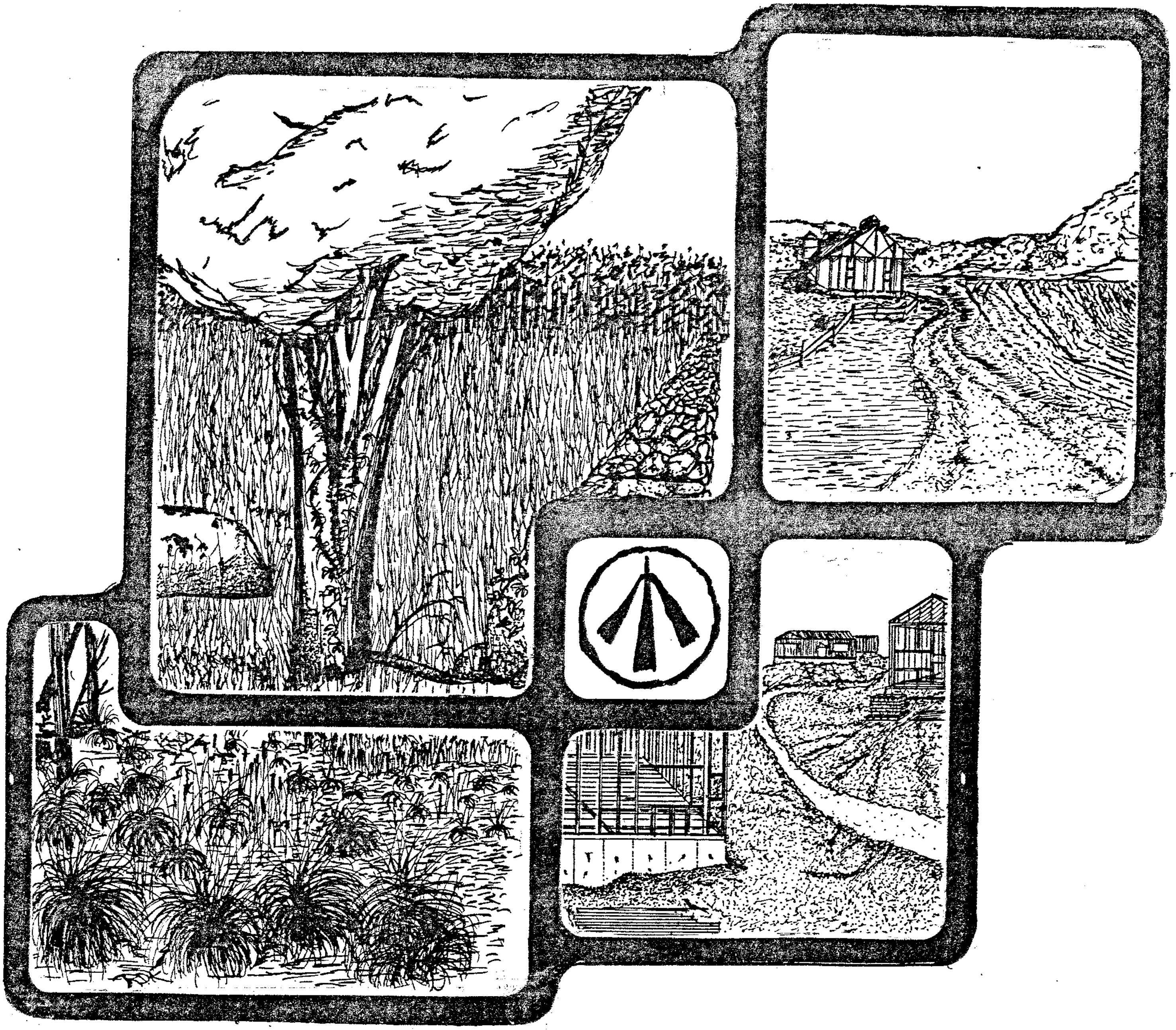
ENVIRONMENTAL REVIEW TEAM REPORT



RADER POND
WOODBURY, CT

KING'S MARK
RESOURCE CONSERVATION & DEVELOPMENT AREA

KING'S MARK
ENVIRONMENTAL REVIEW TEAM REPORT

RADER POND
WOODBURY, CT
JULY 1984

King's Mark Resource Conservation and Development Area
Environmental Review Team
Sackett Hill Road
Warren, Connecticut 06754

ACKNOWLEDGMENTS

The King's Mark Environmental Review Team operates through the cooperative effort of a number of agencies and organizations including:

Federal Agencies
U.S.D.A. Soil Conservation Service

State Agencies
Department of Environmental Protection
Department of Health
University of Connecticut Cooperative Extension Service
Department of Transportation

Local Groups and Agencies
Litchfield County Soil and Water Conservation District
New Haven County Soil and Water Conservation District
Hartford County Soil and Water Conservation District
Fairfield County Soil and Water Conservation District
Northwestern Connecticut Regional Planning Agency
Valley Regional Planning Agency
Central Naugatuck Valley Regional Planning Agency
Housatonic Valley Council of Elected Officials
Southwestern Regional Planning Agency
Greater Bridgeport Regional Planning Agency
Regional Planning Agency of South Central Connecticut
Central Connecticut Regional Planning Agency
American Indian Archaeological Institute
Housatonic Valley Association

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FUNDING PROVIDED BY
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Jamie Whitman, ERT Cartographer
Jamie Whitman, Secretary

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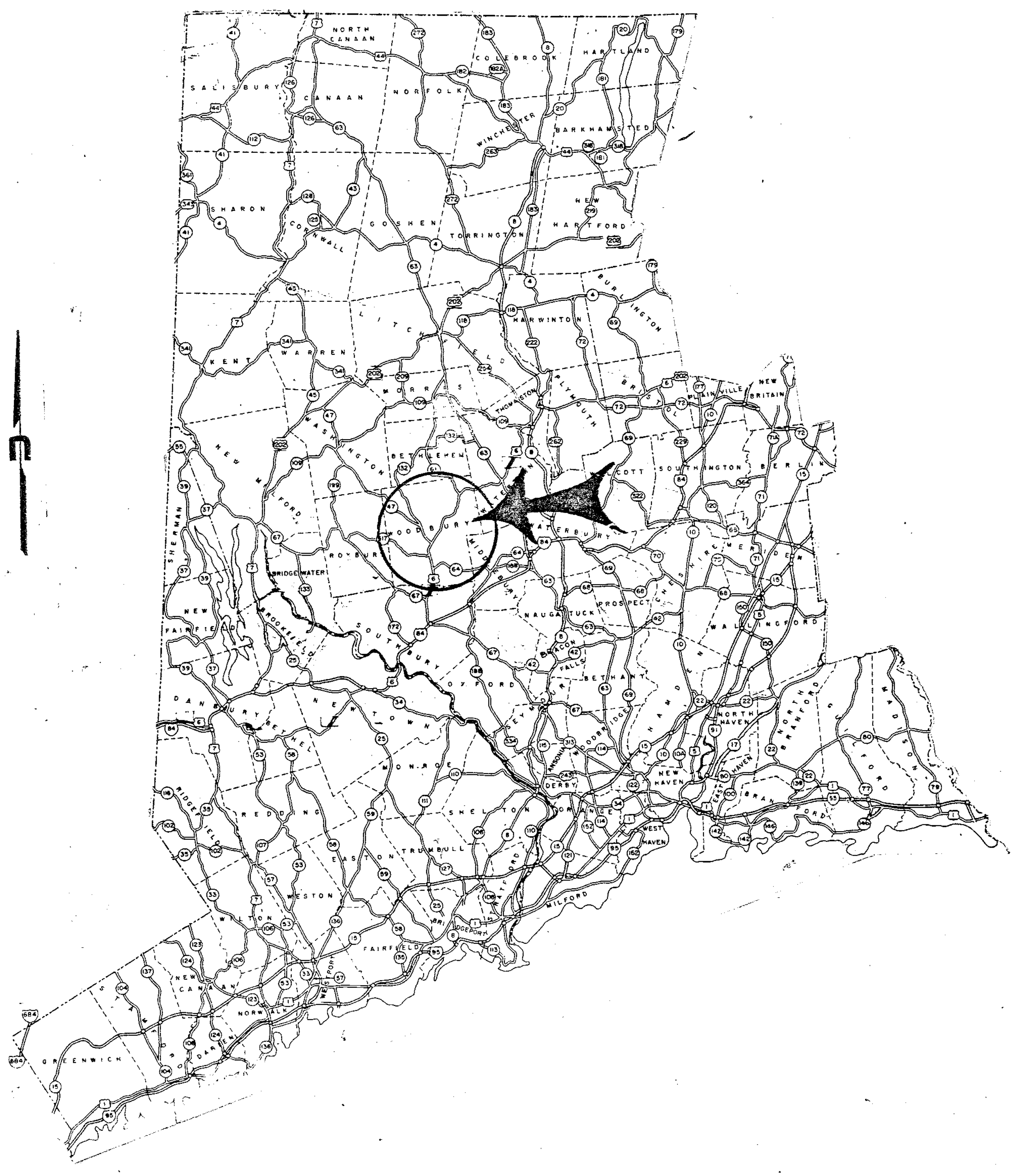

Scale 1" = 10 miles

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ENVIRONMENTAL REVIEW TEAM REPORT

ON

RADER POND

WOODBURY, CT

I. INTRODUCTION

The preparation of this report on Rader Pond was requested by the Town Planner of Woodbury.

Rader Pond is located in the southwestern corner of town and is ± 12 acres in size. The watershed or drainage area feeding Rader Pond is approximately 1555 acres.

Concern has recently been expressed by local residents regarding the environmental health of Rader Pond. Of major concern is the prolific growth of aquatic weeds and algae which are interfering with the recreational use and aesthetic enjoyment of the Pond.

The Town Planner from Woodbury requested this ERT study to learn more about the Pond and its watershed. Specifically the Team was asked to 1) provide a natural resource inventory and evaluation of the Rader Pond watershed, 2) identify what factors are contributing to the above mentioned problems at the Pond and 3) discuss alternatives available for effective Pond management. The Town Planner requested this information to serve as a basis for decision making on how best to protect the future water quality of the Pond. This information will be particularly helpful to the Woodlake Master Condominium Association, Inc. which owns the Pond, the eastern shore of the Pond, and is responsible for management of the Pond.

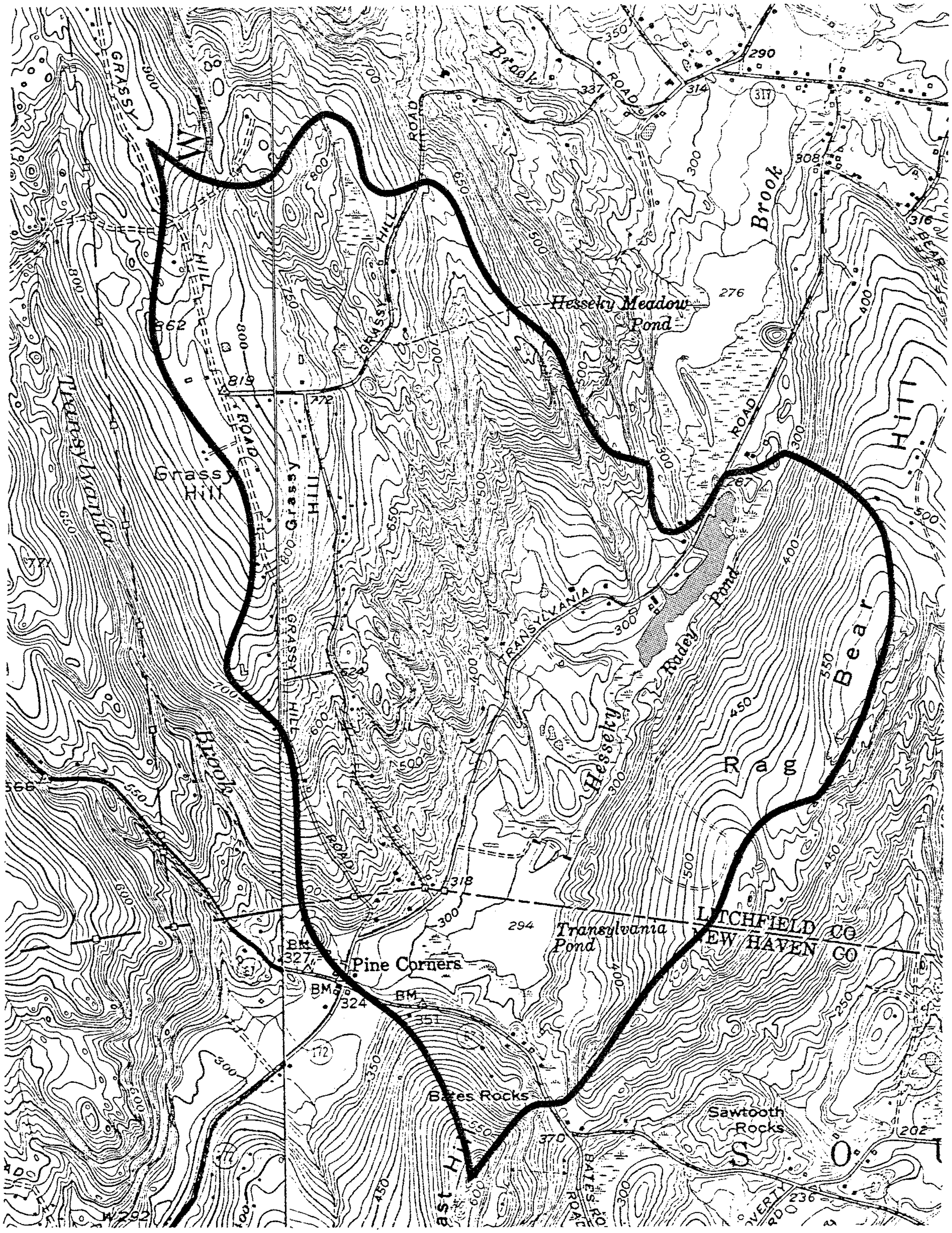
As shown in Figure 1, the watershed of Rader Pond is characterized by moderate to steep slopes. Most of this watershed land is wooded and lightly developed. To the east and south of Rader Pond, however, is the 400 unit Woodlake Master Condominium Development. This development, completed around 1981, is the most intensive land use to be found in the watershed. Major roads traversing the watershed include Rte. 67, Transylvania Road, and Grassy Hill Road. Transylvania Pond is located within the watershed just south of Rader Pond and dischargesvia Hesseky Brook into Rader Pond.

The King's Mark Executive Committee considered the town's request and approved the project for review by the Team.

The ERT met and field reviewed the watershed on March 13, 1984. Team members participating on this review included:

Arthur Cross	District Conservationist	U.S.D.A. Soil Conservation Service
Charles Fredette	Lake Ecologist	CT Department of Environmental Protection
William Hyatt	Fishery Biologist	CT Department of Environmental Protection

FIGURE 1
TOPOGRAPHIC MAP



SCALE
1" = 2000'

Richard Lynn............ERT Coordinator...............King's Mark RC & D Area

William Warzecha........Geohydrologist................CT Department of Environmental Protection

Prior to the review day, each team member was provided with a summary of the proposed project, a checklist of concerns to address, and a detailed soil survey map and topographic map of the subject area. During the Team's field review, team members toured the Rader Pond area and met with representatives from the town to discuss the situation at Rader Pond. Following the field review, individual reports were prepared by each team member and forwarded to the ERT Coordinator for compilation and editing into this final report.

This report presents the Team's findings. It is important to understand that the ERT is not in competition with private consultants and hence does not perform design work or provide detailed solutions to land use problems. The ERT concept provides for the presentation of natural resources information and preliminary land use analyses. All conclusions and final decisions rest at the local level. It is hoped the information contained in this report will assist the town of Woodbury and the Woodlake Master Condominium Association, Inc. in making environmentally sound decisions.

If any clarification of the report is required, please contact Richard Lynn, (868-7342), Environmental Review Team Coordinator, King's Mark RC&D Area, Sackett Hill Road, Warren, Connecticut 06754.

* * * * *

II. SUMMARY

1. *Water quality in the Rader Pond watershed under near natural conditions is generally good to excellent. The water may have elevated hardness levels, however, as well as elevated iron and manganese levels due to local bedrock conditions. These elevated mineral levels may interfere with some domestic uses of the water unless the water is filtered. (p. 12)*

2. *According to a Connecticut Department of Health Services formula, Rader Pond can safely handle 104 swimmers per day during the dry summer months. This figure is useful only if the initial natural quality of the water is acceptable and if other safety factors, such as beach space and lake bottom conditions are satisfactory. If Rader Pond is to be utilized for swimming it should be tested regularly during the swimming season for bacteriological quality. (p. 13)*

3. *Approximately 60 percent of the watershed contains undeveloped soil areas with very severe limitations for residential use. The very severe limitations are due to soils with slopes of 15-35%, soils with bedrock at or near the surface, and poorly and very poorly drained soils. Future development of these areas could cause significant problems from erosion, increased runoff, and septic effluent. Occasional home sites, with careful planning and construction, may possibly be located on less steep areas sufficiently deep to bedrock. However, most of the areas indicated would best be left in forest lands in the opinion of the Team's District Conservationist. (p. 16)*

4. *Rader Pond is reportedly inhabited by largemouth bass, pickerel, yellow perch, bluegill and calico bass. Moderate weed growth should be considered beneficial from a fisheries standpoint in that it provides escape and hiding cover for all fish species, and spawning habitat for pickerel and yellow perch. However, extensive macrophyte growth may prevent efficient predation by bass and pickerel on forage species, often resulting in overcrowded and stunted populations of perch and sunfish and depressed growth rates in bass and pickerel. This obviously reduces the fishing value of the body of water. Partial removal of dense emergent weed beds may thus result in an increase in growth of both predator and prey species, along with increased spawning success for bass. (p. 16)*

5. *The watershed area/surface area/mean depth relationships for Rader Pond indicate a natural predisposition for eutrophic conditions to exist. The natural tendencies are exacerbated by past and present man-made non-point sources of nutrients and sediments. At Rader Pond, the biggest nutrient contributors appear to be the sewage disposal system at Woodlake, and erosion and sedimentation. (p. 18)*

6. *The Woodlake Master Condominium Association, Inc. is served by a community sewage collection and treatment system. The treatment plant is an extended aeration, sand filtration system permitted for an average daily flow of 120,000 gallons per day. The plant provides for domestic wastewater treatment consistent with secondary treatment standards. The plant was not specifically designed to remove nutrients, and removal efficiencies for nitrogen and phosphorus cannot be expected to be consistently high. (p. 20)*

7. *The Woodlake Condominium Association, Inc. is required by their wastewater discharge permit to monitor nitrogen and phosphorus in ground waters in the vicinity of the sand filters once a month. Mean concentrations exhibited in monitoring reports from December 1982 to September 1983 were 2.5 mg/l P and 6.5 mg/l N. If one assumes 120,000 gpd flow of ground water flow at these concentrations into Rader Pond under low stream flow conditions, the pond waters could exhibit 0.2 mg/l P and 0.5 mg/l N from this source alone. Although this analysis assumes extreme worse case conditions, it serves to illustrate the potential importance of this nutrient source. This is particularly true with regard to phosphorus, where .03 mg/l P signals the onset of algae and weed problems and .05 mg/l P represents highly eutrophic conditions in a pond. (p. 20)*

8. *The opportunity for nutrient attenuation of effluent from the new filter beds appears to be much greater than that of the older beds. The distance of travel to the watercourse is much greater, and the ground water passes through wetland soils which provide for attenuation and uptake of nutrients by plants. Utilization of the new sand filters instead of the older sand filters should significantly reduce transport of nutrients from the treatment plant to Rader Pond. Modification of the treatment plant to provide for phosphorus removal could also be investigated as a means to protect Rader Pond from enrichment via wastewaters. (p. 21)*

9. *Due to steep slopes in the Rader Pond watershed, sediment and nutrient inputs due to erosion are a particularly important concern. Erosion control practices should be implemented to correct any known problem areas and to prevent future problems due to new construction. (p. 21)*

10. *Excavating the pond to a greater depth and removing the present accumulation of organic matter would enhance the environmental health of the pond. (p.22)*

11. *Road sand from paved roads within Woodlake could be prevented from entering the pond by installing large concrete "septic" tanks at key and feasible locations. These tanks would need to be properly maintained. (p.22)*

12. *To conclude, it appears that management efforts at Rader Pond can best be directed towards both in-lake management and watershed management. The in-lake management measures which look most promising include: 1) weed harvesting, 2) use of herbicides and algicides, 3) lowering the lake level during the winter months to kill off weeds, and 4) dredging. Watershed management should be directed towards minimizing the controllable nutrient inputs to the lake from sewage disposal systems and erosion and sedimentation. (p. 23)*

III. TOPOGRAPHY AND GEOLOGY

Rader Pond is ± 12 acres in size and located in southwest Woodbury between Hesseky Meadow Pond and Transylvania Pond. The watershed of Rader Pond may be defined as the geographical area from which runoff ultimately drains into the pond. The watershed boundary, as shown in Figure 1, tends to follow along the crests of nearby hills (i.e., Grassy Hill, Bear Hill and East Hill). The watershed comprises ± 1555 acres or 2.43 square miles. Approximately 86 percent of the watershed is located in the town of Woodbury; the remaining 14 percent lies in northern Southbury. Transylvania Pond, which is connected to Rader Pond by Hesseky Brook is the only other major surface water body in the Rader Pond watershed.

The topography east of Transylvania Road, which roughly bisects the watershed, is characterized by moderate to steep slopes. Some relatively flat and gently sloping areas are found mainly in the wetland areas around the ponds and on the tableland of Bear Hill along the eastern boundary of the watershed.

The topography west of Transylvania Road is characterized by moderate to very steep slopes. This is mostly a result of the underlying bedrock which crops out and which is relatively close to the ground surface throughout this portion of the watershed. There are some gentle slopes in the northern parts of the watershed east and west of Grassy Hill Road No. 1 and 2.

Maximum and minimum elevations in the watershed are ± 900 feet and ± 290 feet above mean sea level, respectively.

The Rader Pond watershed is located mostly in the Woodbury topographic quadrangle and partly in the Roxbury topographic quadrangle. A bedrock geologic map (QR-3, by Robert Gates) and a surficial geologic map (GQ-896, by Fred Pessl) for the Woodbury quadrangle have been published by the Connecticut Geological and Natural History Survey and U.S. Geological Survey, respectively. The bedrock geologic map (GQ-121, by Robert Gates) and surficial geologic map (GQ-611, by Harold E. Malde) for the Roxbury quadrangle have been published by the Connecticut Geological and Natural History Survey. All of the above maps can be obtained or reviewed at the Department of Environmental Protection's Natural Resource Center in Hartford.

Surficial Geology

The surficial geologic materials in the Rader Pond watershed (those unconsolidated materials overlying bedrock) may be broadly classified into four major units: till, stratified drift, swamp sediments and artificial fill. Till, which covers nearly 85 percent of the watershed, is a non-sorted, non-stratified deposit of glacial debris that is composed largely of rock particles and fragments with widely ranging shapes and sizes. The debris accumulated on, within, or beneath an ice sheet as it moved across pre-existing soils and bedrock exposures and was later deposited directly from the ice without substantial reworking by meltwater streams. Till is generally sandy, friable and very stony in the upper few feet. However, beneath the sandier, stonier zone, the till becomes silty, less stony and compact. Thicknesses of the till range from zero where bedrock outcrops occur at the land surface to probably not more than 10 feet at various points between outcrops.

Stratified drift found in the watershed are those materials that were deposited by meltwater streams emanating from the active ice sheet. Stratified drift in the watershed is composed primarily of gravel, sand, and silt. The stratified drift deposits are found mostly east of Transylvania Road. They occupy the flat areas around Transylvania Pond, Rader Pond, and along Hesseky Brook. These deposits have been mined in the watershed in the past. Based on air photos of the area, it appears several small ponds were created as a result of the excavation operation. Thicknesses of the stratified drift probably range from a few inches at the stratified drift/till contact to more than 80 feet in the southern parts of the watershed near Pine Corners. Based on the logs of test wells drilled in the Rader Pond Watershed, the thicknesses of the stratified drift range between 31 and 38 feet at the north end of Transylvania Pond (Source: Connecticut Water Resource Bulletin No. 20).

Swamp sediments overlie till, bedrock, and/or stratified drift in the central parts of the watershed, mainly astride Hesseky Brook, along Transylvania Pond and in low-lying areas in the northern parts of the watershed. Swamp sediments consist of sand, silt, clay, and organic plant remains that were deposited in stagnant or slow-moving, well-vegetated bodies of water.

Artificial fill in the watershed consists mainly of subgrade fill which was used for constructing roads and dams.

Figure 2 shows the approximate distribution of the surficial geologic deposits in the watershed.

Bedrock Geology

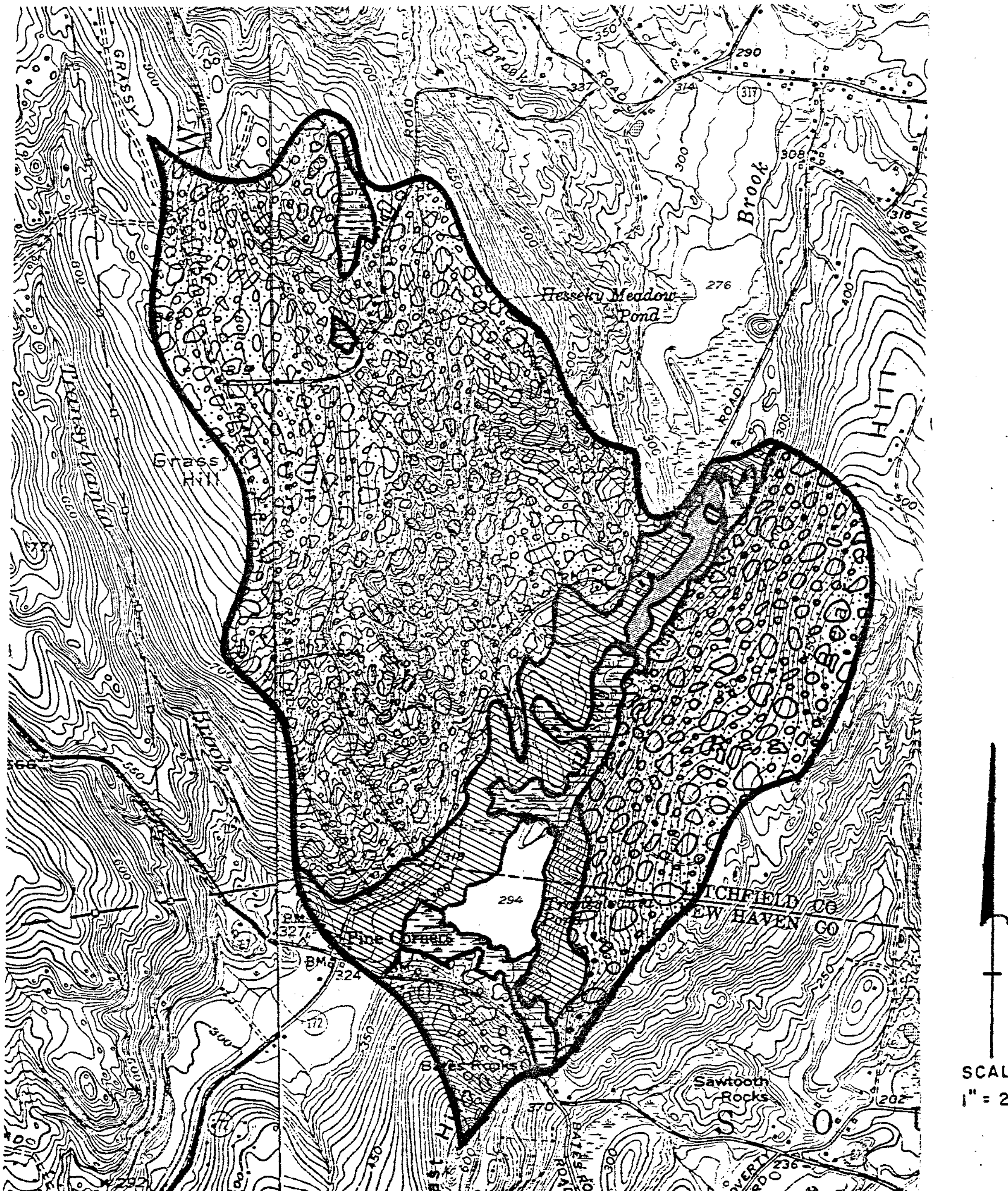
The Rader Pond watershed may be divided into two major bedrock geologic zones. The contact between these two zones bisects the watershed nearly in half.

Numerous bedrock outcrops are visible in the western and northern parts of the watershed (west and north of Transylvania Road). These rocks are composed mainly of interbedded schists and quartzites. The term "schist" refers to crystalline, metamorphic rocks (rocks that have been geologically altered by great heat and/or pressure deep within the earth's crust) in which elongate, platy, or flaky minerals (micas) are predominant and generally parallel.

The term "quartzite" applies to rocks which are also metamorphic. They are rocks composed essentially of the mineral quartz, which formed by the recrystallization of sandstone.

The eastern part of the Rader Pond watershed lies within the Pomperaug Valley. The rocks comprising the Valley consist of interlayered igneous rocks (rocks formed by solidification from a molten magma) and sedimentary rocks (rocks formed by the accumulation of sediment in water or from air), which were deposited during the Triassic geologic period approximately 200 million years ago. The igneous rocks consist mainly of basalt (traprock) while the sedimentary rocks consist primarily of arkosic sandstone and conglomerate. The contact between the metamorphic and sedimentary/igneous rocks in the watershed form a portion of the western border of the Pomperaug Valley. Because the basalt is tougher and more resistant to weathering than sedimentary rocks (such as arkosic sandstone, conglomerate, etc., which are softer and more susceptible to erosion), it outcrops more extensively in the Pomperaug Valley than does the sedimentary rock. In the Rader Pond watershed, basalt outcrops mainly along the eastern limits. When

FIGURE 2
SURFICIAL GEOLOGY



Till

Stratified Drift

Swamp Deposits

Artificial Fill

See text for geologic descriptions

basalt is exposed at the surface, it becomes a reddish color due to the presence of iron sulfides in the rock which causes it to rust. The bedrock geology of the watershed, as adapted from the published reports, is shown in Figure 3.

IV. HYDROLOGY AND WATER RESOURCES

Rader Pond is an artificial impoundment of Hesseky Brook with a surface area of ± 12 acres and a watershed of approximately 2.43 square miles. The pond has a maximum depth of ± 8 feet, an averaged depth of approximately 4.5 feet and a maximum storage capacity of about 19 million gallons. Another surface water body found in the watershed is Transylvania Pond. It covers a surface area of approximately 28 acres and has a drainage area of .7 square miles (or 452 acres). Hesseky Brook, which flows in a northeast direction connects Transylvania Pond with Rader Pond. There are numerous unnamed tributaries to Rader Pond, Transylvania Pond, and Hesseky Brook which originate in the northern parts of the watershed (see Figure 4). The drainage patterns of these watercourses, which are controlled by the underlying bedrock, flow generally in a southward direction. Other than the small inlet stream which enters the southern end of Transylvania Pond, there appears to be no major streams in the eastern part of the watershed. However, based on soil survey maps, air photos, and topographic maps, there are numerous intermittent drainage channels throughout the eastern half.

Based on a method described in Connecticut Water Resources Bulletin #19 and "A Method for Estimating the 7 day, 10 year Low Flow of Streams in Connecticut" it is possible to estimate the flow duration characteristics of the outlet stream for Rader Pond.

The estimates are tabulated in the following table in units of both cubic feet per second (cfs) and million gallons per day (mgd).

TABLE 1.

FLOW DURATION CHARACTERISTICS OF THE OUTLET STREAM FOR RADER POND

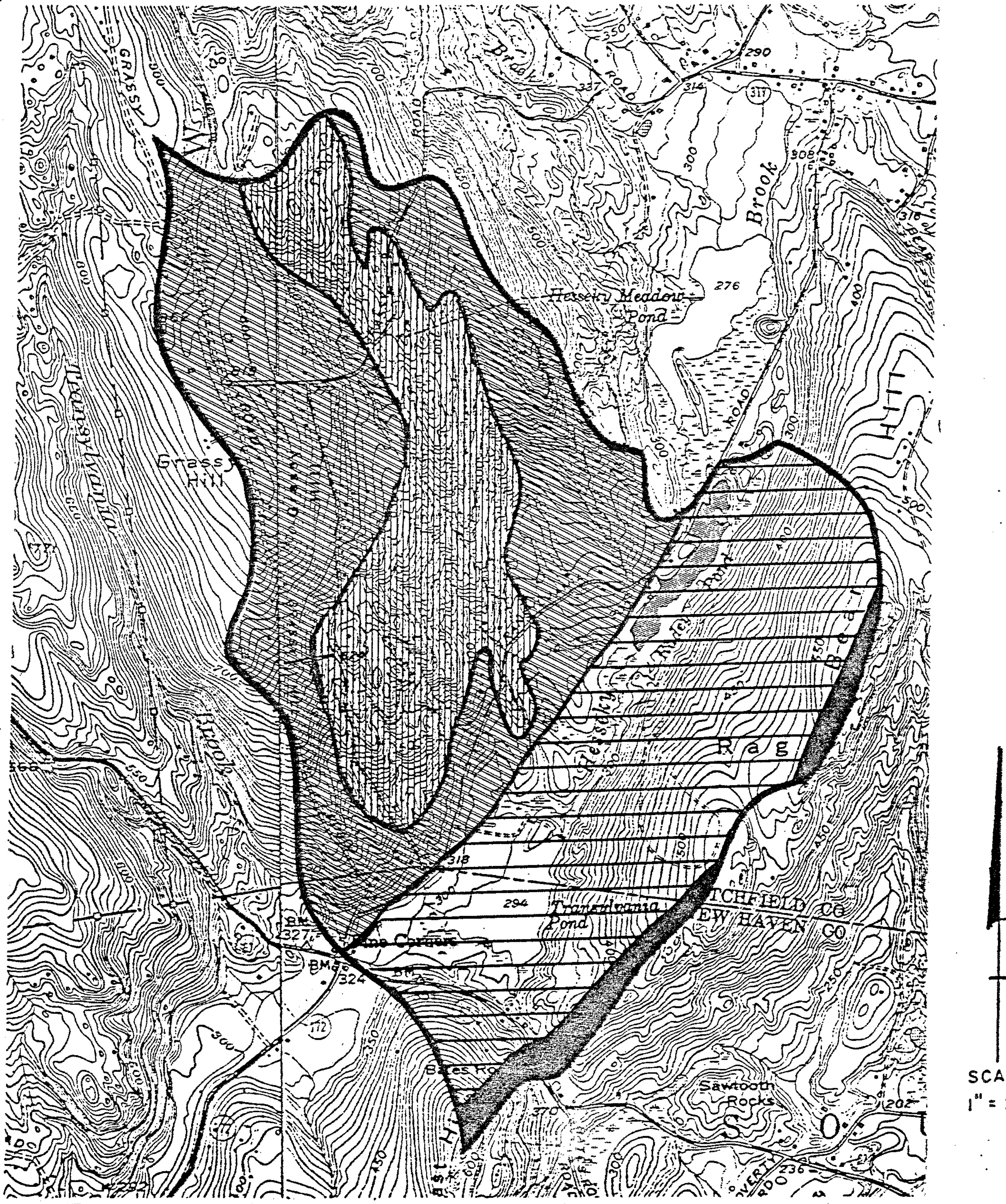
Percent of time flow equalled or exceeded	1%	5%	10%	50%	70%	90%	99%
Flow equalled or exceeded, in mgd	17.0	8.5	6.3	1.8	.94	.36	.12
Flow equalled or exceeded, in cfs	26.3	13.1	9.7	2.8	1.47	.56	.18

The mean annual outflow from Rader Pond is estimated to be 2.68 mgd or 4.14 cubic feet per second (Source: Connecticut Water Resource Bulletin No. 19 Lower Housatonic River basin).

Rader Pond as well as Transylvania Pond are recharged by precipitation both directly and indirectly. Precipitation may enter the Ponds directly, through or via rainfall or snowfall, or indirectly via surface runoff or groundwater movement. The general groundwater flow pattern in the watershed parallels the surface flow pattern in the watershed.

Water quality in ponds is determined in part by the nature of the earth ma-

FIGURE 3
BEDROCK GEOLOGY



SCALE
1" = 2000'

Triassic Newark Series

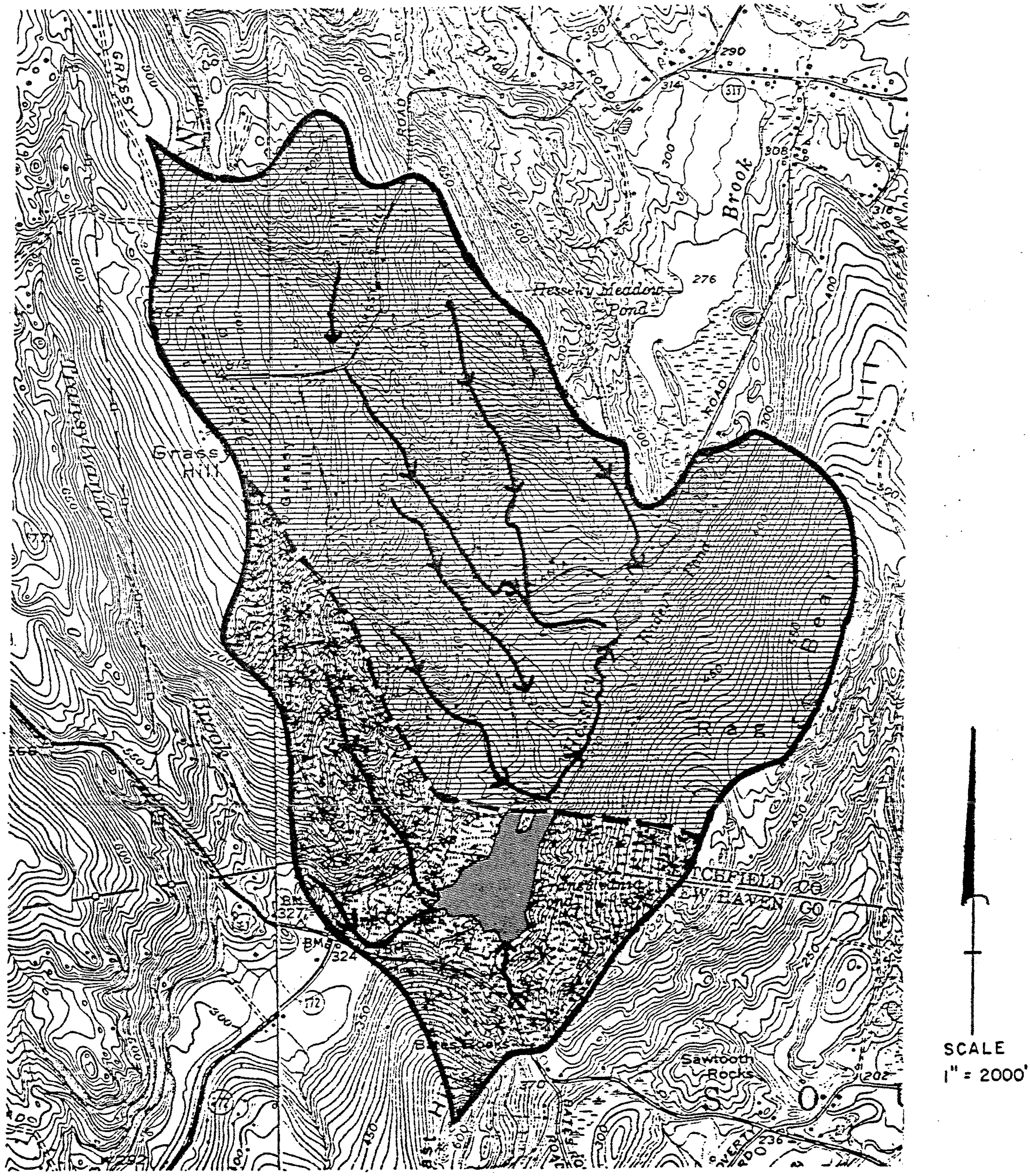
Hartland Formation

Rock Outcrop Areas

Areas Where Bedrock Is At Or Near Ground Surface In Hartland Formation Area

NOTE: See text for bedrock descriptions

FIGURE 4
WATERSHED BOUNDARY MAP



Watershed Boundary for Rader Pond

Subwatershed Boundary for Transylvania Pond

Watercourses Showing Direction of Flow

terials the water comes in contact with and by the length of time in which contact occurs. Therefore, the natural mineral composition of the surficial geologic deposits and underlying bedrock effects the chemical quality of the ponds. Based on Connecticut Water Resources Bulletin #19, surface and ground water in the Rader Pond watershed may yield moderately hard to hard water. "Hardwater", which may interfere with the lathering of soap, is caused by minerals such as calcium (in the plagioclase feldspar), magnesium, and sulfates found primarily in the basaltic rocks and/or overburden which is derived from the local bedrock. In addition, the schist, quartzite and basalt rock found in the watershed may be a source of elevated concentrations of iron and manganese levels to surface waters and groundwater. Any elevated iron and manganese levels found in groundwater and surface waters in the eastern part of the watershed (area underlain by basalt) can probably be attributed to iron sulfide minerals found in the basaltic rocks.

The Connecticut Water Resources Bulletin #19 states that most water in the rural, undeveloped areas in the watershed under near natural conditions is good to excellent in quality. Conversely, water in the more heavily developed areas may be poor in quality. Poor quality water may result from a number of various non-point sources of pollution such as erosion and sedimentation, septic systems, agricultural practices, timber harvesting, road runoff and waterfowl.

Based on air photos, topographic maps and visual inspection, the watershed is presently lightly developed, with the exception of the Woodlake Master Condominiums, in the eastern parts of the watershed. There are also some moderately developed areas along Grassy Hill Road No. 1 and Grassy Hill Road No. 2 in the western limits of the watershed. Sources of contaminations in the watershed will generally have a greater impact on surface water quality if they are relatively close to the water body. Surface runoff originating in the upper reaches of the watershed may pass through wetland areas wherein removal of many contaminants may occur. Runoff will also be purified, at least in part, by passage through soils.

More intensive development in the watershed may degrade the water quality of Transylvania Pond and Rader Pond. As mentioned earlier, major causes of water quality changes, which may be attributed to development, include erosion/sedimentation and wastewater discharges.

Erosion and sedimentation is commonly associated with development and results mainly from clear cutting of vegetation, improperly planned or monitored excavations or fillings and concentrated surface water discharges. Erosion causes surface waters to become turbid and allows surface water bodies to fill with sediment more rapidly than otherwise would be the case. Due to the high erosion potential of most soils in the watershed, any significant future development should be accompanied by an appropriate erosion and sediment control plan.

Septic system discharges may also cause serious deterioration of water quality depending upon the nature of the discharge and the means used (if any) to mitigate the detrimental effects. Septic system effluent is one of the most common pollutants of real estate lakes in Connecticut. This concern is discussed in more detail in later sections of this report.

In terms of transportation related activities such as road salting, and automobile residue, it is possible that street drainage may carry salt, oil, and sand into Rader Pond, Transylvania Pond, and Hesseky Brook. Also, without proper care, there is a potential that road salt storage facilities in the watershed could become a problem in terms of surface and ground water quality. Salt may enter groundwater supply wells or be carried into any of the watercourses or surface waterbodies in the watershed. At this time, the Team has no reason to suspect the above mentioned transportation related contaminants (i.e., deicing compounds, oil, etc.) are a potential threat to the water quality of Rader Pond. Nevertheless, it is recommended the Town and Woodlake Master Condominium Association consider minimizing the use of salt and sand during winter months in this area.

Based on literature reviewed by the Team Geohydrologist, road salt usually affects plant and animal life in smaller streams more than it does in larger rivers.[1] It should be noted, however, that while sodium and calcium may lead to vegetation mortality, these salts are reported to have an insignificant effect on lake eutrophication.[2]

On the review day, the Team geologist was asked to calculate the number of daily swimmers Rader Pond may safely accommodate. The Department of Health Services (DHS) uses the following formula to estimate the number of daily swimmers a pond may safely accommodate: $N=(V/180) + F/1,000$. Where N is the number of swimmers per day, V is the volume of the pond in gallons and F is the surface inflow rate in gallons per day. Assuming that surface inflow is negligible during the extended dry periods the formula reduces to $N=V/180,000$. It was estimated that Rader Pond has an average depth of about four feet. As a result, the normal volume of the pond is estimated at ± 19,000,000 gallons, hence, the maximum allowable number of swimmers per day is 19,000,000/180,000 which equals approximately 104 swimmers per day. It should be remembered this estimate was based on a flow rate of worst case conditions. This formula is useful only if the initial natural quality of the water is acceptable and if other safety factors, such as beach space and lake bottom conditions are satisfactory. If Rader Pond is to be utilized for swimming it should be tested regularly during the swimming season for bacteriological quality.

Water Supply

The rate at which groundwater moves through various earth materials depends in part upon the size, the percentage, and the degree of inter-connection of the pore spaces or cavities in the material. Coarse grained materials such as gravelly st tified drift, tend to transmit groundwater more rapidly than fractured bedrock and other surficial geologic materials. (It should be pointed out, however, that bedrock wells tapping very highly fractured rock have produced high yielding wells). Because of the high transmissibility of coarse grained stratified drift, it is a particularly important resource for the development of high yielding wells. Based on the "Ground Water Availability Map for Connecticut" by Daniel Meade, the area west of Transylvania Pond in the southern part of the watershed is underlain by deposits known or inferred to be capable of yielding moderate to very large amounts of water (50-2000 gallons per minute). The deposits in this area consist mainly of coarse grained stratified drift overlain by finer grained stratified drift. In addition to the "Ground Water Availability Map for Connecticut", there is an unpublished "potential aquifer map" for the Woodbury quadrangle which also identifies the

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1 "Designing A Lake Management Program", by Metropolitan Area Planning Council, Boston, MA, 1979.

2 Ibid

above mentioned area as a potential high yielding aquifer zone. This map is available for review purposes at the DEP Natural Resource Center in Hartford. According to local well data information, the Woodlake Master Condominium site is served by three gravel packed wells which tap stratified drift deposits at varying depths; 30.1 feet, 30.5 feet and 37.9 feet. These wells are located on the east side of Rader Pond. There was no information available to the Team regarding the yields of these wells.

It seems likely that bedrock based wells would be the most important source of water in the upland areas of the watershed. Wells drilled 100-200 feet into bedrock are generally capable of supplying small but reliable yields of groundwater adequate for domestic uses.

As mentioned earlier in the report, the natural groundwater may have elevated mineral content, particularly iron and manganese, as well as elevated hardness levels. If well water proves to be high in these mineral contents, there are several filtration methods available to overcome the problems.

V. SOILS AND LAND USE

Figure 5 of this report presents a Soils Map of the watershed and identifies critical soil areas. As shown in Figure 5, major portions of the watershed consist of steep slopes, shallow to bedrock soils, and inland wetlands. Remaining soils within the watershed consist primarily of hardpan soils on moderate slopes. A detailed description of each soil type identified within the watershed is available in the "Soil Survey of Litchfield County", USDA Soil Conservation Service. This publication is available at the Litchfield County Conservation District (567-8288).

A. Present Land Use

Most of the watershed is wooded with scattered patches of farmland and residential development.

With the exception of the Woodlake development, all houses are concentrated predominantly in the northwest part of the watershed, along upper and lower Grassy Hill Road.

These houses, with on-site sewage disposal systems, are mostly located on hardpan soils, i.e., well drained Paxton and moderately well drained Woodbridge soils. These hardpan soils have a severe limitation for on-site sewage disposal due to slow percolation rates. The Woodbridge soils also have a seasonal high water table. Engineered septic systems are generally required to overcome the natural limitations imposed by these soils.

If some of the septic leaching fields are malfunctioning, some nutrient rich effluent may be reaching the tributary streams draining into Hesseky Brook which flows into Rader Pond.

Corrective measures, if needed, can include interceptor drains over the hardpan, large fields, sand filters, or mound systems, and avoidance of construction when soil is wet to prevent soil smearing.

FIGURE 5
SOILS MAP OF CRITICAL AREAS

Soils 5+ Feet To Bedrock, Slopes 15–35%

Extremely Rocky, Shallow To Bedrock; Slopes Mostly 15–35%

Poorly And Very Poorly Drained Soils

B. Future Development Potential

Approximately 60 per cent of the watershed contains undeveloped soil areas with very severe limitations for residential use. The very severe limitations are due to soils with slopes of 15-35%, soils with bedrock at or near the surface, and poorly and very poorly drained soils (se Figure 5).

Future development of these areas could cause significant problems from erosion, increased runoff, and septic effluent. Occasional home sites, with careful planning and construction may possibly be located on less steep areas sufficiently deep to bedrock. However, most of the areas indicated would best be left in forest lands.in the opinion of the Team's District Conservationist.

C. Agricultural Land Use

One active dairy farm is located in the northernmost portion of the watershed east of Grassy Hill Road and north of North Road. It comprises approximately 50 acres of corn, hay and pasture land (3+% of watershed). Most of the land farmed to support the dairy herd is outside of the watershed. If manure and fertilizer are applied to fields according to soil tests, nutrient enrichment to the nearby eastern stream should be minimal.

VI. FISHERIES

Rader Pond is a shallow (maximum depth 8 feet, average depth approximately 4 feet), 12 acre body of water used by members of the Woodlake Condominium for boating, fishing and swimming. The pond is reportedly inhabited by largemouth bass, pickerel, yellow perch, bluegill and calico bass (black crappie). Concern has been expressed that the dense growth of water lilies (Nymphae spp.) in the southern end of the pond may be adversely affecting the aesthetic and recreational value of the pond. Factors possibly contributing to the heavy growth of weeds in this area include; 1) the shallowness of the ponds south end (maximum depth 3 feet), 2) the settling out of particulate organic matter transported by Hesseky Brook, and 3) nutrient enrichment of the runoff and groundwater entering the effected section of the pond by leachate from the package sewage treatment facility. Weed patches were treated with aquazine (Simazine) in the spring of 1983 and the advancement of weed growth into more of the pond area was temporarily halted.

Moderate weed growth should be considered beneficial from a fisheries standpoint in that it provides escape and hiding cover for all fish species, and spawning habitat for pickerel and yellow perch. However, extensive macrophyte growth may prevent efficient predation by bass and pickerel on forage species, often resulting in overcrowded and stunted populations of perch and sunfish and depressed growth rates in bass and pickerel. This obviously reduces the fishing value of the body of water. Additionally, in lakes containing very large bluegill populations there is a tendency for schools of small fish to surround bass nests during spawning. As the protective male bass chases some fish away others move in and feed on the now vulnerable eggs and fry. Large populations of bluegill and common sunfish (pumkinseed) preying upon largemouth bass eggs and fry can drastically reduce spawning success and the subsequent recruitment of bass into the fishery. A population made up of only a few large old bass, unable to produce a successful spawn and insufficient to support fishing, often results. Partial removal of dense emergent weed beds may thus result in an increase in growth of both predator and prey species, along with increased spawning success for bass. Bass and pickerel growth should improve due to an increase in the available food supply as hiding cover is reduced. Panfish growth may also improve as their population size is reduced by predation, resulting in a greater available food supply per individual fish.

In a lake or pond ecosystem, macrophytes act as buffers of exogenous nutrients and may thus repress phytoplankton productivity by limiting nutrient availability. If the biomass of plants and the corresponding foliar uptake of nutrients is reduced, runoff will proceed to enrich the water column. Phytoplankton may increase due to the greater availability of limiting nutrients. Algae blooms and turbidity may serve to reduce both the fishing quality and aesthetic value of the pond, particularly if blue-green blooms occur.

Chemical treatment is often selected as a quick, efficient and relatively inexpensive means of controlling aquatic weeds. It should be noted that the application of herbicides may result in a quick release of nutrients into the water as dead plant matter decays. This is usually accompanied by an increase in phosphorous levels and may result in greater plankton productivity. The recommended chemical at the present time for the treatment of water lilies is 2,4-D Ester, a slow acting systemic herbicide which is capable of providing protection for more than one year. Water treated with 2,4-D Ester should not be used for drinking or irrigation.

Alternatives to chemical treatment include the construction and maintenance of drawdown facilities at the ponds outlet which would allow the water level to be dropped approximately 3 feet. Once every two or three years the pond could be drawndown in the fall. Exposed plant material would be killed by freezing and should be physically removed from the lake basin. It is unlikely that lilly pad roots and tubers will be killed by exposure as they are located deep in the sediment. Eradication would thus require the removal of approximately 12 inches of muck covering the exposed south end of the pond*. Plant material and sediment should be transported far enough from the pond so as to prevent the reentry of nutrient-rich leachate. This method would prevent the quick release of nutrients into the water from decay, however, an increase in the concentration of nutrients from runoff would still occur (plant buffers gone) and some increase in turbidity may result. Additionally, periodic drawdowns often benefit fish populations by concentrating all fish into a smaller volume of water, temporarily increasing the efficiency of predation on sunfish and perch and thus helping to prevent overpopulation.

Dredging of the pond bottom, while initially very expensive, offers the most permanent method of weed control available. A depth of 10 feet or more is best for preventing the development of nuisance vegetation as sunlight penetration is usually insufficient for the stimulation of plant growth.

The excavation and maintenance of a sediment basin upstream from where Hesseky Brook empties into the pond would also help to reduce nutrient levels

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*It should be noted that harvesting pond lilies rhizomes with a hydrorake has proven effective in other Connecticut lakes. Consideration should be given to pursuing this alternative at Rader Pond.

within the pond. Such a basin would have to be cleaned or reexcavated periodically to remove accumulated material. Weed growth in or around the basin would help to further reduce nutrient levels.

While construction of such a sediment basin would be helpful for lake maintenance, it should not take priority over the aforementioned methods of weed control (i.e., dredging, drawdown, harvesting, chemical control).

The introduction of weed eating fish species is prohibited by law as the effects of such introductions on the complex biology of lakes, ponds and rivers has not yet been adequately quantified. The danger that introduced fish may be caught by anglers and subsequently transported to other bodies of water is another matter of concern.

From a fisheries standpoint, dredging, drawdown, and mechanical weed removal are all preferable to the use of chemicals for aquatic weed control.

VII. LAKE FEATURES AND EUTROPHICATION

A. Lake Features

The major lake charactertistics of Rader Pond are as follows:

Surface area - 12 acres
Mean depth - 4.5 feet
Maximum depth - 8 feet
Retention time - 6 days (mean) 15 days (summer)
Volume - 54 acre feet, 2.35 million cubic feet
Watershed area - 1555 acres
Sediments - several feet soft organic muck
Water clarity - reportedly low due to algae blooms
General water quality - highly eutrophic

Rader Pond is a manmade impoundment on Hesseky Brook, a Class A tributary of the Pomperaug River. It is reported that nuisance algae and aquatic plant (weed) growths preclude swimming and boating in the summer months. Reports indicate that the pond is highly eutrophic - uniformly shallow and highly enriched with plant nutrients. Consideration should be given to verifying lake conditions by water quality monitoring consistent with DEP's trophic classification studies.

The watershed area/surface area/ mean depth relationships for Rader Pond indicate a natural predisposition for eutrophic conditions to exist. The natural tendencies are exacerbated by past and present man-made non-point sources of nutrients and sediments.

B. Eutrophication

Eutrophication is the natural process of lake aging by nutrient enrichment. As a lake eutrophies, many water quality changes occur. Fertility increases and macrophyte (weed) beds become denser and more extensive. Algae blooms occur more frequently and water clarity decreases. Organic matter accumulates on the lake bottom from decaying plants and animals. The lake gradually fills in. Decomposition of lake bottom material reduces oxygen levels in the bottom waters. In general, as these changes occur, recreation opportunities decline.

The eutrophication process can be accelerated by man's activities in the lake watershed which increase nutrient inputs to the lake. The major nutrients of concern are phosphorus, nitrogen and carbon. Phosphorus has been found to be the usual limiting nutrient in the eutrophication process. Therefore, most restoration strategies focus on phosphorus control to reduce the supply to a level where it becomes limiting.

Undisturbed woodland contributes lower nutrient loads to a lake than other land uses. The nutrient loading from agricultural land is generally about five times greater than woodland. Residential and commercial land typically contribute more than ten times the nutrient loading that results from woodlands. Thus, as woodland is converted to other uses, or as agricultural land is converted to residential land, the nutrient contribution to the lake increases, advancing the eutrophication process. Although much of this increase in nutrient export from the watershed is inevitable and unavoidable, best management practices can provide for some degree of mitigation.

It should be noted that the Connecticut DEP has recently (1982) released a report entitled "A Watershed Management Guide for Connecticut Lakes". The DEP's report discusses in detail the process of eutrophication and methods of control. According to the DEP's report, the following factors may contribute nutrients to a waterbody and therefore accelerate the eutrophication process: erosion and sedimentation, spetic systems, lawn and garden fertilizers, yard and garden, vegetation disposal, agricultural land, timber harvesting, runoff, waterfowl, atmosphere, lake sediments. The key to controlling the eutrophication process is controlling the nutrient enrichment from these sources. The DEP's "Watershed Management Guide" is recommended reading and is available from the Department at 566-2588.

Rader Pond is presently experiencing algae blooms and nuisance aquatic weed growth which has diminished recreational opportunities to some degree in recent years. Any additional urban or residential development which does not employ best management practices will serve to worsen these conditions. Local agencies should consider developing and implementing watershed management practices to mitigate the effects of land-use changes in the watershed. The nutrient sources believed to be the most significant at Rader Pond are discussed in the next section of this report.

VIII. MANAGEMENT ALTERNATIVES

A. Watershed Management

As previously discussed, the watershed of Rader Pond is that land area which drains to the Pond. The watershed is therefore the source of water for the pond. The water quality of the pond, to a large extent, is determined by qualities imparted to water by the watershed as the water drains to the pond. If eutrophication of the pond is to be controlled, its watershed must be prudently managed to protect the quality of the water which enters the lake. For this reason, the Woodlake Master Condominium Association and the Town of Woodbury should consider developing a watershed management program for the lake.

Watershed management should be aimed at identifying and controlling existing and potential watershed characteristics which ultimately influence the lake's trophic condition. Since phosphorus is the nutrient which governs the productivity of algae and aquatic plants, watershed management should first and foremost be concerned with reducing phosphorus enrichment. An important secondary consideration is reducing sediment inputs which contribute to the physical filling of the lake.

The DEP's "Watershed Management Guide for Connecticut Lakes" identifies a number of nutrient sources which may contribute to eutrophication. The DEP Guidebook also discusses appropriate measures to control such nutrient sources. At Rader Pond, the biggest nutrient contributors appear to be the sewage disposal system at Woodlake, and erosion and sedimentation. Discussion in this report will therefore focus on these two factors.

Sewage Disposal at Woodlake

The Woodlake Master Condominium Association, Inc., a 400 unit development in the Rader Pond watershed to the east of Hesseky Brook, is served by a community sewage collection and treatment system. The treatment plant is an extended aeration, sand filtration system permitted for an average daily flow of 120,000 gallons per day. The plant provides for domestic wastewater treatment consistent with secondary treatment standards (i.e., an effluent quality of 30 mg/l BOD_5 and 30 mg/l suspended solids). The plant was not specifically designed to remove nutrients, and removal efficiencies for nitrogen and phosphorus cannot be expected to be conistently high. The treatment plant is situated on land adjacent to the east shore of Rader Pond. The sand filters discharge to the ground.

There are two sets of sand filters, the original sand filters which are continuously in use and the newer Phase II filters which have not been used due to hydraulic problems which are to be corrected. The original filters are situated approximately 100 feet (minimum horizontal distance) from the edge of Rader Pond at an elevation approximately 10 feet above the surface of the pond. The soil between the sand filters and the pond appears to be coarse grained artificial fill. These conditions suggest that travel of nitrogen and phosphorus from the treatment plant to the pond through the ground could be significant. As mentioned above, the treatment plant was not designed to remove nutrients. The hydraulic gradient appears to be toward the pond, the travel distance is relatively short, and the soils appear to have a low capacity for attenuating nutrients.

The Woodlake Condominium Association, Inc. is required by their wastewater discharge permit to monitor nitrogen and phosphorus in ground waters in the vicinity of the sand filters once a month. This data can be used to evaluatepotential enrichment of Rader Pond from the treatment plant. Mean concentrations exhibited in monitoring reports from December 1982 to September 1983 were 2.5 mg/l P and 6.5 mg/l N. If one assumes 120,000 gpd flow of ground water flow at these concentrations into Rader Pond under low stream flow conditions (12 day retention time), the pond waters could exhibit 0.2 mg/l P and 0.5 mg/l N from this source alone. Although this analysis assumes extreme worse case conditions, it serves to illustrate the potential importance of this nutrient source. This is particularly true with regard to phosphorus, where .03 mg/l P signals the onset of algae and weed problems and .05 mg/l P represents highly eutrophic conditions in a pond. A detailed hydrological investigation of this situation appears warranted in order to adequately understand the causes of the eutrophication of Rader Pond.

It should be noted that a stormwater drain pipe which discharges to Rader Pond from the vicinity of the sand filters was sampled by DEP on April 10, 1984. The sample exhibited an ortho phosphate concentration of 2.5 mg/l and an ammonia concentration of 3.5 mg/l. These levels indicate ground waters near Rader Pond are indeed enriched with wastewater nutrients.

The newer sand filters, in contrast to the original filters, are situated upstream of Rader Pond adjacent to a wetland contigious to Hesseky Brook. These filters are located approximately 200 feet (minimum horizontal distance) from the channel of Hesseky Brook.

There is a sharp 10 foot drop from the filters to the edge of the wetland, but a relatively flat grade through the wetland to the brook. The opportunity for nutrient attenuation of effluent from these new filters appears to be much greater than that of the older beds. The distance of travel to the watercourse is much greater, and the ground water passes through wetland soils which provide for attenuation and uptake of nutrients by plants. Utilization of the new sand filters instead of the older sand filters should significantly reduce transport of nutrients from the treatment plant to Rader Pond. This could be enhanced by the relocation of the Hesseky Brook channel to the far western edge of the wetland. A detailed evaluation of the benefits and impacts of channel relocation would be desirable.

Modification of the treatment plant to provide for phosphorus removal could also be investigated as a means to protect Rader Pond from enrichment via wastewaters. In this regard, it appears that chemical precipitation prior to sand filtration may be feasible.

Erosion and Sedimentation

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 can therefore be 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 shallow shoals which are conducive to the growth of aquatic plants. In addition, organic matter associated with soil particles is decomposed by lake bacteria, contributing to the depletion of oxygen in waters overlying the lake sediments.

Due to steep slopes in the Rader Pond watershed, sediment and nutrient inputs due to erosion are a particularly important concern. Erosion control practices should be implemented to correct any known problem areas and to prevent future problems due to new construction. Methods for controlling erosion and sedimentation are described in detail in the "Erosion and Sediment Control Handbook for Connecticut", U.S. Dept. of Agriculture Soil Conservation Service, 1976. This publication is available at the U.S.D.A. Soil Conservation Service Office in Litchfield (567-8288).

According to a bathymetric map prepared by Hiram Peck III in March, 1984 for the Woodlake Master Condominium Association, Inc., Rader Pond has many shallow edges and depths. The pond shallows may be due, in part, to soil erosion and sedimentation during the construction of the residential complex adjacent to the pond. In addition, the pond bottom may never have been scraped of organic material prior to the formation of the pond. In this regard, it should be noted that both wetlands southerly and northerly of the pond are soils mapped as peat and muck - soil very high in organic matter.

Excavating the pond to a greater depth and removing the present accumulation of organic matter would enhance the environmental health of the pond. The pond could be drained down in late summer and excavated out with side slopes steepened to 3.1. A suitable disposal site for the dredged material would need to be located prior to the excavation. It appears that a drain could be installed at the north end of the pond, across the Woodlake entrance road, at a low enough elevation to drain the pond. Elevations would be needed to confirm this, however.

Road sand from paved roads within Woodlake could be prevented from entering the pond by installing large concrete "septic" tanks at key and feasible locations. These tanks would need to be properly maintained (i.e., cleaned out as necessary). It should be noted that concrete tanks, such as those suggested above, are presently being used at Woodridge Lake in Goshen.

B. In-Lake Management

Management of algae blooms and macrophyte beds in the lake may be necessary as an adjunct to watershed management in order to improve recreation opportunities and aesthetics. Methods for controlling algae blooms include algicide treatments, artificial aeration, chemical precipitation, and bottom water withdrawal. Of these alternatives, only algicide treatment is viewed a as a feasible control method at Rader Pond.

Algicide treatments are commonly conducted in Connecticut lakes to provide temporary, cosmetic relief from nuisance algae blooms. This method does not correct the source of the problem - nutrient enrichment - and ususally needs to be repeated annually. One treatment at Rader Pond with copper sulfate would cost several thousand dollars. A DEP pesticides permit must be obtained prior to each treatment. The permit specifies treatment conditions which will protect aquatic life and recreation activities.

Methods which are commonly considered for control of macrophytes (i.e., lake weeds) include overwinter drawdown, herbicides, harvesting, and dredging. Over-winter drawdown involves lowering the lake level for several weeks to expose plants to dessication and freezing. This is a low cost alternative where feasible since drawdown requires negligible labor and no equipment or chemicals. Some species are resistant to this method, but excellent control of Myriophyllum and other species has been achieved in Connecticut. The feasibility of this method depends on an evaluation of several factors, including the presence and condition of drawdown facilities, stresses on lake fisheries, lake refill rate, potential for downstream flooding during drawdown.

In comparison to drawdown, other macrophyte control methods have higher costs but more predictable success. Herbicides provide for effective control of macrophytes by killing plants in local areas of application. The effects are cosmetic and temporary, and repeated treatments on an annual basis would be required to maintain control. Treatment of watermilfoil with Diquat would require the application of two gallons per acre, with a present chemical cost of approximately $100 per acre. A DEP pesticides permit must be obtained prior to each treatment. The permit specifies treatment conditions which will protect aquatic life and recreation activities.

Harvesting is a method which physically removes plants from the lake with specialized barges equipped with harvesting machinery. This is a cosmetic method which needs to be repeated when macrophyte beds recover from cutting. Recent harvesting experiences in Connecticut indicate that costs can exceed $250 per acre for one cutting.

Dredging is typically a high cost method which is considered for recreational lakes with severe macrophyte problems. The objective is to eliminate macrophyte habitat by removing sediment and increasing water depth. This is accomplished by either drawdown and excavation, or hydraulic dredging. A recent drawdown and excavation project in Connecticut conducted with town resources incurred a cost of approximately $1.75 per cubic yard, or $4,000 per acre. A hydraulic dredging project being planned for another Connecticut lake has an estimated cost of $3.00 per cubic yard, or $15,000 per acre. Long term control of macrophytes is a benefit of dredging which is not obtained by othe method

To conclude, it appears that management efforts at Rader Pond can best be directed towards both in-lake management and watershed management. The in-lake management measures which look most promising include: 1) weed harvesting, 2) use of herbicides and algicides, 3) lowering the lake level during the winter months to kill off weeds, and 4) dredging. Watershed management should be directed towards minimizing the controllable nutrient inputs to the lake from sewage disposal systems and erosion and sedimentation.

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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, foresters, climatologists, soil scientists, landscape architects, recreation 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 47 town area in western Connecticut.

As a public service activity, the team is available to serve towns and developers within the King's Mark Area --- free of charge.

PURPOSE OF THE TEAM

The Environmental Review Team is available to help towns and developers in the review of sites proposed for major land use activities. To date, the ERT has been involved in the review of a wide range of significant activities including subdivisions, sanitary landfills, commercial and industrial developments, and recreation/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 identifying the natural resource base of the project site and highlighting opportunities and limitations for the proposed land use.

REQUESTING A REVIEW

Environmental Reviews may be requested by the chief elected official of a municipality or the chairman of an administration agency such as planning and zoning, conservation, or inland wetlands. Requests for reviews should be directed to the Chairman of your local Soil and Water Conservation District. This request letter 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 address. When this request is approved by the local Soil and Water Conservation District and the King's Mark RC&D Executive Committee, the team will undertake the review. At present, the ERT can undertake two reviews per month.

For additional information regarding the Environmental Review Team, please contact your local Soil Conservation District Office or Richard Lynn (868-7342), Environmental Review Team Coordinator, King's Mark RC&D Area, P.O. Box 30, Warren, Connecticut 06754.