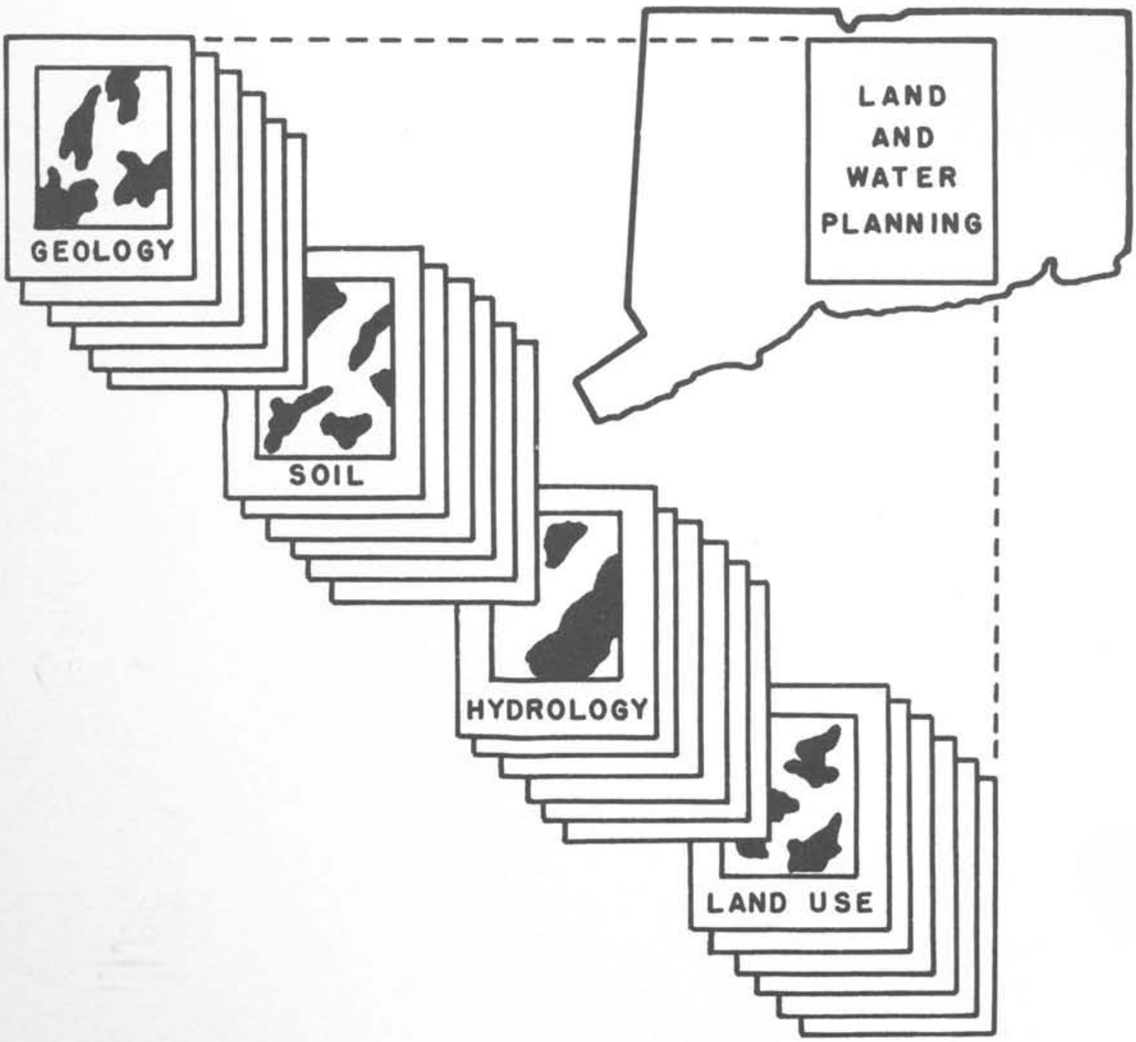
The Connecticut Geology-Soil Task Force

Report on

USE OF NATURAL RESOURCE DATA IN LAND AND WATER PLANNING

David E. Hill and Hugo F. Thomas



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ACKNOWLEDGMENTS

The sheer increase in knowledge, together with its growing specialization, often bewilders the potential beneficiary of science and renders the research that produced the knowledge less useful. Hence, the cry heard more and more for "interdisciplinary" research. In other words, the consumer of knowledge or science wants to see the fragments put together and made more useful. This bulletin reports interdisciplinary research that was made possible by the generous contributions of people from many specialties or disciplines and from many organizations.

The group that accomplished the research is known as The Connecticut Geology-Soil Task Force. The Task Force was created in 1969 following a conference sponsored by the U.S. Soil Conservation Service and the Connecticut Geological and Natural History Survey. The Task Force is informal, unofficial, and its membership is voluntary. Its activities have been supported by the agencies that employ its members. Its goal is encouraging greater collaboration and understanding among the specialists who collect, interpret and use information on natural resources. The Task Force has undertaken several projects.

The resource interpretation system reported in this bulletin is the outcome of one project of the Task Force. The members of the steering committee of the Task Force who initiated this project and assisted with writing and reviews were:

John M. Allen	U.S. Soil Conservation Service
Harold I. Ames	Office of State Planning, Department of Finance and Control
John A. Baker	U.S. Geological Survey, Water Resources Division
Harold M. Bannerman (Chairman)	Consultant, Connecticut Geological and Natural History Survey
William M. Brown	U.S. Soil Conservation Service
David E. Hill	The Connecticut Agricultural Experiment Station
Harry L. Siebert	Connecticut Department of Transportation Bureau of Highways
Hugo F. Thomas	University of Connecticut

Other members of the Task Force who assisted by compiling data or contributing narrative to the report were:

Roger B. Colton	U.S. Geological Survey, Geologic Division
Lincoln R. Page	U.S. Geological Survey, Geologic Division
Maurice H. Pease, Jr.	U.S. Geological Survey, Geologic Division
Joe Webb Peoples	Connecticut Geological and Natural History Survey
Fred Pessl, Jr.	U.S. Geological Survey, Geologic Division
Robert B. Ryder	U.S. Geological Survey, Water Resources Division
Richard N. Symonds, Jr.	Office of State Planning, Department of Finance and Control

Thanks are also due to other members of the Task Force who contributed and advised throughout the project. Special thanks are extended to Clifford Keune, U.S. Geological Survey, for drafting illustrations.

The data used here have been taken largely from reports and maps published by several agencies:

U.S. Geological Survey

U.S. Soil Conservation Service

Connecticut Department of Environmental Protection,
Geological and Natural History Survey

The Connecticut Agricultural Experiment Station

Connecticut Department of Transportation, Bureau of Highways

Office of State Planning, Department of Finance and Control

Our final thanks go to the workers in these departments who through years of painstaking mapping and research built the foundation for this system of resource interpretation.

David E. Hill

Hugo F. Thomas

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USE OF NATURAL RESOURCE DATA IN LAND AND WATER PLANNING

David E. Hill and Hugo F. Thomas

As Connecticut's population increases and the use of land shifts from agriculture and woodland to commerce, industry and housing, great interest has developed in land and water planning. Meanwhile, the wealth of geologic, hydrologic and soil information has also been growing, but those who want to use the information for land and water planning have sometimes been thwarted because the data were not in a form compatible with their needs. For some, the data were too general; for others too detailed. Most information was collected for other purposes, and earlier interpretations could not have anticipated current problems of land and water use planning in a society newly conscious of its environment.

Because of the interest in planning and the abundant storehouse of natural resource information, the time seems ripe to tap the storehouse for planning uses. Thus, the Connecticut Geology-Soil Task Force studied ways to develop a flexible interpretation system for both planners who seek general knowledge and planners who seek detail. For those empowered to regulate land and water use, the new interpretation system hopefully will help resolve conflicts between limitations imposed by the natural environment and the requirements of our expanding population.

In this study, we shall describe the development of the interpretation system and then demonstrate its use in selecting a fictitious site to dump solid wastes. The area we chose for this study is a portion of the Ellington quadrangle in north central Connecticut.

BASIC RESOURCE DATA

Basic to a resource interpretation system are the primary products of the Federal and State agencies which collect and disseminate information on topography, geology, hydrology, soils and land use.

<u>Topographic Map</u>. A topographic map, compiled by the U.S. Geological Survey, is a graphic representation of a small portion of the earth's surface. The configuration of the surface is commonly shown with contour lines that contain points of equal elevation.

Topographic maps are produced at different scales and contour intervals for different purposes. The earliest maps in Connecticut were 15-minute quadrangles on the scale of 1:62,500 (1 inch equals about 1 mile) with 20-foot contour intervals. Later maps were $7\frac{1}{2}$-minute quadrangles on the scale of 1:31,680 (1 inch equals $\frac{1}{2}$ mile). These quadrangles were more recently enlarged to a 1:24,000 scale (1 inch equals 2,000 feet). The $7\frac{1}{2}$-minute quadrangle series has 10-foot contour intervals. Revised editions are issued from time to time, but only the man-made changes are recorded (i.e., new houses, roads and modification of topography along major roads). In 1967, a topographic map of Connecticut was published by the U.S. Geological Survey in cooperation with the State on the scale of 1:125,000 (1 inch equals about 2 miles). The contour interval is 50 feet. Another edition of this State map shows topography by shading.

The $7\frac{1}{2}$-minute topographic map shows such natural features as mountains, valleys, terraces (represented by contour lines) and water and such cultural features as houses and roads.

Bedrock-geology Map. This map, compiled by the U.S. Geological Survey, Geologic Division, in cooperation with the Connecticut Geological and Natural History Survey, represents an interpretation of the near-surface distribution of bedrock determined largely from observations of outcrops.

The base map of the bedrock-geology map in the study area is the $7\frac{1}{2}$-minute topographic quadrangle at a scale of 1:31,680. In other quadrangles the scale may be 1:24,000. Geologic units on the map delineate rock types that can be grouped together as recognizable units at this scale. Cross sections that interpret the geology in third dimension usually accompany the geologic map. The interrelationship of geologic units also is indicated, the geologic history postulated and deposits of potential economic interest described in the text.

Most geologic map units are not suitable for direct use in engineering or land planning, but data in the text can often be interpreted for many uses. Rock properties may vary as significantly within units as between units. Rock types with significantly different properties are often too small to show at the scale of the map. A bedrock lithology map based on the physical properties of bedrock is used to describe the bedrock geology units in terms of physical properties that are more useful for engineering and land management. This kind of map is described later in the section on single-factor maps.

Surficial-geology Map. The surficial-geology map, compiled by the U.S. Geological Survey, Geologic Division, in cooperation with the Connecticut Geological and Natural History Survey, shows the distribution of the different kinds of unconsolidated materials that cover the bedrock as a discontinuous mantle of variable thickness. The base map for the surficial map in Connecticut is the $7\frac{1}{2}$-minute topographic quadrangle at a scale of 1:24,000.

Materials are shown as they occur beneath the soil layer (i.e., as if the soil layer, commonly a foot or two thick, had been stripped from the land's surface). The unit shown is the uppermost material. Other materials, different in composition, may underlie the mapped unit or may occur within it as thin lenses.

Outcrops of bedrock and areas where the surficial material is thought to be less than 10 feet thick are usually shown on the map. Areas that have been filled for such man-made features as highways, flood-control structures or solid-waste storage are also shown and designated artificial fill. Other features of local interest, such as striations gouged along bedrock surfaces, glacially transported boulders, landforms, quarries and pits, may be indicated by separate symbols.

The texture of the materials is shown by special overprint patterns on recent maps. Cross sections and graphic logs of test holes are included on some maps. The text accompanying most maps discusses the characteristics of the deposits. It also interprets the conditions under which the deposits were formed and briefly discusses the geologic history of the map area.

Soil-survey Map. The basic soil information used in the study is derived from a soil survey map compiled by the U.S. Soil Conservation Service in cooperation with the Agricultural Experiment Stations of Connecticut. The base map for Connecticut is an aerial photograph with a scale of 1:15,840 (4 inches equals 1 mile). Areas on the landscape having different physical and chemical properties are delineated. The properties a soil scientist uses to delineate each area (called a mapping unit) are properties of the soil itself, such as color, texture, structure, arrangement and depth of layers (called horizons), temperature, permeability, drainage, pH and organic matter content. Also considered are characteristics of the landscape on which the soil rests, such as slope, surface stoniness, amount of exposed bedrock, erosion, and whether the area may become flooded.

Although the areas on a soils map of quadrangle size number in the thousands, those areas with identical properties are given the same name. Thus, the mapping units identified and described number about 80 to 120.

Mapping at a scale of 4 inches per mile, however, limits the number of areas that can be shown on a map; thus, areas less than one acre with different properties cannot be shown and must be included in larger units. The small areas of dissimilar soils are called inclusions and at least 15% are permitted at this scale. At least 85% of each area delineated on a soils map has its own set of properties. The soil scientist can interpret these properties relative to such uses as agriculture, urban development, forestry and recreation.

Water-resources Inventory. The water-resources inventory of Connecticut, a series of reports by the U.S. Geological Survey, Water Resources Division, identifies and discusses the quantity and quality of water available in various regions. To simplify the calculation and description of water quantity information, the State has been divided into 10 study areas.

Water supplies may be obtained from surface sources such as streams and lakes or from ground water. The inventory identifies lakes, ponds and streams that have water in usable storage and indicates the amounts in storage. More detailed information in tables and graphs shows flow duration, low-flow frequency and duration, flood peaks, frequency of floods and storage required to maintain various flows. Water quality of surface supplies is also summarized.

The availability of ground water in the basins is summarized by showing the areal distribution of the principal aquifers. Also shown are the thickness and the water-transmitting characteristics of the aquifers in sand and gravel deposits. These parameters can be used to estimate yields and drawdowns in wells pumped at a constant rate. Aquifers in stratified deposits that are especially favorable for development are identified and quantities available are estimated. The quality of ground water is also discussed. The basic data in the inventory include well records, pumping-test data, ground-water level measurements, stream-flow records and chemical analyses of water samples.

Land Use and Zoning Inventory. A Connecticut land-use inventory was compiled by the Office of State Planning in 1970-1971 in cooperation with the Connecticut Regional Planning Agencies. Using aerial-photograph interpretation and field checking, 57 different land-use activities were recorded and transferred to 1:24,000 topographic quadrangle maps. The maps show areas in the State used for residential, manufacturing, transportation, communication and utilities, trades and services, cultural entertainment and recreation and resource production and extraction. The inventory also identifies wetlands, open and forested areas. All information on the 57 land-use categories has been prepared for computer analysis by the Connecticut Department of Transportation to quantify and analyze land-use statistics and reproduce the data on a variety of scales. Other land-use inventories are available that include land holdings of water utilities and state-owned property.

A zoning inventory was made in 1970 for each of the towns in Connecticut having zoning ordinances. The various local zoning districts are shown on a map having a scale of 1:72,000. Generalized zoning categories have been plotted on a 1:125,000-scale map of

Connecticut. Both land-use and zoning inventories are based on 1970 data and can be correlated with the 1970 Federal census.

COMPILATION OF AVAILABLE DATA

The basic resource data available for an area of investigation must be gathered by the user from the agencies (see Acknowledgments) who collect and disseminate it. In addition to topography, geology, hydrology, soils and land use, other information may be available on biology, engineering characteristics, geochemistry and geophysics.

Availability of Basic Resource Data

Not all basic data inventories have been completed in Connecticut, so the user may find important kinds of data missing. Table 1 shows the status of these inventories in 1972. Only the topographic and land-use maps are available for the entire state. The other inventories are in progress and are constantly reviewed to improve the quality of data. Occasionally, information can be extrapolated from adjoining areas if not available for the area being studied.

Table 1. Status of Basic Inventories in Connecticut.

	Units in State	Published	Mapped but Unpublished
Topography	115 quadrangles	115	--
Bedrock Geology	115 quadrangles	57	43
Surficial Geology	115 quadrangles	50	32
Soil Surveys	8 counties	3	34 towns
Water Resources Inventories			
Basic Data Reports	10 basins	7	1
Interpretative Reports	10 basins	4	3
1970 Land Use Inventory	115 quadrangles	115	--

In developing a resource interpretation system, it was found that some natural resource data were not available. Either their value was unknown, techniques were not available for their aquisition or they were not considered useful at the scale chosen. Some examples are: depth to bedrock of 15-25 feet, the chemical characteristics of surface and ground water and description of engineering properties of surficial material and bedrock.

Need for Common Base, Scale and Boundaries

In the past, each agency has determined its own needs for scale, base and survey boundaries. The soil survey field mapping is done at a scale of 1:15,840 on an aerial photograph base. Mapping is done town-wide and published county-wide at scales of 1:15,840 or 1:20,000. Geological survey mapping (surficial materials and bedrock) is presently done at a scale of 1:24,000 on a topographic base covering an area of about 56 square miles. Soil mapping is more detailed than geological mapping because it was originally planned to serve as a tool for farm planning.

Scale and boundaries can be adjusted by careful mechanical methods. Controlled aerial-photograph mosaic maps can be reduced in scale to 1:24,000 or the topographic map can be expanded to 1:15,840, whichever is determined the most practical scale. The aerial photograph base map, however, has inherent distortion and the identifiable features on the topographic base and the aerial photograph base are often incongruent. For example, using mechanical methods of reducing soil maps, streams may appear on the opposite side of a road when superimposed on the topographic map. A perfect adjustment of maps requires hand transfer of the information which is time consuming and expensive. The future use of orthophoto base maps for both soils and geology may eliminate such problems. Orthophoto maps combine the traditional elements of the topographic map and the aerial-photograph map and have been corrected for distortion.

Alterations in map scale, however, may affect both the accuracy of the data and its legibility. For example, reduction of scale from 1:15,840 to 1:24,000 alters the validity of the soils data and details become difficult to read. An enlargement in scale from 1:24,000 to 1:15,840 might also affect the validity of the data and a larger map is required to represent the same area. The basic inventory data, then, is most accurate within the scale chosen to represent it.

Despite the problems encountered, the basic resource data from many sources must be converted to a common base map and scale in order that they may be used to integrate the information on the maps. Commonly the basic resource data from each discipline are difficult to use because they include a wide variety of properties. For example, drainage, depth to bedrock, texture and slope segregate different soils in the classification scheme. When these properties are used to define mapping units on a soil survey map, a detailed pattern results which may be too complex for some users' needs. The user may wish to examine some properties separately because they have great impact on the management of land and water resources. Single-factor maps can be derived from the detailed maps to simplify the use of data. The kinds of single-factor maps are limited only by the scope of the basic data from which they are derived. Some basic resource data maps can be used directly as single-factor maps if they relate to only one kind of data; topographic maps, land-use maps and zoning maps are examples. Table 2

Table 2. Matrix of single-factor maps derived from basic data sources.

SINGLE-FACTOR MAPS / BASIC DATA SOURCES	Topographic Map	Geology: Bedrock Map	Geology: Surficial Map	Soils: Soil Survey Map	Hydrology: Water Resources Inventory	Land Use and Zoning	Other sources of data not in map form
1. Topography	●						
2. General slope map	●			●			●
3. Slope greater than 15%	●			●			
4. Slope less than 3% and soil seldom saturated	●			●			
5. Bedrock type		●					●
6. Structural characteristics of bedrock		●					●
7. Outcrops			●				
8. Depth to bedrock: 0-2 feet				●			
9. Depth to bedrock: 0-10 feet			●				
10. Depth to bedrock: 50-foot intervals					●		●
11. Unconsolidated materials			●				●
12. Sand and gravel deposits			●				
13. Unified soil classification of substratum				●			●
14. Soil saturated with water within 3 feet of the surface for 2 to 12 months				●			●
15. Soil saturated with water within 3 feet of the surface for less than 2 months				●			●
16. Peat and muck deposits				●			
17. Percolation rate classes				●			●
18. Agricultural land use capability				●			●
19. Drainage areas	●				●		
20. Floodprone areas	●				●		●
21. Low flow of streams					●		●
22. Saturated thickness of stratified unconsolidated deposits					●		●
23. Availability of ground water			●		●		
24. Location of existing sanitary and water related facilities, services and uses						●	
25. Land use: 1970						●	
26. Zoning: 1970						●	

lists, on the left, examples of single-factor maps that can be produced and, on the right, the sources of basic data from which single-factor maps are derived.

For example, three different published sources may provide depth-to-bedrock information. Some surficial geology maps show the distribution of rock outcrops and areas where bedrock lies within 10 feet of the surface. Soil survey maps delineate shallow-to-bedrock soils where bedrock is within 2 feet of the surface. Some water-resources inventory maps show estimates of depth to bedrock in 50-foot intervals. By extracting this single factor from all three sources, a map can be produced that shows both exposed bedrock and depths to bedrock beneath the surface. Intervals of 0-2 feet, 2-10 feet, 10-50 feet, 50-100 feet, etc., can be delineated. Such single-factor maps show only the distribution of the resource and are not biased by prior knowledge of land and water use.

Single-factor maps show map units of materials, slope, depth and volume selected to maintain accuracy consistent with the limitations of the original data and the scale of map presentation.

Establishment of Management Guidelines

Because land, water and mineral resources vary from place to place, and the concepts of acceptable land and water use also vary, the criteria of use must be established by the user. He must first define criteria of acceptance for a particular use in a specific area. These criteria can be expressed in management guidelines, which may include statutory regulations, availability of specific resources, conditions requiring site preparation,or limitations of money.

The guidelines depend on the specific use that is planned. There are two general types: corridor development and site development. Corridor development requires study of all natural resources along a corridor between two points and whose width is determined by the user. Site development may involve location of a site that has an extractable resource (e.g., sand and gravel) or a site that will serve as a host for a specific use (e.g., sanitary landfill). Here the natural resources of the site and its environs are evaluated. A closer examination of each of these uses follows.

Corridor Development

In corridor development, the controlling factors are the points to be connected by the corridor and the width of the corridor. Usually the end points have already been established and the area between them is the focus of investigation. The management guidelines for corridor development attempt to create the least impact on the environmental quality of the area. Each resource characteristic is evaluated for its effect on the corridor during and after development. In many cases the single-factor maps are used to determine a preliminary cost evaluation before proceeding with site inspection. They can also be used to assess impact along the corridor and costs for alternative routes. The management guidelines in corridor development may include: (1) the existing regulations controlling the use of the resources or the use of the area, (2) attempts to minimize the detrimental effects on the environment of the area and (3) attempts to minimize cost.

Site Development For The Extraction Of An Existing Resource

When a site is developed for the extraction of an existing resource (e.g., sand and gravel) an important consideration is the presence of adequate reserves. Management guidelines can be drafted listing the preferred conditions for extraction and an evaluation of the impact on the area as a result of the extraction. These management guidelines may include: (1) considerations of volume and quality of material, (2) rate and method of extraction, (3) the regulations controlling the use of the resource in the area where it occurs and (4) conflicts with existing land use. The order of selection of other single-factor maps, beyond the initial map which establishes the distribution of sand and gravel, depends largely on the philosophy of the user.

Site Development To Serve As A Host

When a site is developed as a host for a specific use (e.g., sanitary landfill) many physical conditions may exist that are acceptable within the management guidelines but not ideal. Often acceptability of a site will depend on the alternatives available for site preparation to adjust the site to agree with the management guidelines. Since the selection of a site for sanitary landfill will be used to illustrate how the natural resource interpretation system works, a more detailed list of guidelines is appropriate. This list is hypothetical and for illustration only; other local factors also may be important and other guidelines could be chosen.

(1) To comply with State regulations on disposal of refuse (Conn. Dept. Health). These regulations, in part, read: "No refuse shall be deposited in such manner that refuse or leachings from it shall cause or contribute to pollution or contamination of any ground or surface water on neighboring properties. No refuse shall be deposited within fifty feet of the high water mark of a watercourse or on land where it may be carried into an adjacent watercourse by surface or storm water unless protective measures approved by the State Department of Health are provided."

(2) To insure sufficient storage capacity per acre through development of a trench-fill operation with a trenching depth of at least 12 feet.

(3) To provide for the development of an area greater than 25 acres.

(4) To avoid conflicts with land and water uses of the surrounding areas (e.g., sight, odor, traffic).

(5) To prepare the site at minimum cost with tree clearing, trench preparation and establishment of access as the main items of expense.

(6) To provide adequate and suitable cover material at the site and avoid transporting it from other areas.

(7) To minimize the degradation of the existing natural resources in the area.

Once management guidelines have been developed, the single-factor maps can then be used to eliminate from consideration the areas that are unacceptable because of natural limitations or because they exceed the user's willingness to alter the site to make it compatible with the management guidelines.

Analysis of Data

The selection of the single-factor maps to be used in evaluating the intended land or water use is determined by management guidelines. Table 3 illustrates the type of matrix that can be developed to indicate the relationships between the single-factor maps and potential land use. Either columns or rows can be expanded or contracted. The list of single-factor maps is determined by the data available while the use ordinate is chosen by the user. He may require only a single use or he may want to evaluate alternative or multiple uses for a given site.

The single-factor maps can be compared with statements in the management guidelines for each use and those characteristics that directly relate to a statement in the guidelines can then be recorded. A simple check system (verticle column 3, Table 3) can be used to indicate the particular bits of information needed. Alternatively, more specific relationships can be established by assigning a weighted value to the single-factor map (verticle column 11, Table 3) to indicate that some bits of information are more important than others in evaluating for a particular land use.

The map units used on single-factor maps are chosen by the agency collecting the data and are based in part on estimates of field precision. The units of measurement in the management guidelines are often arbitrary but commonly have a scientific base.

Map units and management guideline units often differ, of course, thus introducing a limitation into the system. For example, a management guideline for a trenched sanitary landfill may require a minimum thickness of unconsolidated material of 12 feet. A state regulation which provides another guideline requires that the base of the landfill must be at least 4 feet above bedrock. Therefore, to meet both guidelines the site must have at least 16 feet of unconsolidated materials over bedrock. The single-factor map for depth to bedrock has units of 0-2 feet, 0-10 feet, 0-50 feet and deeper. None of these precisely fits the management guideline. The 0-10 feet depth provides the

Table 3. Matrix of relationship of selected land uses to single-factor maps.

SINGLE-FACTOR MAPS \ SELECTED LAND USES	1. Water supplies - surface	2. Water supplies - subsurface areas of favorable supply	3. Domestic municipal solid waste disposal	4. Industrial and sanitary treatment plant wastes	5. On-site septic disposal sites	6. Injection well - liquid disposal	7. Aggregate excavation	8. Earth work uses	9. Economic deposits	10. Density building development	11. Utility corridors *	12. Transportation corridors	13. Recreation corridors and open space	14. Recreation water impoundment	15. Recreation field development	16 Agricultural uses
1. Topography			●								2					
2. General slope map			●								2					
3. Slope greater than 15%			●								1					
4. Slope less than 3% and soil seldom saturated			●								1					
5. Bedrock type			●								1					
6. Structural characteristics of bedrock			●								1					
7. Outcrops			●								2					
8. Depth to bedrock: 0-2 feet											2					
9. Depth to bedrock: 0-10 feet			●								1					
10. Depth to bedrock: 50-foot intervals			●								1					
11. Unconsolidated materials											1					
12. Sand and gravel deposits			●								1					
13. Unified soil classification of substratum			●								1					
14. Soil saturated with water within 3 feet of the surface for 2 to 12 months			●								1					
15. Soil saturated with water within 3 feet of the surface for less than 2 months			●								1					
16. Peat and muck deposits			●								1					
17. Percolation rate classes			●								3					
18. Agricultural land use capability			●								3					
19. Drainage areas			●								2					
20. Floodprone areas			●								1					
21. Low flow of streams			●								2					
22. Saturated thickness of stratified unconsolidated deposits											2					
23. Availability of ground water			●								1					
24. Location of existing sanitary and water related facilities, services and uses			●								1					
25. Land use: 1970			●								1					
26. Zoning: 1970			●								1					

* 1 = Primary importance; 2 = Secondary importance; 3 = Indirectly related

closest unit, but fails to identify the areas with depths between 10 and 16 feet. This limitation can be reconciled during site investigation. Similarly, reconciliation by site investigation must also be made in the case where single-factor maps are not available that meet the criteria expressed in the management guidelines.

Use of Transparent Maps

The single factors extracted from basic resource data maps can be drafted at a common scale on stable transparent material. The transparent single-factor maps judged critical to the evaluation are stacked congruently by the user to: (1) rule out areas regarded as unacceptable for the particular use or (2) locate areas where the characteristics may be ideal for the particular use. This preliminary evaluation in no way replaces the need for on-site investigation, but it does reduce the number of sites to be studied in detail.

A RESOURCE INTERPRETATION SYSTEM

With the basic information now at hand and the knowledge that integration of data from maps drawn to different scales will not be perfect, we shall develop a resource interpretation system. To clarify and simplify the presentation of data, we shall produce a series of single-factor maps which show specific bits of information. Some of these single-factor maps will be called limiting-factor maps because either nature has placed a severe limitation on the land (i.e., steep slopes, bedrock or water tables at shallow depths) or man has limited its use by earlier decisions (i.e., current land use and zoning). The costs of correcting these limitations may be prohibitive. The resource interpretation system is flexible because the user needs only to use the bits of information considered important in his management guidelines.

To demonstrate the use of the system, an area of about 8 square miles in the Ellington quadrangle will be examined by collating several of the single-factor maps to determine potential areas for dumping solid wastes, an important need in our time.

Single-factor Maps

The single-factor maps for the study area were chosen for their usefulness. Additional factors may be important in other study areas; these must be determined by local needs. For example, soil salinity, which affects all uses of soil, may be important in areas of limited rainfall, but is considered less important in the humid Northeast.

Selecting a potential site for a sanitary landfill has been chosen to illustrate how the single-factor maps can be used. In this example, the resource will serve as a host for the intended use. A variety of conditions may be acceptable depending upon the willingness of the user to spend money on site modification. Some conditions will not be acceptable because the limiting factors outweigh the economic means necessary to change them.

It is assumed that there is no preconception of where the landfill should be or what land is available for such use. The geographical area is scanned to determine where a landfill will conform to the management guidelines. Alternatively, if several available sites within a geographical area are known, they can be examined to evaluate limitations imposed by the resource or management guidelines selected by the user.

Each of the single-factor maps, shown in Table 3, will be briefly described, their units of measure defined, and interpreted for a specific example: the selection of a sanitary landfill site. Each map has been numbered for reference, but not all of them will be used in the example. The complete set of single-factor maps developed for the Ellington quadrangle is on file at the Natural Resource Data Services Center, Department of Environmental Protection, Hartford.

1. Topography. In determining the suitability of land for a particular use, it is important to know where the tract of land lies in relation to its surroundings and if slopes are steep. A topographic map indicates whether the land is on a ridgetop, hillside, or in a valley. Steep slopes are shown as closely spaced contour lines. One may also observe natural and cultural features such as swales, streams, and whether the site is accessible by roads or near houses. Topographic maps, however, will not show roads and houses built since the map was published. Most older maps are being revised to show new cultural features. If the land is used for sanitary landfill, the topographic map will show nearby streams, swamps and houses, and whether the present road network will provide access to the site. These factors may not be critical but may enter into a comparative study of all potential sites. Steep slopes, a critical factor, are shown on a separate map.

2. General slope map. Slope may limit use of the land and is important in land shaping, excavation and final grading for houses, highways, parking lots and industrial development. It influences construction of systems for disposal of septic tank effluent and control of surface water.

General slope maps may be produced from both soils and topographic maps. A soils map shows ranges of slopes measured on the land. The last letter of the map symbol (e.g., ChA, ChB, etc.) indicates its slope range as follows: A = 0-3%, B = 3-8%, C = 8-15%, D = 15-25%, E = 25-35%, F = 35-45%. In very stony or very rocky areas the ranges are combined as BC = 3-15% and DEF = greater than 15% because stones, boulders and bedrock outcrops are more limiting than slope.

General slope maps are derived from topographic maps by scaling the distance of the slope and determining differences in elevation between two points on the scale. Slopes may be expressed in several ways: as percentages, angles or in feet per mile.

Slope, as it concerns sanitary landfill, falls into three categories. The first is land having slopes greater than 15%. This land would be of limited value in preparing a landfill because development costs could be prohibitive and in direct conflict with the selected management guidelines. Because of this relation between excessive slope and costs of site preparation, a separate overlay showing steeply sloping areas was constructed (Map 3, Table 3) which can be utilized as a limiting-factor map.

A second slope category delineates a suitable slope for a sanitary landfill, 0-3%. Relatively flat land would require the least amount of site preparation. Since this resource factor best complies with the management guidelines, a separate overlay map can be used. Map 4 (Table 3) not only shows the distribution of land having slopes less than 3%, but also only those slopes underlain by well-drained soils. Despite favorable slopes and surface drainage, however, these areas may be underlain by coarse materials with low filtration capacity or impeded drainage above a depth of 16 feet which may conflict with the selected management guidelines.

The third category includes all remaining intermediate slopes, 3-15%. In general, costs of site preparation will rise with increases in slope. The general slope map shows whether the land trends toward favorable or prohibitive conditions.

3. Slope greater than 15%. This map delineates those areas where normal site development might be limited by the steepness of the slope. An example of such a site is shown in Fig. 1. Steep slopes require special design for sewage disposal systems and soil and water conservation. Increased construction costs may also be limiting. For sanitary landfills the costs of developing trenches on steeply sloping land may be prohibitive and in conflict with management guidelines. Steeply sloping areas are shown separately and the map can be used as a limiting-factor map. Other slope units could have been used if they had been set forth in the management guidelines for a different use.

4. Slopes less than 3% and soil seldom saturated. This map, derived from the basic soil survey map, delineates areas that are suitable for a wide variety of uses including agriculture, urban development, woodlands and recreation. In these areas, competition for various uses could be great because there are few, if any, natural limiting factors. Design and construction costs should be low. The favorable attributes of areas having slopes less than 3% and underlain by well-drained soil prompts their separation from other data. For sanitary landfills, this map may conform to many of the management guidelines. This map does not show, however, the presence of a water table below normal soil depths (5 feet). On-site investigations in early spring would show if a water table is present within 16 feet of the surface.

Figure 1. Steep slopes, commonly stony, prohibit most kinds of development. Sewage and waste disposal is mostly limited by steepness of slope and shallowness to bedrock. Historically, most steep slopes, as the one above, have remained wooded. (Photo - Soil Conservation Service)

5. Bedrock type. The kinds of rocks that underlie a geographical area are delineated on a bedrock-lithology map. The map units correspond to the geologic map units (Collins, 1954), but have been modified from recent detailed mapping in the Ellington quadrangle, adjacent quadrangles and from interpretations of aeromagnetic data (Pitkin, Philbin and Gilbert, 1969). This map, unlike the geologic map, is not concerned with the relative stratigraphic position of each rock type. The variety of rock types contained within these map units are defined in terms of physical properties that are useful for engineering and land management.

The bedrock map may be used to determine a possible source of conflict between use of the site and use of the underlying rock. If the bedrock is covered by a sanitary landfill, the future use of the rock as a resource could be eliminated. A second conflict could occur if the bedrock is known to be an important aquifer. In this case, a decision must be made either to avoid the use of the land because of possible contamination or to protect the aquifer by special site preparation.

6. Structural characteristics of bedrock. Contacts between the rock types are shown on this map. They may be sharp or gradational, but most contacts are covered by glacial material and cannot be continuously traced. Faults, where displacement of the rock has occurred, are also shown. A fault may involve a single fracture or a zone of fractures up to several hundred feet wide. The bedrock system in fracture zones generally is structurally weak. Joints and fractures are numerous and tend to decrease in abundance outward from the fault. The fault may extend to depths of hundreds of feet and serve as channels for ground water. An example of fractured bedrock is shown in Fig. 2.

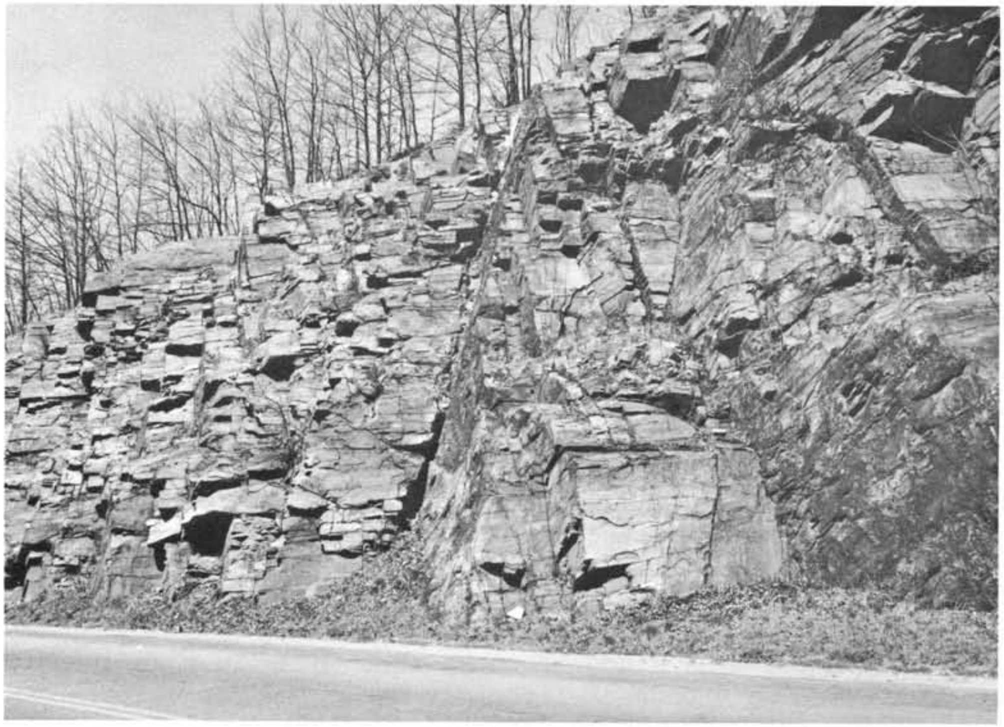


Figure 2. Bedrock outcrops along highway cuts exhibit many fractures. The gently sloping fractures are along bedding and foliation planes. The steeply sloping fractures are along joints. The prominant steeply sloping fracture in the center of the picture is a fault. All of these fractures may extend to considerable depth and serve as pathways of water movement. (Photo - U.S. Geological Survey)

Other symbols on the map define the attitude of surfaces formed by alignment of certain minerals, called foliation. Foliation allows rocks to split apart in preferred directions. Also shown is the attitude of bedding which reflects the way the materials were originally laid down. For the Ellington quadrangle, the bedding symbol is equivalent to the foliation symbol. Trends of foliation and bedding and zones of potential bedrock weakness are shown on a separate map.

The physical properties of bedrock in the area studied are important even though refuse in a sanitary landfill must be kept at least 4 feet above the bedrock surface. As leachate must inevitably move out of the site area, in many places it will probably reach the bedrock surface not far from the site, and may eventually seep to the bedrock. If the bedrock is relatively massive and lacks interconnecting fractures, leachate will follow the bedrock surface. The direction and ease of transport of leachate within bedrock depends upon permeability, water pressure, attitude of layering and abundance of interconnecting fractures.

7. Outcrops. This map, derived from the basic surficial-geology map, shows the location and distribution of outcroppings of bedrock. Small, closely spaced outcrops are not shown on the map separately, but are included in the areas of thin glacial material.

In accordance with management guidelines, the refuse in a sanitary landfill must be kept at least 4 feet above the bedrock surface, thus areas of exposed bedrock (outcrops) are unacceptable for a landfill. This map can be used as a limiting-factor map.

8. Depth to bedrock: 0-2 feet. This map, derived from the basic soil survey map, delineates areas, such as those shown in Fig. 3, where the soil cover is very thin. Areas covered by shallow soils also may

Figure 3. Many acres of Connecticut's landscape are only thinly covered by soil. Shallow depths to bedrock severely influence construction activities, productive agriculture and forest growth. (Photo - Soil Conservation Service)

have numerous rock outcrops (not precisely located as in a surficial-geology map). These areas severely influence construction such as foundations, underground utilities, sewage disposal systems and sanitary landfills. They also limit agricultural and forestry pursuits because of low moisture reserves and difficult management. Most of these areas have remained wooded.

Areas of 0-2 feet to bedrock are in conflict with the management guidelines for sanitary landfills because at least four feet of clean material must lie between the bottom of the landfill and the top of the bedrock. This map can be used as a limiting-factor map when the map showing 0-10 feet to bedrock is not available.

9. Depth to bedrock: 0-10 feet. This map, derived from a surficial-geology map, delineates areas where the thickness of unconsolidated materials is estimated to be 10 feet or less. The glacially-scoured surface of the crystalline bedrock of the Eastern Highlands is seldom flat and smooth, but usually has a rough, jagged appearance. Small deep pockets may occur within the 0-10 foot thick areas shown on the map. Filled with unconsolidated material, they create depths that exceed 10 feet. Bedrock sometimes lies just below existing trenches and seepage pits and might be overlooked if subsurface investigations are inadequate.

Areas of 0-10 feet to bedrock are in conflict with the management guidelines since they require trenches at least 12 feet deep and an additional 4 feet of soil material above the bedrock for a total of 16 feet. Areas having thicknesses of unconsolidated material less than 10 feet would not be acceptable. A map showing depths of 0-15 feet to bedrock would be more useful. Without these data, which more closely conform to the management guidelines, this factor must be closely examined during on-site investigations. This is a limiting-factor map.

10. Depth to bedrock: 50-foot intervals. This map shows ranges in depth to bedrock. Fifty-foot intervals were chosen after consideration of accuracy and irregular distribution of the data. Ranges in depth were derived from the water-resources inventory and records of wells and test holes.

This map serves to identify areas where the depth of unconsolidated materials is not a limiting factor for sanitary landfills. This map can be used in the same way that Map 4 was used to identify areas where conditions may be well suited. It must be recognized, however, that this map only estimates the total thickness of the unconsolidated material lying above the bedrock. The characteristics of the material may change with depth.

11. Unconsolidated-materials map. This map, derived from the surficial-geology map, shows the distribution of the principal kinds of unconsolidated materials. The natural deposits, glacial till, sand

and gravel, and swamp deposits are assumed to be at least 3 feet thick and are shown as they occur beneath the soil layer. The total thickness of a map unit is not shown; different materials may occur at depths beneath the map units.

Glacial till is a poorly-sorted mixture of boulders and stones with sand, silt and clay sizes in varying proportions. Some till is loose, sandy and very stony and is commonly less than 10 feet thick. Other tills are less sandy, less stony and very compact (hardpan) and average more than 10 feet thick. Where these tills occur together, the loose sandy till lies on top of the compact till. The two varieties of till have quite different physical properties. They were not differentiated on this map because the data were unavailable for this quadrangle. Therefore, detailed investigations of the physical characteristics and thickness of till is necessary for planned site development.

Swamp deposits contain organic matter sometimes mixed with sand, silt and clay. They form in very poorly drained areas, in valleys and on broad, flat uplands underlain by hardpan.

Artificial fill is shown only where it is extensive and well defined. They are found in areas filled for highways, flood-control structures, solid-waste disposal and other major construction. In urbanized areas, natural land conditions are often extensively altered but are not shown on the map as such.

The unconsolidated materials map for the Ellington quadrangle delineates the areas of glacial till and stratified sand and gravel. The preferred host material should contain sufficient fine material (silt and clay) to retard rapid percolation and promote chemical and biological filtration of the leachate generated in the landfill, yet the material should be coarse enough to provide a cover that will support traffic when it is wet. These two characteristics of the materials seem to conflict with each other. The materials map, however, is especially useful in identifying areas where the fine-textured till, a good host, is adjacent to deposits of stratified sand and gravel, a good cover. Some tills, however, are quite sandy and also provide suitable cover, but they were not differentiated on this map from the siltier, compact till which commonly provides poor cover. The usefulness of the materials map could be improved if the basic surficial-geology map had differentiated between the two kinds of tills.

12. Sand and gravel deposits. This single-factor map is derived from Map 11. Sand and gravel deposits such as shown in Fig. 4 have been isolated because they are important economic resources. These deposits are composed of varying proportions of sand, pebbles and cobbles which commonly occur in layers. Detailed on-site investigation is necessary to determine composition, thickness and areal extent. These deposits are not only important sources of construction materials, but those covering large areas also may be important aquifers.

Figure 4. Sand and gravel deposits have long been an important economic resource in Connecticut. In some areas these deposits, which are also important aquifers, are rapidly disappearing. (Photo - U.S. Geological Survey)

Sites containing sand and gravel may be easily prepared for a sanitary landfill, but conflicts may arise with management guidelines. For example, the use of the site for sanitary landfill must be evaluated against its use as an extractable resource. Further, both uses must be evaluated against its use for water supply if the sand and gravel aquifer contains a large supply of water.

13. Unified soil classes of substratum. This map, derived from interpretative tables in the soil survey reports, shows the Unified Soil Classes (Waterways Experiment Station, 1953) assigned to the substratum (unweathered material generally below a depth of 30 inches) of each soil series. The Unified System classifies mineral and organic-mineral mixtures of soils for engineering purposes and is based on particle size and moisture characteristics. For simplicity, the soils of the Ellington quadrangle have been separated into classes of coarse-grained, fine-grained and highly organic materials.

The map showing the Unified Soil Classification of the substratum provides information concerning the physical characteristics of the host and cover materials for a sanitary landfill. It enables the user to make preliminary estimates of such performance qualities as strength, compressibility and permeability. The user may determine whether the material at the site can be used as cover or if a different material must be imported at additional cost.

14. Soil saturated with water within 3 feet of surface for 2-12 months. This map, derived from a soil survey map, delineates areas with a persistant high water table which seldom falls below 3 feet from the surface except during prolonged rainless periods. The saturated zone is usually above an impermeable soil layer as in Fig. 5 or bedrock. These conditions are found in generally flat areas and the water table fluctuates through a narrow range of depths below the surface.

Figure 5. Many soils have shallow water tables that persist throughout the year. Septic tank drain fields will not function and solid wastes buried in these soils will become flooded with water, producing undesirable leachate. (Photo - Soil Conservation Service)

The maximum height generally can be determined by noting the depth in the soil at which color mottling occurs. Poor drainage limits many uses, but in places it can be corrected by drainage systems. Generally, the soil drainage classes delineated here are:

a. Poorly-drained soils where the zone of saturation is within 0-6 inches from the surface during the wettest part of the year. The saturated zone persists into early summer and may reappear after prolonged or unusually heavy summer rains. The water table is usually observed within 4-5 feet of the surface even at its lowest point of fluctuation.

b. Very poorly-drained soils where water ponds on the surface for significant periods in winter and early spring and persists within 3 feet of the surface throughout the year.

Management guidelines established the need to locate the high water table relative to the base of the landfill (greater than 2 feet below). A map showing the depth to saturated zones is not available. This single-factor map, however, identifies the soils saturated with water within three feet of the surface for known lengths of time. It serves to identify areas in conflict with the management guidelines. This map can be used as a limiting-factor map. The user must be aware that a water table which rises seasonally within 14 feet of the surface will still conflict with management guidelines. In the absence of water table information within 14 feet of the surface, this factor must be critically examined during detailed site investigation.

15. Soil saturated with water within 3 feet of surface less than 2 months. This map, derived from a soil survey map, delineates areas which have a temporary high water table within 3 feet of the surface. In these areas, the water table may fluctuate over a wide range of depths. During the highest point of fluctuation, generally occurring in early spring, the zone of saturation may lie within 15 to 20 inches of the surface. The high water table seldom persists beyond late spring. In wooded areas the lowering of the water table is augmented by transpiration as new leaves begin to form on the trees. Areas delineated on this map belong to the class of moderately well-drained soil. Imperfectly drained areas, like poorly drained ones, may be in conflict with management guidelines, for greater quantities of leachate may be produced in early spring and following prolonged rains which may affect ground-water and surface-water quality in the region. An alternative to the prohibition of use of areas of high water table would be to drain the site or control the leachate produced in the landfill.

16. Peat and muck. This map, derived from a soil survey map, delineates the areas of organic soils where centuries of plant remains have accumulated in former lakes and ponds. Most of the plants are reeds and sedges, but in places remains of former forests are found buried in the peat. Accumulations of peat commonly range in depth from

1 to 25 feet. Many shallow deposits and the surfaces of most deep deposits are highly decomposed and called muck. Virtually all peat and muck areas are undrained and have a permanent high water table. They are limited for most uses.

Areas of peat and muck are in conflict with the selected management guidelines for they usually have a persistant high water table and the materials may not serve as a suitable host. The use of these sites for sanitary landfill would require extensive preparation. Although all areas shown on this map are also shown on Map 14, this map segregates wet unstable organic soils from wet mineral soils.

17. Percolation rate classes. This map, derived from interpretative tables in soil survey reports, delineates areas of probable percolation rates which can be used to assess the capability of a soil to transmit effluent from on-site sewage systems. The rates are estimated from percolation tests which measure the rate at which the water level falls in a percolation test hole 30 to 36 inches deep. As water passes into the surrounding soil, its rate is influenced by the condition of the wall and by the porosity and moisture content of the unsaturated soil through which it flows (Hill, 1966).

Percolation rates may be expressed in two ways: "inches per hour" and inversely "minutes per inch". Class limits are arbitrary, but correspond to those established by the Connecticut Department of Health (1970). It is difficult to assign a precise percolation class to each mapping unit, therefore, a probability factor is introduced to account for site and seasonal variations. Percolation rates vary with site and season in all soils, but the variation may fall within a single percolation rate class. These soils are easy to segregate. Those whose seasonal variations straddle one or more classes are more difficult to segregate. At best we can estimate the probability of soils with intermediate rates being classed with the fast or slow rates. The rate classes are fast, probably fast, probably slow and slow.

Although percolation rate data is derived from soil maps and therefore limited to depths of 3 or 4 feet, broad estimates may be made on deeper materials if they are similar to the materials from which the soil has developed. The map can be used best to estimate the rate of movement of leachate from landfill areas into the surrounding soil. Soils in the "fast" percolation class indicate that leachate may move rapidly from the landfill area. Soils in the "slow" category of percolation may indicate areas where the movement of leachate is slow. There is, unfortunately, little information on the rate of production and control of landfill leachates at the present time.

18. Agricultural land use capability. This map delineates the broad capability classes of soils. Groups of soils are classed to show, in a general way, their suitability for most kinds of farming. The grouping is based on limitations of the soils (i.e., drainage, erosion, stoniness and wetness), the risk of damage when they are used,

and how they respond to such treatments as drainage, irrigation and fertilization. There are eight capability classes designated by Roman numerals I through VIII. In Class I are soils with the fewest limitations, the widest range of potential use, and the least risk of damage. The soils in other classes have progressively greater limitations.

Capability classes are primarily used to evaluate and plan methods of farm management, yet they provide the planner with an evaluation of the land for agriculture against use for sanitary landfill, home sites, open space and recreation.

19. Drainage areas. This map, derived from a topographic map and the water-resources inventory, segments the landscape into natural surface drainage basins. The divides between basins and the total drainage area in square miles that contributes streamflow to selected sites on major streams are shown. These sites may be stream-gaging sites, surface water sampling sites, or mouths of tributary streams.

The distribution and size of drainage areas may provide information on the direction of leachate flow and show where the landfill would lie in relation to a stream discharging from the basin. The increased potential of pollution loading from a landfill in relation to that contributed to the basin by other sources may also be estimated.

20. Flood-prone areas. This map, derived from a topographic map and the water-resources inventory, delineates areas that may be flooded on the average of once in fifty years (i.e., there is a 1 in 50 chance that flooding could occur in any one year). Areas larger than those shown could be flooded less frequently and smaller areas flooded more frequently. This map identifies areas that are in conflict with regulatory management guidelines for sanitary landfills. Regulations require a minimum distance of 50 feet from the burial of refuse to the high water mark of a surface water body. To resolve the conflict, the area would have to be protected with a dike. This map can be used as a limiting-factor map.

21. Low flow of streams. This map shows, for selected streams, the lowest average daily streamflow that can be expected for 30 consecutive days on an average of once in 2 years. This low-flow parameter is one measure of the minimum quantity of surface water available from run-of-the-river development. Typical high and low streamflows are shown in Fig. 6.

The distribution of low streamflow as mapped was determined by correlating long-term and miscellaneous streamflow records available within the quadrangle and adjoining areas. The standard error of estimate for any mapped unit is ± 35%.

Figure 6. In May the stream above was flowing at a rate of 11 mgd (million gallons per day); it flows at least this much 40% of the time. In August the same stream below was flowing about 0.9 mgd; it flows at least this much 90% of the time. (Photo - U.S. Geological Survey)

The units are: low flow less than 1 mgd (million gallons per day), 1 to 10 mgd, and 10 to 100 mgd. This information can be used to evaluate the potential effects of known volumes of wastes, as from sewage treatment plants, on the receiving streams. Regulatory restrictions prohibit the deposition of refuse in a sanitary landfill in a manner that will allow leachate to contaminate or pollute surface water on neighboring properties. The surface water low-flow map may be used to estimate the diluting effects a stream will have upon the leachate if it should reach a stream.

22. Saturated thickness of stratified, unconsolidated deposits. The map shows by contours the thickness of sand and gravel deposits saturated with ground water. Where these deposits form a significant aquifer (water-yielding earth material), saturated thickness provides information on the amount of water-level lowering available if the aquifer is developed for water supply. The map is based on contour maps of land and bedrock surfaces and water-level data from streams, wells and test holes. Contour intervals were chosen after consideration of accuracy and density distribution of the data and of the map scale. The map shows the limits of each stratified deposit and its saturated thickness in 10, 30 and 40 foot intervals. Deposits having saturated thicknesses exceeding 10 feet may be important aquifers. Areas underlain by such aquifers may have a potential conflict between use for landfills and for ground-water supply.

23. Availability of ground water. This single-factor map was derived from the preceeding map and simply delineates the areas where the saturated thickness of sand and gravel deposits exceeds 10 feet and may be a potential water supply. Under usual circumstances well yields in sand and gravel deposits should exceed 50 gallons per minute. Most of these potential water supply areas in sand and gravel deposits may also be acceptable as hosts for sanitary landfill. Porous, sandy material allows rapid transmission of leachate without adequate filtration, however, and contamination of the ground water may result. This conflicts with management guidelines, and the map may be used preliminarily as a limiting-factor map. On-site investigation, however, may show that the aquifer has too poor a yield or quality for development of water supplies. This may resolve the conflict. Alternatively, the site could be prepared at the additional cost of leachate control by sealing the bottom and controlling the leachate generated in the landfill.

24. Location of existing sanitary and water-related facilities. This map, derived from land-use maps, shows the locations and boundaries in 1970 of water utility service areas, land owned by water utilities, reservoirs, watersheds tributary to existing water-supply reservoirs, water-supply wells, and water bodies supporting recreational activities (boating, fishing and swimming). Also shown are sewer service areas, sewage treatment plants, solid waste disposal sites and incinerators. This map can be used to recognize conflicts between

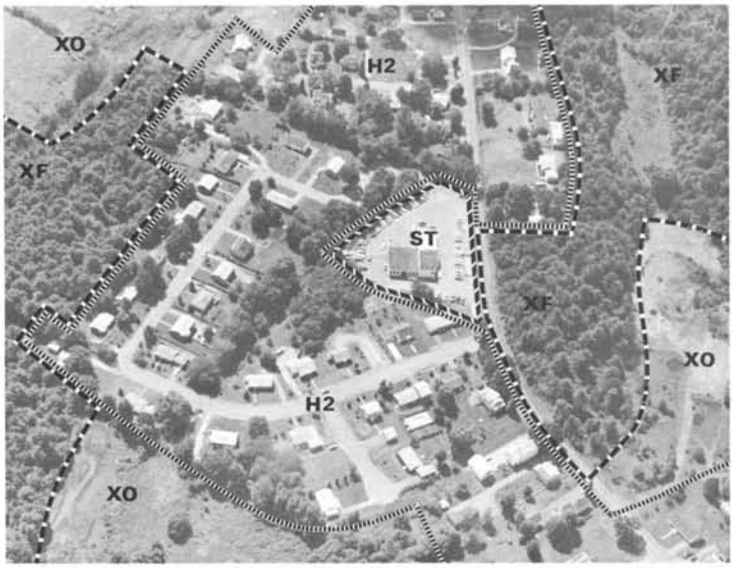


Fig. 7A

H2 Residential (Urban Low)

ST General Trades and Services

XF Open Lands

XO Open Lands

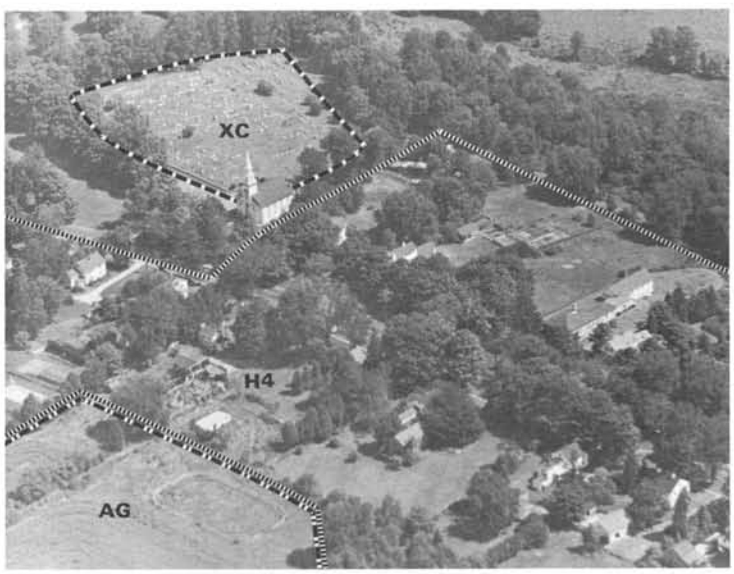
Figure 7. Connecticut's land resources are used in many ways. In 7A residential and commercial uses abut open and forest land. In 7B residential uses are scattered among agricultural and forest land. Here a sanitary landfill would offend fewer neighbors, but its location may be inconvenient to many. (Photo - Northeastern Connecticut Regional Planning Agency)

Fig. 7B

AG Active Agriculture

H4 Residential (Suburban Low)

XC Cemeteries



location of landfills and watersheds protected for surface-water supplies. Because of possible contamination of soil and water by leachates from landfill, most watershed areas presently are not acceptable as sanitary landfill sites. This map also identifies nearby sewer lines through which collected leachates might be pumped to a treatment plant.

25. Land use: 1970. This map shows the distribution of areas for 57 kinds of land use under such categories as residential, manufacturing, transportation, communication, trades and services, and recreation. Some of these uses are illustrated in Fig. 7. The map shows existing uses of land which may conflict with development of a landfill. Conflicts must be resolved by the user on the individual merits of population needs and costs of alternative use. The uses in conflict with management guidelines can be ruled unacceptable for the development of a sanitary landfill and the map can then be used as a limiting-factor map.

26. Zoning: 1970. This map delineates areas zoned for residential, industrial, and commercial use in towns which have zoning ordinances. Special zones may also include flood plains and open space. This map indicates whether the intended use conforms to current zoning regulations. If a conflict occurs between the existing zoning regulations and the potential use of the area for a sanitary landfill, the earlier decision could be reviewed. Conflict with the management guidelines can be resolved by either changing the zoning in the area or prohibiting the use of the land for sanitary landfill.

A Pilot Study

The area chosen for the pilot study and development of the single-factor maps was the Ellington quadrangle (U.S. Geological Topographic Series) that covers about 56 square miles in north central Connecticut, shown in Fig. 8, lies about 15 miles northeast of Hartford, and straddles the boundary between the Eastern Highlands and the Connecticut River Lowlands.

This particular quadrangle was chosen for three reasons: (1) The area provides sharp contrasts in topography, hydrology, and types of bedrock, surficial materials and soils, (2) the existing land and water uses include both fixed urban uses and potentially alterable rural uses, and (3) the basic resource data were available from all participating agencies and had been collected within the past 25 years. Most of the data are published; some are in open file. A list of resource data used in this study may be found in Appendix A.

Collating the Single-factor Maps

The single-factor maps which can be prepared on scale-stable transparent material provide the user with pertinent available information on soil, geology, hydrology and land use. The user can then select information that will help identify areas not in conflict with

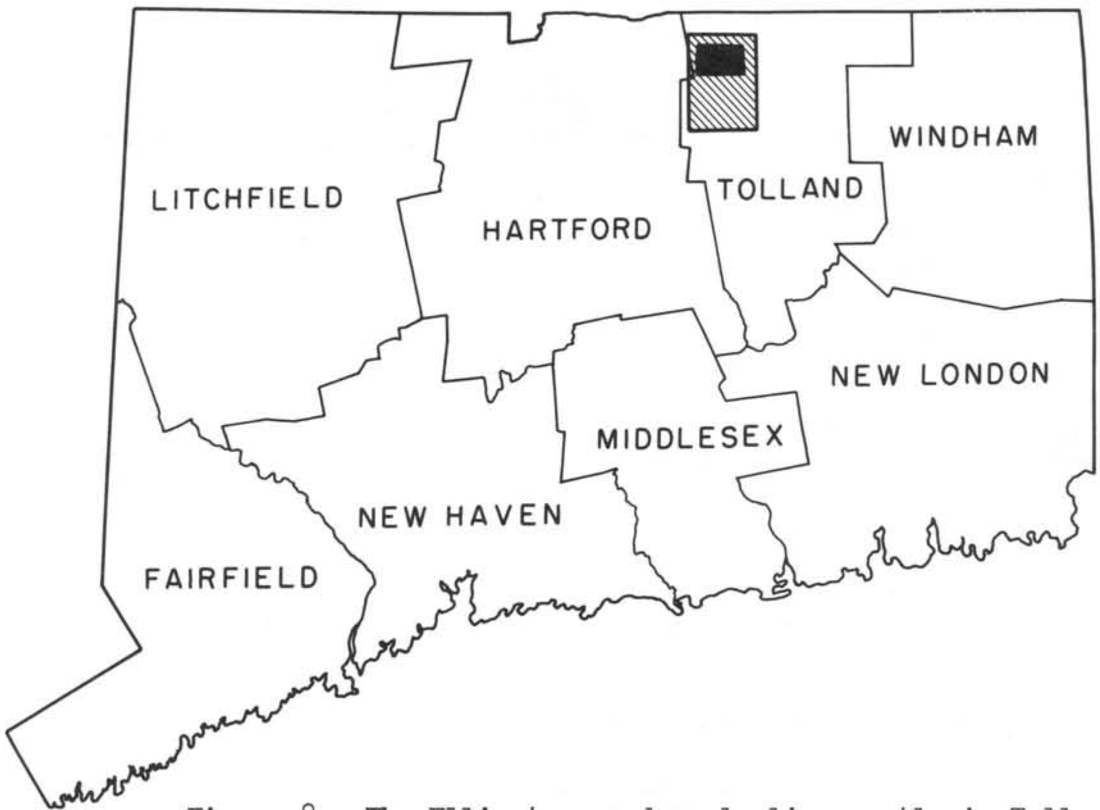


Figure 8. The Ellington quadrangle lies mostly in Tolland County in north central Connecticut. The dark area within the quadrangle is that portion used in the example, Figures 9-17.

management guidelines chosen for selection of a site for sanitary landfill. The maps can be used to identify three kinds of areas:

1. Areas can be identified that are not acceptable for sanitary landfill because they conflict with the original management guidelines. The conflicts may be due to limitations created by regulations, those created by the limiting characteristics of the resource, or those created by incompatibility with existing use. In short, all areas that are inappropriate to use for sanitary landfill can be identified and ruled out of consideration.

2. Areas can be identified that provide the ideal physical characteristics of land and water resources. These are the areas in perfect agreement with the guidelines and will most likely require the lowest costs of site preparation. In short, the best areas should be the first to be considered for on-site study.

3. The remaining areas to be identified are those containing some degree of compatibility with the guidelines, but requiring some adjustments by site preparation to overcome conflicts with the guidelines. Conflicts may be problems in access, drainage, transportation

of cover material or control of leachate. These areas can also be marked for on-site study.

A composite view can be obtained by stacking all of the transparent maps that are limiting-factor maps for sanitary landfill. For the purposes of illustrating the composite, shown in Figs. 9-17, only the small shaded portion of the Ellington quadrangle shown in Fig. 8 was used. This area covers about 8 square miles.

The following transparent maps, each with areas of single limiting factors shaded out, can be collated in the following manner:

To: Map 9, Depth to bedrock, 0-10 feet (Fig. 9)
Add: Map 14 and 15, Soil saturated with water within 3 feet of the surface (Fig. 10).

COMPOSITE LOOKS LIKE FIG. 11.

Add: Map 20, Flood-prone areas (Fig. 12) and
Map 3, Slope greater than 15% (Fig. 13).

COMPOSITE LOOKS LIKE FIG. 14.

Add: Map 23, Availability of ground water (Fig. 15) and
Map 25, Land use: 1970 (Residential areas) (Fig. 16).

COMPOSITE LOOKS LIKE FIG. 17.

The final composite will serve to block out all areas of limiting characteristics. The potentially acceptable areas appear as transparent spaces or "windows" in the composite (Fig. 17). These windows focus attention on specific areas. Some windows can be eliminated from further examination because they are smaller than the minimum of 25 acres set forth in the management guidelines. The windows are primary areas where on-site investigation is necessary. In order to find those sites within the windows that may be well suited for landfill development, Map 4, Slope less than 3% and seldom saturated, and Map 10, Depth to bedrock: 50-foot intervals, could be inserted beneath the stack.

Many of the unshaded areas which appear as "windows" and seem well suited for landfill may still conflict with other management guidelines. Additional maps must be added to evaluate this possibility. For example, Map 13, Unified soil classification of substratum, can be inserted in the stack of other maps to determine the quality of the site as host and supplier of suitable cover material. Map 26 could also be inserted to determine conflicts with current zoning regulations.

If, after stacking the maps, the user finds that no sites within the geographical area appear well suited for sanitary landfill, he may wish to change his management guidelines. If he accepts additional site modification (e.g., by drainage) than the transparent map which locates

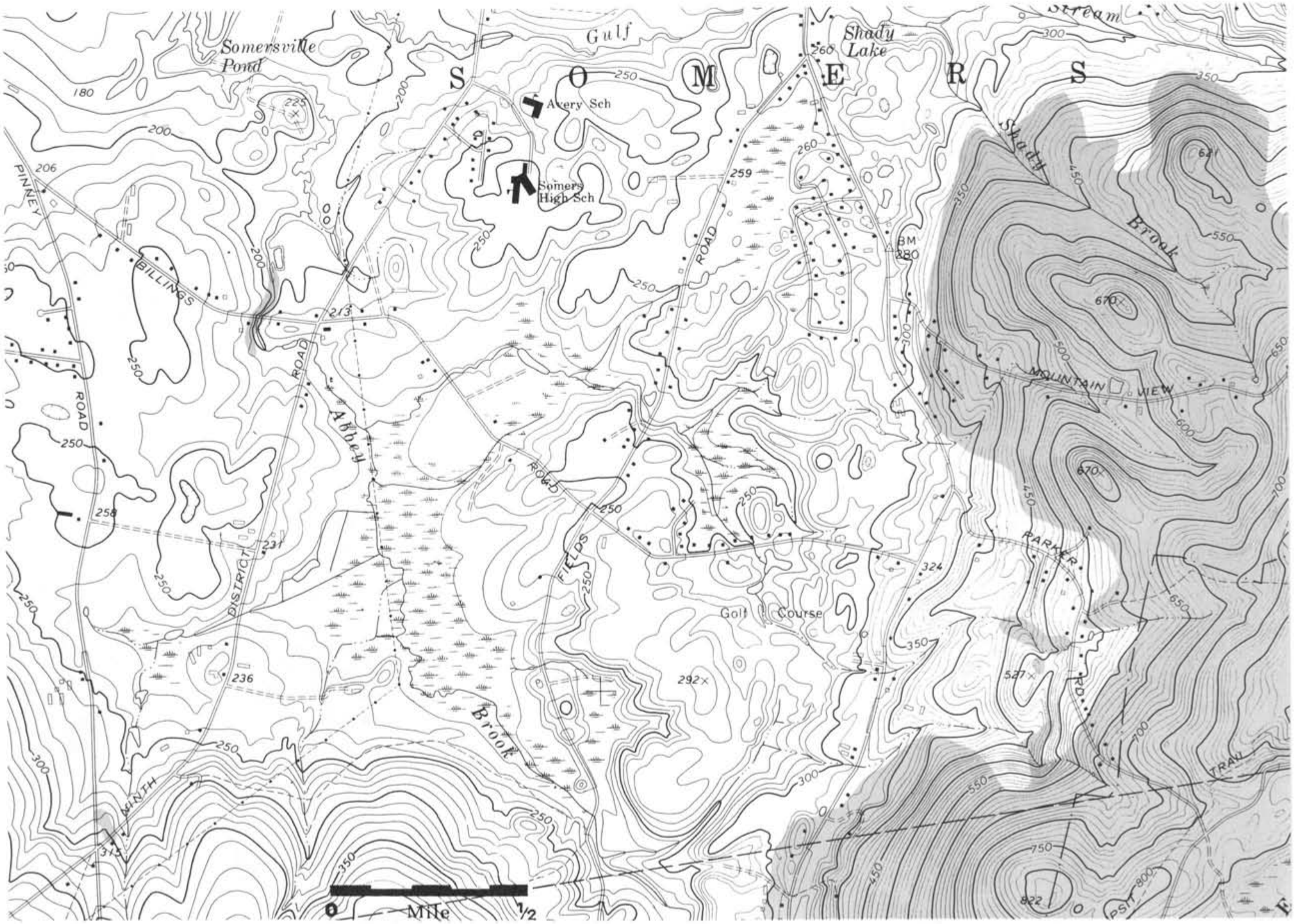


Figure 9. Map 9. Shaded areas contain bedrock less than 10 feet below the surface. The shaded areas are superimposed on a topographic base map.

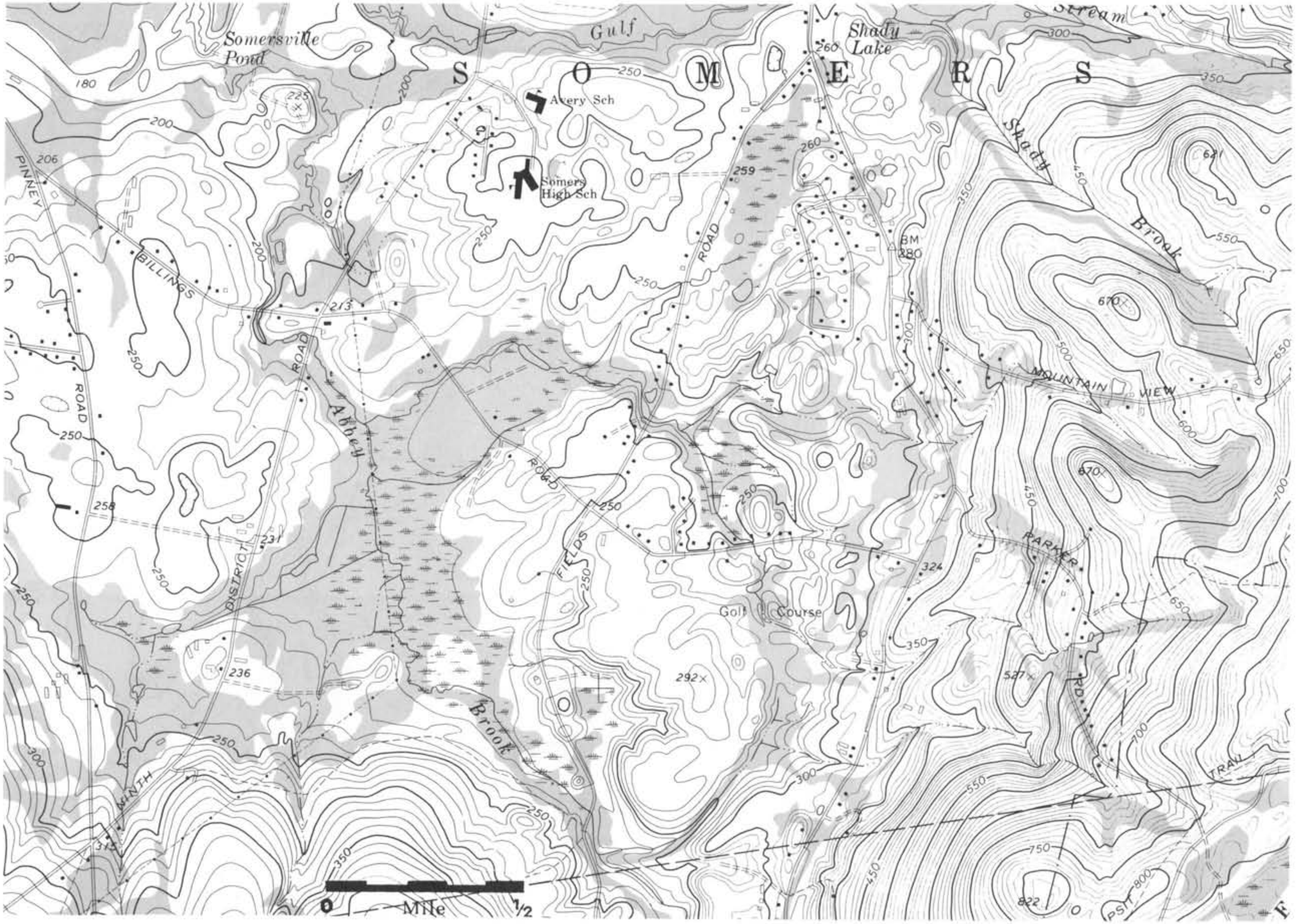


Figure 10. Maps 14 and 15. Shaded areas contain soil saturated with water within 3 feet of the surface. Use of these areas for sanitary landfill would require drainage.

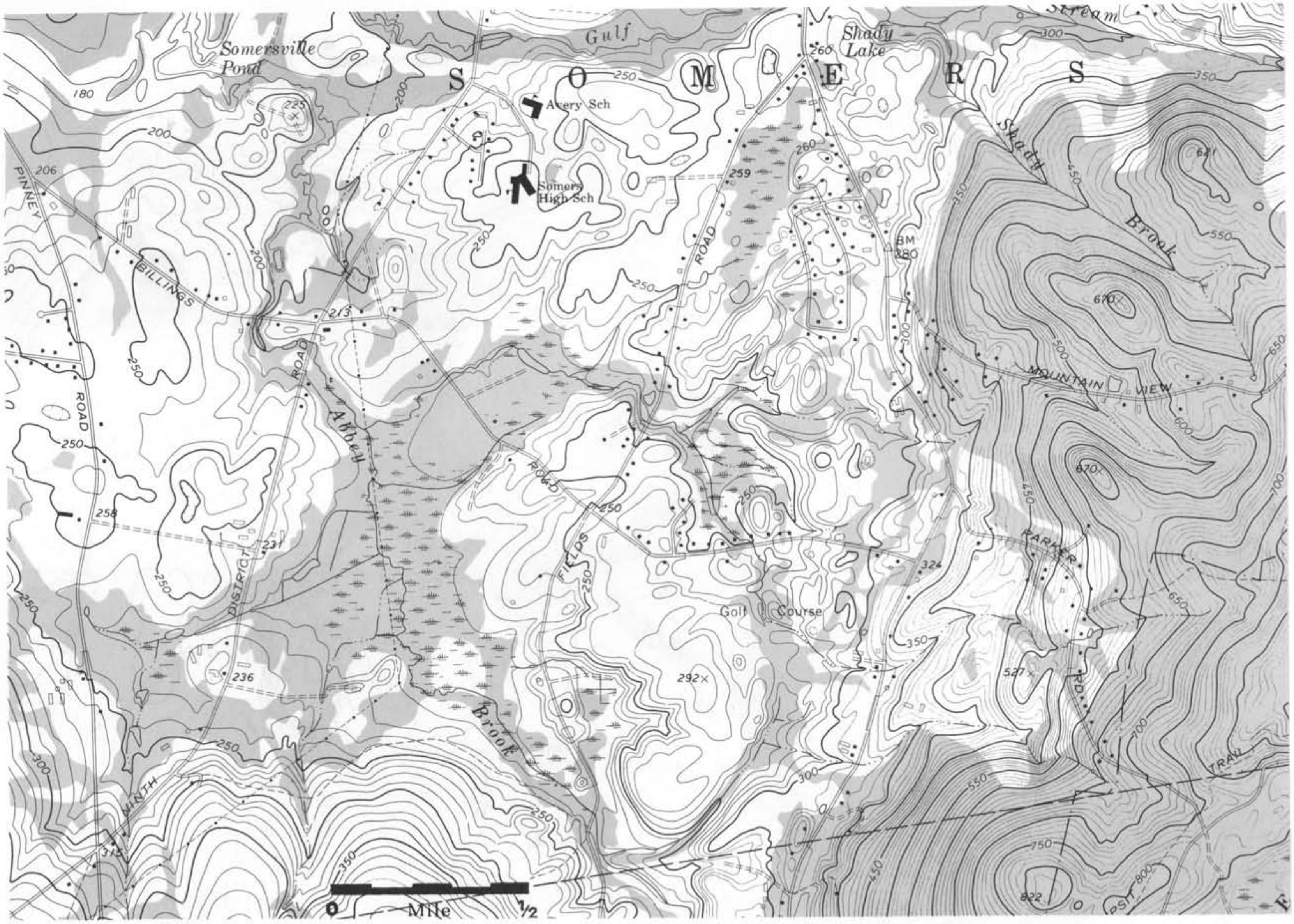


Figure 11. A composite formed by superimposing the transparent maps of Figures 9 and 10. Shaded areas do not comply with management guidelines.

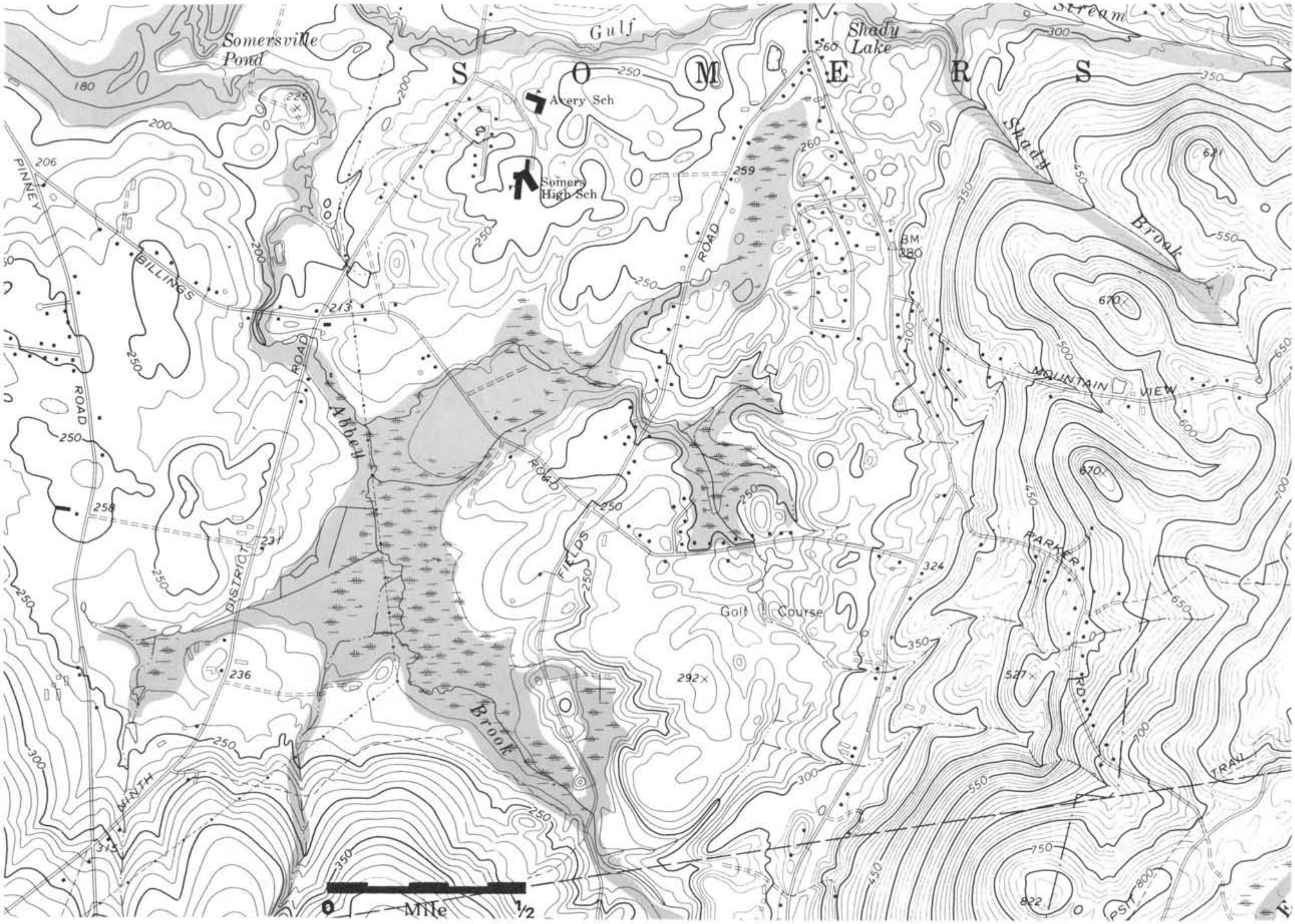


Figure 12. Map 20. Shaded areas have a 1 in 50 chance of being flooded in any year along major streams and brooks. Landfills in these areas would have to be diked to be in accord with State regulations.

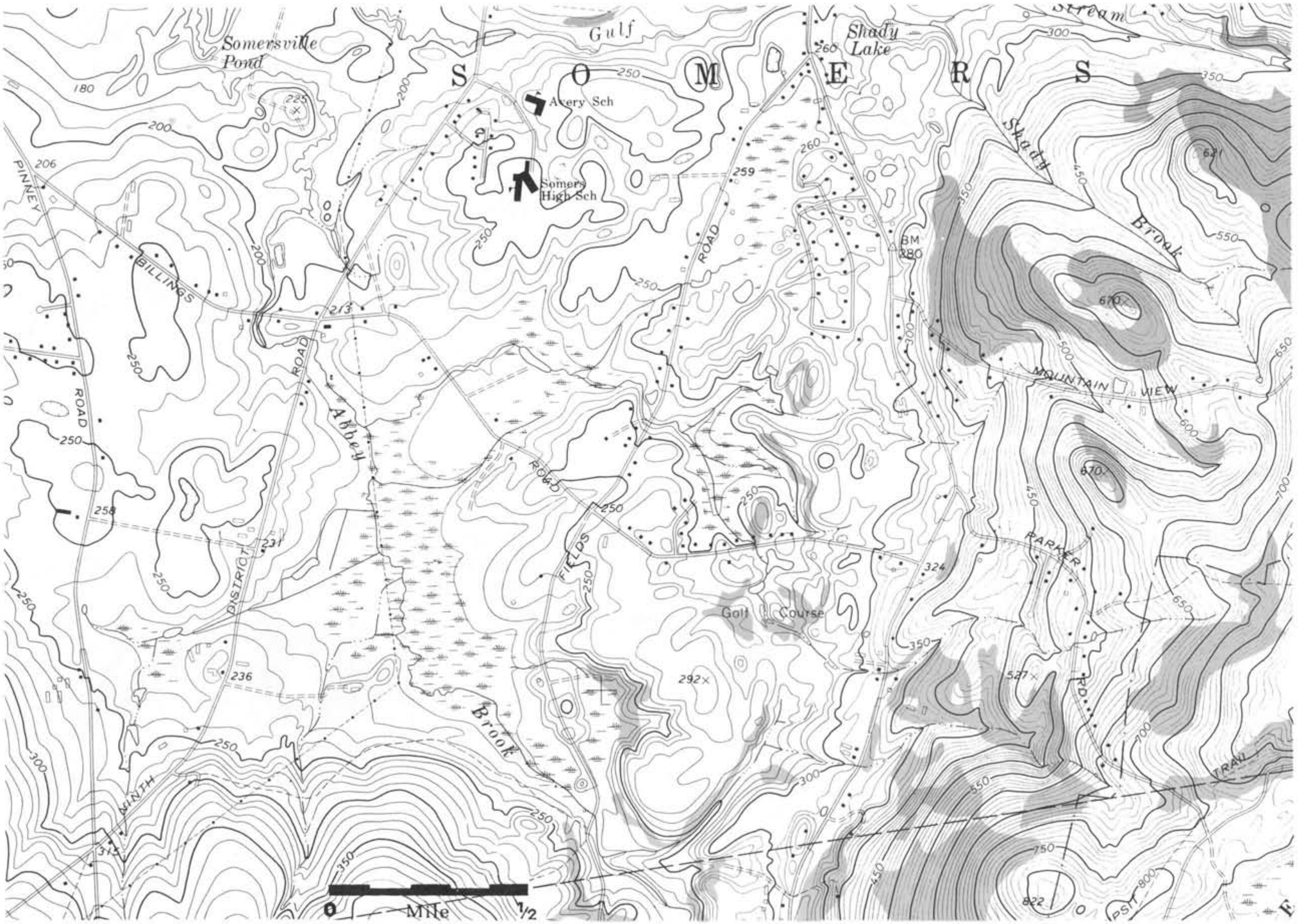


Figure 13. Map 4. Shaded areas have slopes exceeding 15%. These areas are too steep for sanitary landfill trenches and erosion control without excessive site preparation.

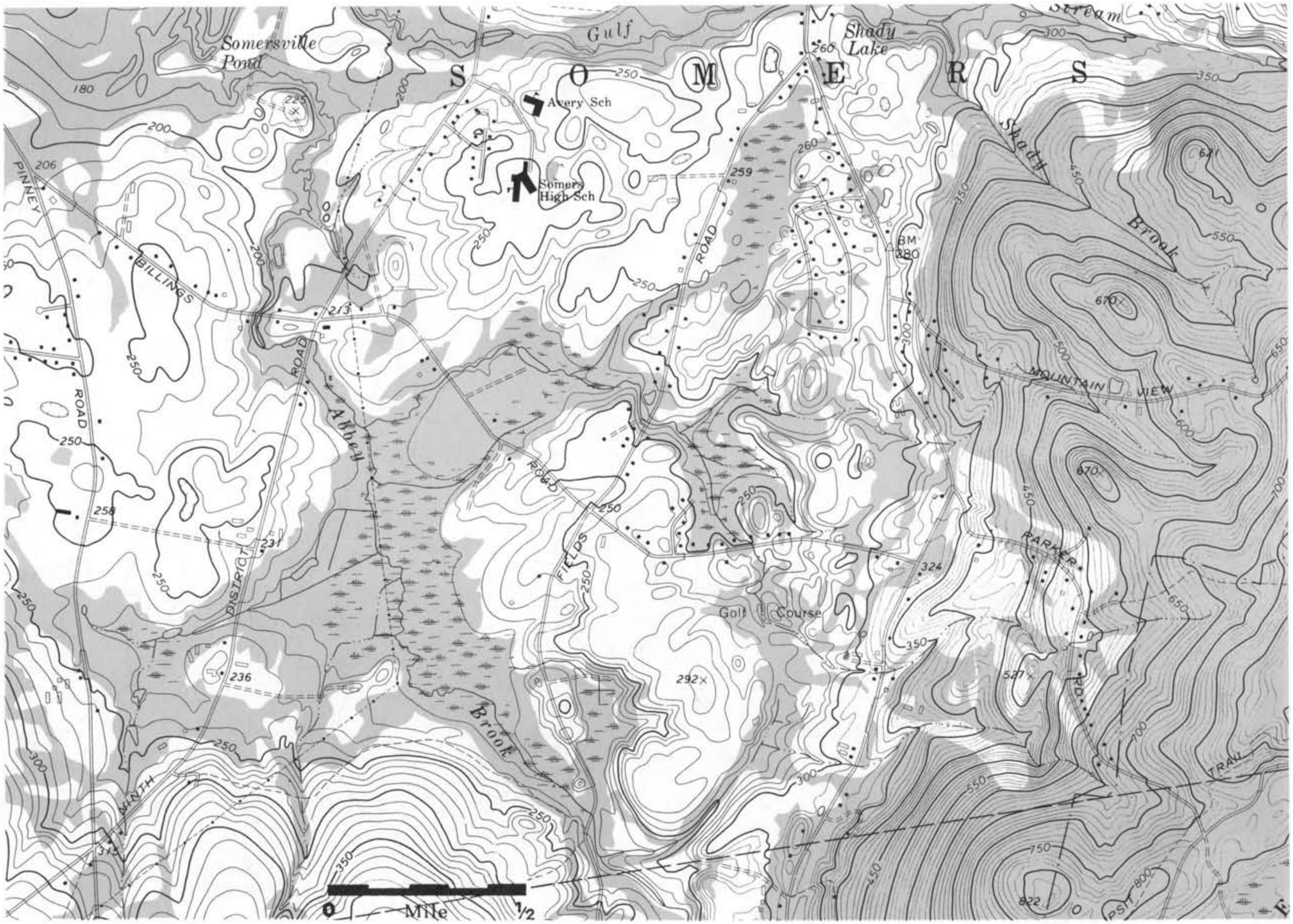


Figure 14. A composite formed by superimposing the transparent maps of Figures 9, 10, 12 and 13. Shaded areas do not comply with management guidelines.

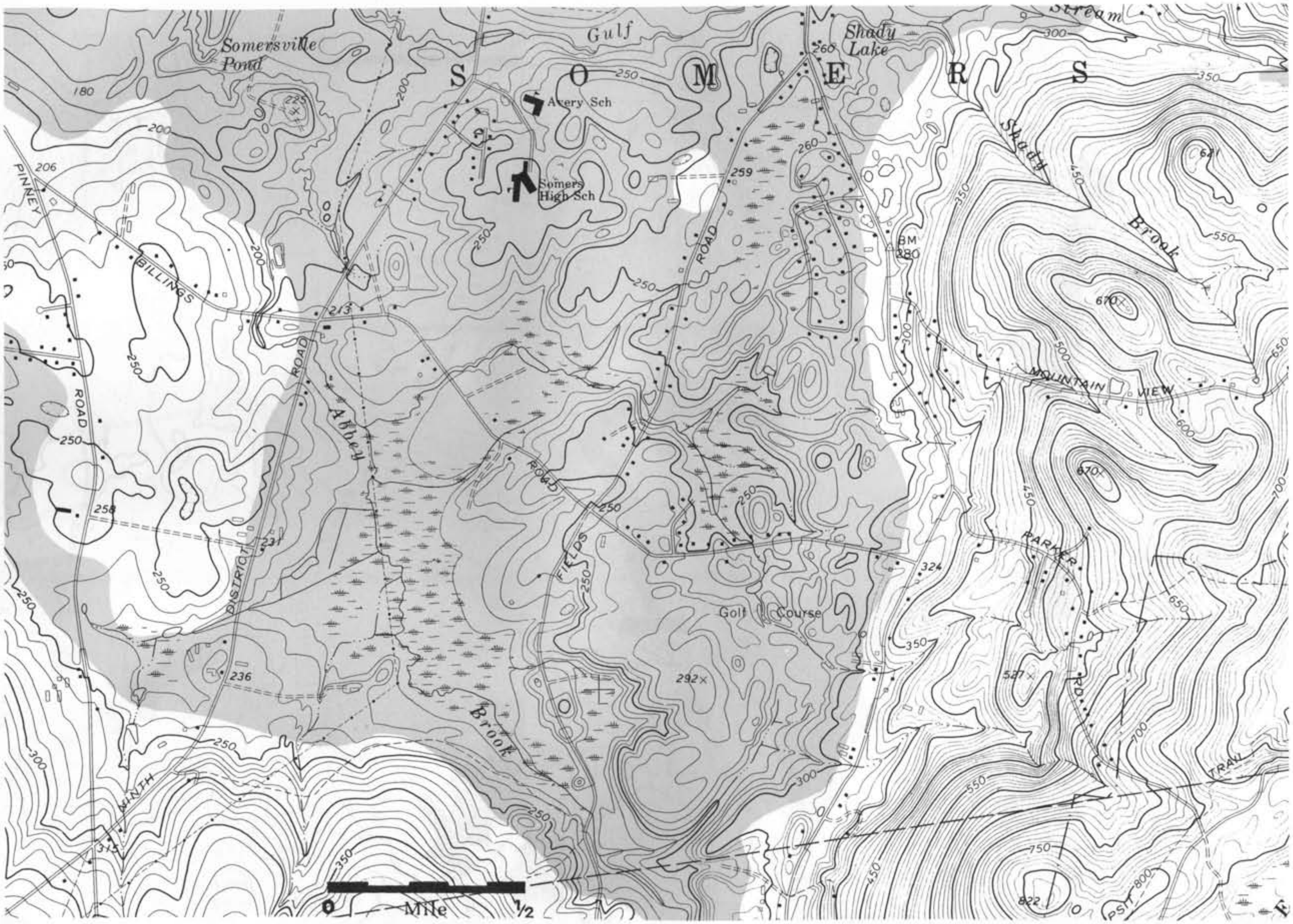


Figure 15. Map 23. The shaded areas have potential for ground-water supply from unconsolidated materials. Here the unconsolidated stratified sand and gravel deposits have a saturated thickness greater than 10 feet. In some areas, however, yields may be poor.

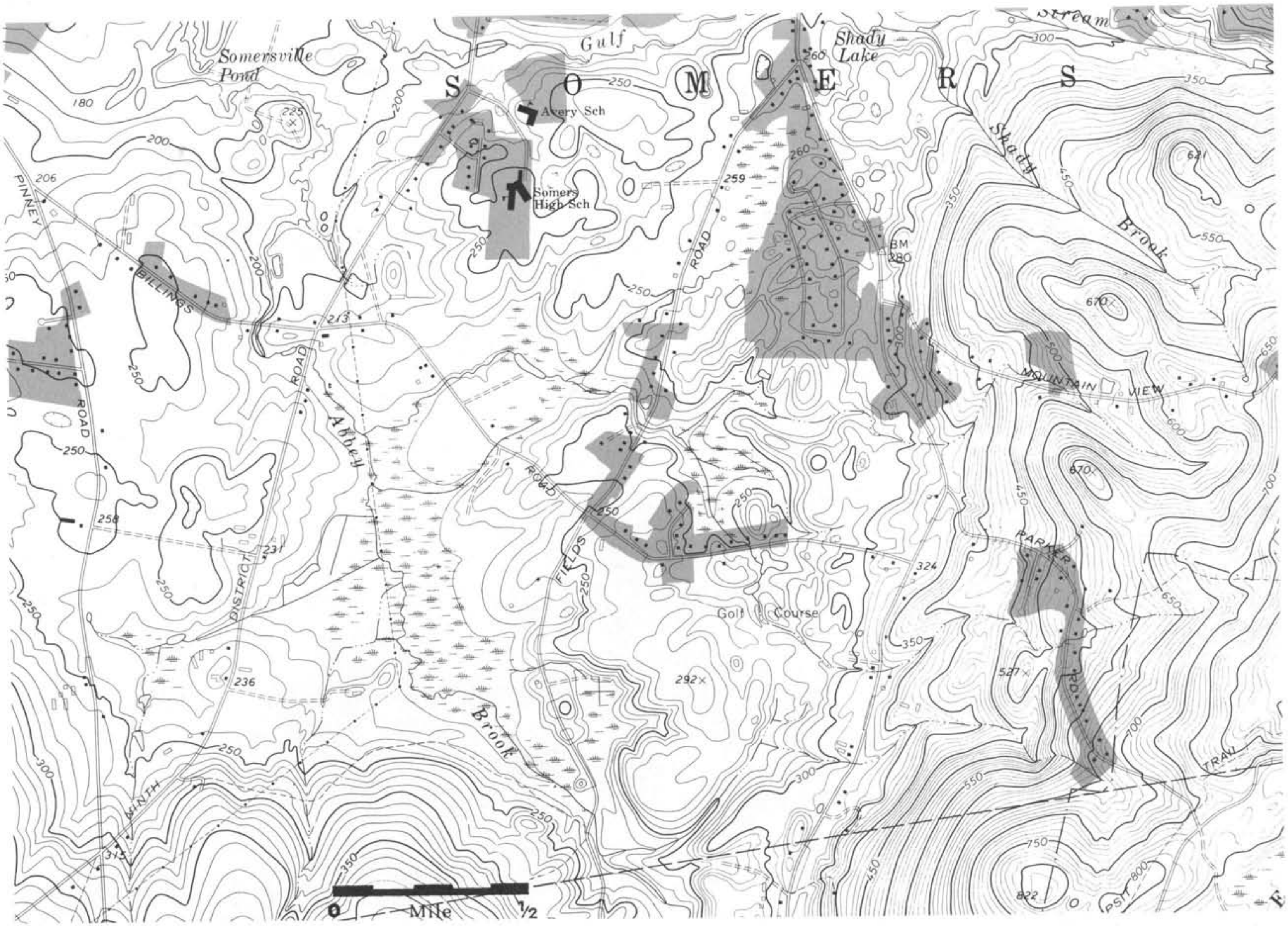


Figure 16. Map 25. The shaded areas are residential zones. These areas could conflict with use for sanitary landfill.

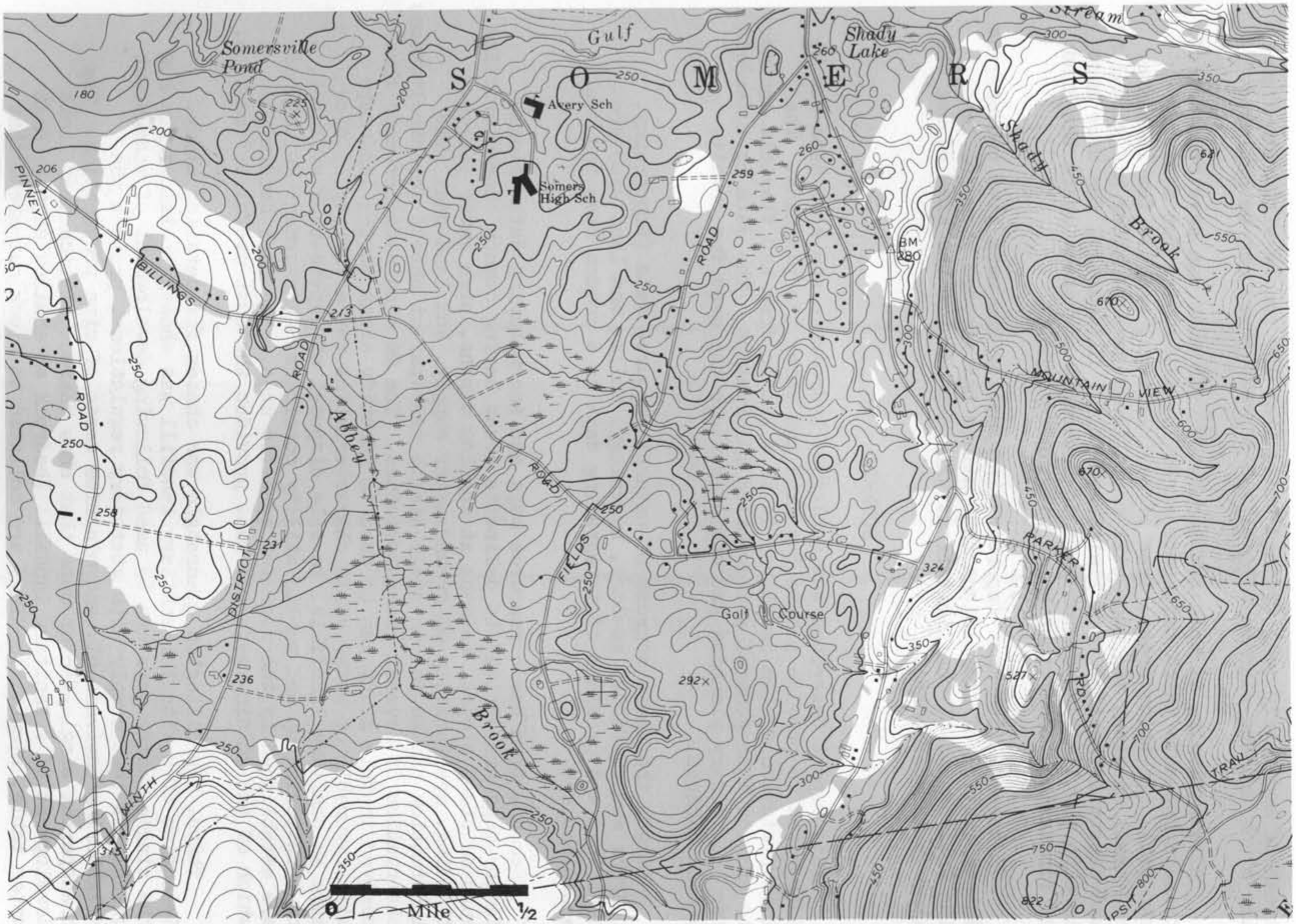


Figure 17. A composite formed by superimposing the transparent maps of Figures 9, 10, 12, 13, 15 and 16. Shaded areas do not comply with management guidelines.

areas of moderately well drained soils (Map 15) can be withdrawn from the stack and the windows will expand and new areas can be explored.

Alternatively, if data are available, the user can develop a set of transparent maps which delineate areas ideally suited for sanitary landfill. If these areas, free of restrictions, are too few in number and small in size, the user will most likely have to alter his guidelines and accept correction of a limiting factor. Ultimately, the user must turn to the limiting-factor maps to determine new areas where the kinds of limitations occur that he is willing to accept.

In essence, the most important information the maps give the user is identification of limitations that nature has imposed upon the land. The seriousness of the limitations will depend upon the kind of use the land is to accomodate.

SUMMARY

This report describes how geologic, hydrologic and soil data can be integrated to provide a base for land and water use planning. The interpretation system developed is in a simple form and flexible enough to provide both general and detailed information. The data is intended for preliminary planning and cannot replace the need for on-site investigations.

First, the basic sources of natural resource data (topography, bedrock and surficial geology, hydrology, soils, and land use) are described and problems of integrating data to a common base and scale are discussed.

Second, from basic resource maps and accompanying data, single-factor maps are derived to delineate areas having common characteristics such as steep slopes, bedrock at shallow depths, high water tables, flooding, availability of ground-water supply, and land use. The information can be put on scale-stable transparent sheets for simultaneous observation of several characteristics. The 26 single-factor maps thus derived in this study can be used to identify areas on the landscape with favorable or unfavorable characteristics for a variety of uses such as sanitary landfills, on-site disposal of septic tank effluent, or transportation and public utility corridors. Management guidelines are established by the user for specific uses. The user determines which of the 26 single-factor maps provides the most useful information.

Third, the Ellington quadrangle was chosen for detailed study. Selection of a site for sanitary landfill was chosen to illustrate how the single-factor maps can be used following development of management guidelines that comply with statutory regulations, protect the neighboring environment, and minimize costs of site preparation. The transparent single-factor maps that show characteristics that limit development of a sanitary landfill (bedrock at shallow depths, high water table, slope, flooding) are collated to block out areas that

conflict with the management guidelines. The areas that do not conflict appear as "windows" and on-site investigation can then focus on these "windows".

REFERENCES

Published

1. Collins, G. E. 1954. The bedrock geology of the Ellington quadrangle with map. Quad. Report No. 4. Conn. Geol. and Nat. History Survey.
2. Connecticut Department of Health. 1970. Private subsurface sewage disposal. Hartford.
3. Connecticut Department of Health. Public Health Code Sec. 19-13-24a. Disposal of refuse. Hartford.
4. Cushman, R. V. 1964. Ground-water resources of north-central Connecticut. U.S. Geol. Survey Water-Supply Paper 1752.
5. Hill, D. E. 1966. Percolation testing for septic tank drainage. Conn. Agr. Exp. Sta. Bul. 678.
6. Pitkin, J. A., Philbin, P. W., and Gilbert, F. P. 1969. Aeromagnetic map of the Ellington quadrangle and part of the Rockville quadrangle, Hartford and Tolland Counties. U.S. Geol. Survey Geophysical Invest. Map. GP-648.
7. Ryder, R. B. and Weiss, L. A. 1971. Hydrogeologic data for the upper Connecticut River basin, Connecticut. Conn. Water Res. Bul. 25.
8. Waterways Experiment Station Corps of Engineers. 1953. The unified soil classification system. Tech. Memo. No. 3-357. 2 vol. Vicksburg, Miss.

Open File Maps

1. Colton, R. B. 1972. Bedrock outcrops and areas of thin drift, Ellington quadrangle. U.S. Geol. Survey, Geologic Div., Middletown, Conn.
2. Colton, R. B. 1972. Materials map, Ellington quadrangle. U.S. Geol. Survey, Geologic Div., Middletown, Conn.
3. Handman, E. H. 1972. Depth to bedrock, Ellington quadrangle. U.S. Geol. Survey, Water Resources Div., Hartford, Conn.
4. Handman, E. H. 1972. Saturated thickness of unconsolidated stratified deposits, Ellington quadrangle. U.S. Geol. Survey, Water Resources Div., Hartford, Conn.
5. Olin, D. A. 1972. Low flow of streams, Ellington quadrangle. U.S. Geol. Survey, Water Resources Div., Hartford, Conn.
6. Olin, D. A. 1972. Flood-prone areas, Ellington quadrangle. U.S. Geol. Survey, Water Resources Div., Hartford, Conn.
7. Pease, M. H. Jr. 1972. Bedrock lithology, Ellington quadrangle. U.S. Geol. Survey, Geologic Div., Middletown, Conn.
8. Pease, M. H. Jr. 1972. Strike trends of foliation and zones of potential weakness, Ellington quadrangle. U.S. Geol. Survey, Geologic Div., Middletown, Conn.

9. Pease, M. H. Jr. 1972. Summary of properties of bedrock types (tabular material), Ellington quadrangle. U.S. Geol. Survey, Geologic Div., Middletown, Conn.
10. Thomas, M. P. 1972. Drainage areas, Ellington quadrangle. U.S. Geol. Survey, Geologic Div., Middletown, Conn.

APPENDIX A: RESOURCE DATA INVENTORY, ELLINGTON QUADRANGLE

Resource	Description	Scale	Base	Status
Topography	Topographic Map Ellington Quad., Conn.	1:24,000	Polyconic projection	Published (1953) Scale changed (1967)
Bedrock	Bedrock Geology Map Ellington Quad., Conn.	1:31,680	Polyconic projection	Published (1954)
Surficial Geology	Surficial Geology Map Ellington Quad., Conn.	1:24,000	Polyconic projection	Published (1972)
Soil	Hartford County Soil Survey	1:20,000	Air photo mosaic	Published (1962)
	Tolland County Soil Survey	1:15,840	Air photo mosaic	Published (1966)
Hydrology	Water Resources Inventory of Connecticut, Part 7, Upper Conn. River Basin	1:24,000	Polyconic projection	Portions in open file; USGS, Water Resources Division
Land use & Zoning	1970 Existing Land Use Inventory	1:24,000	Polyconic projection	Open file; Conn. Office of State Planning
	Location of Existing Sanitary and Water-Related Facilities, Services and Uses	1:24,000 (Reduced to 1:48,000)	Polyconic projection	Published (1970)
	Zoning of the Municipalities of the State of Connecticut	1:24,000	Polyconic Projection	Open file; Conn. Office of State Planning
Materials Map	Statewide Coarse Aggregate Inventory by Districts	1:24,000	Polyconic projection	Published (1972); Conn. Dept. of Transportation

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