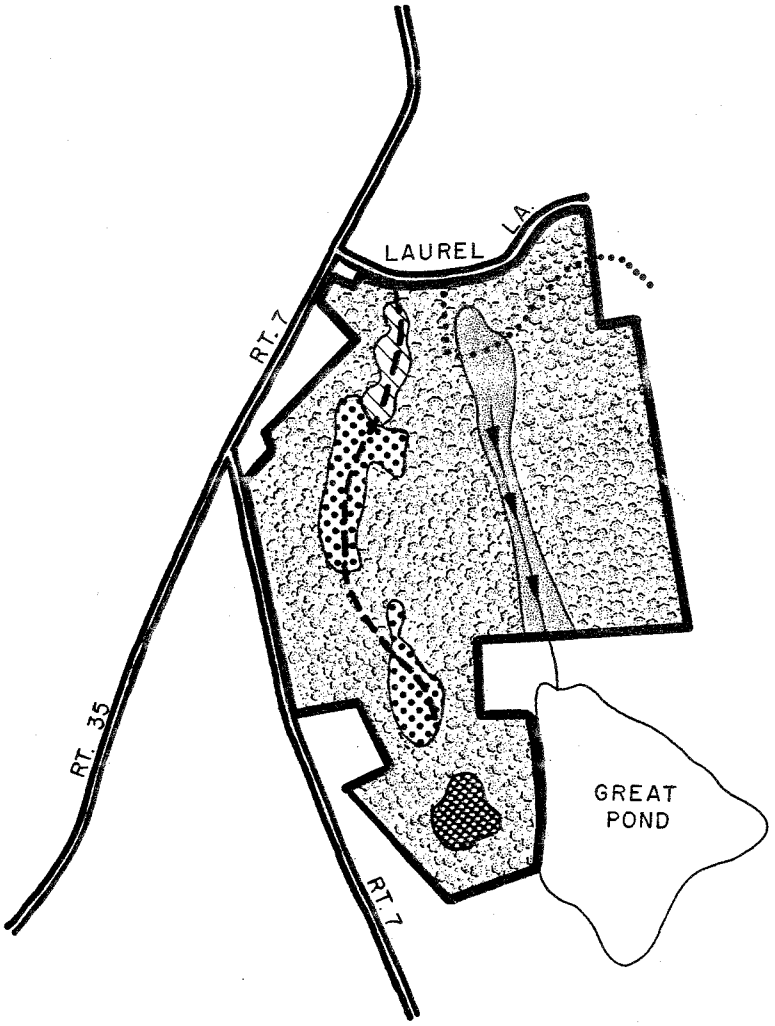
(3) Soil compaction, which changes soil moisture and aeration, and can damage roots.

(4) Severing of roots during excavation.

(5) Changing the grade or drainage around trees.

Trees can die from these impacts as long as six years after the time of injury. The initial damage may stress the tree and weaken it so that a secondary insect or disease can invade and kill the tree. Death may occur long

Figure 7



OLD FIELD (Stand 1)

CONIFER PLANTATION (Stand 2)

HARDWOOD SWAMP (Stand 3)

OAK RIDGE (Stand 4)

OAK/MIXED HARDWOODS (Stand 5)

WOODS ROAD

STREAM

TELEPHONE R.O.W.

LAUREL HILL CONDOMINIUMS

RIDGEFIELD, CONNECTICUT

VEGETATION TYPES

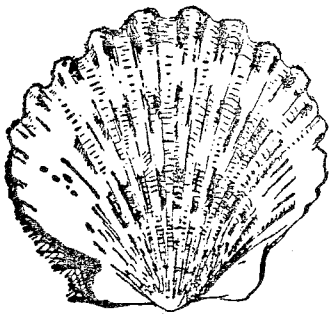
King's Mark Environmental Review Team

0 1000'

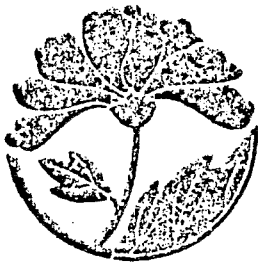
N

observed. The north end of the pond appears to be somewhat shallow and borders on a wetland area. This wetland could serve as an important spawning site for pickerel and largemouth bass during the spring, by providing suitable substrate over which they could lay their eggs. Since the major portion of the pond is relatively steep-sided and barren, the wetland is very important in that it provides diversity of aquatic habitats. Any increase in nutrient inputs as a result of disturbance to the wetland or surrounding forested area would increase the fertility of the pond and thus increase the fishery.

The presence of an outlet structure (i.e., surface water gate and deep-water outlet) for pond level control is a considerable advantage in this pond. If used properly this mechanism could serve a dual function, to both control the development of aquatic macrophytes and enhance the existing fishery. Winter drawdowns of several feet every 3 to 4 years might be advisable if a weed problem begins to develop.



LAND USE
AND
PLANNING CONSIDERATIONS



future generations..." and also that "...uses incompatible with conservation purposes should be discouraged by local regulations."

The proposed land use for the subject site according to the Ridgefield Comprehensive Town Plan adopted in 1980, is primarily research/office for the western half of the site and open space/recreation for the eastern half. Regarding office development, the plan states: "The establishment of campus-type office and research laboratory uses and planned industrial parks should continue to be encouraged on suitable sites within the Town in order to provide job opportunities, a balanced tax base and the preservation of large amounts of open space. Sites for such uses should be of adequate size to permit generous buffer areas alongside residential lands and should be located on major arteries which are capable of handling the additional traffic and provide reasonably direct routes into and out of the Town. The objective of this plan is to achieve 10%-15% of the total assessed value of the Town in office and industrial uses. This type of development should be limited to the best sites in Ridgefield for these uses."

Regarding open space, the Town Plan states: "Conservation of existing open space, particularly in areas of high visibility, should receive high priority in the overall planning of future development in Ridgefield." The plan also states that "...the Town should continue to encourage the imaginative planning of all new development so as to preserve open space and the natural environment as integral parts of such development. In view of the large amount of developable land remaining, it should continue to be required that new residential development participate in the setting aside of open space for park and recreation purposes."

The site is currently zoned for restricted corporate development (RCDD) on the western half of the site and two-acre residential (RAA) on the eastern

half. The applicant is proposing a rezoning of the entire site to a new one, entitled special multi-family development distirct (SMFDD) to allow multi-family dwelling structures at a density not greater than 2.5 units per acre overall. Along with a rezoning of this parcel, amendments to both the zoning regulations and the Town Plan are being requested by the applicant to accommodate his development proposal.

In general, the proposed project is not consistent with the HVCEO's regional land use plan which calls for more limited growth at the site. Nor is the proposed project consistent with the comprehensive Town Plan map which calls for office development and open space use of the site. Nevertheless, with the proximity of the site to Route 7, its location directly adjacent to an area proposed for urban growth by the HVCEO, and the availability of sewers, the proposed project is not viewed as completely inappropriate. In addition, a section of the Ridgefield Town Plan speaks to the need for developing additional multi-family units in town. Specifically, the plan states that "...where suitable sewage treatment can be achieved, it is recommended that the town permit additional multi-family housing." In the final analysis, a judgement decision is required by the town as to whether the proposed residential project is preferable on this particular site to an office development constructed under existing town regulations.

While a number of social, economic, and environmental aspects should be considered in arriving at such a decision, including the locational criteria for multi-family units identified in the Town Plan, one broader factor which should be considered is the desired balance in town between dwellings and jobs. According to HVCEO Bulletin No. 10 entitled Growth Capacity Within Local Zoning prepared in 1980, the ratio of dwellings in 1978 to employment in 1978 in Ridgefield was 1.33, showing a predominance of dwellings. Under existing

(1978) zoning, the ratio of dwellings at capacity to employment at capacity is projected to fall dramatically to 0.39. The basic reason for this trend toward a predominance of jobs is the municipal preference as expressed through local zoning for employment-producing land uses since they usually yield a greater net tax surplus than residential uses. If Ridgefield desires to strike a closer balance between the number of jobs in town and the number of dwellings, rezoning some additional land for multi-family residential use could be justified.

According to the Director of Planning for the town, an update to the Ridgefield Master Plan is now in progress. This update will be addressing corporate development and multi-family development in town and should prove useful in addressing this issue of balancing jobs to dwelling units.

Traffic and Access Considerations

Access to the site is proposed to be provided through the construction of a new driveway on Route 7 approximately 450 feet south of where Laurel Lane intersects Route 7. Sight line distances are good in both directions at the proposed access point. A traffic signal and left turn lane at the project's driveway has nevertheless been recommended by the applicant's traffic consultant to improve traffic safety.

A traffic impact study of the proposed Laurel Hill Condominium project was prepared for the applicant by a consultant in September 1986. For comparison purposes, the consultant's report also addressed the vehicular impact of a 461,000 square foot general office building which could be constructed on the site under existing zoning regulations. Trip generation rates presented in this report were based on the Institute of Transportation Engineers Trip

Generation Manual - Third Edition (1982). This is a widely used and accedited method for calculating trip generation rates.

The consultant's calculations showed that the proposed 265 condominium unit project could be expected to generate 1,378 vehicular trips on an average weekday while the 461,000 square-foot office complex would generate 5,670 trips. Thus, the proposed project would generate less than one-fourth the traffic of an office complex constructed under existing regulations.

According to Department of Transportation (DOT) statistics, the average daily traffic along Route 7 in the project vicinity is 21,400 trips. Thus, the proposed project would increase existing traffic flows on Route 7 by about six percent.

The applicant's consultant concluded that the level of service on Route 7 will not decline with construction of the proposed project but would substantially deteriorate with the hypothetical office development. The traffic consultant's analysis was based on existing Route 7 being upgraded to two lanes in each direction in the project vicinity as planned. This new construction is scheduled to begin in the spring of 1987 and will require approximately one year to complete according to the DOT. As indicated above, the consultant recommended as part of his investigation that a traffic signal and left turn lane be provided at the project's driveway to improve traffic safety.

As part of the development process, the applicant must submit an application for a certificate of public safety to the State Traffic Commission. Prior to acting on the application, the State Traffic Commission will review the proposed driveway and surrounding traffic patterns to ensure that the project will not pose a safety hazard or interfere significantly with the flow of traffic in the area. One potential area of concern is that a new

signal at the project's driveway, as proposed, is only about 1000 feet away from the signal at the Route 25 and 7 intersection. This could pose a noticeable impediment to through traffic unless the two traffic signals are interconnected to produce a smooth progression of traffic.

In addition to a certificate from the State Traffic Commission, a permit for construction will also be required from the DOT District IV office in New Milford. In acting on this permit application, the District office will also review traffic impact and design issues.

A desirable planning technique to lessen congestion on arterial highways such as this section of Route 7 is to minimize the number of curb cuts or driveways on the highway. One alternative for doing this at the subject site is to have the access to the parcel directly off Laurel Lane in the vicinity of the driveway to the existing structure on the site. Although the need for a new curb cut on Route 7 would be avoided with this alternative, it does not appear that Laurel Lane has sufficient right-of-way to accommodate the road improvements which would be required to handle the additional traffic generated by the project. This conclusion was supported by the Director of Planning for the town on the day of the ERT field review.

Design Considerations

Based on a review of the Master Plan for Laurel Hill, the landscape, grading, and erosion and sediment control plan for Phase One of the project, and the architechtural perspective plan, the proposed project promises the construction of an attractive complex characterized by a New England style of architecture with a single-family home appearance. Both passive and active recreational amenities are proposed together with ample areas of open space. The 100-foot buffer around the central wetland on the site and the 150-foot

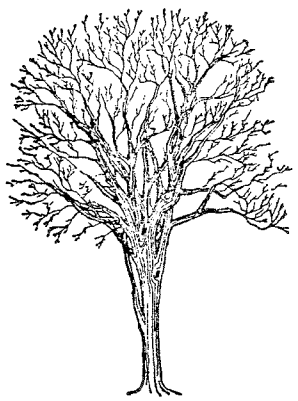
buffer around Great Pond will serve to protect these important natural resources. The series of loop roads and cul-de-sacs proposed for the site appear well designed and generally follow existing contours.

A major concern raised during the field review was the visual impact of the project on surrounding land uses. On-site inspection shows that the proposed project is generally well screened from surrounding land uses. Three surrounding areas where the project will likely be visible to a limited degree include the land along Laurel Lane, homesites to the south and west of the proposed project, and the beaches on the southern shore of Great Pond.

The 3 or 4 homes on the north side of Laurel Lane adjacent to the subject site will likely have a limited view of 2 or 3 structures proposed in the northeastern corner of the site. A number of houses, along with the Perkin-Elmer plant, were also visible from the southwestern portion of the site where several units are proposed. Construction at these locations will therefore likely be visible from these adjacent areas. The beaches on the southern shore of Great Pond were also visible from the area of the southernmost structure proposed for Laurel Hill. The visual impact on these surrounding areas can be mitigated through careful landscaping. Accoring to the Team Forester, hemlock or white pine could be planted in selected areas of the site to help screen the new structure from surrounding land uses. This would be particularly valuable during the winter months when the leaves are off the trees.

The most significant visual intrusion in the opinion of the Team's Planner is on the beaches of Great Pond. While it appears that only one structure, the southernmost unit proposed for the project, will be visible from the beaches, this is perceived as significant since the panoramic view from the beaches is one of great natural beauty with no man-made intrusions at the present time.

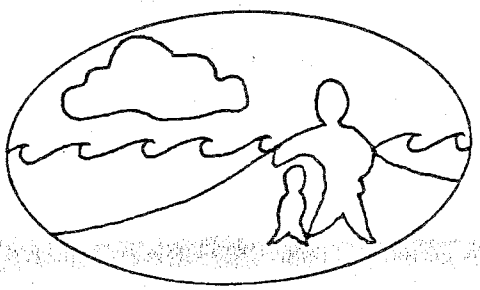
The presence of even one structure in the viewshed, even though over 1000 feet away as presently planned, will reduce the "wilderness" atmosphere at Great Pond. The applicant indicated the day of the ERT's field review that earth-tone coloring of this structure will be used to blend the structure in with the landscape. Heavy landscaping with conifers to the south of the structure will further serve to screen the view of this structure from the beach. Some consideration should be given by the applicant to constructing a one-story structure in this location to further minimize the visual impact. The applicant may also wish to consider relocating this structure elsewhere on the site where the visual impact would not be so noticable.



APPENDIX A

WATER QUALITY AND MANAGEMENT REPORTS

A WATERSHED MANAGEMENT GUIDE FOR CONNECTICUT LAKES



CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER COMPLIANCE UNIT

Revised 1986

A WATERSHED MANAGEMENT GUIDE FOR CONNECTICUT LAKES

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER COMPLIANCE UNIT

REVISED 1986

TABLE OF CONTENTS

	Page
Introduction	1
Eutrophication	2
The Process of Eutrophication	2
The Rate of Eutrophication	2
Stages of Eutrophication	2
Eutrophication of Artificial Lakes and Ponds	3
Eutrophication as Water Pollution	3
The Limiting Nutrient	4
Watershed Management Overview	5
Objectives	5
Point Sources and Non-Point Sources	5
Connecticut 208 Program	5
Watershed Resource Maps	6
Lake Watershed Boundary	6
Land Use Map	6
Wetlands Map	6
Erosion and Sediment Source Map	6
Areas of High Erosion Potential map	7
Detailed Soils Group Maps	7
Accessory Land Use Maps	7
Non-Point Sources and Controls	8
Erosion and Sedimentation	8
Construction Site Erosion	8
Erosion and Sediment Control Regulations	9
Residential Land	9
Failing Septic Systems	10
Prevention of Failing Septic Systems	10
Non-Failing Septic Systems	11
Cottage Conversions	12
Lawn and Garden Fertilizers	12
Yard and Garden Vegetation Disposal	12
Agricultural Land	13
Woodland and Timber Harvesting	14
Wetlands	14
Stormwater Runoff	16
Preservation of Wetlands	16
Existing Residential Areas	16
New Residential Areas	16
Roadway Runoff	16
Waterfowl	17
Streambanks and Shorelines	18
Atmosphere	18
Lake Sediments	18

TABLE OF CONTENTS (continued)

	Page
Resource Agencies	19
State and Federal	19
Regional Planning Agencies	20
County Offices	21
Resource Maps	22
Resource Publications	23
Connecticut Lake Trophic Conditions	24

INTRODUCTION

Connecticut's lakes and ponds are valuable natural resources which are used intensively for swimming, fishing, sailing, waterskiing, and many other forms of water based recreation. Lakes and ponds add diversity and aesthetic interest to the landscape and contribute immeasurably to the enjoyment of daily life in lakeside communities. They are important economic entities as well, with money spent in the pursuit of recreation contributing to local and regional economies. Lakes and ponds also enhance local property values, thereby augmenting the tax revenues of local communities.

Unfortunately, all lakes and ponds undergo the aging process called eutrophication, a form of water pollution which results in a decline in recreational utility and aesthetic appeal. Eutrophication is a gradual natural process which is accelerated by man's use of the lands which surround the waterbody. Through awareness and considerable effort and commitment, the eutrophication process is controllable and manageable. Every lake and pond in Connecticut will benefit from "preservation" oriented management which slows the eutrophication process and prolongs the useful life of the waterbody. Many lakes and ponds are also in need of "restoration" oriented management to correct or reverse undesirable conditions brought about in the absence of prudent management in past years.

This handbook has been developed to assist concerned citizens in understanding the process of eutrophication and the principles of eutrophication control through the management of the lake's surrounding watershed land. The handbook is a synthesis of information assimilated by the DEP through its eutrophication abatement activities in recent years. Material in the handbook was selected to fulfill basic information needs of the general public,as determined by our experiences with a variety of lake projects and our contact with numerous individuals and lake organizations. The handbook is intended to assist the layman in working more effectively with technical experts in government agencies and private industry to protect and restore Connecticut's lakes.

EUTROPHICATION

The Process of Eutrophication

Eutrophication is the process of lake aging, caused by enrichment of the lake with plant nutrients from its surrounding watershed land. During the aging process many lake characteristics undergo dramatic changes. To lake users, changes observed include algae blooms increasing in frequency, intensity, and duration; beds of aquatic plants becoming dense and more extensive in coverage of the lake bottom; sediment deposits accumulating, shoal areas developing, and the lake becoming shallower; and the oxygen content of bottom waters declining. As these conditions become pronounced, recreation opportunities become seriously impaired. During the latter stages of the eutrophication process, the lake evolves to a wetland - a swamp, marsh, or bog - and no longer can support its former recreation uses.

The Rate of Eutrophication

The rate at which eutrophication advances is determined by the rate at which the lake is fertilized by its watershed. Under natural conditions, nutrient inputs from a forested watershed are minimal and it may take many centuries for a lake to change in appearance. However, man's development and use of watershed land inevitably results in greater nutrient export from the watershed, and an acceleration in the rate of eutrophication. If man's watershed activities are not controlled, severe lake eutrophication can be brought about in a matter of decades.

Stages of Eutrophication

There are three basic stages of eutrophication which are used to describe the age of a lake. These stages are termed "oligotrophic", "mesotrophic" and "eutrophic". Oligotrophic refers to lakes in the early stages of the eutrophication process, while eutrophic refers to lakes in the late stages. Mesotrophic refers to middle-age lakes in transition between oligotrophic and eutrophic states. These stages are also referred to as trophic states or trophic classifications.

Each stage of eutrophication is characterized by a distinct set of lake conditions. Oligotrophic lakes are deep lakes with clear, infertile waters. They are low in biological productivity, having sparse amounts of algae and aquatic plants. They have minor accumulations of bottom sediments, and have well oxygenated bottom waters. Oligotrophic lakes are prime recreation lakes. Eutrophic lakes are relatively shallow lakes with fertile, turbid waters. They are high in biological productivity, having dense blooms of algae and dense beds of vascular aquatic plants. Eutrophic lakes have substantial accumulations of bottom sediments and have poorly oxygenated bottom waters. Eutrophic lakes have limited recreational utility. Mesotrophic lakes exhibit a mid-range of fertility, productivity, depth, and sedimentation.

Studies of the trophic conditions of Connecticut lakes have resulted in the development of a formal classification system which defines trophic states on the basis of scientific measurements of water quality. A "highly eutrophic" stage was included in the eutrophic lakes. The mesotrophic state was subdivided into "early mesotrophic", "mid mesotrophic", and "late mesotrophic" conditions in order to further differentiate among lakes in this relatively broad category. A list of Connecticut lakes which have been formally classified is presented on pages 26 and 27 of this handbook.

These classification categories are useful tools for comparing the water quality of different lakes, for establishing benchmarks for short and long term trend comparisons, and for estimating the probable level of management required to meet lake use objectives. Trophic classifications are not rigid, and a lake may be eutrophic in some respects and mesotrophic in others. Also, the designation of a lake as eutrophic does not indicate that it is unsuitable or undesirable for all types of recreation, nor should it discourage efforts to manage the lake resource. Similarly, the classification of a lake as oligotrophic should not engender complacency towards management. In both instances, water quality can be maintained and improved through a management program.

Eutrophication of Artificial Lakes and Ponds - When initiating a lake study, it is important to recognize that many lakes and ponds in Connecticut were formed by the construction of a dam across a stream or across the outlet of a wetland. These artificial waterbodies often exhibit an advanced stage of eutrophication. They are relatively shallow waterbodies which are enriched by the nutrients accumulated by the predecessor wetland or terrestrial ecosystem. However, these water quality conditions do not evolve from the oligotrophic state - these lakes experience an advanced state of eutrophication from the time they are formed. Improvement of conditions in these lakes is exceptionally difficult because restoration does not involve the return to previous water quality conditions, but rather involves the creation of conditions which had never existed previously. Examples of this type of lake are Silver Lake in Berlin/Meriden, North Farms Reservoir in Wallingford, Mamanasco Lake in Ridgefield, Lake Winnemaug in Watertown, and Winchester Lake in Winchester.

Eutrophication as Water Pollution - Eutrophication is widely recognized as a form of water pollution which seriously impacts the recreational value of lakes and ponds. Programs to address eutrophication problems are mandated by both state and federal legislation.

Section 25a-338 of the Connecticut General Statutes requires the DEP to conduct a study of the growth and cause of algae and other plant life in the inland waters of the State, and to undertake programs of algae abatement and weed control in cooperation with other public and private agencies.

Section 314 of the Federal Clean Water Act (P.L. 95-217) requires that each State submit to the Environmental Protection Agency an

identification of publicly owned freshwater lakes and a classification of those lakes according to trophic condition. The statute further requires states to submit to the EPA procedures, processes, and methods to control sources of pollution to lakes, and methods and procedures to restore the quality of lakes.

The Limiting Nutrient, The Key to Controlling Eutrophication

In order for any form of life to grow and multiply, the basic building blocks of life must be available in the environment. Those essential substances are commonly referred to as nutrients. In a lake, algae depend on nutrients in the water column to satisfy their growth. The larger rooted aquatic plants also depend on nutrients in the water column, although to a lesser extent since many species can also extract nutrients from lake sediments.

The term "limiting nutrient" refers to that particular nutrient which is in shortest supply relative to the growth needs of an organism grows. When the limiting nutrient becomes depleted, growth stops even though other nutrients are still available in surplus. Any increase in the supply of the limiting nutrient will result in a corresponding increase in growth. Conversely, any decrease in the supply of the limiting nutrient will result in a corresponding decrease in growth. The key to controlling the growth of algae and vascular plants in a lake - the key to controlling eutrophication - is to reduce the supply of the growth limiting nutrient.

Carbon, nitrogen, and phosphorus are the three basic plant nutrients which could hypothetically be limiting to the growth of algae and aquatic plants in a lake. Surface waters have an abundant supply of carbon because carbon dioxide gas (CO_2) readily dissolves in lake waters from the atmosphere. Similarly, nitrogen gas (N_2) readily dissolves in lake waters from the atmosphere and is present in abundance. There are many forms of common nuisance blue-green algae which are physiologically capable of "fixing" N_2 and utilizing this form of nitrogen for growth. These algae thrive even when dissolved mineral nitrogen forms (ammonia, nitrate) are scarce. Thus, carbon and nitrogen are not generally limiting to the eutrophication process.

Phosphorus, the third basic plant nutrient, has been found to be the growth limiting nutrient in the eutrophication process of most lakes and ponds. Phosphorus is not readily available as a gas from the atmosphere, and it is usually present in relatively scarce quantities in lake waters. Lake water quality studies have found that most lakes have a scarce supply of phosphorus relative to other nutrients and are phosphorus limited. Some highly eutrophic lakes have been found to be nitrogen limited, although this is not due to a low nitrogen supply but rather to an excessive phosphorus supply. In these lakes, restoration strategies focus on phosphorus control to reduce the supply to a level where it becomes limiting.

The key to controlling the eutrophication process, therefore is controlling phosphorus enrichment.

WATERSHED MANAGEMENT OVERVIEW

Objectives

The watershed of a lake is that land area which drains to the lake. The watershed is therefore the source of water for the lake. Water quality of a lake, to a large extent, is determined by qualities imparted to water by watershed land as the water drains to the lake.

Watershed management is aimed at identifying and controlling existing and potential watershed characteristics which ultimately influence a lake's trophic condition. Since phosphorus is the nutrient which governs the productivity of algae and aquatic plants, watershed management is first and foremost concerned with reducing phosphorus enrichment. An important secondary consideration is the reduction of sediment inputs which contribute to physical lake filling and the development of shallow shoal areas where tributaries and storm waters enter the lake.

Watershed management is imperative for each and every lake, regardless of the lake's trophic condition. If a lake is oligotrophic, watershed management will serve to preserve its superior quality and prolong its useful life for recreation. If a lake is eutrophic, watershed management will serve to temper the eutrophication process and enhance the effectiveness of restoration measures within the lake. Watershed management must be the foundation for all lake preservation and lake restoration programs.

Point Sources and Non-point Sources

Sources of phosphorus and sediment are divided into two broad categories, point sources and non-point sources. Point sources are concentrated, localized discharges such as outfalls from sewage treatment plants. Non-point sources are diffuse and are not easily identified because they do not enter a watercourse at a single point. Rainstorm runoff from a residential area and drainage from a cornfield are examples of non-point sources.

In Connecticut, State policy has prohibited point source discharges to a natural lakes and ponds and many artificial impoundments (including their tributary watercourses). In a relatively few cases, artificial river impoundments are significantly enriched with point sources of phosphorus. State and federal point source control programs are responsible for implementing advanced waste treatment to control eutrophication in these lakes. Thus, the primary concern for management of eutrophication in lakes and ponds in Connecticut is the identification and control of non-point sources.

Connecticut 208 Program - Connecticut's program for controlling non-point sources was developed through the Connecticut Areawide Waste Treatment Management Planning Program (Connecticut 208 Program). This program, established and funded under Section 208 of the 1972 Federal

Water Pollution Act Amendments, was instrumental in developing information on the nature and characteristics of non-point sources, non-point source control measures, and institutional arrangements for implementing controls. Lake watershed management principles draw substantially from information provided by the Connecticut 208 Program efforts.

WATERSHED RESOURCE MAPS

The first step in developing a lake management program is to obtain information about the lake watershed which is pertinent to existing and potential non-point sources of phosphorus and sediment. Several recent statewide natural resource and land use inventories have produced valuable baseline information which is portrayed on maps at 1/24,000 scale (USGS topographical guadrangle scale). This baseline information can be used to construct various lake watershed maps which show features related to eutrophication.

Lake Watershed Boundary Map

The Natural Resources Center of DEP has delineated watershed boundaries on mylar overlays which are on file at the State Office Building in Hartford. A boundary map for a lake watershed can be traced from the mylar onto USGS topographical maps. This serves as a base map on which various watershed characteristics can be portrayed.

Land Use Map

The Connecticut 208 Program developed maps of predominant land use in 5.7 acre grids. Fifteen land use categories were considered - low density residential, moderate density residential, high density residential, institutional, commercial, industrial, open land, cropland, orchard land, dairy production, forest production, resource extraction, wetland, water, and woodland. This information is on file at Regional Planning Agency offices on mylar overlays. A watershed land use map can be constructed by tracing this information onto a lake watershed boundary map.

Wetlands Map

The Connecticut 208 Program developed "water quality sensitive areas" maps which portray legally defined wetlands as well as flood prone areas of environmental or historic interest. This information is on file at Regional Planning Agency offices on mylar overlays. A map of wetlands and other sensitive areas in a lake watershed can be constructed by tracing this information onto a watershed boundary map.

Erosion and Sediment Source Map

The Connecticut 208 Program conducted a statewide inventory of active erosion and sediment sources in 1977 and 1978. The inventory considered cultivated cropland sites greater than two acres, construction sites greater than two acres, surface mines, stream banks, road banks, gravel roads, and unpaved driveways. Active sites were mapped on mylar overlays

which are on file at Regional Planning Agency offices and at Soil and Water Conservation District offices. An erosion and sediment source map for the lake watershed can be developed by tracing sites onto a watershed boundary map. This map can serve as a baseline for developing an updated erosion and sediment source maps based on field observations. It is possible that some sites identified in the 1977-78 inventory have stabilized and no longer are active sources. It is also possible that new sites developed in the lake watershed since the 1977-78 inventory.

Areas of High Erosion Potential Map

The Connecticut 208 Program conducted a statewide inventory of high erosion potential areas based on slope of the land and soil type. This information is portrayed on mylar overlays on file at Regional Planning Agency offices. A map of high erosion potential areas for the lake watershed can be constructed by tracing this information onto a watershed boundary map.

Detailed Soils Group Map

The U. S. Department of Agriculture Soil Conservation Service has developed a statewide mapping of detailed soils groups in cooperation with the Natural Resources Center of DEP. This information is on file at the Natural Resource Center in Hartford as mylar overlays. A map of soils groups for a lake watershed can be constructed by transferring this information onto a watershed boundary map. This information can be used to evaluate the suitability of watershed land for on-site sewage disposal (septic systems), and to evaluate erosion potential of watershed land. Technical assistance may be needed to properly interpret the soils information.

Accessory Land Use Maps

The Connecticut 208 Program conducted two additional statewide inventories which can be used to construct useful lake watershed maps. The "Open Space and Dedicated Lands" inventory portrays land in public ownership, quasi-public ownership, and non-profit organization ownership. These lands include water utility property, land trust property, golf courses, recreation areas, nature preserves, and institutional property. This information is portrayed on mylar overlays at Regional Planning Agency offices. A map of open space and dedicated lands in the lake watershed can be constructed by tracing this information onto a watershed boundary map.

A statewide inventory of "lands Unavailable for Development" portrays flood hazard areas, wetlands, watercourses, waterbodies, urban areas, and dedicated lands. This information is available on mylar overlays at Regional Planning Agency offices. A map of property in the lake watershed which is unavailable for development can be constructed by tracing this information onto a watershed boundary map.

NON-POINT SOURCES AND CONTROLS

Erosion and Sedimentation

Erosion is a natural process whereby soil is worn away from the land by running water. Sedimentation is the deposition of eroded material in a watercourse. The severity of erosion and sedimentation is influenced by soil type, slope of the land, type of vegetative cover, intensity and duration of precipitation, and proximity to a watercourse. Some erosion and sedimentation from a lake watershed is inevitable, since this occurs as a natural process. Erosion and sedimentation can be greatly increased by activities of man which disturb the land, remove vegetation, and expose soil to the direct forces of rainfall and surface runoff.

The transport of eroded soil to a lake contributes to eutrophication in several ways. Most importantly, phosphorus and other plant nutrients associated with soil particles are introduced into the lake. Erosion and sedimentation is a dominant cause of phosphorus enrichment of lake waters. Another important effect is the physical presence of solid particles in the lake. Sedimentation reduces water depths, creating shoals which are conducive to the growth of aquatic plants. In addition, organic matter associated with soil particles is decomposed by micro organisms, contributing to the depletion of oxygen in waters overlying the lake sediments.

Serious natural erosion can occur on land with steep slopes, along streambanks, and along lake shorelines. Common man-made sites of erosion are cultivated fields, roadway embankments, roadway drainage ditches, timber harvesting, and construction sites. Erosion associated with specific land features or specific land uses can be controlled by utilizing the "best management practices" which are addressed in subsequent sections of this report. Erosion associated with construction activities is a serious source of erosion which is not restricted to any particular land use of land feature, but rather can occur anywhere in the lake watershed. Special consideration of this erosion source follows:

Construction Site Erosion - Research has shown that soil erosion from construction sites may be 10 to 100 times greater than erosion from agricultural land of the same size, slope, and soil type. The demand to develop lake watershed land, especially land near the lake, is exceptionally strong Construction site erosion must therefore be regarded as a major causative factor in the lake eutrophication process.

Methods for controlling construction site erosion and sedimentation are described in Guidelines for Soil Erosion and Sediment Control, CT Council on Soil Water Conservation, January 1985. This document can be obtained from the DEP Natural Resources Center. This publication is a technical handbook which was developed to assist government officials, developed, engineers, contractors, and others to minimize erosion and sedimentation from sites undergoing development. Among the erosion control topics which are discussed in detail are site planning;

vegetative controls such as seeding, sodding, and tree planting; non-structural controls such as hay bale checks, mulching, land grading, and traffic control; and structural controls such as diversions, rip rap, and sediment basins. This handbook should be used as the basic guidance manual for controlling construction site erosion in lake watersheds.

Erosion and Sediment Control Regulations - Excessive sedimentation from construction activities can be reduced when erosion and sedimentation (E & S) control needs are recognized and BMP's are employed. In Connecticut, E & S control management roles are well defined and E & S control management is a shared responsibility. Municipal government through its Inland Wetlands Agency, Zoning Commission, or General Site Plan Review procedures, are required by State Statues to evaluate E & S control needs. The Connecticut Council on Soil and Water Conservation, the Soil and Water Conservation Districts, and Regional Planning Agencies routinely promote the need for thorough municipal E & S control programs and are available to provide technical assistance.

Similarly, DEP's role is to encourage the development of municipal programs. Furthermore, DEP - Water Resources Unit is the E & S control plan reviewer and regulator for State sponsored projects requiring Inlands Wetlands Permits and manager of local Inland Wetland Permit Programs where municipalities have not assumed such authority.

In 1983, major E & S control legislation was passed (P. A. 83-388) to strengthen this program in Connecticut. Key provisions of this statute require:

- development of E & S control guidelines and model regulations for municipalities by the Connecticut Council on Soil and Water Conservation (completed in 1985); and

- mandatory adoption of municipal E & S control programs by July 1, 1985.

This law was amended in 1985 to defer mandatory municipal adoption to June 30, 1986.

Residential Land

An acre of residential land will contribute much more phosphorus to a spell than an acre of woodland in the same location. Residential land adjacent to the lake will contribute more to eutrophication than residential land in distant areas of the watershed. The importance of residential land in the eutrophication of a lake is readily appreciated when on observes the amount of land adjacent to any particular lake which is occupied by seasonal or permanent residences.

Sources of phosphorus associated with residential land include construction site erosion, failing septic systems, properly functioning septic systems, fertilization of lawns and gardens, disposal of vegetation from yard upkeep, and stormwater runoff. Construction site erosion has been discussed in the preceding section, and stormwater

runoff will be addressed in a later section. The remaining sources and their controls will be discussed below.

Failing Septic Systems - Sewage disposal in residential areas not serviced by sanitary sewers is accomplished with on-lot subsurface disposal systems commonly referred to as septic systems. When functioning properly, septic systems provide for the sanitary breakdown of wastewaters into simple chemical substances including soluble phosphorus compounds. The basic components of the system include a house sewer, septic tank, distribution system, and leaching field. Sewage is delivered to the septic tank via the house sewer. In the septic tank, solids are physically separated from liquids (primary treatment) by the sedimentation of heavy solids to form a sludge blanket, and the flotation of light solids to form a scum layer. The distribution system delivers the liquids to the leaching field. The liquid effluent is decomposed biologically (secondary treatment) in the leaching system.

A septic system can fail if it is not properly designed, installed, or maintained. A failing system will wither result in the backflow of wastewaters into the house, or the breakout of wastewaters on the surface of the ground. A failing septic system can contribute phosphorus and other pollutants to lake waters. A far more important consideration, however, is that a failing septic system is a public health hazard. The public health threat is an overriding concern which demands correction of the problem, irrespective of the lake eutrophication issue.

The correction of individual or scattered failing septic systems in a residential area is the responsibility of town health official. The correction of widespread failures within a residential community is initiated by facility planning as provided by state and federal water pollution control statutes. A community sewage disposal system is a likely outcome in these cases.

Prevention of Failing Septic Systems - The first safeguard against septic system failure is the proper design and installation of the system. The DEP has published a document entitled Septic System Manual to guide local land use officials on the legal and technical aspects of the design and installation of on-site subsurface sewage disposal systems. The manual provides a brief explanation of the actual process of sewage treatment that takes place in a septic tank, leachfield and surrounding soil. It is intended to enhance the knowledge of local officials and provide for a more informed review of development proposals. This manual should be consulted by local commissions when reviewing applications for planning, zoning, and wetlands permits which involve the installation of new septic systems in the lake watershed.

Proper operation and maintenance practices will serve to prevent the premature failure of existing septic systems in the lake watershed. The septic system should not be used for the disposal of garbage, solvents, paints, household chemicals, and medicines because these materials can cause clogging or can interfere with biological treatment processes. Water conservation should be practiced in the household since heavy water use can hydraulically overload a septic system and cause failure. A poster detailing water conservation practices is available from the DEP:

Water Compliance Unit. For maintenance, a septic tank should be pumped routinely every 3-5 years to remove accumulated scum and sludge which would otherwise move into the distribution system and leaching system, causing clogging and eventual failure.

The Connecticut 208 Program has de eloped three reports which can guide a lake organization in the development of a community wide septic system management program. Theses are "A Proposed Septic System Inspection and Maintenance Program for Killingworth, Connecticut" by the Connecticut River Estuary Regional Planning Agency; "Voluntary Septic System Management Program for the Towns of Canterbury, Killingly, and Woodstock" by the Northeastern Connecticut Regional Planning Agency; and "Voluntary Septic System Management Program For Quaddick Lake, Thompson" by the Northeastern Connecticut Regional Planning Agency.

A simple and effective means of educating lakeside residents about the proper operation and maintenance of septic systems is an information pamphlet distributed by a lake organization to property owners. The pamphlet should advise homeowners about the consequences of failures, list materials which should not be disposed of in a septic system, explain water conservation measures, and stress the need for routine septic tank pumping. An excellent pamphlet for these purposes was developed by the Northeastern Connecticut Regional Planning Agency and the Northeast District Department of Health entitled "Homeowners Guide to Septic System Maintenance - Or How To Save Thousands of Dollars."

Non-failing Septic Systems as Phosphorus Sources - The liquid effluent which flows from the leaching field of a septic system passes into the surrounding soil and enters the ground water system. This leachate has a high concentration of soluble phosphorus. The ground water flow is generally in the direction of the lake, where it enters the lake as springs. Whether phosphorus travels with the ground water to the lake depends on interactions between soil particles and phosphorus. Many factors are involved, including the proximity of the septic system to the lake, the age of the septic system, the soil type and its capacity to attenuate phosphorus, the path of travel of leachate, the time of travel of leachate, the time of travel of leachate, and the elevation of the ground water table.

At present, the incomplete scientific understanding of the interactions between soil particles and ground water phosphorus makes it difficult to predict if or when a septic system will become a source of phosphorus to lake waters. Some soil studies in Connecticut have suggested that soils have an enormous capacity to adsorb and retain phosphorus. More recent Connecticut studies have suggested that leachate may travel in preferential channels through the soil, limiting the exposure of phosphorus to soil adsorption sites. The studies also found that soils will release phosphorus to the ground water when the water table is high and the soils are flooded for several weeks.

In view of this information, it is apparent that the likelihood of a septic system contributing phosphorus to lake waters is enhanced if the septic system is located in thin soils on ledgerock, or if the septic system is located in an area which experiences a seasonally high water

table which saturates soils with water. If many lakeside septic systems fall into these categories, it is probable that septic systems are an important factor in the eutrophication of the lake.

In homes with laundry facilities, the phosphorus passing through the septic system can be reduced 30-40 percent by the use of nonphosphate laundry detergents. Concerned lakeside residents should adopt a "better safe than sorry" attitude towards phosphate detergents. The use of nonphosphate laundry detergents by lakeside residents would constitute a sincere personal commitment to taking every available step to abate eutrophication of the lake.

In homes with laundry facilities, the phosphorus passing through the septic system can be reduced 30-40 percent by the use of nonphosphate laundry detergents. Concerned lakeside residents should adopt a "better safe than sorry" attitude towards phosphate detergents. The use of nonphosphate laundry detergents by lakeside residents would constitute a sincere personal commitment to taking every available step to abate eutrophication of the lake.

Section 25-54oo of the Connecticut General Statutes enables the DEP to an the use of phosphate detergents in a lake watershed to protect lake water quality. Originally, this authority was developed to enable the DEP to control eutrophication in cases where community-wide septic system failures had been identified but the construction of community sewers was not imminent. The exercise of this authority to control phosphorus from non-failing septic systems is a new concept which warrants consideration as lake diagnostic studies develop detailed information about septic systems and soils in lake watersheds.

Cottage Conversions - In many lakeside communities, seasonal cottages have been winterized and converted to permanent homes. If a septic system is not expanded and upgraded when a conversion occurs, it may not conform to minimum requirements of the Public Health Code. Local health officials must evaluate the adequacy of septic systems serving converted cottages, and oversee the timely correction of inadequate systems. Cottage conversions are usually subject to local building permits and zoning approval.

Lawn and Garden Fertilizers - Lawns and gardens are generally very efficient at utilizing soil nutrients and preventing their loss through runoff and leaching. However, runoff and leaching of nutrients can occur if fertilizer applications exceed nutrient requirements, or if fertilizers are applied prior to storm events which cause runoff. These situations can be avoided if fertilizers are matched to soil requirements, and if applications are timed to avoid periods of runoff. Soil test kits can be purchased at a nominal charge from the University of Connecticut Cooperative Extension Service county offices. The samples are analyzed at the Extension Service Laboratory, and the results identify soil nutrient deficiencies.

Yard and Garden Vegetation Disposal - Leaves, grass clippings, and other vegetative material from yard and garden maintenance should not be deposited in a location where the material may be washed into the lake.

Vegetative material will add to the sediment in the lake and will provide plant nutrients upon decomposition. Each property owner should select a suitable site away from the lake and its watercourses for the composting of vegetative material.

Agricultural Land

An acre of agricultural land will contribute less phosphorus to a lake than an acre of residential land in the same location, but more phosphorus than an acre of woodland in the same location. Agricultural sources of phosphorus and sediment are associated with cropland, with pasture land and feed lots, and with manure storage and handling.

The Connecticut 208 Program, through the Connecticut Council on Soil and Water Conservation, conducted a statewide study of agricultural non-point sources of pollution and developed a program for the implementation of Best Management Practice (BMP) controls. The most effective agricultural BMP's identified by the Connecticut 208 Program are cover crops, field border filter strips, critical area planting, diversions, grassed waterways, streambank protection, animal waste management, optimum manure and fertilizer application rates, and changing from cultivated crops to permanent vegetation. Additional effective practices, very effective in some areas, are contour farming, contour strip cropping, no-till planting, conservation cropping, pasture and hayland management, planned grazing, protection of heavy use areas, subsurface drainage, roof gutters in barn areas, mulching, fencing to keep livestock from streams and stream banks, proper manure spreading and fertilization techniques, and prompt incorporation of manure into soils.

Implementation of the statewide agricultural BMP Program is being managed by the Connecticut Council on Soil and Water Conservation. The program relies on voluntary participation through education and incentives, resorting to regulatory authority only in major problem areas where voluntary initiative is unsuccessful. Technical expertise is provided by the USDA Soil Conservation Service and State Soil and Water Conservation Districts. A primary source of federal cost sharing for BMP's is the USDA Agricultural Stabilization and Conservation Service, which can provide up to 75% funding for erosion and sedimentation controls, and soil and water conservation.

A basis goal of the statewide program is to promote accelerated implementation of BMP's in watersheds designated "high priority" by the 208 Program agricultural study. Several lakes will benefit from this strategy. The watersheds of Roseland Lake and Wappaquassett Lake are designated "Highest Priority" by the 208 study. The impact of agricultural activity on the water quality of Roseland Lake was estimated to be highly significant. The impact on Wappaquassett Lake was estimated to be moderately significant. The Watersheds of Lake Wononpakook, Mudge Pond, Beardsley Pond, and Fitchville Pond were designated as "High Priority" by the 208 study. The impact of agricultural activity on water quality was estimated to be highly significant for Mudge Pond and moderately significant for Wononpakook, Beardsley, and Fitchville.

The agricultural BMP Program also includes the implementation of several statewide objectives over the next 15-20 years. These consist of the implementation of erosion controls on sites with high calculated soil loss; the implementation of BMP's for retention of soils on critical sites near watercourses; the establishment of vegetated buffer strips between cultivated fields and watercourses, and between barnyards and watercourses; the establishment of winter cover crops on cultivated fields; and the development of farm waste management systems with routine review and follow-up inspections.

A lake organization should consult with the local Soil and Water Conservation District to obtain information on the status of agricultural activities in its particular lake watershed. The lake organization should establish cooperative, working relationships with District personnel, Soil Conservation Service personnel, and local farmers in order to develop a strategy for the timely implementation of agricultural BMP's needed to protect lake water quality.

Woodland and Timber Harvesting

An acre of properly managed woodland in a lake watershed contributes much less phosphorus to the lake than an acre of residential land in the same location. However, harvesting of timber for firewood or lumber is aland disturbance activity which has the potential to cause serious erosion and sedimentation. Under the Connecticut 208 Program, a Forestry Advisory Committee undertook a statewide study of the impacts of timber harvesting on water quality. A field study and analysis of 80 logging sites was conducted by the committee in 1979. In general, it was found that harvesting practices in Connecticut are limited in scope and intensity, and rarely involve types of timber, slopes, harvesting equipment, or management practices which lead to severe water quality degradation. The committee concluded that harvesting operations did not affect nutrient export levels, but could cause site specific problems with sedimentation.

The Forestry Advisory Committee has adopted a policy of advocating voluntary compliance with best management practices to control erosion and sedimentation by timber harvesting. Appropriate practices are described in the Committees' handbook entitled "Logging and Water Quality in Connecticut - A Practical Guide for Protecting Water Quality While Harvesting Forest Products". This document is available from the Connecticut 208 Program or the Connecticut Forest and Park Association, Inc. The handbook describes effective and practical erosion and sedimentation controls related to haul roads, skid trails, stream crossings, harvesting practices, and job termination practices. A lake organization should develop cooperative working relationships with landowners, loggers, and foresters to ensure that these best management practices are employed in the lake watershed.

Wetlands

Scientific research has demonstrated that wetlands in a lake watershed play a vital role in regulating the timing of transport of phosphorus to the lake. During the spring and summer biological growth

period, wetlands remove significant amounts of phosphorus from overlying waters and effectively withhold that phosphorus from transport downstream. Mechanisms by which wetlands retain phosphorus include physical entrapment of particulate phosphorus, chemical sorption by organic matter and soil particles, uptake by aquatic plants and attached algae, and utilization by bacteria and other microorganisms. During the fall and winter, wetlands release phosphorus as decomposition of wetland vegetation takes place. Consequently, transport of this phosphorus to downstream waters and to the lake occurs at a time of the year when the phosphorus is least likely to contribute to nuisance algae blooms and weed growth.

Thus, although little phosphorus is permanently withheld by wetlands on an annual basis, the "spring and summer storage; fall and winter release" pattern of phosphorus flux through a wetland serves to minimize summer algae blooms and weed problems in a downstream lake. Wetlands in a lake watershed should be appreciated for this valuable service provided to lake water quality.

The perpetuation of a wetland's phosphorus regulatory function involves, quite simply, maintaining the wetland in a natural state. Alteration or elimination of the wetland reduces or eliminates the effectiveness of this regulatory role and contributes to the degradation of the trophic condition of a downstream lake.

Another important function of wetlands relevant to lake water quality is the control of flooding and associated erosion. Wetlands retain water during periods of high runoff and gradually release water at moderate rates of flow. This flow regulation reduces flooding and erosion which could contribute sediment and phosphorus to a lake. The importance of this function for a particular wetland depends on the topography of the surrounding land, the location within the lake drainage basin, and the size of wetland area relative to the size of its drainage area. Alteration or elimination of wetlands would impair the regulation of runoff, and sediment and phosphorus loads to a downstream lake would increase.

It is recommended that the appropriate wetlands regulatory agency utilize the authorities of Connecticut's Inland Wetlands and Watercourses Act (Sections 22a-36 through 22a-45 Connecticut General Statutes) to maintain the wetlands in a lake watershed in their natural states. This is particularly important for wetlands which are contiguous with the lake or its tributary watercourses. Maintaining wetlands in their natural states will protect lake water quality by providing for continued regulation of seasonal phosphorus loads, and continued control of flooding which could cause erosion.

Specifically, a wetlands agency should give due consideration to wetlands functions which enhance lake water quality when acting on permit application for regulated activities in legally defined wetlands. This consideration is appropriate since the review of application must, by statute, weigh environmental impacts of proposed actions, and weigh irreversible and irretrievable commitments of resources associated with

proposed actions. In order to facilitate the implementation of this recommendation, a wetlands agency should make special recognition of lake watershed wetlands on working maps used by agency members.

Stormwater Runoff

Stormwater runoff is the overland flow of water associated with precipitation events of periods of snowmelt. Runoff from residential areas and roadways in a lake results in the transport of sediments, phosphorus, and other pollutants to lake waters. A watershed management program should include measures for minimizing the impacts of stormwater runoff. The following measures should be considered:

Preservation of Wetlands - Wetlands provide for the temporary storage and gradual release of stormwater runoff, and provide for the retention of phosphorus, sediments, and other pollutants. Preservation of wetlands in accordance with Sections 22a-36 through 22a-45 of the Connecticut General Statutes is an important way to control stormwater runoff.

Existing Residential Areas - Stormwater transport of sediment from residential areas to a lake can be controlled by the installation of storm sewers with sediment traps at catch basins and points of discharge. Sediment traps must be cleaned of sand, leaves, and other debris on a regular basis to maintain their effectiveness. Routine street sweeping in the early spring should be conducted in lakeside residential areas to minimize the amount of sand and debris susceptible to stormwater transport. The rate of stormwater runoff can be reduced by employing artificial stormwater detention ponds and by minimizing the amount of impervious and semipervious pavements and surfaces.

New Residential Areas - Stormwater runoff from planned residential areas can be controlled by including stormwater management as part of the overall site development plan. Stormwater control measures should be incorporated into the site plan so that the runoff rate from the developed site is the same as it had been prior to development. Methods of stormwater control which can be considered include preservation of wetlands, installation of artificial stormwater detention ponds, temporary storage in open spaces, temporary storage in underground tanks, and the use of permeable pavements.

An effective means of implementing stormwater management is through town planning and zoning regulations which require Stormwater Runoff Control Plans for the detention and controlled release of stormwater runoff from new developments. Generally, plans should be required for sites where impervious surfaces exceed 60 percent of the total area. The Guidelines for Soil Erosion and Sediment Control can be used as a guide for local regulations.

Roadway Runoff - State highways, town streets, and unpaved roads can be significant sources of sediments in lake watersheds. Under the Connecticut 208 Program, the Northwestern Connecticut Regional Planning Agency developed a report entitled "Best Road Maintenance Practices for Critical Watersheds" which should be used as a guide to minimizing

erosion and sedimentation from roadways in lake watersheds. The report presents detailed information on the design of roadway drainage systems; the management of paved roadways, including sanding operations and early spring street cleaning; the stabilization of road banks with vegetation and proper grading; and the grading and surfacing of unpaved roads. A lake organization should establish cooperative working relationships with appropriate town and/or state maintenance officials in order to implement a sound management program for lake watershed roads.

Waterfowl

Ducks and geese are generally considered attractive wildlife assets which enhance the aesthetic appeal of a lake. However, large numbers of migratory waterfowl which spend considerable periods of time on a lake can contribute appreciable loadings of phosphorus and nitrogen to lake waters. In a study of one Connecticut Lake, it was estimated that the phosphorus in the excrement of four geese in one month was equivalent to the total annual loading of phosphorus from 2.5 acres of watershed land. In order to quantify the impact of waterfowl on a lake, it is necessary to develop accurate information on waterfowl population numbers, feeding habits, resting areas, and periods of occupancy. In the absence of detailed information, it should be recognized that large flocks of migratory waterfowl which stop at a lake for many weeks can be an important factor in the eutrophication process.

Waterfowl can be controlled by methods which discourage large flocks from frequenting the lake. The U. S. Fish and Wildlife Service regulates all migratory bird activities that involve handling the birds, such as trapping, banding, and hunting. This agency also provides information on methods of harassment. These activities include mechanical barriers, landscaping techniques, scarecrows and other foreign objects, automatic exploders, flashing lights, balloons, and chase dogs. Information on these methods can be obtained from U. S. Fish and Wildlife Service, 4 Whalley Street, Hadley, Massachusetts 01035.

The DEP Wildlife Bureau lends assistance and cooperation in controlling nuisance waterfowl whenever possible. The DEP is studying the potential of special goose hunting by certified, competent hunters to control nuisance populations in areas where safety considerations are not prohibitive. Assistance regarding special goose hunting can be obtained from the DEP Wildlife Bureau in Hartford.

Streambanks and Shorelines

Streambanks and shorelines are sites where erosion can cause serious cause sedimentation which immediately impacts a lake. Activities which disturb the land surface should be avoided in these areas, and maintenance of a zone of natural vegetation, or a greenbelt, should be encouraged. Construction activities in these areas should employ erosion and sediment controls as described in Guidelines for Soil Erosion and Sediment Control.

General guidance for stabilizing streambanks and protecting streambanks and protecting streambanks against scour and erosion is

presented in the Guidelines for Soil Erosion and Sediment Control. Measures to be considered for critical streambank sites include bank sloping, riprap, vegetation, jetties, fencing, and removal of obstructions. Each streambank site is unique, and implementation of controls should be done under the guidance of the federal Soil Conservation Service and/or the county State Soil and Water Conservation District.

It is a common practice for lakeside property owners to construct masonry retaining walls along shorelines which are vulnerable to erosion. Retaining walls absorb the shock of waves, and prevent soil from moving off the land and into the lake. General guidance on the construction of retaining walls is provided in the Guidelines for Soil Erosion and Sediment Control. Additional guidance should be obtained from professional builders.

Erosion and sediment control measures undertaken along streambanks and shorelines may require approval of the Inland Wetland Agency and/or the U. S. Army Corps of Engineers.

Atmosphere

Recent eutrophication studies have shown that measurable amounts of phosphorus may enter a lake through precipitation and dry atmospheric fallout. Precipitation data at one Connecticut lake suggested that atmospheric phosphorus was associated with pollen dispersion. Other research has suggested that atmospheric phosphorus emanates from local and distant sources of air pollution. Although atmospheric phosphorus is a factor in lake eutrophication, control of atmospheric loadings is not within the scope of a local lake management program.

Lake Sediments

Under certain conditions, sediments on the lake bottom can release phosphorus and nitrogen to overlying waters. Depending on lake mixing characteristics and algae bloom sequences, these recycled nutrients may contribute to nuisance algae blooms. The identification of internal enrichment can only be made through detailed lake water quality monitoring. Control of this source involves in-lake technology which is outside the scope of this handbook. However, it is important to recognize that for some Connecticut lakes, lake sediments are a significant source of enrichment of lake waters.

Resource Agencies

State and Federal

Department of Environmental Protection
Natural Resources, Water Compliance, Water Resources, Wildlife & Forestry Units
165 Capitol Avenue
Hartford, Connecticut 06106

Connecticut 208 Program
c/o Connecticut DEP Water Compliance Unit
165 Capitol Avenue
Hartford, Connecticut 06106

Connecticut Council on Soil & Water Conservation
State Office Building
165 Capitol Avenue
Hartford, Connecticut 06106

USDA Soil Conservation Service
Mansfield Professional Park
Storrs, Connecticut 06268

Connecticut Agricultural Experiment Station
123 Huntington Street
New Haven, Connecticut 06054

U. S. Geological Survey
450 Main Street
Hartford, Connecticut 06103

U. S. Fish and Wildlife Service
4 Whalley Street
Hadley, Massachusetts 01035

Connecticut Forest and Park Association, Inc.
1010 Main Street
P. O. Box 389
East Hartford, Connecticut 06108

U. S. Army Corps of Engineers
Regulatory Branch
424 Trapelo Road
Waltham, Massachusetts 02254

Regional Planning Agencies

South Central RPA
96 Grove Street
New Haven, Connecticut 06510

Housatonic Valley CEO
256 Main Street
Danbury, Connecticut 06810

Greater Bridgeport RPA
525 Water Street
Bridgeport, Connecticut 06604

CT River Estuary RPA
Hitchcock Corners
Essex, Connecticut 06426

Central CT RPA
1019 Farmington Avenue
Bristol, Connecticut 06010

Northeastern CT RPA
Sackett Hill Road
Warren, Connecticut 06754

Windham RPA
Main Street
Willimantic, Connecticut 06226

Capitol Region COG
214 Main Street
Hartford, Connecticut 06106

Southeastern CT RPA
139 Boswell Avenue
Norwich, Connecticut 06360

Northeastern CT RPA
P. O. Box 198
Brooklyn, Connecticut 06234

Central Naugatuck Valley RPA
20 East Main Street
Waterbury, Connecticut 06702

Midstate RPA
100 DeKoven Drive
Middletown, Connecticut 06457

Valley RPA
Derby Train Station
Main Street
Derby, Connecticut 06418

Southwestern CT RPA
213 Liberty Square
E. Norwalk, Connecticut 06855

County Offices

USDA Soil Conservation Service District Conservationist (SCS)
Soil and Water Conservation Districts (S&WCD's)
UConn Cooperative Extension Service Extension Agents (UCONN)

Fairfield County SCS, S&WCD
UConn Agricultural Center
Route 6 Stony Hill
Bethel, Connecticut 06801

Hartford County, SCS, S&WCD
Agricultural Center
340 Broad Street
Windsor, Connecticut 06095

Hartford County UCONN
Extension Service
Carriage House
Hartford, Connecticut 06105

Litchfield County SCS, S&WCD
UConn Agricultural Center
Litchfield, Connecticut 06759

Middlesex County SCS, S&WCD
UConn Extension Center
Route 9-A
Haddam, Connecticut 06438

New Haven County SCS, S&WCD
UConn Extension Service
322 North Main Street
Wallingford, Connecticut 06492

New London County SCS, S&WCD
UConn Extension Service
562 New London Turnpike

Tolland County SCS, S&WCD
UConn Agricultural Center
24 Hyde Avenue
Vernon, Connecticut 06066

Windham County SCS, S&WCD
UConn Extension Center
P. O. Box 112
Wolf Den Road
Brooklyn, Connecticut 06234

Resource Maps

Title	Prepared by*	Scale
Watershed Boundary (Drainage Basins)	RPA's, DEP NRC	1:24,000
Land Use	RPA's	1:24,000
Water Quality Sensitive Areas	RPA's	1:24,000
Erosion & Sediment Source Inventory	RPA's, S&WCD's	1:24,000
Areas of High Erosion Potential	RPA's	1:24,000
Open Space & Dedicated Lands	RPA's	1:24,000
Detailed Soils Groups	SCS DEP NRC	1:24,000

* RPA - Regional Planning Agency
S&WCD's - Soil & Water Conservation Districts
SCS - Soil Conservation Service
DEP NRC - Department of Environmental Protection Natural Resources Center

Resource Publications

Title	Source
"Erosion & Sediment Source Inventory"	CCSWC, RPA's, S&WCD's
"Guidelines for Soil Erosion and Sediment Control"	CCSWC
"Septic System Manual"	DEP Water Compliance Unit
"A Proposed Septic System Inspection & Maintenance Program for Killingworth, Ct."	CRERPA
" Voluntary Septic System Management Program for Canterbury, Killingly, and Woodstock"	NERPA
"A Voluntary Septic System Management Program for Quaddick Lake, Thompson"	NERPA
"A Homeowners Guide to Septic System Maintenance"	NERPA, NDDH
"Logging & Water Quality In Connecticut - A Practical Guide for Harvesting Forest Products & Protecting Water Quality"	Ct. 208 Forestry Advisory Committee
"Best Road Maintenance Practices for Critical Watersheds	NWRPA
"Connecticut AG 208 Project"	CCSWC
"Inventory of the Trophic Classifications of Seventy Connecticut Lakes"	DEP Natural Resources Center
"Lake Management Handbook - A Guide To Quantifying Phosphorus Inputs to Lakes"	DEP Water Compliance Unit, Windham RPA
"Lake Waramaug Watershed Management Plan"	DEP Water Compliance Unit, Northwestern CT RPA

Connecticut Lake Trophic Conditions

Trophic Condition	Lake	Town(s)	Surface Area (Acres)
Oligotrophic	Alexander	Killingly	190.4
	Bashan	East Haddam	276.3
	Beach	Voluntown	394.3
	Billings	North Stonigton	105.1
	Highland	Winchester	444
	Mashapaug	Union	297.1
	Uncas	Lyme	69
	West Hill	New Hartford	263
Early Mesotrophic	Bigelow	Union	18.5
	Candlewood	New Fairfield Sherman New Milford Danbury Brookfield	5,542.0
	Columbia	Columbia	277.2
	Crystal	Ellington, Stafford	200.9
	Dodge	East Lyme	33
	Long	Ledyard, North Stonington	98.6
	Mount Tom	Litchfield, Morris Goshen	61.5
	Norwich	Lyme	27.5
	Rogers	Lyme, Old Lyme	264.9
	Quassapaug	Middlebury	271
	Waumgumbaug	Coventry	378
	West Side	Goshen	42.4
	Wyassup	No. Stonington	92.4
Mesotrophic	Amos	Preston	105.1
	Black	Woodstock	73.4
	Burr	Torrington	85
	Cedar	Chester	68
	Cream Hill	Cornwall	72
	East Twin	Salisbury	562.2
	Gardner	Salem, Montville Bozrah	486.8
	Glasgo	Griswold	184.2
	Gorton	East Lyme	53
	Hayward	East Haddam	198.9
	Little School house	Thompson	68.4

(continued)

Trophic Condition	Lake	Town(s)	Surface Area (Acres)
Mesotrophic	Lower Bolton	Bolton, Vernon	178.4
	Pachaug	Griswold	830.9
	Pattagansett	East Lyme	123
	Pocotopaug	East Hampton	511.6
	Powers	East Lyme	152.6
	Quaddick	Thompson	466.8
	Quonnipaug	Guilford	111.6
	Shenipist	Vernon, Ellington Tolland	52.8
	Squantz	New Fairfield Sherman	288
	Terramuggus	Marlborough	83
	Tyler	Goshen	182
Late Mesotrophic	Ball	New Fairfield	89.9
	Black	Meriden Middlefield	75.6
	Hitchcock	Wolcott	118.4
	Middle Bolton	Vernon	114.9
	Moodus	East Haddam	451
	Mudge	Sharon	201
	Taunton	Newtown	126
	Waramaug	Warren, Washington Kent	680.2
Eutrophic	Bantam	Litchfield, Morris	916
	Batterson Park	Farmington New Britain	162.7
	Beseck	Middlefield	119.6
	Eagleville	Mansfield	80
	Housatonic	Shelton	382.2
	Kenosia	Danbury	56
	Linsley	No. Branford Branford	23.3
	Long Meadow	Ledyard, No. Stonington	11.7
	Mamanasco	Ridgefield	95
	Roseland	Woodstock	88
	Wononpakook	Salisbury	164
	Wononscopomuc	Salisbury	352.6

(continued)

Trophic Condition	Lake	Town(s)	Surface Area (Acres)
Highly Eutrophic	Cedar	North Branford	21.8
	1860 Reservoir	Wethersfield	35
	Lillinonah	Southbury Bridgewater Brookfield, Newton	1900
	North Farms	Wallingford	62.5
	Silver	Berlin, Meriden	151
	Winnemaug	Watertown	120
	Zoar	Newtown, Monroe Oxford, Southbury	975

A Management Guide for Connecticut Lakes

A Primer on the Control of Algae and Aquatic Weeds

State of Connecticut

Department of Environmental Protection

Water Compliance Unit

June 1986

A MANAGEMENT GUIDE FOR CONNECTICUT LAKES

A Primer on the Control of Algae and Aquatic Weeds

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER COMPLIANCE UNIT

JUNE 1986

For more information contact:
Charles Fredette
Nancy Marin
DEP Water Compliance Unit
Lakes Management Section
165 Capitol Avenue
Hartford, Connecticut 06106
(203) 566-2588

A MANAGEMENT GUIDE FOR CONNECTICUT LAKES

INTRODUCTION

Connecticut's lakes and ponds are valuable natural resources which are used intensively for swimming, fishing and boating. Our lakes are also important economic entities, adding to local property values and augmenting the tax revenues of local communities. Connecticut's lakes are resources deserving of our protection and, in many cases, our commitment to restoration.

CONNECTICUT'S LAKES PROGRAM

The Lake's Management section of the DEP Water Compliance Unit is the agency which oversees lake water quality and related issues. Our staff of biologists and engineers are available for assistance on the following:

- in-lake algae and weed control techniques
- watershed management guidelines
- general information on algae and weeds
- general water quality data on a large number of Connecticut lakes
- technical assistance and review of proposed plans for lake projects
- Environmental Review Team Projects
- information on financial assistance programs for algae and weed control activities.

EUTROPHICATION

Unfortunately all of our lakes and ponds undergo a natural aging process called eutrophication. Eutrophication is a form of water pollution which results in the decline of a lake's recreational utility and aesthetic appeal. The process generally advances over many, many years, however it can be accelerated by human activities in the lake's watershed. Through awareness and commitment the process is controllable and manageable. "A Watershed Management Guide for Connecticut Lakes" (1986) presents the principles of eutrophication control through prudent management of the land surrounding the lake. This publication is available at no charge from the Department of Environmental Protection (DEP) Water Compliance Unit at (203) 566-2588. The effectiveness of the lake management techniques described in this handout will be greatly enhanced by the implementation of a sound watershed management plan.

It is generally accepted that there are 3 stages of eutrophication. These stages are termed oligotrophic, mesotrophic and eutrophic. Oligotrophic lakes are in the earliest stages of the process. These are deep lakes with clear, infertile waters and little or no algae and aquatic weed growth. There are only minor accumulations of sediments on the bottom and even the deepest waters are well oxygenated. Eutrophic lakes are in the latter stages of the process, with water quality characteristics exactly opposite those found in oligotrophic lakes. These lakes have limited recreational utility. Mesotrophic lakes fall somewhere between these two extremes.

The preceding description of the eutrophication process applies to natural lakes. There are many man-made lakes and ponds in Connecticut, formed by

damming a stream or excavating a wet area. These artificial waterbodies often exhibit an advanced stage of eutrophication from the time they are created. Improvement of water quality conditions in man-made lakes is extremely difficult because restoration does not involve the return to previous conditions, but rather involves the creation of conditions which never existed previously.

MEASURES OF WATER QUALITY

Every lake is a complex system of interactions between chemical, physical and biological components. In order to better understand the lake system, it is essential to have a basic understanding of many of these elements. Selection of the most appropriate management option depends on a sound knowledge of the lake system. The following is a brief description of the most common parameters used to assess lake water quality.

Nutrients: Algae and aquatic weeds, not unlike their terrestrial counterparts require nutrients to grow. The most common of these plant nutrients are phosphorus and nitrogen. Enrichment of a lake with these nutrients is the fundamental cause of eutrophication. The nutrient most often in the shortest supply in the lake system is phosphorus, therefore, controlling phosphorus inputs to lake waters is the key to controlling eutrophication.

Water Temperature/Dissolved Oxygen: Water temperature and dissolved oxygen levels play extremely important roles in the lake ecosystem. The two parameters are very closely linked. Water temperature determines the lake's mixing characteristics, dissolved oxygen levels and the type and extent of the fishery. Dissolved oxygen (D.O.) is essential to the metabolism of nearly all aquatic organisms.

Summer Stratification: Deep lakes thermally stratify into distinct "thermal zones" during the summer months. These zones are depicted in Figure 1. Each zone is physically separated from the other by temperature/density differences between the layers.

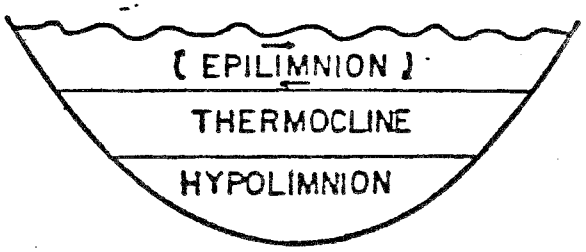


Figure 1.

TYPICAL SUMMER STRATIFICATION OF A DEEP LAKE

Typical Summer Stratification of a Deep Lake: The epilimnion, or top layer, is fairly uniform in temperature and well mixed. Aquatic weeds

and most summer algae blooms occur in this zone. Oxygen levels are generally high due to atmospheric diffusion and photosynthetic activity. The thermocline or metalimnion is a transition zone in which the water temperature drops approximately 1°C with each meter increase in depth. The hypolimnion or bottom layer contains the lake's coldest waters.

The distribution of D.O. is within a lake is dependent upon water temperature and biological activity. The colder water is, the more oxygen it can "hold." During the summer months the cold bottom waters of unproductive, oligotrophic lakes are generally well oxygenated. In a highly productive, eutrophic lake, biological processes like as the decay of organic material such as dead aquatic weeds, "robs" oxygen from the overlying waters of the hypolimnion. During stratification when the bottom zone is separated from the upper layers, the oxygen supply cannot be replenished by the well oxygenated epilimnion and the oxygen supply can become depleted. If this occurs, only those organisms which can live in the absence of oxygen can survive. Lack of oxygen or anaerobic conditions results in the loss of fish habitat and sets up conditions which allow for the release of nutrients like phosphorus and ammonia nitrogen into the overlying waters. Lakes in which anaerobic conditions exist for a long period of time may have significant quantities of nutrients recycled from the sediments into lake waters.

Fall Overturn: In the fall the epilimnion cools off, becomes more dense and consequently sinks and mixes with the underlying waters. This is referred to as fall overturn. Eventually the entire lake mixes surface to bottom and temperature and nutrient levels are uniform throughout the water column. Dissolved oxygen concentrations are replenished to all depths.

Winter Stratification: Winter stratification differs from summer stratification in that the coldest waters are found at the lake's surface. When the lake or pond freezes over, D.O. levels can once more become low or depleted. The formation of the ice cover eliminates the atmospheric oxygen contribution. If there is snow on the ice, light penetration is greatly reduced and consequently so is photosynthetic activity, of which oxygen is a product. In shallow, eutrophic lakes winter fish kills can result when oxygen levels become insufficient.

Spring Turnover: In the spring, when the ice melts. the lake turns over a second time. The spring turnover is accomplished primarily by wind action. At this time the water column is again uniform in it's physical and chemical characteristics. The lake will remain mixed until the surface waters warm, bringing about the onset of summer stratification and the stratification cycle begins again.

Stratification of Shallow Lakes and Impoundments: There are some exceptions to the typical stratification pattern. These exceptions include artificial impoundments with short residence times and shallow lakes and ponds. In these cases, there may be a temperature gradient where surface waters may be only slightly warmer than bottom waters or

the temperature and chemical characteristics may be nearly uniform throughout the water column. In many shallow ponds, such as man-made ponds, D.O. depletion of the bottom waters by decay processes and subsequent nutrient release into overlying waters may be a significant source of nitrogen and phosphorus. In lakes that don't stratify, these nutrients are readily available to algae and weeds in the surface waters.

Algae and Aquatic Weeds: Perhaps the most familiar characteristic of a eutrophic lake is the presence of nuisance populations of algae and aquatic weeds.

Algae: There are three basic types of algae: planktonic, filamentous and macrophytic. Planktonic algae are microscopic single cells or filaments and are suspended in the water column. These include the diatoms, green and blue green algae. Filamentous algae are the long green thread-like algae that many times form floating mats but also may grow on the lake bottom. Most often these mats are composed of members of the blue green algae. Macrophytic algae resemble rooted plants but are actually advanced forms of algae. The two most common types are Chara and Nitella, the stoneworts, which grow on the lake bottom.

Aquatic Macrophytes: There are four types of aquatic macrophytes: free floating, emergent, rooted with floating leaves and submergent. The free-floating aquatic plants are commonly referred to as duckweed and watermeal. These plants are non-rooted forms that appear like small clovers. Frequently their growth is so dense that a dense mat may form over the entire water surface. Emergent forms of weeds are rooted in the lake bottom but extend through the water on into the air. Examples of emergent weeds are cattails, pickerelweed, and arrowhead. Waterlilies and the smaller-leaved watershield are types of rooted plants with leaves that float on the water's surface. Submergent macrophytes are rooted in the sediments and the entire plant grows under the water. Many of these plants grow right to the water surface, and some have floral bracts which may extend out of the water. Most forms which are considered the greatest nuisance are found in this group: the pondweeds (Potamogetons), coontail (Ceratophyllum), and the water milfoil (Myriophyllum).

The mere presence of algae and/or aquatic weeds does not indicate that a water quality problem exists. Algae and aquatic weeds provide fish and other aquatic organisms with food, habitat, spawning areas, as well as supply oxygen through the process of photosynthesis.

When algae or weed growth becomes so extensive that it interferes with the desired uses of the lake or pond, then some sort of balance between intended uses and nature must be achieved, and some measure of control or management technique must be employed.

The following is a brief discussion of the most common methods of algae and weed control. As stated earlier in the handout, it is extremely important to understand that the effective life of each of these methods will greatly

enhanced if a prudent management plan is instituted for the watershed. It is also important to realize that a basic understanding of the lake system is necessary to enable the proper choice of method.

ALGAE CONTROL METHODS

Aeration/Destratification: Aeration is the process of artificially mixing the waterbody with compressed air or mechanical aerators (fountins). The purpose of aeration is actually two-fold. First by maintaining elevated levels of oxygen in the water column the nutrient contribution from the sediments is sealed off and secondly, the turbulence created by the system selects for growth of certain algal types which are less likely to become a nuisance.

Chemical Treatments: The use of any algicide or herbicide within Connecticut's lakes and ponds is regulated by state statute (section 430 of Public Act 872) and permits are required from the pesticides control section of the DEP. Prior to its approval, the permit application is reviewed by the DEP Pesticides Control staff, DEP Fisheries Bureau personnel and if the lake if located in a public water supply watershed, it is also reviewed by the State Department of Health Services.

The Pesticides Control Section offers a publication "Control of Water Weeds and Algae" available at no charge from (203) 566-5148. This booklet explains the types of chemicals available and the algae and weed types on which they are most effective. Chemical treatments are only cosmetic, providing immediate short term relief. Repeated applications may be necessary during the growing season.

Lakewide herbicide treatments may actually be detrimental to water quality. When all of the weeds die off at once, they are all decomposing on the lake bottom at the same time. This creates a tremendous drain on the oxygen supply of the bottom waters, setting up the proper condition for sediment recycle of nutrients as explained earlier. In a shallow, unstratified lake these nutrients are readily available for uptake by algae and blooms may result. Reduced competition for the nutrients by the weeds may also induce increased algae growth.

Hypolimnetic Withdrawal: This technique is a new experimental method which is currently in use at two Connecticut lakes. Prior to consideration of this technique, a diagnostic study must be completed to investigate the lake's nutrient cycling patterns.

AQUATIC WEED CONTROL METHODS

Aquashade: Aquashade is an inert blue coloring agent or dye which filters out the wavelengths of light which are required by aquatic plants to grow. Lakes which are candidates for aquashade treatments should have a relatively small volume of water and a long retention time (time it takes lake to flush). Aquashade however, is non-selective in the weeds it controls and also may not control some of the more vigorous weed growth. Aquashade does not control

weeds growing in water less than 3 feet deep, nor does it prevent surface blooms of planktonic algae. The application of Aquashade requires a permit from the DEP Pesticides control section. Permit applications and additional information on Aquashade may be obtained by calling (203) 566-5148.

Benthic Weed Barriers: Benthic weed barriers consist of various grades of fiberglass mesh screening or perforated black nylon screening which is laid down upon the sediments to prevent weeds from growing by "mulching" them. Bottom barriers are useful at beach areas, docks and to create boating lanes.

Chemical Treatments: (see discussion in the algae control section above).

Drawdown and Excavation: If the spillway has the capacity to effectively lower the water level, lakes and ponds may be drawn down to expose the sediments in order to dry them out. In other cases when there is no water level control structure, the lake may be pumped or siphoned out. The water level is generally lowered following the recreation season.

Drawdown and excavation is sometimes employed to remove the substrate utilized by the plants for growth. The process increases water depth to levels where plants growing on the bottom will not receive enough light to survive. The effects of this method are generally long-termed. Selective excavation allows some areas to remain untouched as aquatic habitat. The DEP Fisheries Bureau should be consulted on the impact on the fishery.

The drawdown and excavation process requires the use of heavy equipment and it must be determined through engineering studies whether the pond bottom can support this weight.

This method has a relatively high capital outlay; however, the restorative effects are long termed. It is relatively quick and inexpensive compared to hydraulic dredging. State and/or local inland wetlands permits are required.

If this method is given further consideration, a feasibility study should be conducted to "map" lake sediments according to depth, composition, and underlying substances. Final disposal of excavated sediments should also be explored during the feasibility study. Hydraulic dredging (see discussion below) accomplishes the same goal as drawdown and excavation, but is far more costly due to increased specialization and complexity.

Hydraulic Dredging: Hydraulic dredging is the process of removing lake sediments without draining the water from the lake. Specialized dredges are employed which remove the sediments by suction as a slurry. The slurry is approximately 90% water and 10% sediments. This sediment must be "dewatered" prior to disposing of it, and the remaining water usually must be treated before it can be discharged. The development and construction of dewatering,containment basins is a major and expensive undertaking. State discharge and state and/or local inland wetlands permits are required.

A great deal of feasibility work must be completed by a qualified engineering/environmental firm prior to undertaking project of this scale. Capital outlay is extremely high, however the benefits of this method are generally long-termed.

Weed Harvesting: Weed harvesting entails the mechanical cutting of the weeds. After the weeds are cut they are drawn up into the harvester by a conveyer belt. When the harvester is full it is unloaded at a shoreline location. The weeds must then be disposed of at a site far removed from the lake so as not to become a source of nutrient enrichment. One benefit of harvesting is the actual removal of nutrients from the lake system. Another is that selected areas may be left untouched while others are harvested thus creating fishery habitat while increasing recreational utility. Although harvesting provides immediate relief it too may have to be repeated at periodic intervals and is a moderately expensive measure.

There are a few lakes in Connecticut whose lake associations have purchased their own weed harvesters for use on their particular lake. Many other lake associations contract out to weed control specialists for this service.

No state or local permits are required for weed harvesting activities.

Hydroraking: Hydroraking is a specialized type of weed harvesting which involves the mechanical removal of aquatic plants and their root systems. Hydroraking is more effective on certain weed types than on others. Adequate control over water lilies has been achieved with the hydrorake in some cases. As with weed harvesting there is the benefit of removing both weeds, and nutrients from the system.

Weed Eating Fish: Although this technique is used to varying extents in other states, the introduction of weed eating fish species is prohibited by law in the State of Connecticut. The effects of such introductions on the complex biology of lakes, ponds and rivers has not yet been adequately quantified. Contrary to what has been published in much of the popular literature, there is substantial evidence that the weed eating white amur, also called grass carp (members of the minnow/carp family), does effect the food chain in lakes and ponds. Some of the negative impacts observed during scientific studies are: (1) a reduction in crayfish production, (2) an increase in the populations of some plant species due to preferential feeding on others, (3) the inducement of algal blooms due to the concurrent elimination of macrophytes and influx of nutrients via grass carp feces, (4) interference with the reproduction of game fishes requiring vegetation for spawning, (5) reduced production of fishes requiring weed beds for refuge, and (6) the creation of unbalance ecosystems where species diversity was reduced and fish populations become unstable. these negative effects do not occur in all cases. However, we do not yet have the knowledge to predict what will happen in a specific pond or lake and therefore, cannot allow grass cap introductions to be made. The danger that introduced fish may be caught and subsequently transported to other bodies of water must also be considered.

Winter Drawdown: If the spillway has the capacity to effectively lower the water level, lakes and ponds may be drawn down to expose the sediments. In some cases lakes may be siphoned or pumped out. Over the winter, the bottom freezes and destroys roots, vegetative parts and susceptible seeds. Winter drawdown does not kill algae. Several Connecticut Lakes have gained control over weed problems using this method.

There are several advantages to overwinter drawdown including: no loss of summer recreational utility during project, virtually no-cost, and by

concentrating fish populations there may be an increase in the growth rates of predator fish because of a reduction in the energy used for foraging for prey species. While the water level is down it is possible to selectively excavate sediments from areas that are particularly shallow or weed infested. These nutrient rich sediments should be deposited at a site removed from the lake so as not to become a source of sedimentation or nutrients to lake waters. Excavation activities may require state or local inland wetlands permits.

There are some disadvantages to overwinter drawdown including: lowering the water table significantly may dry up shallow wells around the lake, there may be possible downstream flooding during the drawdown, some species of weeds are not controlled by this method, and the method is non-selective and may result in the loss of fish and aquatic organism habitat. All of these considerations should be thoroughly examined prior to lowering the lake level.

ABOUT THE TEAM

The King's Mark Environmental Review Team (ERT) is a group of environmental professionals drawn together from a variety of federal, state, and regional agencies. Specialists on the Team include geologists, biologists, soil scientists, foresters, climatologists, landscape architects, recreational specialists, engineers, and planners. The ERT operates with state funding under the aegis of the King's Mark Resource Conservation and Development (RC & D) Area - a 83 town area serving western Connecticut.

As a public service activity, the Team is available to serve towns and/or developers within the King's Mark RC & D Area - free of charge.

PURPOSE OF THE ENVIRONMENTAL REVIEW TEAM

The Environmental Review Team is available to assist towns and/or developers in the review of sites proposed for major land use activities. For example, the ERT has been involved in the review of a wide range of significant land use activities including subdivisions, sanitary landfills, commercial and industrial developments, and recreational/open space projects.

Reviews are conducted in the interest of providing information and analysis that will assist towns and developers in environmentally sound decision-making. This is done through indentifying the natural resource base of the site, and highlighting opportunities and limitations for the proposed land use.

REQUESTING AN ENVIRONMENTAL REVIEW

Environmental Reviews may be requested by the chief elected official of a municipality, or the chairman of an administrative agency such as planning and zoning, conservation, or inland wetlands. Environmental Review Request Forms are available at your local Soil and Water Conservation District, and the King's Mark ERT Coordinator. This request form must include a summary of the proposed project, a location map of the project site, written permission from the landowner/developer allowing the Team to enter the property for purposes of review, and a statement identifying the specific areas of concern the Team should investigate. When this request is approved by the local Soil and Water Conservation District and King's Mark RC & D Executive Committee, the Team will undertake the review. At present, the ERT can undertake two (2) reviews per month.

For additional information regarding the Environmental Review Team, please contact your local Soil and Water Conservation District or Keane Callahan, ERT Coordinator, King's Mark Environmental Review Team, King's Mark Resource Conservation and Development Area, 322 North Main Street, Wallingford, Connecticut 06492. King's Mark ERT phone number is 265-6695.