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GEOLOGICAL SURVEY CIRCULAR 674

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ABSTRACT

Decisions that affect land and water use require an understanding of the complex geologic and hydrologic systems that exist within the earth's crust. There is, therefore, a need for earth-resource information in a form that is easily understandable and readily available to planners and other decision makers responsible for land use and resource management. The U.S. Geological Survey's Connecticut Valley Urban Area Project is developing a flexible resource data base that is designed to supply such information. This data base is in the form of maps that present a single characteristic or a combination of related characteristics of the land surface, earth materials, or water resources at a common scale and in a simplified format.

The maps are prepared by interpretation of existing geologic and hydrologic maps and data available from ongoing cooperative programs between the U.S. Geological Survey and the State and from State programs. Map subjects include unconsolidated materials, depth to bedrock, depth to water table, thickness and distribution of extensive clay deposits, resources of aggregate, slopes, availability of ground water, flood-prone areas, and quality and quantity of surface water.

A single planning decision commonly involves information on several aspects of earth resources. Superposition of copies of two or more maps printed on transparent plastic may be necessary to provide the information needed for a specific planning problem. Combinations of these maps can be adapted to changing technological, economic, statutory, and social conditions.

INTRODUCTION

Decisions affecting land use and resource management are being made every day. These decisions frequently require an understanding of the distribution and the physical and chemical properties of our earth resources, but the decisions are often made by people who are not trained in the earth sciences. There is, therefore, a need for earth-resource information presented in a manner that is understandable and useful to the general public. Several groups within the earth-science professions are attempting to provide for this public need. One such effort is the Connecticut Valley Urban Area Project (CVUAP) of the U.S. Geological Survey. The project area is shown in figure 1.

The Connecticut Valley was chosen as an urban area project largely because the existing programs for geologic and hydrologic mapping within a four-state area are an excellent source of basic natural-resource information. In Connecticut the (1) State–U.S. Geological Survey cooperative programs, (2) geologic mapping program of the State Geological and Natural History Survey, and (3) information from other State agencies such as the Department of Transportation and the Office of State Planning provide the essential basic data. Similar programs exist in Massachusetts. In Vermont and New Hampshire, U.S. Geological Survey—State Geological Survey cooperative hydrologic programs have provided the basic data. Furthermore, in Connecticut the Geology-Soils Task Force, a volunteer group of geologists, hydrologists, soil scientists, engineers, and planners representing State and Federal agencies and universities, was already studying

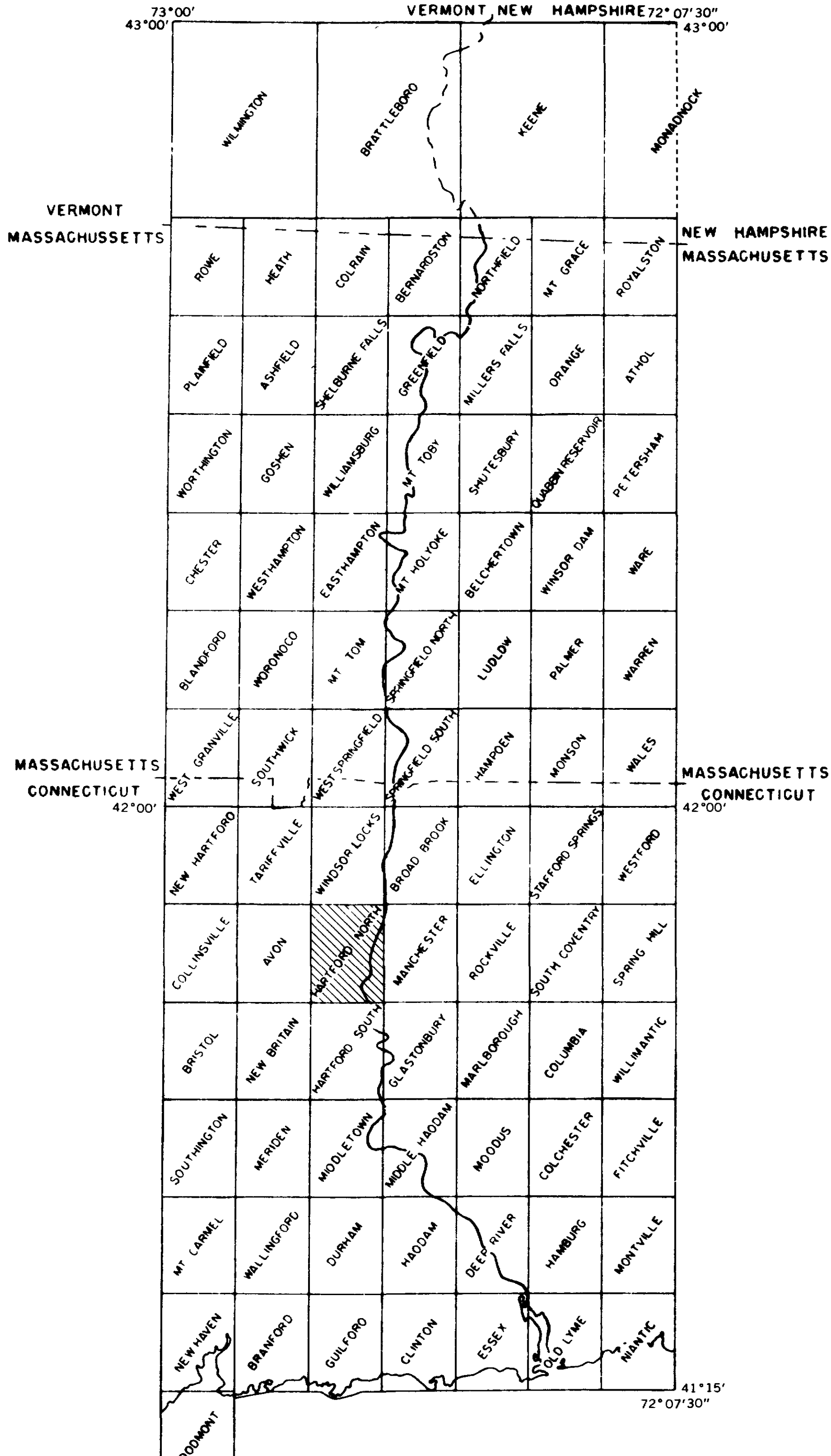

FIGURE 1.—Index map showing area of Connecticut Valley Urban Area Project and topographic quadrangle coverage. The project area covers about 5,000 square miles in parts of Connecticut, Massachusetts, New Hampshire, and Vermont. Hartford North quadrangle patterned.

the feasibility of integrating earth-science data for land-use planning in the Ellington quadrangle within the Connecticut Valley. CVUAP has been able to draw on the experience of this task force and some of the concepts and methods presented herein are derived from its work.

OBJECTIVE

The objective of the Connecticut Valley Urban Area Project is to provide geologic and hydrologic information to aid in planning and resource management. Some limitations are implicit in this objective.

We have chosen to present our resource information at two map scales, 1:24,000 (1 inch = 2,000 feet) and 1:125,000 (1 inch = approx 2 miles). The 1:24,000 scale provides information for local (town) planning. The 1:125,000 scale aids in regional and state planning. The difficulty in establishing precise ground locations for the data presented at these scales emphasizes the necessity of onsite studies in the planning and development process. For example, a circle that is 40 acres in area is about the size of a dime at 1:24,000 scale. Therefore, our information is for planning purposes and must not be considered a substitute for detailed onsite investigations. Although the planning process can determine potentially favorable areas for a particular use, potential sites must be studied in detail.

Geologic and hydrologic data provide only part of the resource information necessary for effective planning. Information from the soil scientist, engineer, biologist, ecologist, meteorologist and other natural scientists and information on human resources must ultimately be integrated to form a satisfactory information base.

With these limitations in mind, we are producing a series of maps, each map showing a single earth-resource characteristic or combination of related characteristics. These maps are designed to be used by people directly involved in making land-use decisions. Insofar as possible, technical data are presented in nontechnical terms and the complex symbolism of standard geologic maps is simplified. The intent is to provide a flexible resource-data base that can be used for the widest possible range of decisions by people with diverse backgrounds, all concerned with wise land use. The data base is made as flexible as possible so that it can respond to the great variety of today's planning problems and still remain relevant for future needs. We are not, therefore, making suitability maps that show areas suitable or unsuitable for a given land use—suitable in the opinion of the map compilers. Such maps may appear attractive to those looking for a quick and simple dictate, but suitability is a complex judgment involving many factors, some of which are well outside the technical competence of the geologist or hydrologist. Suitability maps also tend to become outdated as soon as the assumptions defining suitability change. Such factors as technological capability, economics, statutory regulations, and social attitudes are all part of a suitability judgment. Today, many of these factors vary from place to place, and all of them can be expected to change with time; what is unsuitable today may well be suitable tomorrow, and vice versa. On the other hand, maps that directly show the physical and chemical characteristics of our earth resources do not reflect such limited judgments. They can be used in a variety of ways according to local or regional priorities and can easily be adapted to changing planning requirements.

EARTH-RESOURCE INFORMATION

Earth-resource map information may be divided into two groups—basic data and resource-characteristic maps. For the purposes of illustration, basic data and resource-characteristic maps for a single 7½-minute quadrangle in the project area, the Hartford North quadrangle, Connecticut, are discussed below.

BASIC DATA

The basic data for the Hartford North quadrangle consist of a standard topographic quadrangle map at 1:24,000 scale, a U.S. Geological Survey geologic quadrangle map (Cushman, 1963) at the same scale, a 1:62,500-scale map from a U.S. Geological Survey water-supply paper (Cushman, 1964), and subsurface information from water wells and test holes. The topographic map is the base for our resource-characteristic maps and provides important information on landforms, the drainage network, and the road system and buildings. The geologic map provides basic geologic information such as the location of bedrock outcrops (solid rock exposed at the surface of the ground) and the general nature of the surface materials. Some of the technical terminology used on the geologic map creates problems for a nongeologist. For example, one unit on the geologic map of the Hartford North quadrangle (Cushman, 1963) is defined as "ice-contact stratified drift." This unit is mostly mixtures of sand and gravel in varying proportions, and for our purposes can be divided into map units of sand, sand and gravel, or gravel. Similarly, another unit, "lake-bottom deposits," can be defined as fine deposits which are predominantly fine sand, silt, and clay. The map from the U.S. Geological Survey water-supply paper (Cushman, 1964) contains information on the water-bearing properties of the loose unconsolidated materials that overlie the bedrock and provides more specific information from selected test holes and water wells. This map, however, is a different scale (1:62,500) than the topograpic and geologic maps, so the information on this map must be adjusted in order to be useful at the scale of 1:24,000.

RESOURCE-CHARACTERISTIC MAPS

Resource-characteristic maps are made from the basic data. They show selected elements of the earth resources. Some elements play a relatively static role and others play a dynamic role in the geohydrologic system. Static elements such as bedrock geology, the nature and thickness of unconsolidated materials overlying bedrock, landforms, and slopes vary from place to place but remain virtually unchanged from season to season and from year to year unless altered by large-scale manmade excavation or filling, or by natural catastrophic events such as landslides, earthquakes, storms, and floods. At present, natural catastrophic events other than floods and storms are not of major importance in the Connecticut Valley. Where conditions have been extensively altered by man prior to the date of mapping, special map symbols identify and locate these changes.

Dynamic elements such as depth to water table and streamflow not only vary from place to place, but also vary significantly from year to year, season to season, and even day to day. Accordingly, the mapped distribution of such dynamic elements may either be shown for a particular time and place, or may be expressed in some graphic or statistical summary that generalizes the expected effect of natural changes. Any manmade changes occurring after preparation of these maps may alter conditions significantly.

Resource-characteristic maps are the principal products of the Connecticut Valley Urban Area Project and deal with a variety of subjects. The following is a list of such maps published for the Hartford North quadrangle, Connecticut:

U.S. Geol. Survey Misc. Geol. Inv. Map	*Subject*
I–784 A (Pessl and Hildreth, 1972)	Unconsolidated materials.
B (Pessl and Langer, 1972)	Bedrock geology.
C (Ryder, 1972b)	Contour map of the bedrock surface.
D (Handman and Hildreth, 1972)	Depth to bedrock.
E (Langer, 1972c)	Thickness of principal clay unit.
F (Langer, 1972b)	Thickness of material overlying principal clay unit.
G (Langer, 1972a)	Resources of coarse aggregate.
H (Barker, 1972)	Landforms.
I (Barker and Stone, 1972)	Natural land slopes.
J (Thomas, 1972a)	Drainage areas.
K (Ryder, 1972a)	Availability of ground water.
L (Handman, 1972)	Depth to water table.
M (Thomas, 1972b)	Flood-prone areas.
N (Olin, 1972)	Low flow of streams.
O (Weiss, 1972a)	Maximum concentration of dissolved solids in surface water.
P (Hildreth and Keune, 1972)	Location of wells and test holes.
Q (Weiss, 1972b)	Sites of solid-waste storage and liquid-waste discharge.
R (Office of State Planning, State of Connecticut, 1972)	Sanitary and water-related facilities, services, and use, July 1970.

These maps are described in more detail below. All of these maps will not be prepared for each quadrangle in the project area. They are, however, examples of the kinds of maps that can be made for quadrangles throughout the project area, although the elements shown may vary from place to place because the geology may differ and the availability of information is not uniform. The maps are also available on transparent scale-stable material to facilitate

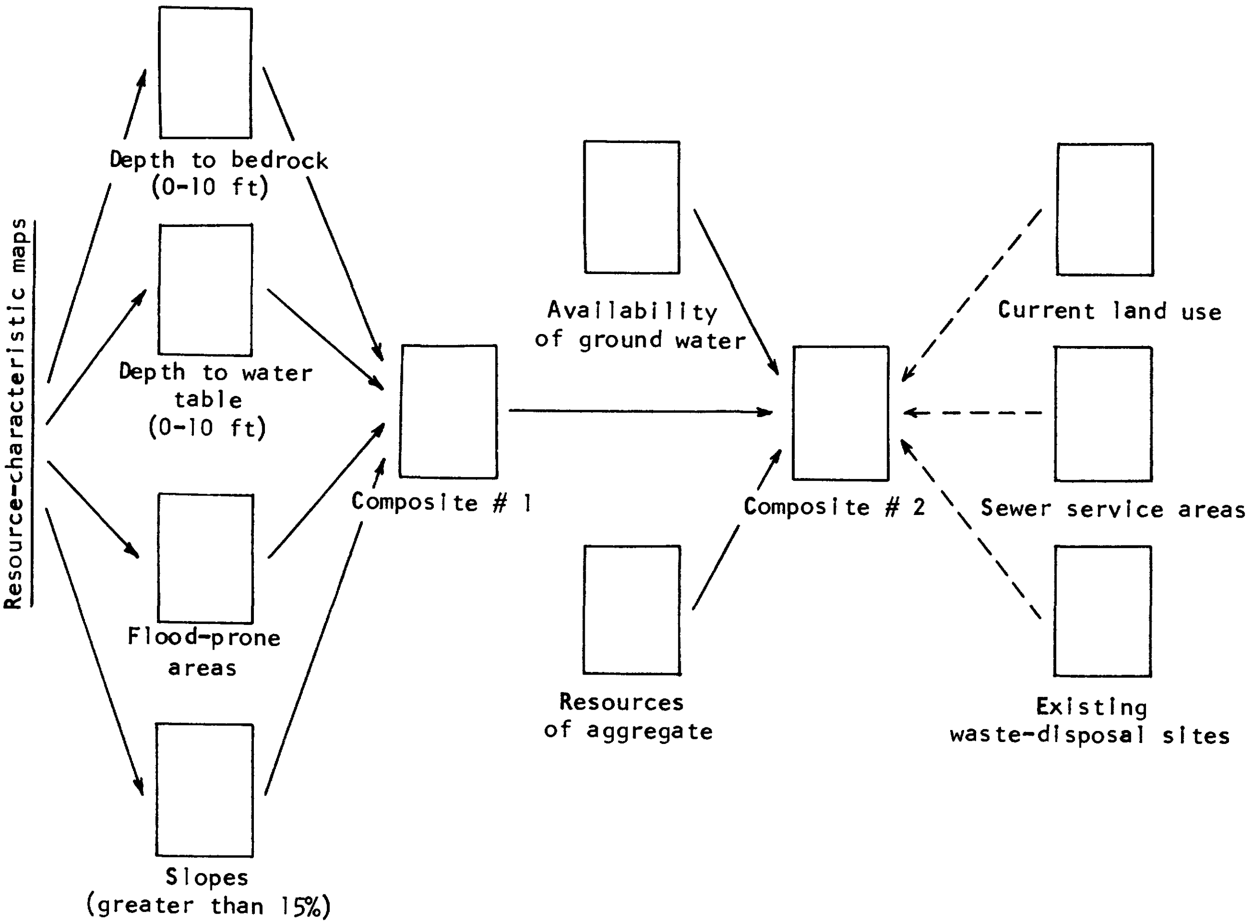

FIGURE 2.—Flow chart showing procedure of resource evaluation for a sanitary landfill using criteria suggested in this paper as an example.

their use in various combinations depending on the nature of the planning problem at hand.

RESOURCE EVALUATION

One way in which our information can be used by planners and other decision makers in evaluating earth resources for a particular land use is described below. The first step in this method of resource evaluation is to establish guidelines which define basic criteria such as the type of facility desired, the area of land required, limits of funding, and pertinent statutory regulations. Other guidelines which establish priorities on uses of resources, such as protecting potential water-supply areas or encouraging preservation of open space can also be formulated. Once these guidelines have been established, the distribution of significant earth resources, in terms of the land use in question, can be determined by stacking the appropriate resource-characteristic map transparencies on one another. From the resulting composite map, areas where existing earth resources are incompatible with the intended land use can be identified. The remaining areas on the composite map indicate potentially favorable areas. Maps that identify protected resources or preempted land uses can be added to the composite. Where such resources or land uses coincide on the map with potentially favorable areas for the land use in question, decisions on priority of use or sequence of uses can be made.

Figure 2 illustrates the use of several maps that show the distribution of some of the factors that may affect the use of land for a sanitary landfill. In this example the following guidelines have been chosen:

1. A trench-fill operation is desired.
2. At least 25 acres is necessary.
3. Minimum depth of trench is 10 feet.
4. Cost must be minimized; that is, no funds can be used for special engineering-design modifications.
5. Conformity to all State and local statutes regulating location and operation of a sanitary landfill.
6. Protection of potential sources of ground water will have highest priority in cases of competing resources.

These guidelines have been established arbitrarily for the purposes of the example presented here. Other guidelines and other priorities could have been selected, and others probably would be selected in actual practice.

Regulations in many states define three of the resource limitations shown in the example:

1. Minimum distance between bedrock surface and the base of landfill (depth to bedrock).
2. Minimum distance between high water table and the base of landfill (depth to water table).
3. Minimum distance from high-water mark (flood-prone areas).

A fourth factor, slopes greater than 15 percent, is considered a limitation here because of potential increased costs for special erosion-control and access-road design in areas where slopes are greater than 15 percent. From composite 1 (fig. 2), potentially favorable areas for a landfill will appear as clear windows surrounded by areas in which incompatible factors occur.

The map showing availability of ground water identifies a protected resource under the established guidelines. The map showing resources of coarse aggregate identifies a resource which might be exploited prior to development of a landfill site. If an area is capable of supporting two potentially incompatible land uses (composite 2, fig. 2), such as an area where an aquifer occurs beneath a possible landfill site, a planning decision establishing some priority of use should be made. This may require additional detailed information such as the quality and quantity of the available ground water. The resource-characteristic maps only identify the existing situation.

Other considerations in the planning process such as current land use, sewer-service areas, and existing waste-disposal sites can also be presented as maps and added to the analysis. Current land-use maps identify preempted land, such as industrial, commercial, and high-density residential areas. Sewer-service areas near potentially favorable landfill sites might influence design criteria for the control and treatment of leachate from the landfill. Knowledge of existing waste-disposal facilities combined with data on low streamflow might influence the selection of future sites in order to minimize pollution of surface water.

The product of the analysis in this example is several potentially favorable areas for the location of a sanitary landfill. Many other possible areas have been eliminated from consideration because of incompatible or competing resources and land uses of higher priority. Detailed site investigations in the potentially favorable areas can now be efficiently planned with a minimum of wasted time and unnecessary cost. If site studies show that none of the areas are actually acceptable for development of a landfill, the planning process must begin again with a new look at the initial guidelines to determine what modifications are possible. The analysis can then be repeated within the framework of the revised guidelines.

The resource evaluation shown here is only an example of a suggested methodology, as not all considerations for successful location and operation of a sanitary landfill have been included. This method can also be applied to almost any other land-use planning problem. Many different resource factors should be considered for proper land-use planning; a flexible resource-data base can provide information that is essential to the planning process.

DESCRIPTIONS OF RESOURCE-CHARACTERISTIC MAPS OF THE HARTFORD NORTH QUADRANGLE, CONNECTICUT

UNCONSOLIDATED MATERIALS

(Map I–784 A)

Unconsolidated materials are nonrenewable resources, composed predominantly of sand, gravel, silt, and clay. These materials cover large areas in most regions and consequently are the earth materials most commonly involved in our everyday affairs. They must be used as necessary, but they should not be wasted and should, therefore, be an important consideration in many land-use decisions.

The nature of the unconsolidated materials and the slopes on which they lie determine the characteristics of agriculture soils. The characteristics of unconsolidated material can also determine (1) its suitability for construction materials, (2) engineering properties, and (3) capability for effective waste disposal. The three-dimensional distribution of unconsolidated materials below the water table is a critical factor in the occurrence and availability of ground water. The shape of the land in areas underlain by unconsolidated materials reflects the physical properties and origin of these materials and provides an important aesthetic element in natural settings.

Most unconsolidated materials are mixtures of different sizes of rock fragments. These fragments can be separated into three classes on the basis of size: coarse, sand-sized, and fine. The map units "gravel," "sand and gravel," "sand," and "fine deposits" as used on the unconsolidated materials map of the Hartford North quadrangle (Pessl and Hildreth, 1972) are defined by the percentage of each size class present in the deposit. For example, "gravel" is defined according to this system as a mixture of coarse and sand-sized particles containing 50 percent or more coarse particles. Other map units, most notably till and swamp deposits, contain a wide range of particle sizes in such variable proportions that they are defined on the basis of origin as well as composition. Till, for example, is a material deposited primarily by glacier ice. It is composed of a heterogeneous mixture of boulders and stones with sand, silt, and clay in varying proportions. Some till is loose, sandy, and very stony. Other till is less sandy, less stony, and very compact. The two varieties of till are not differentiated on most maps, but they differ so significantly in physical properties that onsite investigations of till deposits are necessary for specific uses.

Areas where the land surface has been extensively altered by urbanization and development are shown by a gray pattern superimposed on the color for the natural unconsolidated material. Specific deposits of fill materials (map units af and aft) resulting from road building, landfills, and other major construction are also shown.

BEDROCK GEOLOGY
(Map I–784 B)

These maps show bedrock types (rocks having similar mineral composition) at and below the land surface. Structural characteristics of these rock units such as faults joints, strike and dip of inclined units, and boundaries between rock units are also shown. Each bedrock map differs in the ease with which the information presented can be used for planning purposes. These differences in part reflect the degree to which engineering properties of the bedrock units are included on the maps and in the reports.

For the Hartford North quadrangle, information from the published geologic map (Cushman, 1963) has been combined with data from wells and test holes and tunnels to show the various types of rock that occur in the area. Thickness, strike and dip, color, and general rock type are shown at localities where bedrock is exposed at the land surface. Color and general rock type are also given for the first rock layer beneath the unconsolidated materials at localities where drilling data are available.

DEPTH TO BEDROCK AND CONTOUR MAP OF THE BEDROCK SURFACE
(Maps I–784 D and C, respectively)

Depth to bedrock is expressed in feet below the land surface and is a measure of the thickness of the unconsolidated material that overlies the bedrock. It is a limiting factor of special importance in planning for and designing storage facilities, foundations, industrial and municipal waste disposal systems, residential septic systems, municipal water services, tunnels, highway alinements, and utility corridors. Specific mention of depth to bedrock is made in many state regulations pertaining to sanitary landfills and septic systems.

Map I–784 D (depth to bedrock) was prepared from records of water wells, test holes, structure borings and trench lines, together with projections from the topographic surface and interpretations of geologic history. The map shows areas where the thickness of unconsolidated material overlying the bedrock is within stated ranges. These ranges in thickness reflect the degree of accuracy of the available data.

The contour map of the bedrock surface (map I–784 C) shows, by contours in feet above or below sea level, the shape of the bedrock surface.

THICKNESS OF PRINCIPAL CLAY UNIT AND THICKNESS OF MATERIAL OVERLYING PRINCIPAL CLAY UNIT

(Maps I–784 E and F, respectively)

The principal clay unit may consist of a thick, massive bed of relatively pure clay, or it may occur with discrete layers of silt and very fine sand. The upper layers of the clay unit commonly grade upward into layers of silt and very fine sand. The properties of clay are distinctive—where it occurs in extensive or thick deposits, the possible effects on land use should be considered. When wet, clay may become exceedingly mobile under even slight stresses and thus creates problems of landsliding, foundation failure, uneven settling, and other engineering problems. In addition, clay has a relatively low permeability—water or liquid wastes move through it very slowly. Production of ground water is generally low from saturated deposits of clay and other fine-grained materials. Precipitation does not soak readily into the ground in areas of near-surface clay, often resulting in temporary ponds and wet ground in flat areas. Rapid runoff is common in sloping areas underlain by clay and may cause serious problems of flash flooding. On the other hand, the low permeability of clay and its potential for renovating some kinds of liquid waste may make it suitable host material for some waste-disposal sites. Clays are also a source material for bricks, expanded aggregate, and other construction materials. Clay, therefore, may be a limitation or extra-cost factor in the development of land for some uses, a favorable factor for other uses, or a potentially exploitable mineral deposit.

The thickness of unconsolidated material overlying clay deposits is an important consideration. Substantial thicknesses of material overlying clay may allow the founding of a structure in these overlying materials. Where the overlying material is thick and easily worked, it may provide cover material for a landfill operation in which the host material is the clay deposit. Areas with thin deposits overlying clay are potentially favorable for extracting clay at minimum cost for stripping.

Clay maps are prepared with information from geologic and topographic maps, and with information from wells, test holes, structure borings, and other sources of subsurface data. Most extensive clay deposits in the project area occur as lake-bottom sediments laid down in the relatively quiet waters of former or present lakes. An understanding of the geologic history and of the geologic and hydrologic processes are important elements in the preparation of such maps. The contour intervals shown on the maps are chosen according to the accuracy and distribution of the available data.

RESOURCES OF COARSE AGGREGATE

(Map I–784 G)

This map shows the distribution of resources of coarse aggregate compiled from the unconsolidated materials map and from other sources such as highway department aggregate surveys and limited field observations. No information is given about value, quality, or quantity of the aggregate. Such information should be obtained from onsite investigations. The texture of coarse aggregate shown on this map is variable and some areas may contain as much as 75 percent sand.

Availability of coarse aggregate is a critical cost factor in many construction projects. Location of deposits close to market areas is important. Construction aggregate is obtained from naturally occurring sources such as sand and gravel deposits and from quarrying and crushing certain kinds of bedrock such as basalt (traprock).

As urban and suburban development increases, the need for construction aggregate also increases. However, the future use of sand and gravel deposits and traprock for construction aggregate is likely to be increasingly restricted through zoning regulations and regulations pertaining to the operations of processing plants. Residential housing and commercial and industrial developments built on sand and gravel deposits further restrict exploitation of this resource. Planning decisions which are based on knowledge of the distribution of this important resource and on concepts of multiple use may permit extraction of this resource prior to other types of land use.

NATURAL LAND SLOPES AND LANDFORMS
(Maps I–784 I and H, respectively)

Slope maps characterize areas of the land surface in terms of their prevalent slopes. The slope units are chosen to emphasize ranges relevant to land use. Use of the land and the cost of developing land are strongly influenced by slopes. Restrictions on alinements and cost of construction are generally less in areas of gentle slopes. Special construction practices and foundation designs are commonly necessary for development of residential and commercial buildings in areas of steep slopes and rugged topography. Some steep slopes and some areas where slope values change abruptly over short distances, especially where vegetation is sparse, are subject to intense erosion. Accumulations of rock fragments (sliderock or talus) are common in rocky areas with very steep slopes. Septic systems require special design modifications in areas of steep slopes.

A landform map showing shape elements of the landscape, complements the slope map and provides a different picture of the terrain. Individual landforms are seldom well displayed on slope maps. A hill, for example, may be composed of several slope units and may be obscured as a unified element of the landscape. The landform map shows areas that differ with respect to relief, altitude, shape, and slope.

DRAINAGE AREAS
(Map I–784 J)

This map shows drainage areas that contribute streamflow to selected sites on streams. Drainage areas shown have not been adjusted for the changes man has made in the natural regimens such as diversion dams, canals, and tunnels.

The drainage areas, in square miles, shown on the map are the total of as many as several hundred component areas upstream from the selected site. The area, in square miles, of individual component drainage areas can be determined by subtracting the area of the site next upstream from the area at the site of interest.

The selected sites shown on the map include stream-gaging sites, outlets of surface-water impoundments, surface-water sampling sites, mouths of tributary streams, and supplemental sites. Supplemental sites include highway and railroad bridges, outfalls from sewage-treatment plants, and main stems of streams immediately upstream from mouths of tributary streams.

The size and location of drainage areas can be used in a regional streamflow analysis for the design of water-supply and waste-disposal facilities and to determine the flow direction of wastes discharged at a point on the land surface.

AVAILABILITY OF GROUND WATER
(Map I–784 K)

The availability of ground water is expressed in terms of yields that can be expected from properly developed individual wells that tap unconsolidated and consolidated earth materials.

The map is a generalization of several hydrogeologic factors. Consequently it provides only a planning guideline that shows the relative availability of ground water from place to place. It does not describe the absolute quantities of ground water available. The map should not be used in lieu of detailed test drilling and hydrologic investigations at specific sites, because well yields can be affected by local variations in the materials of the aquifer, as well as mutual interference effects between closely spaced wells and effects of boundary conditions such as the location of streams and abrupt changes in water transmitting characteristics.

DEPTH TO WATER TABLE
(Map I–784 L)

The water table is an uneven surface below which earth materials are completely saturated with water. The water table intersects the land surface in almost all natural surface water bodies, and when a hole excavated in earth materials is extended below the water table, water will rise in the hole to the level of the water table. Deepening the excavation generally will not significantly affect the water level in the excavation because deeper earth materials will always be saturated with water.

Depth to water table varies both areally and temporally. The water table is generally deepest below the land surface under hilltops and shallowest under broad valleys. It is exposed at land surface in swamps, ponds, lakes, and streams. At any site, the depth to water table fluctuates seasonally. It generally is closest to the land surface during late fall and early spring, and deepest below land surface during late summer and early fall. Seasonal fluctuations may range from tens of feet under some hilltops and upper hillsides to less than a foot under broad valleys. Accordingly, in areas where depth to water table is shown on the map to be 10 feet or less at least part of the year, depths may be within this range for the entire year or for only short periods during a year.

The depth to water table map is based on average precipitation. During two or more consecutive years of significantly below-average precipitation, the water table within areas mapped as 10 feet or less may be deeper than 10 feet all year. In contrast, during two or more consecutive years of significantly above-average precipitation, the water table within areas mapped as deeper than 10 feet may be within 10 feet of the land surface during some part of the year.

Manmade conditions can also affect the depth to water table. Extensive ground-water development, drainage of swamps and other long-term ground-water dewatering operations and long-term lowering of water levels in large impoundments can significantly lower the water table locally. In contrast, extensive irrigation, water-spreading operations, and long-term raising of water levels in existing or new impoundments can raise the water table.

FLOOD-PRONE AREAS
(Map I–784 M)

Floods of different recurrence intervals can be shown on maps. Maps based on the 100-year recurrence interval show areas that have a 1 in 100 chance, on the average, of being inundated in any year. Such maps are based on natural conditions adjusted for flood-retention and flood-prevention structures, channel improvements, and degree of urbanization existing as of the date of the map. Changes made by man after this date can affect the extent and the chances of inundation of the mapped flood-prone area. Changes such as additional paved areas, installation of storm sewers, and construction in the flood-prone area tend to increase the extent and chances of inundation. Changes such as additional flood-retention structures tend to decrease the extent and chance of flooding downstream of the structures, but tend to increase the extent and chance of flooding upstream. In contrast, channel improvements tend to decrease the extent and chance of flooding upstream of the channeled area, but tend to increase the extent and chance of flooding downstream.

LOW FLOW OF STREAMS
(Map I–784 N)

This map shows the lowest average daily flow for a 7-consecutive-day period that has an average recurrence interval of once in 10 years. Generally such a 7-consecutive-day period occurs during late summer or early fall. In terms of flow duration, daily flow equal to or greater than the mapped values has a 99 percent chance of occurring on any day in a year. The map is based on natural and manmade conditions as of the date of the map. Changes in conditions after this date can either increase or decrease the low-flow value at a given site. Changes such as new or additional releases from upstream impoundments and new or additional discharges from sewage-treatment plants and septic tanks tend to increase low flow. In contrast, changes such as new or additional upstream withdrawals from the stream or a nearby well field and new or additional areas served by storm sewers or paved tend to decrease low flow

MAXIMUM CONCENTRATION OF DISSOLVED SOLIDS IN SURFACE WATER
(Map I–784 O)

The dissolved-solids concentration is the concentration, in mg/l (milligrams per liter), of all mineral (inorganic) constituents dissolved in the water. The concentration is measured in a clear water sample either directly by chemical analysis or indirectly by electrical conductivity. The dissolved-solids concentration does not include the concentration of any dissolved organic material or suspended material such as silt and clay or any organic or inorganic material adsorbed on suspended material.

Information on the areal variability of dissolved-solids concentrations is helpful in planning the location of surface-water withdrawals, particularly when low concentrations are required. For example the U.S. Public Health Service (1962) recommends, among other quality parameters, that the dissolved-solids concentration of water used for public supply not exceed 500 mg/l.

LOCATION OF WELLS AND TEST HOLES
(Map I–784 P)

This map shows locations at which subsurface information is available. The data points are identified according to the filing system of the U.S. Geological Survey in Hartford and information from them can be retrieved by individuals with special interest. The subsurface data were used in compiling maps showing separate elements of the geologic and hydrologic conditions beneath the land surface. The map also shows the density of subsurface data and thus provides a partial measure of the reliability for resource maps based on the subsurface information.

SITES OF SOLID-WASTE STORAGE AND LIQUID-WASTE DISCHARGE
(Map I–784 Q)

This map shows industrial and municipal facilities in existence or under construction in 1968. The map locates solid-waste-storage and liquid-waste-discharge sites and identifies liquid-waste sites as municipal or industrial. The average daily discharge for liquid-waste sites is expressed in gallons. Liquid-waste is classified as (1) discharge to surface water, (2) discharge into the ground, and (3) discharge to surface water and into the ground.

The location of existing waste-disposal facilities may be an important consideration in decisions affecting future waste-disposal sites. Comparison of this map with maps showing drainage areas, surface-water quality, and low streamflow can help in determining potential pollution-loading effects from existing and proposed waste-disposal facilities.

SANITARY AND WATER-RELATED FACILITIES, SERVICES, AND USE, JULY 1970
(Map I–784 R)

This map was prepared by the Connecticut Office of State Planning and identifies areas served by sewer systems and water utilities in July 1970. It also locates solid-waste disposal sites, sewage treatment plants, incinerators, and identifies water-based recreational activities. Such information may help in determining the feasibility of integrating existing service facilities with proposed waste-disposal facilities, residential subdivisions, and industrial-commercial developments.

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