GROUND-WATER SUPPLY OVERVIEW OF THE TOWN OF LEWISBORO, NEW YORK

SUMMARY

The Town of Lewisboro is comprised of six hamlets encompassing approximately 29 square miles. Local drainage is to nearby surface water bodies and regionally water drains south and west towards the Muscoot Reservoir as part of the Croton River Basin, with the exception of the Vista and Lewisboro areas, which drain south to the Silvermine River Basin. The area is underlain by bedrock of the Manhattan Prong, which includes metamorphic gneiss, schist and carbonate rock. The bedrock generally is productive enough to support individual domestic needs, with the carbonate rocks providing higher yielding wells. Saturated unconsolidated material above the bedrock is of limited thickness, however, stratified glacial-drift deposits potentially capable of supporting higher-yielding wells have been identified near most wetland areas in the Town.

Based on the 2000 Census data, the Town population is approximately 12,324. Westchester County Department of Health guidelines indicate the average daily water demand per person is 75 gallons. For an average family size of 3.25 people per household, the average potable use is approximately 250 gpd (gallons per day), or approximately 925,000 gpd for the entire town.

Recharge to the underlying bedrock ranges from 8.30 to 9.87 inches per year or approximately 670 gallons per day per acre. This recharge rate to the Town of Lewisboro is equivalent to 12.4 million gallons per day, well above the estimated daily water needs.

This recharge rate is reduced to approximately 6.75 inches during periods of extreme drought (defined as a one-year-in-thirty occurrence) or approximately 500 gallons per day per acre. Total recharge to the Town during periods of drought is reduced to 9.3 million gallons per day, a recharge rate that is well above the average demands. During periods of drought, conservation measures can reduce the overall daily water demands.

Most of Lewisboro is served by individual wells and septic systems. On an annual basis, 85 percent of the water being pumped from the individual water supply wells gets returned back into the ground. Consequently, the underlying aquifer is not usually impacted by most conventionally developed areas. For areas with sewage treatment, water use is nearly 100 percent consumptive because treated water is generally discharged to nearby surface water bodies and does not recharge the local ground-water system.

INTRODUCTION

Leggette, Brashears & Graham, Inc. was retained by the Town of Lewisboro to complete an aquifer-mapping project of the Town. This study includes a compilation of published literature and maps to develop Town-wide bedrock and surficial geologic maps. In addition to the geologic maps, LBG prepared a Town-wide map that shows subwatershed divisions throughout Lewisboro, and estimated average recharge to the bedrock in these subwatersheds. These maps could be used for an aquifer protection overlay zone similar to those in place in Bedford and Somers.

HYDROGEOLOGIC SETTING

The Town of Lewisboro comprises 18,560 acres (29 square miles) and is bounded by the Muscoot Reservoir and Somers on the west, North Salem on the north, Ridgefield, Connecticut on the east and Bedford, Pound Ridge and New Canaan, Connecticut to the south. The Town consists of six hamlets that include Vista, Lewisboro, South Salem, Cross River, Waccabuc and Goldens Bridge. Water bodies constitute approximately 851 acres of the Town or less than 5 percent of the land in Lewisboro.

Drainage in the majority of the Town is generally toward the local reservoirs, which include Brown's and Scotts Reservoirs (Vista), Cross River Reservoir (Cross River), and Muscoot Reservoir; and lakes (Lake Kitchawan (Vista), Truesdale Lake, Lakes Oscelata, Rippowam and Waccabuc (South Salem), and Lake Katonah (Goldens Bridge). Most of Lewisboro drains to Muscoot Reservoir or to Cross River Reservoir which meets with the Muscoot Reservoir as part of the Croton River Basin. However, Vista and Lewisboro drain southerly to the Silvermine River Basin in Connecticut. The topographic relief of Lewisboro ranges from 850 feet above sea level north of Lakes Waccabuc and Rippowam to 210 feet in Goldens Bridge along the Muscoot Reservoir.

Annual precipitation in Lewisboro averages about 48.6 inches per year. Figure 1 is a precipitation probability graph for the nearby West Point station. Based on this graph, it can be projected that median annual precipitation is 40.4 inches and that one-year in ten, precipitation will exceed 55 inches. Annual rainfall during drought conditions are reduced to about 34.3 inches once in ten years and 30.5 inches one year in 30, an extreme-drought scenario.

Bedrock Geology

Bedrock underlying the Town is the Manhattan Prong of the New England Upland, comprised mainly of metamorphic gneiss, schist and carbonate rock. The individual rock units of the Manhattan Prong are known as the Fordham Gneiss, the Inwood Marble, the Manhattan Formation and the Siscowit granitic gneiss, listed in order of relative age from oldest to youngest, plus several unnamed and younger igneous granite intrusions found in any of these units. In general, hills and ridges are underlain by gneiss and granite. Intermediate areas are commonly underlain by schist and the valley regions by marble (Prucha, 1968).

The predominant bedrock type found in Lewisboro is the Manhattan Formation gneiss and schist (found in South Salem, the northern regions of Cross River and Goldens Bridge, and southern Waccabuc), which is separated from the Fordham Gneiss (found in the southern regions of Cross River and Goldens Bridge and the northern area of Waccabuc) by limited bands of the Inwood Marble (generally expressed topographically by valleys and swamps), as shown on the Town-wide bedrock geologic map. Lewisboro and Vista are underlain primarily by the Siscowit granitic gneiss, which is separated from the Inwood Marble (near Mill River) by an ancient northwest-dipping fault.

The rocks of the Manhattan Prong are generally productive enough to support a domestic-supply well. Wells completed in the marble generally yield more water than wells completed in gneiss, schist or granite, although the carbonate rocks of the Inwood Marble can be highly variable in character and water production. The Inwood can be massive and poorly fractured in places, barely able to support a domestic home, or highly fractured and productive, yielding large quantities of water. Local geologic records indicate domestic wells completed in the marble formation have produced as much as 100 gpm (gallons per minute) compared to domestic wells completed in the other metamorphic formations that have an average yield less than 30 gpm.

Most bedrock contains vertical fractures that will often intersect with other fractures. These fractures allow water to move from one layer to another. Wells that penetrate a large number of fractures or a few large fractures produce large water yields and vice versa. In Lewisboro, most wells are completed in the bedrock and are at depths ranging from 100 to 700 feet.

Surficial Geology

In addition to bedrock, some wells are completed in the saturated portion of unconsolidated material above the bedrock. However, because most of Lewisboro is underlain by metamorphic rocks (marble, gneiss, schist) or igneous (granite) rock at relatively shallow depths, the

unconsolidated material above the rock generally cannot adequately support domestic water needs. The surface soils of Lewisboro were left in place after the retreat of continental glaciers from northern Westchester about 14,000 years ago (Flint, 1971). Most ridges and topographic uplands have been smoothed by glacier scouring action and contours have been rounded by glacial deposits on the flanks of the ice. Generally thin surficial soils are found at higher elevations and thick surficial soils are found in the valleys. These deposits are subdivided into two main types, till and stratified drift.

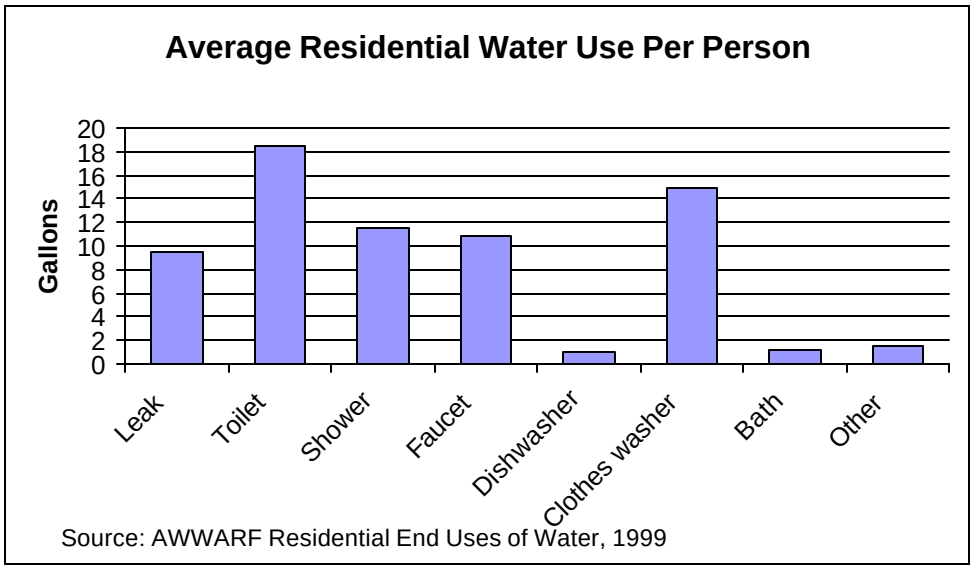
The surficial soil material in Lewisboro predominantly consists of glacial till, covering most of the uplands. Till is a very poorly-sorted mixture of sand, gravel, silt, clay and stones deposited directly by the glacial ice. Till containing primarily sand or gravel can yield sufficient water to support a house and, if thick enough, can serve as an important ground-water reservoir for the underlying bedrock. However, till containing a high percentage of clay and/or silt will result in low-yielding wells. Upland areas with limited saturated till over the rock are more likely to experience well failures during dry seasons.

Stratified drift refers to glacial sediments that were transported and sorted by running water, the meltwater from the retreating glacier. Where deposited from a swiftly-flowing stream, stratified drift is mainly sand and gravel, but where ice blockages or debris caused a temporary lake to form, the stratified drift can be silt or clay. Sand and gravel stratified drift deposits, which can potentially yield more water, have been identified near most wetland areas in the Town. These deposits are reported to be over 200 feet thick in the valley west of South Salem and over 50 feet thick in other valleys throughout Lewisboro. Well yields from these deposits range from 30 gpm to 600 gpm with an average of 200 gpm. The occurrence of stratified drift in Lewisboro is shown on the Town-wide surficial geologic map.

WATER DEMAND

The specific water demand for the Town of Lewisboro is unknown. There are several metered systems that exist (such as Oakridge Community Water in Vista, Meadows Condominiums in Cross River and Wild Oaks Water and Goldens Bridge Community Association (Colony) in Goldens Bridge). For any development proposal, the projected water demands are based on experience and Westchester County Department of Health (WCDH) guidelines. These guidelines are usually regarded as conservative.

Nationwide averages for water use per person in a typical home are presented below.



These averages translate to:

- Toilet flushed 5.05 times per person per day
- Showers and baths taken 0.75 times per person per day
- Clothes washers run 0.37 times per person per day
- Dishwashers run 0.1 times per person per day
- Faucet run for 8.1 minutes per person per day

The WCDH assumes an average daily usage of 75 gallons per person per day for new residential housing supplied by a metered community supply or by individual domestic wells. The expected demand for a non-metered community system is 100 gpm per person, although un-metered community systems are no longer acceptable. The 75-gpd allowance includes all normal water use, including normal levels of lawn and garden maintenance, but does not include intensive landscaping maintenance and in-ground sprinkler systems (recently WCDH advised using 150 gpd/person to account for possible landscaping irrigation). Based on an average daily usage of 75 gpd/person, a household of 5 persons would use 375 gpd and 6 persons would use 450 gpd, but these estimates could double using the higher guidance values. However, the 375-gpd and 450-gpd values are

commonly accepted as upper-limit values for potable water use for 3-bedroom and 4-bedroom homes, respectively.

If the 2000 census data are correct and the average family size in Lewisboro is 3.25 persons, a per-person water allowance of 75 gpd would suggest an average use of about 250 gpd per household. Similarly, if the total population of 12,324 is correct, the total potable water use in the town can be approximated as about 925,000 gpd. Review of metered water usage of new single-family residences, such as the Conant Valley development, served by the Oakridge Community system in Vista, that are served by community water supplies, would be useful in evaluating the accuracy of the guidance values.

For commercial projects, the quantity of water use is dependent on the type of enterprises and the number of people involved. Small office buildings tend to have four to six or more persons per 1,000 sf (square feet) whereas major corporate buildings typically have 3 to 3.5 persons per 1,000 sf. Modern warehouses can have very low worker populations. Retail uses vary greatly from dry to wet stores. Per-person water allowances in commercial buildings have gone down in recent decades from traditional values of 20 to 25 gpd per worker to 12 to 15 gpd or less as the result of water-saving plumbing and more mobile job functions. Recent guidance by WCDH suggests 400 gpd per toilet and 200 gpd per urinal as conservative estimates for commercial buildings.

Consumptive water use is also an important consideration. Traditional water use throughout Lewisboro has been individual wells for supply and individual septic systems for wastewater disposal. On an annual basis, septic systems return approximately 85 percent or more of the water pumped back to the ground, where it is renovated by passage through the soil. The consumed water is mainly used for lawn and garden irrigation, car washing and recreational uses, predominantly during the warm months of the year. Some of that renovated wastewater percolates slowly back to the bedrock aquifer, some percolates in the soil zone to eventually recharge local wetlands and streamflow. As a result of the returned wastewater, the overall consumptive use of the available resource is only about 15 percent or approximately 50 to 70 gpd per residence. Because individual potable supply systems have little impact to the underlying aquifer, the available ground-water budget is rarely overtaxed by conventional residential densities.

Residential or commercial developments that utilize a sewage treatment plant generally discharge their treated water effluent to a surface-water body. Most developments withdraw their water supply from the same watershed that they discharge treated effluent. As a result, there is

minimal impact to the basinwide runoff balance. However, seasonal variations can cause an increase in normal low flows and conversely a decrease in high flows.

For most sewage treatment plant situations, water removed from wells to supply the development property is discharged as treated wastewater to a surface stream. Because the water is lost from the local ground-water system (water does not infiltrate and recharge the underlying aquifer), the water use associated with sewage treatment plants are nearly 100 percent consumptive with respect to the local ground-water resource. In some cases, water discharged to a stream may be partly recovered for capture by downstream wells. However, the water is usually not captured by the onsite supply wells of the development being served by the waste treatment plant.

Of note, recent housing construction trends (four to five bedroom homes) has shown an overall increase in daily water usage. This increase is primarily related to irrigation requirements during the growing season. Where lawn and garden irrigation is done by handheld hose or by moving hose sprinklers from place to place, the irrigation water demands are moderate and depend on the owner. Where in-ground sprinklers systems are used, the daily irrigation demand during the growing season can be many times the potable demand of a household. For example, irrigation of one acre of lawn/garden at one inch per week, a common irrigation rule-of-thumb in this region, consumes an average of 3,900 gpd, about ten times the typical household potable demand.

Prevalence of in-ground sprinkler systems in residential subdivisions has resulted in supply problems at several locations in Westchester County in the past decade. Where in-ground sprinkler systems are supported by ground-water supplies, they can seasonally overtax the local water resources.

GROUND-WATER RECHARGE

Ground-water recharge is a result of precipitation falling on local watersheds. Ground water is precipitation that enters into the ground within the local drainage basin and reaches the water table. Ground-water supplies are continually replenished by rain and snow melt. Typically, Lewisboro receives approximately 48.6 inches of precipitation a year. The rate of recharge in any specific area is largely dependent on the nature of the surficial soils with some influence by localized precipitation patterns, vegetation and degree of manmade development and differences in topography. As a result, recharge rates in stratified-drift areas, which generally are coarse, well-sorted deposits found in flat-lying regions, are substantially greater than recharge rates in till-covered bedrock uplands. In

addition, runoff from uplands to valley flats contributes to overall recharge rates for stratified-drift aquifers.

In addition to geologic influences, recharge also varies seasonally, with most recharge occurring in the non-growing season. Generally, only the very heavy summer and early fall storms result in any significant recharge. During the growing season plants use most of the water that penetrates the ground and is quickly returned to the atmosphere as evapotranspiration. During the summer months, evaporation and transpiration are greatest and, therefore, little precipitation replenishes the bedrock. During the winter months, snow pack and frozen ground prevent water from seeping to the underlying bedrock. Most ground water recharge occurs during late fall and early spring when evaporation and transpiration are low and the ground is not frozen. The frequency distribution of precipitation throughout the year is critical in influencing the relative abundance of ground water. Because the water table rises and falls in response to the seasons and annual precipitation, the water table is usually at its highest in early spring and lowest in late summer or early fall.

Recharge-Stratified Drift

Recharge to stratified-drift areas is commonly estimated as up to one mgd/sq.mi. (million gallons per day per square mile), equivalent to 21 inches of precipitation annually. This value has been derived from numerous studies on Long Island and demonstrated as reasonable for stratified-drift areas in upstate New York (Snavely, 1980) and more recently in the study by Wolcott and Snow (1995). Essentially, this estimate notes that about half of the annual precipitation is consumed by evapotranspiration and that little direct runoff occurs from flat, stratified-drift areas, so that almost half of annual precipitation reaches the water table as recharge.

Recharge-Till/Bedrock Areas

Most residents of Lewisboro obtain their household water supplies from drilled wells completed in the till-covered bedrock underlying the Town. As a result, recharge rates to the till-covered bedrock is of more concern since most of the present and proposed residential and commercial development of the Town, obtain or will obtain their water supply from individual domestic-supply wells or community-supply wells completed in the fractured bedrock. Several published sources provide guidance to recharge rates to the local bedrock.

The Westchester County "208 Report" (Napolitano, 1978) estimates that the average dry-season recharge rate to the bedrock in northern Westchester County is 0.4 cubic feet per second per square mile. This is equivalent to approximately 5.4 inches of annual precipitation, and is considered conservative because it is based on the ground-water contribution to the dry-season flow of streams and does not consider recharge contributed during the other seasons.

Reports by the USGS for nearby till-covered bedrock areas in Connecticut estimate an average recharge rate of 7 inches in crystalline metamorphic bedrock (Cervione et al., 1972) and 7 to 10 inches for mixed metamorphic and sedimentary rock basins (Mazzaferro et al., 1979). These estimates are based on the hydrologic separation of streamflow into direct runoff and ground-water runoff.

Another USGS report, developed for the Fishkill-Beacon area of Dutchess County (Snavely, 1980) indicates that recharge to the till-covered metasedimentary rock is approximately 0.4 mgd/sq.mi. or about 8 inches annually.

Recharge rates to till-covered bedrock in northern Westchester developed by Wolcott and Snow (1995) using digital computer modeling techniques on a subwatershed by subwatershed basis, estimate the average recharge rate to till-covered bedrock in the area of about 8.45 inches annually. For the subwatersheds within the Town of Lewisboro, this study indicates average annual recharge rates of 8.30 to 9.87 inches, and average 9.26 inches. The local distribution of these average recharge rates is shown on the Town-wide subwatershed basin map. An average recharge rate of 9 inches is equivalent to approximately 670 gpd per acre. Using this average recharge rate for the entire town, the average annual rate of replenishment to the bedrock aquifer is about 12.4 million gallons daily.

Drought Considerations

Average recharge does not occur every year. Substantially greater or less than normal precipitation can cause the water table to rise or fall. Drought conditions result in a natural decline of the water table caused by less than normal recharge replenishing the water table and by continuous use, which can be aggravated by a high density of ground-water users.

As indicated by figure 1, once in ten years annual precipitation can be expected to be about 33 inches, or about 82 percent the normal. The annual precipitation one year in 30 can be expected to be about 30.3 inches, or about 75 percent the normal. During such periods, recharge is reduced, in

approximate proportion to the precipitation deficiency, although the seasonal distribution of drought-year precipitation can influence the ground-water impact.

During drought periods, ground water levels decline and water supplies draw on ground-water storage to make up the difference between withdrawals and recharge rates. Lower than normal ground-water levels may cause some normally productive wells to run dry. Some homeowners are accustomed to their wells routinely running dry during the summer months and regularly practice water conservation, and others may experience it for the first time during unusually dry summers. During extreme drought periods, as the case of the spring of 2002, government officials can declare water emergencies to conserve available water resources by reducing unnecessary water demands. Any new ground-water supply should include consideration of drought conditions.

WATER AVAILABILITY VERSUS HOUSING DENSITY

With 29 square miles of recharge area and a population of less than 13,000 people, it is evident that Lewisboro has ample ground-water resources to support its population and its water needs. However, in a mainly rural town, where transportation of water over long distances is not economically feasible, local population density as well as local patterns of water use can overtax the available local ground-water resources, especially during drought periods.

Localized high-density development such as condominium developments that put a relatively large number of dwelling units on a relatively small land area can be problematic. Although ground-water flow does not respect property boundaries, it is commonly seen that condominium developments tend to be in areas with other water-using development including shopping areas, restaurants and other services that compete for the available ground-water recharge. In Lewisboro, this type of development pattern can be seen in Cross River, Goldens Bridge and Vista. The recent take over by the Town of the community water system that serves the Oak Ridge Community is an example of local population density that is tight for water supply.

A further potential problem occurs where large irrigation demands occur on relatively small parcels of land, such as a relatively dense subdivision with a high percentage of in-ground irrigation systems or irrigated athletic fields supported by well water. Many peoples also consider golf course irrigation to be a large seasonal water user, which of course they are, but golf courses usually control several hundred acres and usually irrigate only 60 to 80 acres, so their impact is less than seasonal irrigation on smaller parcels.

As new development is proposed in Lewisboro, the Town land-use agencies should carefully review proposals that include high population densities or potential large irrigation supplies.

WATER SUPPLY PROBLEMS

Common water supply problems typically result from hydrogeologic conditions of an area or density of development. These problems are usually local and do not extend through the entire region. Examples of potential (or existing) water supply problems include the following.

Areas with a high density of housing with wells and septic systems are a cause for concern with respect to potential impacts to water quality. These high density housing areas generally are the older established areas or lake communities that originated as summer cottages. Areas with water quality concerns may make it necessary to sewer the areas. Because septic systems provide natural recharge to the aquifer, the loss of the individual septic systems may result in a local water budget shortage, leading to a need for additional community water supplies. High density areas must also be concerned with possible ground-water contamination. If an individual domestic-supply well becomes contaminated, and the contamination affects many of the nearby homes with no immediate remediation available, a community water-supply system may be required.

In some areas of Lewisboro, specifically in upland regions, it is sometimes difficult to develop an adequate domestic-supply well to support a single-family residence. As a result, additional wells or deeper wells are required to obtain a marginal supply. Marginal well supplies can be vulnerable to failure during periods of drought conditions.

Although new community-supply systems are generally tested at rates double their expected demands, long-term effects of operational pumpage can potentially interfere with offsite wells. It remains possible that remedial actions may be required by some developers to restore water supply to residences whose wells are damaged by drawdown.

Water quality problems can occur almost anywhere as a result of a variety of causes. When individual domestic-supply wells are contaminated, there may be few alternatives to expensive and potentially unreliable household treatment. Contamination of community-supply wells is also a serious potential problem because of the number of people that are potentially affected. Typically the unit cost of treatment of larger volumes of water can be more cost-effective and more reliable than treatment offered for individual domestic-supply wells.

WATER QUALITY

In general, ground water in Lewisboro is of satisfactory potable quality. However, often natural conditions of the local underlying bedrock can affect the water quality. Areas underlain by the Inwood Marble generally have hard water. Iron and manganese content, especially in the Vista area, is commonly high and often above the State Secondary Drinking Water Standards. Nitrate concentrations may be high in areas with a high concentration of septic systems or where fertilizer use is high. Most domestic supply wells produce water that is safe to drink. Water treatment generally is used to address hardness or other mineral content that is aesthetically undesirable.

In an emergency, contaminated well water can be used after it has been boiled or chemically disinfected. The safest way to make a small quantity of water satisfactory for drinking is to boil it for a minimum of two minutes. If heat is unavailable, the American Red Cross recommends adding a small amount of liquid chlorine solution, such as bleach. The amount of chemical added to the affected water will depend on the amount of available water and strength of the chemical solution. The American Red Cross website (www.redcross.org) provides a detailed description of how to purify water prior to using it for drinking, food preparation or hygiene.

Ground water contamination is a common result of leaking underground fuel oil tanks, failed septic systems, improper used and disposal of pesticides, agricultural and lawn fertilization, and barnyard waste. Additional sources can include leaks and spills at gasoline service stations or industrial facilities; landfills; storage and use of road deicing salts; pipeline breaks; and poorly sealed wells. All potable wells should be located in an area away from possible contamination, preferably upslope of a potential source. A well must be located a minimum of 50 feet upslope from a septic tank and 100 feet upslope of the disposal system.

Low levels of organic contamination are often found to exist in certain commercial areas. The Town should exercise vigilance regarding ground-water pollution. LBG is aware that the water quality in the bedrock supply wells serving the Meadows at Cross River has been impacted by the upgradient gasoline service stations. The water supply is currently being treated for MTBE (methyl tertiary-butyl ether) contamination. MTBE is a common gasoline additive and often a precursor of gasoline-constituent contaminants.

AQUIFER PROTECTION

Pursuant to State Environmental Quality Review Act, Article 8 of the New York State Environmental Conservation Law, Lewisboro has incorporated the Environmental Quality Review Law section of the Town Code (Chapter 110), requiring consideration of protection of the environment with social and economic consideration. This law requires applicants for new developments to submit an assessment form to determine if the proposed activity (Type I, Type II or the Unlisted Action) is subject to the SEQRA process. If the proposed activity is determined to have potential impact to the environment, a Draft Environmental Impact Statement (DEIS) is required for review by the Lead Agency.

In addition to the State Environmental Quality Review Act, the Town Code also includes protection of wetlands and watercourses (Chapter 217). Associated with this section of the code, the Town is charged to protect the wetlands and watercourses which are recognized as water resources to surface water and recharge to groundwater and aquifers.

Although the Town recognizes the importance of evaluating any potential effects of proposed activities to the environment, the Town may want to consider developing specific aquifer protection provisions. It may be considered desirable to prohibit certain types of new activities in the aquifer protection zones and to require information about the underlying aquifer, identify impacts on stratified-drift aquifers, and to identify measures to minimize or mitigate any such impacts. Combining this into an ordinance or regulation would enforce the protection provisions.

Protection of the water quality of bedrock aquifers is not particularly amenable to regulation and is best dealt with by public education and enforcement of zoning and health regulations.

CONCLUSIONS AND RECOMMENDATIONS

1. Ground-water use throughout the Town of Lewisboro is predominantly from individual wells in the underlying fractured bedrock. To a lesser degree, ground water is obtained from the limited stratified-drift deposits located in limited areas throughout the Town.
2. Individual domestic-supply wells completed in the bedrock can generally be developed throughout Lewisboro with little difficulty. Wells completed in bedrock generally can support individual domestic requirements, with average yields less than 30 gpm.

3. The rock units of the Manhattan Prong generally produce fairly high-capacity wells for community supply systems. Typically, wells completed in the Inwood Marble are higher capacity wells than those completed in the Manhattan Formation.
4. Stratified-drift deposits are limited throughout Lewisboro and are typically found near wetlands and surface water bodies. Thick deposits are reported in the valley west of South Salem.
5. Average recharge rates to the stratified drift aquifers of Lewisboro are estimated as 18 to 21 inches of precipitation annually, the equivalent of 850,000 to 1,000,000 gpd per sq. mi.
6. Average recharge rates to the till-covered bedrock aquifers of Lewisboro are estimated as 9.26 inches of precipitation annually or equivalent of about 670 gpd per acre. Based on this average recharge rate, approximately 12.4 million gallons per day is returned throughout the Town to the underlying bedrock aquifer.
7. Predictable droughts can reduce the recharge rates to 75 percent of the average recharge in a one-in-thirty year drought. During drought periods, daily recharge to the underlying bedrock can be reduced to 9.3 million gallons per day.
8. Ground water quality in Lewisboro is generally good, although treatment to remove high hardness, iron or manganese is not uncommon.
9. The Town should consider adopting an aquifer protection policy to protect the stratified-drift aquifers.
10. The Town should consider adopting a local law to provide reasonable limits on the use of in-ground sprinkler systems in new residential subdivision.

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REFERENCES

Asselstine, E. S. and I. G. Grossman, 1955, "The Ground-Water Resources of Westchester County, New York, Part I, Records of Wells and Test Holes", U. S. Geological Survey, Bulletin GW-35.

Cervione, M. A., Jr., D. L. Mazzaferro and R. L. Melvin, 1972, "Water Resources Inventory of Connecticut, Part 6, Upper Housatonic River Basin", Connecticut Water Recources Bulletin No. 21.

Fisher, Donald W., Yngvar W. Isachsen and Lawrence V. Rickard, 1970, "Geologic Map of New York, Lower Hudson Sheet", New York State Museum and Science Service, Map and Chart Series No. 15.

Flint, Richard, F., 1971, "Glcial and Quaternary Geology", John Wiley & Sons, New York.
Prucha, John James, David M. Scotford and Robert M. Sneider, 1968, "Bedrock Geology of Parts of Putnam and Westchester Counties, New York, and Fairfield County, Connecticut", New York State Museum and Science Service, Map and Chart Series Number 11.

Mazzaferro, D. L., E. H. Handman and M.P. Thomas, 1979, : Water Recources Inventory of Connecticut, Part 8, Quinnipiac River Basin", Connecticut Water Resources Bulletin No. 27.

Napolitano, A. E., 1978, "Areawide Waste Management Plan", Water Quality Planning Task Forse, Westchester County, New York.

Ryder, R. B., M.A. Cervione, Jr., C. E. Thomas, Jr. and M. P. Thomas, 1970, "Water Resources Inventory of Connecticut, Part 4, Southwestern Coastal River Basins", Connecticut Water Resources Bulletin No. 17.

Snavely, Deborah S., 1980, "Ground-Water Appraisal of the FishKill-Beacon Area Dutchess County, New York", U. S. Geological Survey, Open File Report 80-437.

Thaler, J. S., 1977, " The Westchester Weather Book". George Candreva Environmental Center, Inc.

Wolcott, Stephen W. and Robert F. Snow, 1995, "Computation of Bedrock-Aquifer Recharge in Northern Westchester County, New York, and Chemical Quality of Water from Selected Bedrock Wells", U. S. Geological Survey, Water-Resource Investigations Report 92-41