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SUMMARY

The **geologic structure** of the Pomperaug River watershed includes a down faulted block known as the Pomperaug Basin. This basin has filled with glacial sands and gravels creating a significant groundwater resource known as the Pomperaug Aquifer (Pages 8-12; Aquifer Map - Page 4).

The potable water supply has been sufficient thus far to support growing communities in the region. The quantity and quality of the basin's water resources continue to be assessed (Page 15).

Diversions of water include registered maximum withdrawals of 16.9 million gallons per day, which exceed United States Geological Survey (USGS) estimates for what the aquifer deposits can actually provide (Page 15). Data are incomplete on actual withdrawal amounts. The Pomperaug River (Southbury section) is on the Connecticut Department of Environmental Protection's (CTDEP) Impaired Waterbodies 303(d) list for flow impairment (Page 17).

Water quality classification by the CTDEP indicates that surface and ground waters are generally potable, and meet criteria for recreational use and fish and wildlife habitat. However, there are local areas of concern, such as the MTBE and trichloroethane contaminations in Woodbury (Page 33; Water Quality Classification Map - Page 29).

Wastewater treatment facilities are located in Southbury at the Southbury Training School, IBM, and the Heritage Village Sewer Company. Combined, they are permitted to discharge up to 1,163,000 gallons of wastewater per day into the Pomperaug River and its tributaries (Page 31).

Changing land use in the region including rapid suburban development is altering the natural environment and placing increasing demands on local resources, especially water supplies. Bethlehem, Southbury and Woodbury are among the fastest growing towns in the region. Increased impervious cover associated with development results in increased runoff, which can include contaminants, and diminish the percolation of water into the aquifer. Continued growth will likely result in increased demand for out-of-basin transfers of water (Pages 5, 14, 37).

Management responsibilities for watershed resources are divided among town, state and federal agencies. Town agencies include planning and zoning and inland wetland commissions, water pollution control authorities and local public health districts. State agencies include the Connecticut Department of Environmental Protection, the Connecticut Department of Public Health, the Department of Public Utility Control, and the Connecticut Department of Agriculture. Federal agencies include the United States Geological Survey, the United States Environmental Protection Agency, the United States Department of Agriculture Natural Resources Conservation Service, and the Litchfield County Soil and Water Conservation District (Page 37).

Open space in the Pomperaug River watershed helps support the natural functioning of the Pomperaug River, minimizes development impacts in critical habitat areas, and provides recreational opportunities and overall quality of life in the watershed (Page 40).
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ACKNOWLEDGEMENTS

This project was funded by the Council of Governments of Central Naugatuck Valley (COGCNV) and The Pomperaug River Watershed Coalition, Inc. (PRWC). COGCNV is a regional planning organization concerned with the physical development and conservation of the Central Naugatuck Valley region, which includes many of the towns in the Pomperaug Watershed. The PRWC is a voluntary partnership of stakeholders dedicated to protecting the quantity and quality of the Pomperaug River's surface and subsurface waters as well as the plants and wildlife that contribute to its natural beauty.

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The Connecticut Department of Environmental Protection
The Central Naugatuck Valley Council of Governments
The Pomperaug River Watershed Coalition, Inc.
The Woodbury Junior Women's Club
The National Audubon Society
United Water Connecticut
Hydro Technologies, Inc.
Heritage Water Company
The Watertown Fire District
River's Alliance of Connecticut
The United States Geological Survey
The Natural Resources Conservation Service
The Towns of Bethlehem, Middlebury, Morris, Oxford, Roxbury, Washington, Watertown, Woodbury and Southbury

Comments and feedback to this report are welcome.
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INTRODUCTION

This report is designed to provide an overview of current conditions in the Pomperaug River Watershed. It is primarily intended to serve as an information source for those involved in the management of the Pomperaug River and surrounding watershed lands. This assessment is preliminary in nature, and provides baseline data that will be used to develop a comprehensive watershed management plan for the region. To increase public awareness of watershed issues, a summary version of this report has been widely distributed to households and businesses in the Pomperaug watershed. This report is also available on The Pomperaug River Watershed Coalition (PRWC) website at www.pomperaug.org.

The 90 square mile (56,958 acre) Pomperaug River Watershed is located in west central Connecticut. This area, renowned for its rural atmosphere, rolling hills, densely wooded forests, and rocky soils, is the result of millions of years of geologic, climatic, and human activity. The movement of the earth's continents and glacial regressions and other geological processes helped produce a landscape similar to the fertile Connecticut River Valley (Bell, 1985). One of the most important geological features of this watershed is the underlying stratified-drift aquifer - the predominant source of potable water in the region.

A *watershed* is the area that drains to a river, lake or other body of water. Within a larger watershed or drainage basin, there are typically sub-drainage basins that contribute surface flows into lower lying streams and wetlands. An *aquifer* is a geologic formation (sediments or rock) that contains a usable amount of water. Stratified-drift aquifers, of the sort found in the Pomperaug River Watershed, are highly productive, potentially yielding millions of gallons of water per day.

The main stem of the Pomperaug River flows from the center of Woodbury through the town of Southbury, and ultimately discharges into the Housatonic River at Lake Zoar. The two main tributaries to the Pomperaug are the Nonnewaug and Weekeepeemee Rivers. It is at the confluence of these two rivers where the Pomperaug River begins. The Pomperaug River

Watershed consists of seven sub-regional drainage basins (Figure 1). A total of eight towns, Bethlehem, Middlebury, Morris, Roxbury, Southbury, Washington, Watertown, and Woodbury, are partially situated within the watershed, although Bethlehem, Southbury, and Woodbury combined encompass 83% of the total watershed area. The majority of the Pomperaug Aquifer falls within the towns of Woodbury and Southbury (Figure 2). Table 1 is a summary of the area of each of the eight towns within the watershed.

Table 1. Land area of towns within the Pomperaug River watershed based on GIS data from Uconn MAGIC website.

Town	Total Town Acreage	Acreage in Watershed	Percent of Town in Watershed
Bethlehem	12,608	11,974	95%
Middlebury	11,520	184	2%
Morris	12,032	894	7%
Roxbury	16,896	2,982	18%
Southbury	26,176	12,623	48%
Washington	24,768	3,272	13%
Watertown	19,072	2,491	13%
Woodbury	23,552	22,534	96%

The population in the eight watershed towns and the town of Oxford has increased dramatically since 1960 (Figure 3, Appendix 1). The population of Woodbury and Southbury increased by over 50% between 1960 and 1970. Between 1970 and 1980, the population of Southbury increased by 80.3%, due largely to the development of Heritage Village. Although Oxford lies outside of the Pomperaug Watershed, it receives some of its water from the Aquifer and is therefore included in this analysis. As the population in these towns has increased over the last several decades, demands for water for drinking and industry also have increased. The demand for water by watershed towns and surrounding municipalities is expected to continue to grow in the future.

Regional Drainage Basins of the Pomperaug River Watershed

Regional Drainage Basin

- EAST SPRING BROOK
- HESSEKY BROOK
- NONNEWAUG RIVER
- POMPERAUG RIVER
- SPRAIN BROOK
- TRANSYLVANIA BROOK
- WEEKEEPEEMEE RIVER

Prepared by the Council of Governments of the Central Naugatuck Valley

Not to Scale

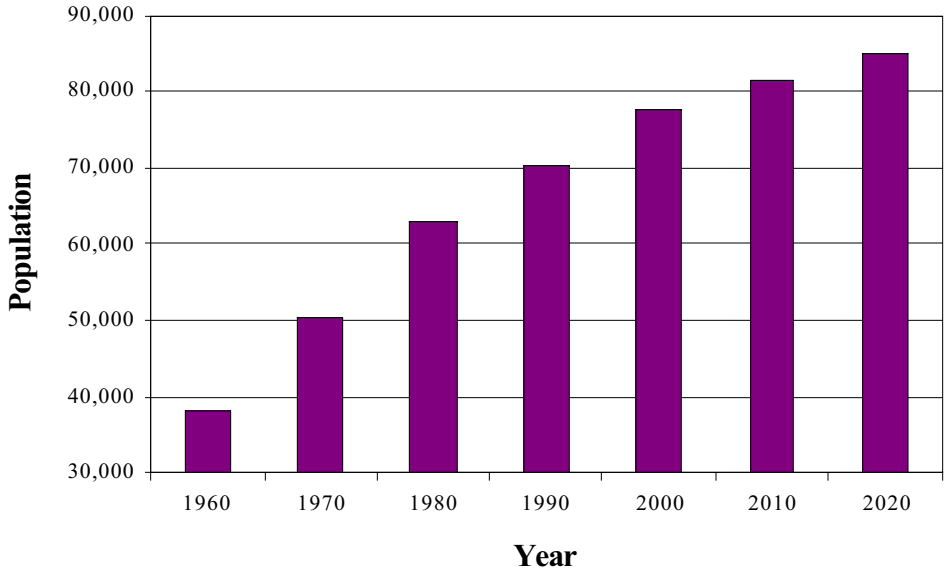
The Pomperaug River Aquifer

Pomperaug Aquifer

Prepared by the Council of Governments of the Central Naugatuck Valley

Not to Scale

Figure 3. Population change in the eight watershed towns and Oxford between 1960 and 1995, and the projected population in these towns through the year 2020 based on data from the Office of Policy and Management, 1995.



A BRIEF GEOLOGIC HISTORY OF THE POMPERAUG RIVER WATERSHED

Five hundred million years ago (mya), what we now know as southern New England was a vastly different place. It was the southern, not eastern, shore of what would become North America, located much closer to the equator than it is presently, and was presumably far more humid and tropical. As the earth's plates shifted, this Proto-North America underwent significant change. The present geologic features of the watershed are the result of three distinct episodes in its geologic history.

The first episode, lasting from 500 to 250 mya, was the shifting and collision of the ancient continents and plates, forming a massive continent called Pangea. At the junction of the Proto-African, Eurasion, and North American plates, a Himalayan like mountain chain formed, the remnants of which now exist as the Appalachians. The metamorphic rocks known as schists and gneisses that compose the bedrock of the higher hills in the watershed are a direct result of these collisions.

The next episode, extending from 250 mya to the present, was the rifting and breakup of Pangea to form the present distribution of continents and the Atlantic Ocean. Recent measurements indicate that the continents are still separating, causing the Atlantic Ocean to grow a few centimeters each year. This rifting also created a series of down faulted blocks of bedrock called rift basins along the East Coast. One of these basins formed in central Connecticut. It extends 100 miles north from New Haven to Greenfield, Massachusetts, and averages 20 miles in width. A smaller down-faulted block called the Pomperaug Basin, formed in the watershed. Averaging two to three miles in width, it extends 6 miles north from the intersection of Route 172 and I-84 in Southbury to the vicinity of Nonnewaug Regional High School in Woodbury. This basin collected sediments that eventually formed such present day sedimentary rocks as sandstone and shale. On three separate occasions, volcanic fissure eruptions filled the Pomperaug Basin with lava flows that hardened to form an igneous rock called basalt (commonly known as traprock). Later, the sedimentary and igneous rock within the basin underwent faulting and erosion causing the harder basalt to form the traprock valley ridges extending from Rattlesnake Hill in Southbury to Orenaug Park in Woodbury (Figure 4).

The third and last geologic episode occurred one to two mya when a series of massive glaciers intermittently covered the northern half of North America. Roughly eighteen thousand years ago, the last ice age was ending and the large glaciers covering Connecticut began to retreat northward. As the ice melted, the sediments suspended in the ice and flowing in the glacial melt were deposited in the watershed.

As the higher hills of the watershed emerged, unsorted debris, of all different shapes and sizes, covered much of Connecticut's bedrock. Debris of this type is called *glacial till*. It was among the first deposits laid down on the bedrock, and was done so directly by the glacial ice. Well-sorted sediments were the last to be deposited, and were left by glacial waters in the lowest lying areas, such as valleys, stream channels, and lake bottoms. These deposits are collectively termed *stratified-drift* and generally include gravel, sand, silt, and clay. Perhaps the greatest significance of these sediments is their influence over the development of aquifers. The thick

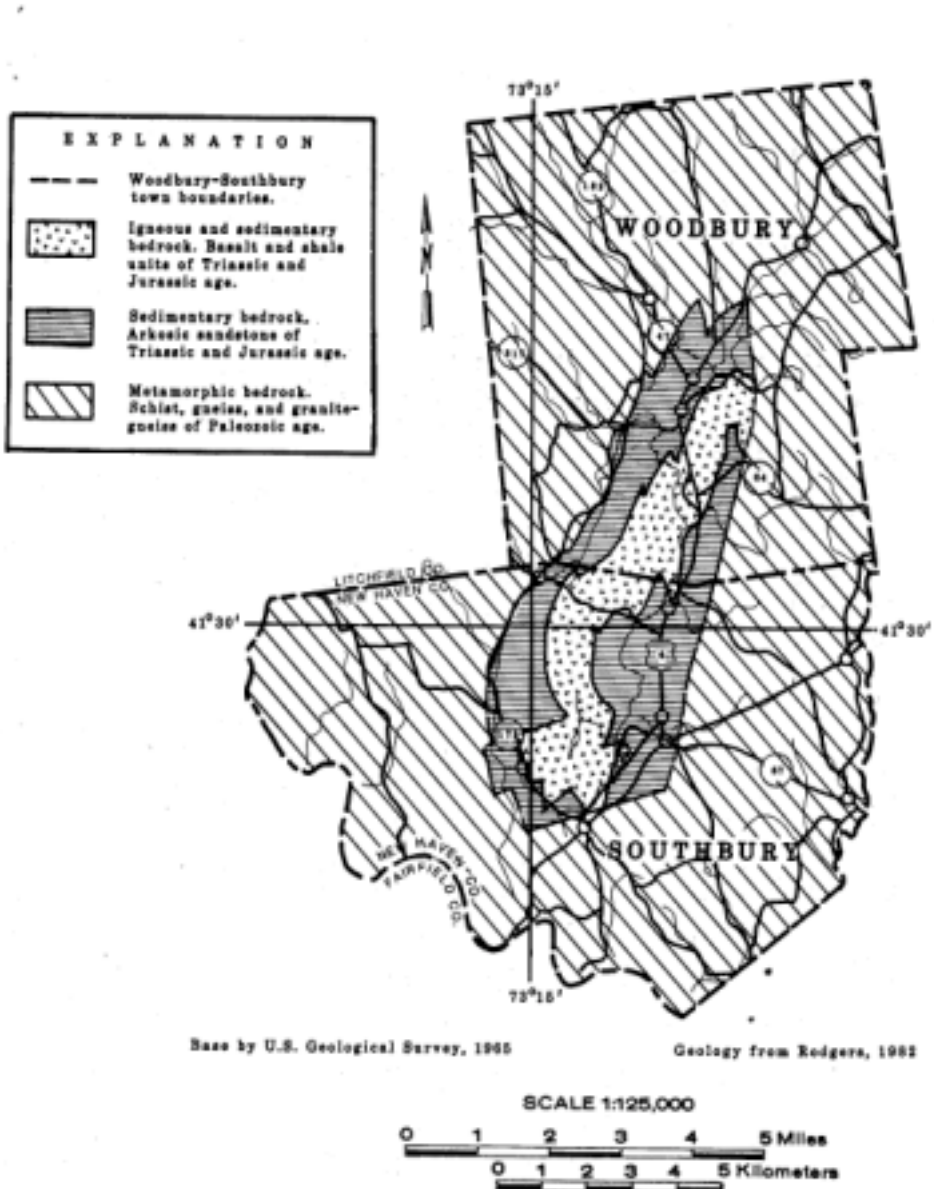


Figure 4. Bedrock geology of the Southbury-Woodbury area (Mazzaferro, 1986).

glacial deposits found in the Pomperaug Basin were extensively laid and have large pore spaces in between which water can readily flow through and be stored (Hust and Murphy, 1997). These deposits form the Pomperaug Aquifer (See Figure 2).

The topography of the Pomperaug watershed is diverse, reflecting the geological processes that help formed the New England landscape. The highest point in the Pomperaug watershed is in the town of Morris at 1,150 feet above sea level. The lowest point, where the Pomperaug River empties into the Housatonic River, is 100 feet above sea level (Meizner and

Sterns, 1929).

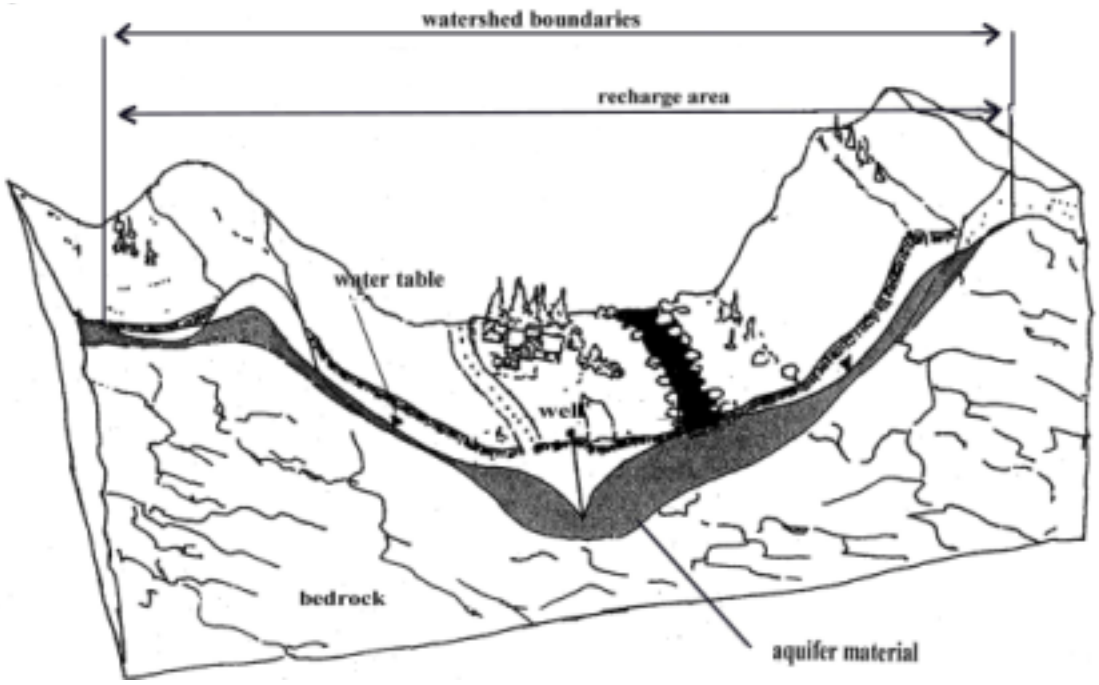
HOW THE POMPERAUG AQUIFER FUNCTIONS

The main portion of the Pomperaug Aquifer (in the down faulted Pomperaug Basin) is approximately 18 square miles, following the entire course of the Pomperaug River from central Woodbury to the Housatonic River (Mazzaferro, 1986). Less extensive aquifer materials were also deposited in the low-lying valleys of Woodbury, Southbury, and Bethlehem, including those valleys carved out by the Nonnewaug and Weekeepeemee Rivers (Marin, 1990).

The amount of water an aquifer can supply for consumption depends primarily on three factors - recharge rates, withdrawal rates, and the aquifer's storage capacity. Other factors that influence the potential of an aquifer to yield water include the number of wells, the distance between wells, the duration of pumping, and the proximity of a well to a stream, river, or impermeable boundary (Mazzaferro, 1986). Figure 5 is a representation of a typical river-aquifer system and surrounding watershed.

The recharge rate is the continual process of the aquifer replenishing itself, which also occurs after water withdrawals. Much of the recharge for the Pomperaug Aquifer comes directly from precipitation. Precipitation that lands directly on areas of stratified drift can more easily penetrate into the aquifer than precipitation falling on glacial till. In fact, precipitation falling on stratified drift may recharge the aquifer at rates up to three times higher then precipitation landing on till (Mazzaferro, 1986). Water may also re-enter the aquifer via underground flows from other aquifers, from sources of water located near the aquifer, such as wetlands, lakes and streams, and through artificial recharge by septic systems or other groundwater discharges.

Figure 5. Watershed model with a river-aquifer system, reproduced by permission from Hust and Murphy, 1997.



The withdrawal rate is the quantity of water removed from the aquifer over a period of time. Wells are a common means of removing water from an aquifer. The rate at which a well pumps out the contents of its source is one withdrawal rate. If the water from that well is used within the watershed, it may also contribute to the recharge rate. If water is diverted out of the basin, the withdrawal represents a net loss to the aquifer because this water is no longer available for recharge or to maintain river flows. In the Pomperaug watershed, examples of out-of-basin diversions are the waters supplied to portions of the towns of Middlebury, Oxford and Watertown. Besides commercial and residential private wells that withdraw water from the watershed, there are three water utilities with wells in the Pomperaug Aquifer. Heritage Water Company, United Water Connecticut, and the Watertown Fire District provide water for residents and businesses within and outside of the watershed.

The ability of an aquifer to supply water is also dependent on the aquifer's ability to store the water that enters it. Certain geologic formations, such as the stratified drift found in

the Pomperaug River Basin, have a high storage capacity. Also important is the aquifers saturated thickness, the hydraulic conductivity of materials in the aquifer, and the aquifer's specific yield.

The saturated thickness of an aquifer (the depth from the water table to the bottom of the aquifer) generally determines the water yield from a well site. In the Pomperaug Aquifer, the saturated thickness ranges from 1 foot along its exterior boundaries to up to 150 feet in its interior. The coarse-grained deposits, which yield the most water, have been recorded at depths of 70 to 85 feet in Southbury and 80 to 100 feet in Woodbury (Mazzaferro, 1986).

The hydraulic conductivity is the rate at which water flows through a section of soil or aquifer over time (cubic feet of water passing through a cross-sectional area of one square foot per day). It is, in other words, a measure of how easily water is transmitted. The rate of transmission increases as the soil moisture content increases (Dunne and Leopold, 1978). Stratified drift aquifers generally have a good rate of conductivity.

The specific yield is the ratio of the quantity of water received from aquifer material per cubic foot of material. It demonstrates the availability of water in the aquifer. The specific yield for aquifers similar to the Pomperaug range from a ratio of 0.1 to 0.3 cubic feet of water per cubic foot of material, indicating that that aquifer yields water comparatively well.

The Hydrologic Cycle and How Water Recharges an Aquifer

The hydrologic cycle is the continuous movement of water from the oceans, the atmosphere, and the earth's continents. When precipitation falls within watershed boundaries, it either collects as runoff or penetrates into the soil becoming groundwater. Runoff is the term used for rainwater and melting snow that flows over the ground's surface into surface water bodies, such as oceans, lakes, rivers, and swamps. The amount of runoff generated following a rainfall or other storm event is dependent upon factors such as the rate of precipitation, topography, and the ability of the soil to absorb moisture. Steep slopes, slopes with little vegetation, and areas where soil is covered by impervious materials (such as paved parking lots,

roads, driveways and roofs) affect the ability of water to infiltrate the soil and cause increased rates of runoff.

Water that penetrates into the soil is pulled downward by gravity. The unsaturated zone is the first part of sediment (mineral or organic matter) that water flows through above the water table. Here, the spaces between the particles of sediment are partially filled with water. It is not possible for wells to pump water located in this zone. Deeper down, the water flows into the saturated zone, where all the spaces between sediment particles are filled with water. Once water reaches the saturated zone, it is referred to as groundwater. Aquifers are located within this zone. The very top of the saturated zone is called the water table. The depth to the water table is generally shallowest near wetlands and permanent bodies of surface water, but the depth can change depending on precipitation rates and the rate nearby wells pump water out of the ground.

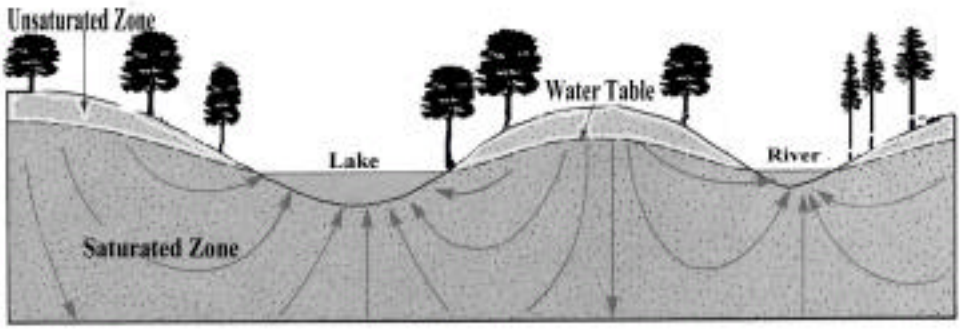
Water moves through the saturated zone from areas of recharge to areas of discharge. Recharge areas are those areas within the watershed boundaries where precipitation is able to penetrate into the soil. Areas of discharge are places where the water table and the ground's surface intersect, such as wetlands, rivers, lakes, and oceans. Groundwater is an important contributor of water to these waterbodies. If the water table drops below the level of the surface water, a portion of the surface water may flow into the ground to replenish groundwater levels.

The Pomperaug Aquifer and watershed have provided ample water for local residents and businesses, yet there are reasons for concern today. Stratified-drift aquifers are highly susceptible to contamination. For the same reasons that water is able to flow relatively quickly through these aquifers and be stored for long periods within them, so too can contaminants. Aquifers can also be depleted through overuse. As the demand for water increases, so does the potential for depleted wells and lower river flows.

The River-Aquifer Relationship

Groundwater and surface water are constantly interacting (Figure 6). Water from the Pomperaug Aquifer seeps into the Pomperaug River and its tributaries, supplementing stream flows. It is a critical source of water to the river, especially during periods of little precipitation, in which case it may be the only natural source of stream flow. Likewise, if sufficient groundwater is removed from the aquifer, surface waters can help replenish depleted aquifer levels because the two bodies of water are connected by the soils and sediments between them. The actions of humans can affect this groundwater-surface water relationship, thereby changing the quantity and quality of existing water supplies. Low stream flow rates, caused either by drought or human intervention, alter the stream environment and stress the fish and wildlife species that rely on this habitat. During periods of low flow, water temperature rises, dissolved oxygen levels decrease, the stream bank dries out, and pollutants become more highly concentrated (Oliver, 1984). During low flow conditions, it is also more difficult for the river to assimilate treated effluent discharged from wastewater treatment plants.

Figure 6. Relationship between groundwater and surface water.



Previous studies indicate that groundwater is a significant factor in maintaining surface water levels in southern New England (Mazzaferro, 1986). Precipitation that percolates into the groundwater is normally transferred over time to surface waters. This is an important source of water to the river, especially during dry summer months. The higher the percentage of

stratified drift in comparison to other deposits, the higher the contribution of groundwater to surface waterbodies. Extractions of water from groundwater wells can directly impact river flows by reducing the amount of water available to supplement stream flows.

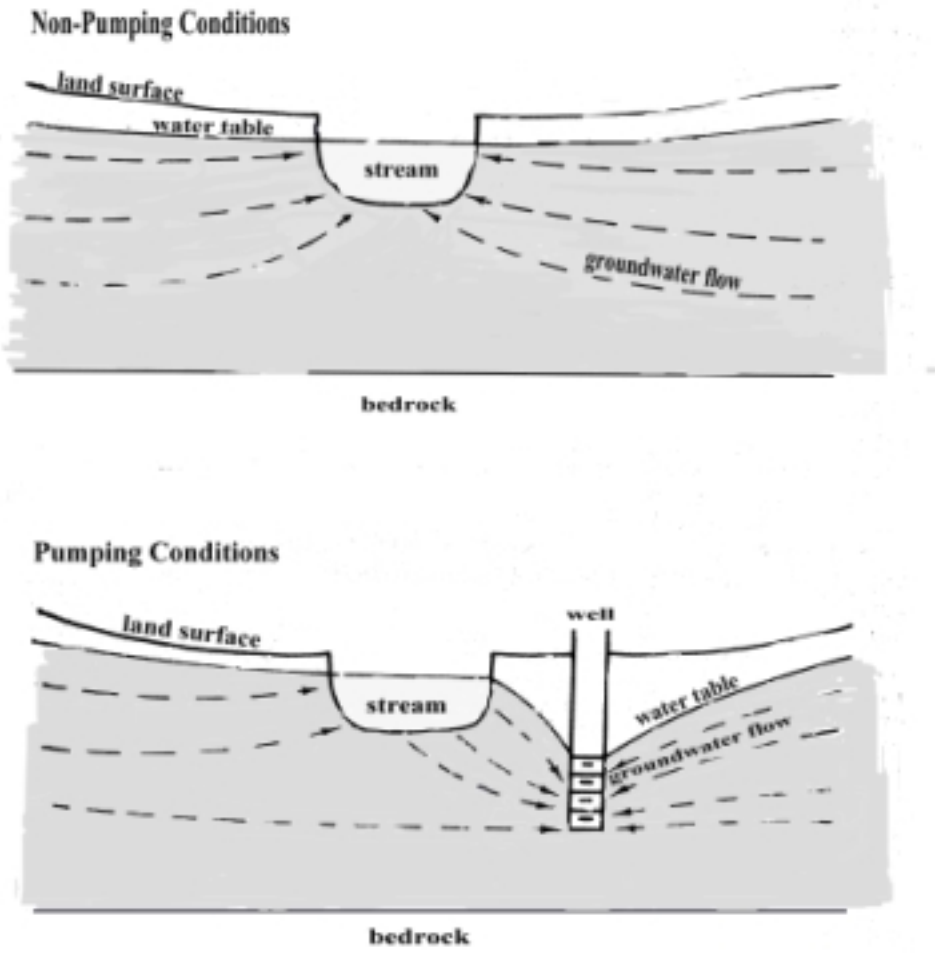
A 1990 report conducted for the towns of Southbury and Woodbury indicated that water diversions up to that point may have decreased summertime flows in the Pomperaug River by 30-40 percent (Marin, 1990). Figure 7 illustrates how high-yielding wells in stratified drift aquifers can reverse the normal flow of groundwater. In this model, the river recharges the aquifer. This process is called *induced infiltration*. In addition to drawing ground water away from the river, induced infiltration can also affect water quality in the aquifer. Wastewater, which is discharged into the Pomperaug River and its tributaries, becomes more concentrated during low river flows. This more highly concentrated effluent could be induced into the aquifer by wells pumping near the river.

WATER RESOURCES

Safe Yield and Recharge

Safe yield is the term used to express the amount of water an aquifer or well can yield for consumption without producing unacceptable negative effects. Connecticut defines the safe yield for public water as, "the maximum dependable draft, which can be made continuously from a water supply source without causing unacceptable effects during a critical dry period with a one percent chance of occurrence." However, *unacceptable effect* is not well defined in the regulations, and therefore it is often difficult to reach a consensus on the actual safe yield of an aquifer. Potential unacceptable effects discussed previously are contamination of the aquifer water by induced infiltration, decreased river flows, and lowering of the water table.

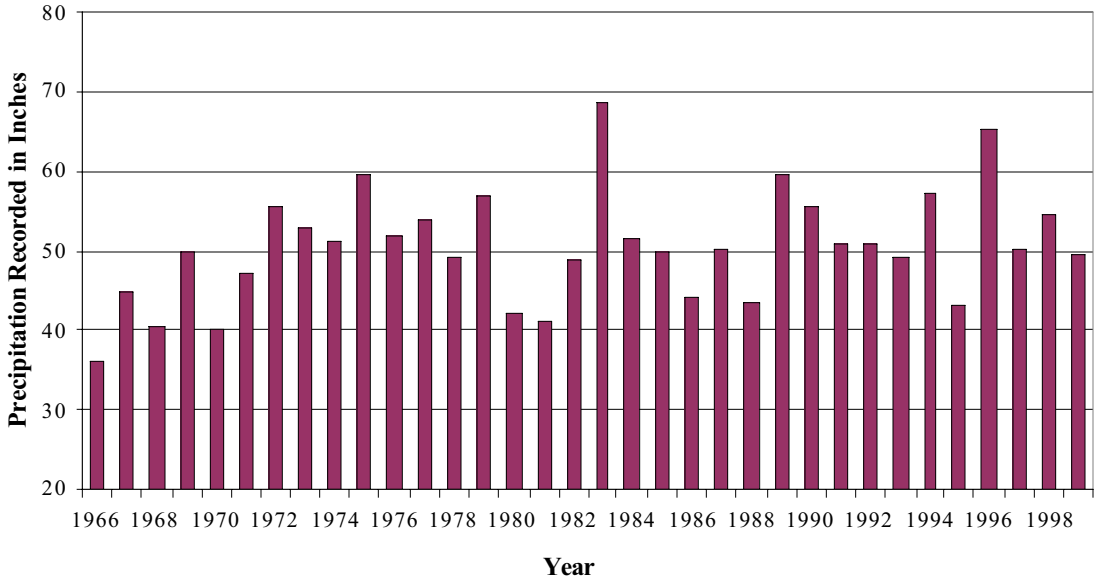
Figure 7. Groundwater flow under pumping and non-pumping conditions, modified from Mazzaferro, 1986.



Changes in land use within a watershed can change the rate of recharge to an aquifer. An increase in impervious cover over areas of stratified drift prevents water from percolating into the soil as quickly as it would under natural conditions. As infiltration rates are decreased, surface water volume and runoff rates are increased. Unless Best Management Practices (BMPs) are employed, increased runoff can lead to erosion and flooding. Many Connecticut towns, including Southbury and Woodbury, have adopted aquifer protection zones in their planning and zoning regulations to address these potential problems.

Precipitation has been identified as the principal source of recharge to the Pomperaug Aquifer (Mazzaferro, 1986). Annual precipitation rates can vary substantially, and therefore the amount of water the aquifer yields also varies. For example, the average annual precipitation in the town of Woodbury between 1966 and 1999 was 50.6 inches (Mr. Earl Gillette, personal communication). However, in 1966 the total annual rainfall was only 36.1 inches, with a mere 1.7 inches of rain falling in August. Conversely, in 1985 the total rainfall was 49.99 inches, with 8.21 inches falling during the month of August (Figure 8). According to a USGS 1989 report, there was a statewide drought in Connecticut between 1961 and 1971.

Figure 8. Precipitation data (inches per year) recorded in Woodbury by Earl Gillette between 1966 and 2000.



Water Quantity

To date, there have been sufficient water resources in the watershed to meet regional demands. However, as the demand for water increases, so will withdrawal rates from the aquifer. The current registered diversions in the watershed exceed USGS estimates for the aquifer's water capacity. Heritage Water Company (HWC), United Water Connecticut (UWC), and Watertown Fire District (WFD) are allowed by registration under the 1982 Connecticut Water Diversion

Policy Act to withdraw a total of 4.142 million gallons per day (mgd) from the Pomperaug Aquifer. Presently, these companies withdraw less than half of what they are legally allowed by the CTDEP. In addition, other large water users such as the Southbury Training School, golf courses, local farms, and local businesses have registered diversions with the CTDEP. A diversion is not necessarily a water withdrawal from the aquifer. It can be one of many types of water use, including the redirection of a stream channel, the use of surface waters for irrigation, or the creation of a stormwater detention basin. All of these uses can affect the river and the aquifer.

The CTDEP classifies the State's existing diversions in two ways - registered and permitted. Registered diversions came into being with the 1982 Diversion Act. Prior to the Act, the CTDEP did not regulate water diversions. The Diversion Act gave the CTDEP limited authority to regulate the use of ground and surface waters in the state. Under the Act, existing diversions were grandfathered and registered with the CTDEP. Registrants had to inform the CTDEP of the location, capacity, frequency, and rate of the withdrawal of the diversion, as well as give a description of the water use and/or distribution system. According to the CTDEP's 2000 Report to the General Assembly on State Water Allocation Policies Pursuant to Public Act 98-224, "These registered diversions may continue indefinitely, regardless of their environmental effects and their impact on the water needs of others."

Since the Water Diversion Act of 1982, new applicants for a water diversion need to apply for a permit and undergo an environmental review process. However, by Special Act of the State Legislature, fish farms can be allowed to divert water by the Connecticut Department of Agriculture. These diversions do not appear on either the DEP's Registered or Permitted Diversions list and do not need to pass an environmental review process. There is at least one such diversion in the Pomperaug Watershed for a fish farm in Bethlehem that is allowed to divert 250,000 gallons per day (gpd) from the Nonnewaug River.

According to the CTDEP Inland Water Resources Division records, the sum of the registered diversions for the Pomperaug River Watershed equals 16.9 mgd (See Appendix 2). Based on available information, it does not appear that the total registered amounts are being

used. The water utilities monitor and report their usage to the CTDEP, the Department of Public Utilities (DPUC), the Department of Public Health (DPH), and others. Other registrants are not required to monitor or report their usage and therefore determining exactly how much is water is being used is difficult to assess. In the town of Southbury, for instance, there are four registered agricultural diversions equaling 9.6 mgd (twice what the three water companies are permitted to divert) with few conditions placed on where or how that water is used. The Town of Southbury recently purchased the Berry Farm, which has two registered diversions totaling four mgd, for use as a town recreational facility.

Since the 1982 Diversion Act, six other water diversions in the watershed have been issued permits withdrawing a total of 600,000 gpd. Diversions of less then 50,000 gpd do not need a permit from the CTDEP despite the fact that the Pomperaug River is currently on the CTDEP's Impaired Waterbodies 303(d) list for flow impairment. The CTDEP Report to the State Legislature in January of 2000 discussed these issues and indicated the need to institute greater protection for Connecticut's water resources. Because the State of Connecticut does not have minimum stream flow standards, it is particularly important that stakeholders from the watershed work cooperatively to preserve stream flows.

Table 2. Reductions in stream flow due to leakage to the aquifer and reduced groundwater runoff for four pumping rates and 10-year average recharge conditions, from Mazzaferro, 1986.

Pump Rates		Reduction in groundwater runoff	Reduction due to leakage from the stream	Total reduction in stream flow
mgd*	cfs	cfs	cfs	cfs
8.3	12.8	8.1	4.3	12.4
11.2	17.3	9.7	7.1	16.8
11.5	17.7	8.2	8.9	17.1
14.3	22.2	10.0	11.6	21.6

*Units are: million gallons per day (mgd); cubic feet per second (cfs).

The 1986 study conducted by Mazzaferro suggested that increasing water diversion quantities would have a measurable impact on Pomperaug River flows. Table 2, taken from Mazzaferro's report, illustrates the connection between pumping rates of wells near the

Pomperaug River and river flow. The 10-year average recharge that Mazzaferro used to create the following table was the average precipitation for the 10 years preceding his study (51.4 inches).

These data were the product of an aquifer model Mazzaferro developed for the Pomperaug. In Mazzaferro's model, hypothetical wells pumped at the rates listed above. The river in the model then exhibited decreases in flow ranging from 12.4 to 21.6 cubic feet per second (cfs), or 8 to 14 million gallons per day (mgd). However, it is important to note that in the model Mazzaferro assumed that all of the water pumped from the aquifer would not be returned and was a net loss from the watershed.

The accuracy of these data are limited by the methodology used, but the model does indicate the substantial effect pumping rates and diversions may have on stream flow. In the drier summer months and during periods of drought when river flows are already diminished, the effects can be substantial. Water withdrawals combined with low rates of precipitation can lower the water table dramatically, impacting river flow, degrading fish and wildlife habitat, increasing the potential for low water yields, and decreasing the dilution of treated wastewater discharged into the Pomperaug River system. Mazzaferro concluded that the Pomperaug Aquifer had a potential long-term yield of 5.0 to 8.8 mgd. The registered and permitted diversions in the watershed exceed this amount by 9 to 12 mgd. If the Mazzaferro model is correct, future water shortages in the Pomperaug River Watershed are probable.

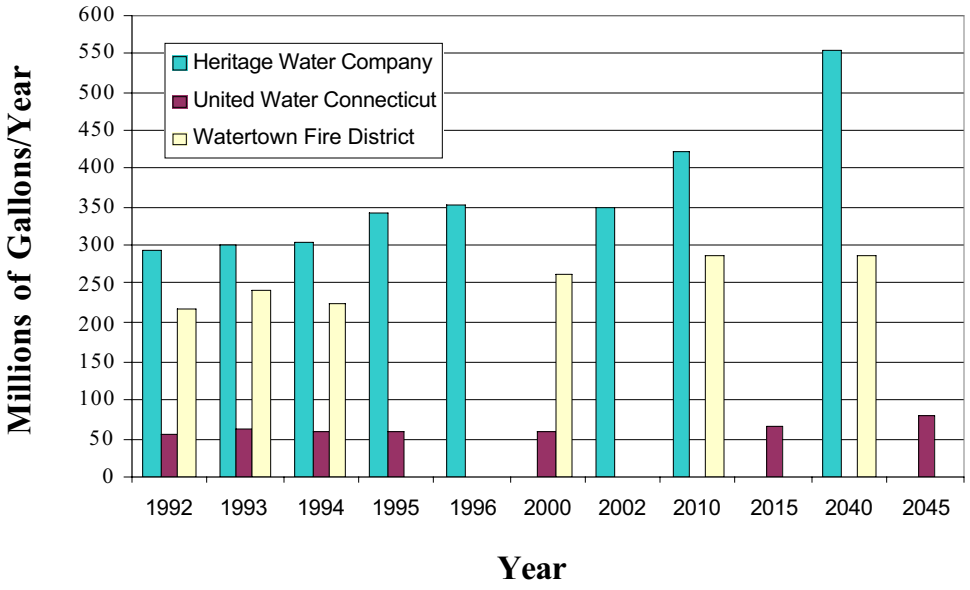
Water Companies

Water utilities operating in the Pomperaug Watershed represent a considerable percentage of the total registered diversions. Their withdrawals have a direct impact on the water table and flow rates in the Pomperaug River. Based on the water supply plans for Heritage Water Company (HWC), United Water Connecticut (UWC), and the Watertown Fire District (WFD), the demand for water is going to continue to increase in the future (Figure 9). HWC expects the greatest increase in its future demand. Its total water consumption is predicted to

rise 66% between 1996 and 2040 (Leggette, Brashears and Graham, 1996).

In 1994, these three water companies withdrew almost 589 million gallons of water from the Pomperaug Aquifer. By the year 2040, this number is expected to exceed 900 million gallons. Over one third of the water pumped in 1995 was transferred outside of the watershed to the towns of Middlebury, Oxford, and Watertown. HWC's service area includes two out-of-basin towns, Middlebury and Oxford. WFD's usage is presently entirely out of basin.

Figure 9. Historic and projected pumping rates for Heritage Water Company, United Water Connecticut, and Watertown Fire District based on data available in their water supply plans.



Tests completed for Watertown Fire District's 1996 Water Supply Plan, indicated in the Mazzaferro study, noted a connection between pumping rates and river flow. During the first two days of a pump test conducted in November, 1995 at the Hart Farm Well Field (located near the Nonnewaug River), the Nonnewaug River's flow rate was diminished by 0.88 cfs or 0.567 mgd. At the time, nine wells located at the field were pumping slightly above their registered diversion of 1.73 mgd. If these tests are accurate, pumping at this rate could seriously impact the Nonnewaug River. For instance, in the drought of 1964 the Nonnewaug River Gauge

recorded flows at levels below 0.88 cfs on numerous days. In the months of August, September, and October 1964, for example, 25 days had average flows of less than 0.88 cfs. On days in which the flow is below 0.88 cfs or 0.567 mgd and WFD is pumping at its registered diversion limit, there would theoretically be times when the Nonnewaug River was dry. Understanding the relationship between withdrawals and river flow rates is critical to the protection of our water resources, which is why continuous stream flow data is a priority for the Watershed Coalition. The Nonnewaug Gauge was discontinued in 1979 after seventeen years of use, but was reactivated in September of 2000.

Although UWC and HWC both have wells in close proximity to either the Pomperaug River or a tributary, neither provided data concerning the relationship of pumping rates to river flow in their last water supply plans.

Non-Revenue and Unaccounted-for Water

The Department of Public Utility Control (DPUC) recommends that no more then 15 percent of a utility's total diversion be *unaccounted-for water*. This is water that is pumped from its source, but is lost in transport or appears to have been lost due to inaccurate meters. Water companies, in their water supply plans, report the percentage of unaccounted-for water in their systems if possible. Water companies can also report the percentage of non-revenue water. *Non-revenue water* is the difference between the water that was produced and/or purchased by the water company, minus what was actually sold, such as water for fire protection.

The accuracy of both non-revenue and unaccounted-for water figures are highly dependent on the status of metering in the water system. If there are numerous un-metered customers in the water distribution system, as is the case in the Pomperaug Watershed, the results, whether they are reported as non-revenue or unaccounted-for water, are merely estimates. Therefore metering is an important first step in any water conservation program. Heritage Water Company has the highest percentage of un-metered customers of the three

water companies. In 1996, 74% of all HWC customers were un-metered (Leggette, Brashears and Graham, 1997). To determine the percentage of non-revenue water, consumption rates were estimated for un-metered consumers.

United Water Connecticut and Watertown Fire District reported their percentage of *unaccounted-for* water in their last water supply plans, but Heritage Water Company only provided the percentage of their *non-revenue water* (Table 3). WFD's *unaccounted-for* water figures were not adjusted for non-revenue usage, and therefore an unknown percentage of their *unaccounted-for* water was used for *non-revenue* purposes. In 1994, Watertown Fire District's unaccounted-for water equaled 46,624,000 gallons, United Water's equaled 10,112,000 gallons, and Heritage's non-revenue water equaled 32,266,000 gallons.

Table 3. Percentages of Unaccounted-for or Non-Revenue Water reported by Heritage Water Co., United Water CT, and Watertown Fire District in their water supply plans.

Year	Heritage Water Company (Non-revenue water)	United Water Connecticut (Unaccounted-for water)	Watertown Fire District (Unaccounted-for water)
1991	N/A	15.6%	18.3%
1992	11.1%	16.8%	16.6%
1993	10.6%	28.8%	17.7%
1994	10.6%	17.0%	20.8%
1995	12.4%	19.5%	29.5%*

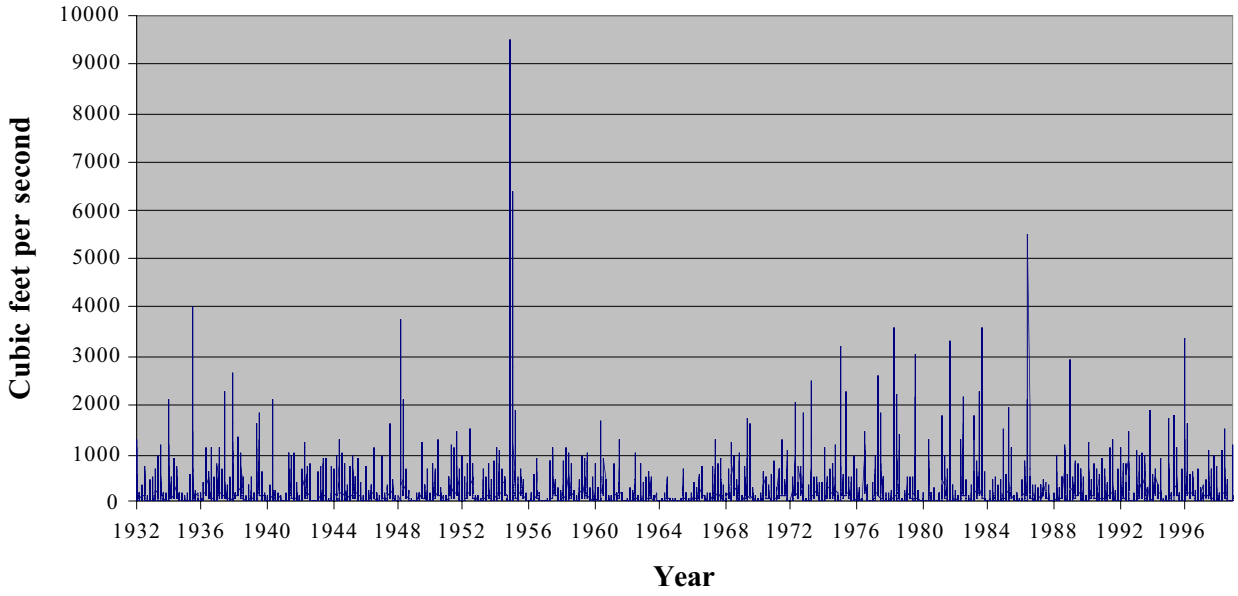
*Partial recording year.

Watertown Fire District has had the highest percentage of unaccounted-for water of the three water companies. According to data supplied in its Water Supply Plan of 1996, its lowest percentage of unaccounted-for water since 1983 was 14% in 1985. Its highest percentage of unaccounted for water was 35.8% in 1987. In the past few years, WFD has made successful efforts to lower their percentage of unaccounted for water and in 1999 it met the DPUC criteria. WFD's percentages for unaccounted-for water for years 1997 through 1999 were 33.1%, 24.4%, and 14.8%, respectively (Mr. Ernie Coppock, Superintendent of the Watertown Fire District, personal communication).

Gauging Stations and Groundwater Wells

Three USGS gauging stations have recorded river flow data in the Pomperaug Watershed (See Figure 14). Two stations, one located on the Weekeepeemee and the other on the Nonnewaug River, have only recorded data intermittently; and were discontinued due to lack of funding. These two gauging stations were reactivated in summer 2000 due to the collaborative efforts of the Pomperaug River Watershed Coalition, the Town of Woodbury, the USGS, and Towantic Energy, LLC.

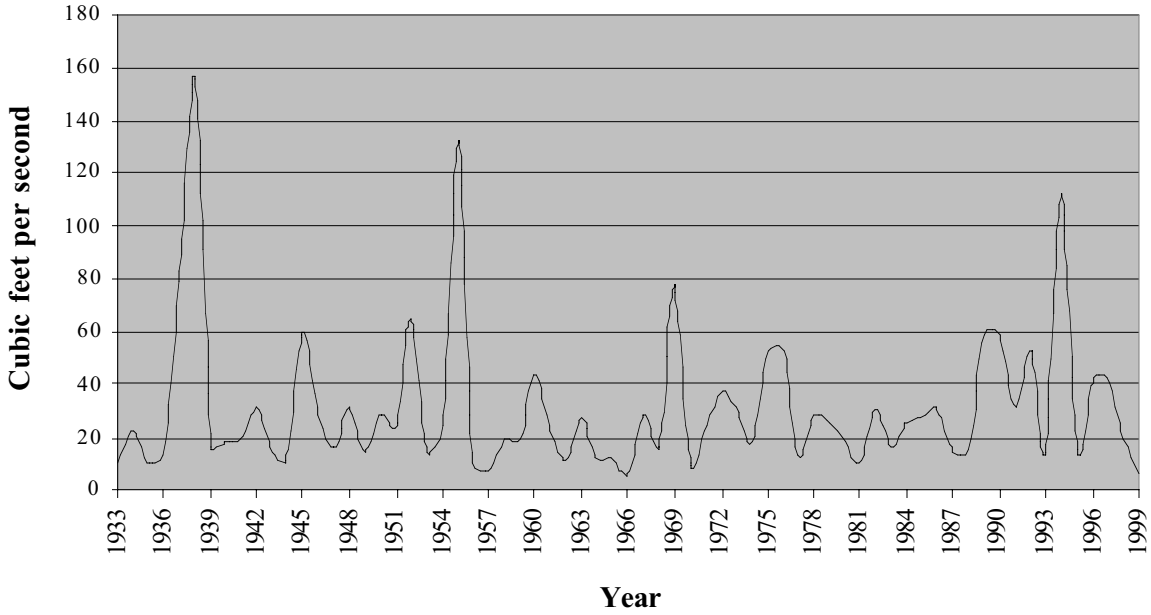
Figure 10. Mean daily flows at the USGS Pomperaug Gauging Station between 1932 and 1999.



The Pomperaug River Gauge in Southbury has been recording flows rates since 1932 (Figure 10). These historical data can be used to track changes in river flow data over time. Periods of flooding and of drought are evident in the graph. Major droughts occurred during the following time periods: 1940 to 1945, and 1961 to 1971. According to the USGS, the most phenomenal flood in the watershed occurred in 1955 when Hurricane Diane stalled over New England.

One measure of the health of a river is its median flow rate over time, especially during the summer when flows are typically lower. The median flow rate for the month of August (typically a month exhibiting low flow rates) between 1933 and 1999 was calculated for the Pomperaug River using USGS stream gauge data (Figure 11). The median for each month was determined by taking the thirty-one daily average flow rates and finding the middle (median)

Figure 11. August median flows at the USGS Pomperaug Gauging Station between 1933 and 1999.

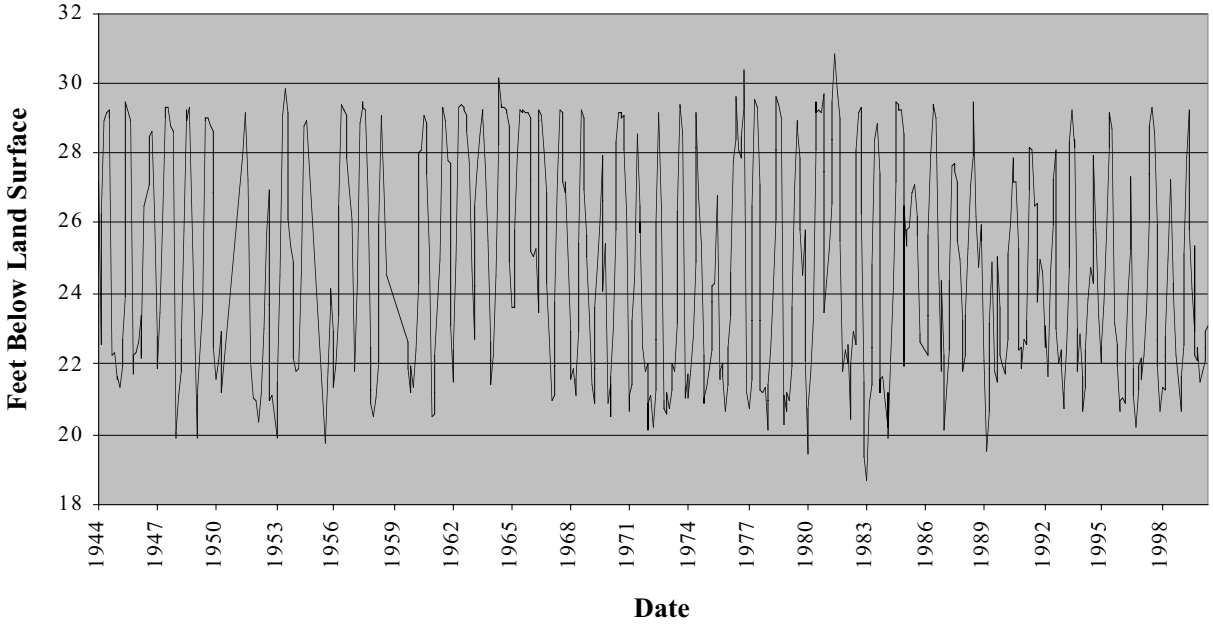


value. Since a single very high or low flow (such as during a large flood event or drought) can disproportionately affect the average flow rates, the median flow rate is a more accurate depiction of the rivers' health over time.

While the median August flow rate varies considerably from year to year, it has not decreased precipitously since 1933 despite the large diversions that are occurring in the watershed. Fluctuating precipitation rates, changes in the quantities of discharges into the river, and changing land use and water use patterns can all affect river flows. Today a higher percentage of the river flow may come from discharges and runoff into the river than in the

past. A primary function of The Pomperaug River Watershed Coalition is to determine a water budget for the watershed and better understand the relationship between water withdrawals and stream flows. Due to rising costs and static or decreasing funding, many stream gauges around the state are in jeopardy of being discontinued, including the Pomperaug Gauge. Without this important stream data, it will be difficult, if not impossible, to quantify the health of the Pomperaug River.

Figure 12. Average monthly ground water levels at USGS Well WY1 in Woodbury between 1944 and 2000.

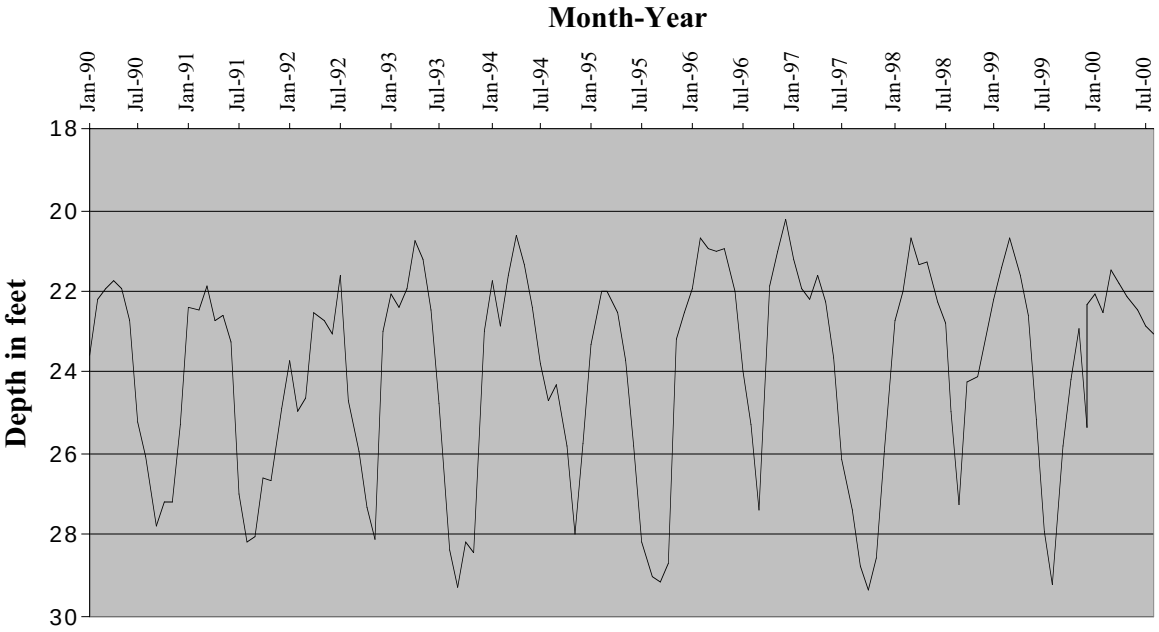


Another type of water gauge is groundwater-monitoring wells. These wells are used to monitor changes in the depth from the land surface to the water table. The USGS has four groundwater-monitoring wells in Southbury and one in Woodbury where the local water table depth are recorded. Water levels in the Southbury wells have been monitored consistently since the early 1990's. The well in Woodbury (WY1) has data from 1913 to the present, although no measurements were taken between 1916 and 1944. Figure 12 is a graph of ground water measurements (in feet below the surface) from 1944 to 1999, illustrating seasonal and annual

fluctuations in groundwater levels.

Figure 13 shows the well data for Woodbury Well WY1 for the period January 1990 to August 2000. At this scale, the seasonal fluctuations in the groundwater level are more evident. The water table is typically highest (closer to the surface) during the winter and spring months, and lowest in the summer and fall. This information is useful for watershed modeling to help predict the quantities of water that will be available from the aquifer for future withdrawals.

Figure 13. Ground water levels at USGS groundwater monitoring well (WY1) in Woodbury, January to August, 2000.



Dams, Reservoirs, and Storage Tanks

Dams, reservoirs, and storage tanks were historically constructed in the Pomperaug Watershed to ensure an adequate water supply for customers of the local water companies, as well as to serve industrial and commercial interests. Dams and reservoirs can function together as a storage facility, retaining water during periods of high flow for use during periods of low flow. If stored water is unavailable during peak periods of water use, water company supply wells are forced to pump at accelerated rates in order to meet demands. Stored water enables the water

utilities to save a surplus of water as reserve for peak demand periods. Small dams (or weirs) are also used to divert water into water company well fields. The Watertown Fire District, for instance, uses two weirs to divert water from the Nonnewaug River into its Woodbury well fields, thus ensuring it has an adequate supply of water at the well pumps. The Fire District also releases water from the Bronson-Lockwood Reservoir to augment flows in the Pomperaug River.

Existing reservoirs in the Pomperaug watershed are no longer used to supply drinking water directly. After new drinking water standards were implemented by the CTDEP in 1974, it became more cost-effective for the water companies to use groundwater sources for drinking water supply. Many of the dams previously used to retain surface drinking water or constructed for industrial, commercial, and private purposes remain on the river (including at least one from the colonial era).

Dams alter the natural flow of rivers and streams, affecting riparian habitat along the entire course of the waterway. Dams can decrease natural flow rates, increase water temperatures, lower the dissolved oxygen content, cause sediment buildup, and prevent migrating fish populations from entering spawning grounds. Figure 14 illustrates the locations of the water companies' supply wells, major dams, and the three USGS gauging stations in the watershed.

Water Quality

According to CTDEP Water Quality Standards and Classifications, the surface waters of the Pomperaug Watershed are classified from Class AA to B (Figure 15). These classifications indicate the water is generally of high quality and is suitable for multiple uses. The Pomperaug River is rated class B/A along its entire course until the discharge of the Heritage Village Sewage Treatment Plant in Southbury, where it is rated B. The rating of B/A indicates that it is presently Class B, but that the water quality goal is to achieve Class A status. Class A surface water does not accept waste water

Dams, Water Company Supply Wells, and USGS Gauging Stations in the Pomperaug River Watershed

Water Company Supply Wells

- W Watertown Fire District
- U United Water Connecticut
- H Heritage Water Company

USGS Gauging Stations

- 1 Nonnewaug River Gauge
- 2 Weekeepeemee River Gauge
- 3 Pomperaug River Gauge

Dam

Prepared by the Council of Governments of the Central Naugatuck Valley

Not to Scale

discharges from public or private drinking water treatment systems, dredging and de-watering facilities, and industrial and municipal waste treatment plants. Connecticut water quality classifications for surface waters are summarized in Table 4.

Table 4. Surface water standards for the State of Connecticut, CTDEP, 1997.

Designated Uses	Class AA	Class A	Class B	Class C	Class D
Existing or proposed drinking water supply	X			Class C and D waters can not support one or more of the Class B uses	
Potential drinking water supply		X			
Fish and wildlife use	X	X	X		
Recreational use	X	X	X		
Agricultural and industrial supply	X	X	X		

The classification on the upper reaches of the Pomperaug River is B/A, instead of A due to groundwater contamination sites near the river. These sites are known or suspected water pollution sources. The CTDEP locates areas affected by waste disposal sites, accidental spills or leaks, and other discharges or releases in their Leachate and Wastewater Discharge Sources Inventory (See Figure 15, Appendix 3).

The management of wastewater and the quality of supervision given to its purification and disposal can directly affect water quality. Failing septic systems, whether public or private, can create water quality problems in both surface and ground waters. Sanitary waste disposal statistics for Bethlehem, Southbury, and Woodbury, the three towns that occupy the greatest area in the Pomperaug Watershed and that overlie most of the Pomperaug Aquifer, are provided in Table 5. A Water Pollution Control Plan is currently being developed for the Water Pollution Control Authority of the Town of Southbury. This report, when finalized, will suggest strategies for wastewater management based on current conditions.

Leachate and Wastewater Sites and Surface and Groundwater Quality Classifications of the Pomperaug River Watershed

▲ Leachate and Wastewater Sites

Groundwater Quality Classifications

- GA
- GAA, GAAs
- ⊕ GA, GAA may not meet standards

Surface Water Quality Classifications

AA A B/A B

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Not to Scale

Table 5. Number of housing units in Bethlehem, Southbury, and Woodbury by method of waste disposal, from 1996 Census.

Town	Public Sewer/ Community System	Septic Tank/ Cesspool	Other	Total Housing Units	Percent Public or Community System
Bethlehem	15	1,220	18	1253	1.2%
Southbury	3,024	3,669	133	6,826	44.3%
Woodbury	854	2,508	83	3,445	24.85%

Ground Water Quality

Groundwater, which is the source of drinking water, is rated on a scale of GAA through GC. Generally, the groundwater quality found in local aquifers of the Pomperaug Watershed is classified as GA or ready for consumption without treatment (Figure 15). Connecticut is one of only two states that require its drinking water be obtained either from surface waters that do not receive industrial or municipal treated discharges, or from its high quality class GA and GAA groundwater. Bronson E. Lockwood Reservoir and East Spring Brook, both in Bethlehem, are classified AA. The Lockwood Reservoir has been abandoned as a drinking water source and would need to pass an environmental review process before being reactivated.

There are two distinct types of wells in the watershed, those in bedrock and those in sand and gravel aquifers. Bedrock wells, which are typically located on hills areas, receive groundwater from interconnected fissures in the bedrock. The water production of adjacent wells can vary significantly depending on the size and orientation of the bedrock fissures. Aquifer wells are typically found in the valleys. The water quality of these high production wells is usually excellent, however, due to the high hydraulic conductivity of aquifer materials, any contamination occuring within their recharge areas may reach these wells.

CTDEP Permits

The CTDEP has both individual and general permits for wastewater discharges and inland water resource activities. General permits are statewide permits which allow a particular, while individual permits are granted directly to one applicant on a case-by-case basis. The CTDEP could not provide a complete list of all the registered or permitted discharges in the Pomperaug Watershed. Their records indicate three facilities in the Pomperaug Watershed have individual surface water discharge permits – IBM (83,000 gal./day), Heritage Village Sewer Company (780,000 gal./day), and the Southbury Training School (300,000 gal./day). There are also eleven facilities with groundwater discharge permits or registrations (community septic systems get individual permits). At least two facilities have cooling water discharge permits or registrations: IBM (20,000 gal./day); Heritage Inn (134,000 gal/day), at least eleven have stormwater permits, and at least two have hydrostatic permits. A hydrostatic permit enables the registrant to use water to test the structural integrity of its water system. All of the known registrations or permits were issued in the towns of Woodbury and Southbury.

Those registered or permitted to make discharges of treated water into surface and groundwater are required to perform effluent monitoring. The quarterly, semi-annual, or annual reports are sent to the CTDEP. However, some types of discharges are not reported. For instance, at least one company in Woodbury discharges water used for cooling directly into the ground. The discharges are monitored solely by the company and not reported to any state or federal agency unless its water testing indicates that they are not in compliance with state or federal guidelines. In most other cases, an annual effluent report is required from each permitted or registered facility.

Prior to the interconnection of the Pomperaug Woods treatment facility and Heritage Village, the Heritage Village Sewage Treatment Plant was running at 49% of capacity. This facility has generally met water quality standards, although excesses in phosphorous have been recorded in the last two years (Malcolm Pirnie, 2000). The IBM facility is running at 30% of

its permitted capacity, and the Southbury Training School is running at 109% of permitted capacity.

Point and Non-Point Source Pollution

Groundwater contamination has been discovered in virtually every Connecticut town, affecting the water supplies of over a quarter of a million people (Hust and Murphy, 1997). In general, there are two sources of water contaminants, point and non-point sources. *Point sources* are distinct discharges from a single point, such as a sewage-treatment plant. A leak in an underground oil tank would be another. *Non-point sources* are widespread and often diffuse. The deterioration of stream banks over the length of a river, allowing silt and sediment to accumulate in the water, is an example of non-point source pollution. Other examples are the discharges from numerous septic systems, runoff from large impervious areas, and the use of pesticides in farming and on residential lawns. Non-point sources are sometimes numerous small point sources grouped together.

There are many ways in which ground and surface water can become contaminated. Industrial facilities, gasoline stations, and landfills, for example, can leak chemicals into the soil and infiltrate into the groundwater. Cleaning products used in homes may contain water-soluble chemicals that make their way through septic systems into groundwater. Fertilizers, herbicides, pesticides (used on lawns and agricultural fields), leaky sewer lines, dry cleaners, and automobile garages are all potential sources of groundwater contamination.

Many contaminants are oxidized in the upper layer of the soil and released to the air or biodegraded. When this does not occur, they will slowly move deeper into the soil. Once contaminants have reached the saturated zone below the water table, the possibility of oxidation is reduced, and the contaminants are trapped, left to flow into the groundwater. These contaminants can form a "plume" reaching from the point of the pollution and extending with the flow of water. Depending on the location and the amount of contaminants, plumes can range in size from a few feet to several miles.

It is often difficult to determine how a contaminant will travel in groundwater. Some contaminants travel more readily through the groundwater than others. Furthermore, the chemical reactions that may occur underground, which can affect the speed of the chemical's dispersion and its level of harmfulness, often are unpredictable. The density of the chemical may determine how quickly it penetrates to the lowest levels of the aquifer where it can remain for decades.

Common Contaminants: Nitrogen and Phosphorus

Moderate levels of nitrogen and phosphorus are a major source of pollution in water bodies throughout New England. These nutrients are found in fertilizers used on residential lawns and agricultural fields, as well as in certain types of municipal and septic discharges. An overabundance of these nutrients in lakes and streams causes algae blooms, such as those that have occurred in Lake Zoar, Lake Lillinonah, and Sprain Brook. Lake Zoar currently appears on the CTDEP list of Eutrophic Lakes due to, among other things, high levels of these nutrients. Eutrophic lakes may have Class B waters or above, but are nutrient rich and experience frequent algae blooms and accelerated growth of other aquatic plants. Aquatic vegetation can become dense, clogging waterways and impeding the growth of other species, and interfere with recreational activities such as boating and swimming. Furthermore, when the algae and aquatic vegetation decays, the water becomes depleted of oxygen or anoxic, which may suffocate other aquatic organisms.

The CTDEP, the USDA NRCS (Natural Resources Conservation Service), and the UCONN Cooperative Extension Service have all been working with farmers in the watershed to institute Best Management Practices (BMPs) to prevent nutrient runoff into surface and groundwater bodies.

Water Contamination in Woodbury

Groundwater testing has been performed consistently by the town of Woodbury since 1979, when traces of a degreasing chemical 1,1,1, trichloroethane was found in United Water

Company's Well #2 in amounts exceeding Connecticut's water quality standards. Subsequent tests also found chloroform, trichloroethylene, and tetrachloroethylene in the water. The point source for the contamination has never been identified, but the tests did suggest that the source was most likely located in Woodbury's Middle Quarter Mall (Marin, 1991). In 1980 United Water installed a carbon filter to purify the water pumped from their Well #2. Testing has shown that the concentration of trichloroethane has dropped, but the water from this well is still unsuitable for drinking without treatment.

Another known contamination site in Woodbury is in the Woodbury Center Plaza, where dry cleaning chemicals were improperly disposed of in the 1970's. Both the contaminants released near the Middle Quarter Mall and those spilled in the Center Plaza are DNAPL's (dense, non-aqueous phase liquids). These contaminants have a specific gravity greater than one, causing them to sink in water. Thus, they are able to penetrate into the deepest parts of the aquifer, even into cracks in the bedrock beneath the aquifer, and can be impossible to remove. The groundwater near the Middle Quarter Mall has been tracked to move at speeds of 1.1 to 4.3 feet per day (Leggette, Brashears & Graham, 1990). This is quick movement for groundwater and would assist the transport of any contaminants.

A third significant contamination event involves the introduction of Methyl Tertiary Butyl Ether (MTBE) into the aquifer at the Shell Station and neighboring properties on Route 6 in north Woodbury. MTBE is a gasoline additive used in reformulated gasoline in order to reduce the amount of pollutants released in car emissions and to increase octane rating. In Woodbury and throughout the nation, MTBE has become an increasing source of groundwater contamination. Fifteen percent of drinking water wells in New England have trace amounts of MTBE (CTDEP Website, 2000). In Connecticut, according to the CTDEP, several hundred private wells and four public wells are known to be contaminated by MTBE, while trace levels have been found in 30% of drinking water wells (CTDEP Website, 2000). Not only does MTBE make the water taste and smell undrinkable, but it is also a possible human carcinogen.

MTBE is highly soluble, meaning it travels rapidly through water. Remediation efforts

are presently underway in Woodbury to attempt removal of the MTBE from the aquifer. The EPA, the CTDEP, and the Northeast States for Coordinated Air Use Management (NESCAUM) have all recommended restricting, and perhaps eliminating, the use of MTBE in reformulated gas.

In September 2000, Hydro Technologies, Inc. of New Milford, CT, prepared a water quality report summarizing surface water quality data collected in Woodbury from 1993 to 2000. The following parameters were measured during the surveys: temperature, total phosphorus, ammonia, total nitrogen (TKN), nitrate, sodium, pH, total dissolved solids (TDS), turbidity, color, fecal coliform bacteria, enterococcus bacteria, and E-coli. The average value for each parameter for the entire sample period is listed for the six sampling locations in Table 6.

Table 6. Average value for water quality parameters measured between 1993 and 2000 at six sample sites in Woodbury, CT. Samples were collected and analyzed by Hydro Technologies of New Milford, CT.

SITE	Temp (•C)	Total Phos. (Mg/l)	Ammonia (Mg/l)	TKN (Mg/l)	Nitrate (Mg/l)	Sodium (Mg/l)	PH	TDS (Mg/l)	Turbidity (NTU)	Color (CU)	Fecal Coliform (Cfu/100 mls)	Entero-coccus (Cfu/100 mls)	E-Coli (Cfu/100 mls)
Pomperaug	18.4	0.14	0.06	1.8	0.12	9.8	7.3	65	0.55	23	181	37	112
Nonnewaug	16.3	0.15	0.05	1.3	0	11	7.2	70	0.36	10	217	151	116
Weekeepeemee	15.7	0.18	0.03	1.2	0	7	7.4	50	0.28	5	238	68	32
Landfill Brook	14.9	0.12	0.15	1.2	0.24	14.8	7.1	136	3.63	40	189	178	118
Town Drain	13.7	0.2	0.10	1.7	3.4	16.6	7.7	141	0.3	1	1141	1175	9
Woodlake	24.4	0.15	0.13	1.8	0	13.5	7.1	84	1.77	33	439	9	3

Fecal coliform and *enterococcus bacteria* tests are used to determine the sanitary and swimming quality of a water body. In waters classified A or B by the CTDEP standards, enterococcus is not to exceed an average of 33 organisms per 100 ml and a single sample should not exceed 61 organisms per 100 ml. Fecal coliform bacteria should not exceed an average of 200 organisms per 100 ml, nor should 10% of all samples exceed 400 organisms per 100 ml. All six sites exceeded state minimums for one or both of these bacteria. In accordance with water

quality standards, field studies should be completed by the CTDEP to identify the source of these organisms.

In class B waters, there should be no visible discoloration of the water outside of any designated zone of influence, nor should the waters be unusually congested with sediment. Color and the amount of sediment in a water body (*turbidity*) can be related. Color is measured in color units (CU). A rating of less then 5 CU is considered clear water. Clear water does not necessarily signify healthy water, nor does colored watered necessarily signify unhealthy water, but color can be an indicator of water quality, especially if the color changes markedly over time. Turbidity is the measure of suspended sediment present in a water body. Though rivers and streams can be naturally turbid, high turbidity readings can indicate such things as increased erosion. Connecticut water quality guidelines state that a water body should not be 5 NTU over its natural level.

The acidity or alkalinity of a water body is measured on the pH scale. The scale runs from 1 to 14. A rating of 7 is considered neutral. Ratings below 7 indicate acidic water and ratings above 7 indicate alkaline conditions. A healthy pH range for freshwater fish species is between 6.5 and 9. All of the sites monitored were within the pH and temperature ranges suitable for freshwater fish habitat.

The water quality in Woodbury is generally good, although some sites of concern were noted by Hydro Technologies, Inc. These are the Landfill Brook, Woodlake, and the Town Drain sites (Main Street Storm Drain). The town drain, which for years met drinking water standards, now has high concentrations of fecal coliform, enterococcus, dissolved solids, and sodium (salt).

Transylvania Brook, Southbury

The treatment facility at the Southbury Training School (Connecticut Department of Mental Retardation), which discharges treated wastewater into Transylvania Brook, has been operating at 109% of its permitted capacity. One result has been a deterioration of the water

quality in the receiving waterbody. While the headwaters of the Transylvania Brook are rated Class A, its rating lowers to Class B after the school's discharge. A preliminary look at the fish species upstream and downstream of the facility noted more pollutant tolerant species downstream of the facility than upstream. Further study is needed to verify these results and to determine the relationship, if any, between the Training's School discharges and local fish species. In 1998, Transylvania Brook was listed on *Connecticut Waterbodies Not Meeting Water Quality Standards* due to the quantities of copper, zinc, ammonia, and chlorine.

Under guidelines established by the Federal Clean Water Act, all surface water bodies that do not meet minimum water quality standards must be studied to determine the Total Maximum Daily Load (TMDL) allowed. This study is currently being conducted on Transylvania Brook. The Southbury Training School will then complete the necessary alterations to its treatment system in order to be in compliance with the findings of the TMDL study. All modifications to the treatment system are expected to be completed by 2003.

The local community has taken an active interest in the brook in order to preserve and protect it. Trout Unlimited and other interested citizens are considering projects to stabilize stream banks, install in-stream habitat structures for the fish species, and increase the riparian buffer zones.

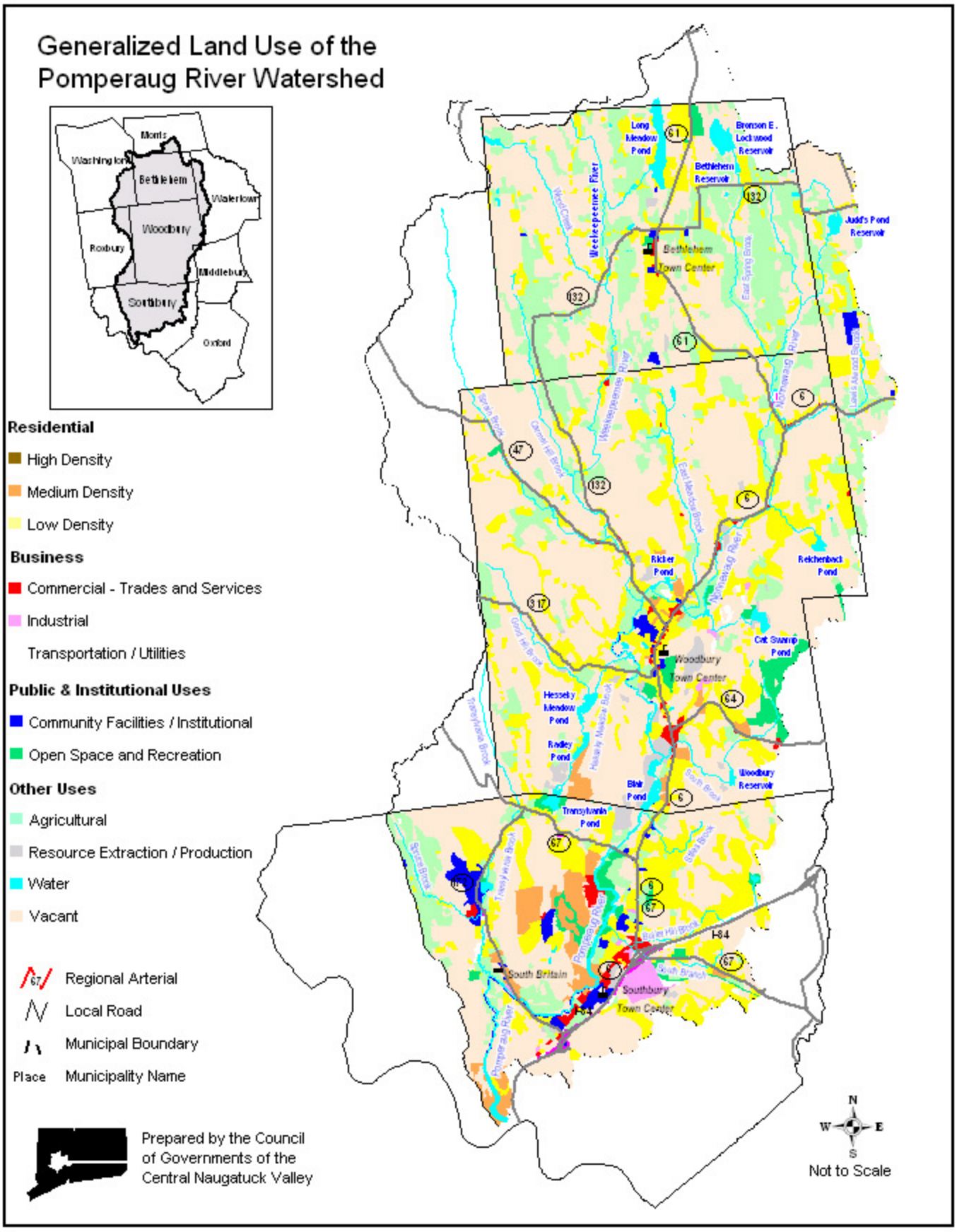
LAND USE

Land use and zoning regulations effect the appearance and patterns of development within a community, as well as the quantity and quality of remaining natural resources. The regulatory responsibilities for managing the watershed resources are divided among town, state and federal agencies. Town agencies include planning and zoning and inland wetland boards, water pollution control authorities and local public health districts. The state agencies include the Connecticut Department of Environmental Protection, the Connecticut Department of Public Health, the Department of Public Utility Control and the Connecticut Department of Agriculture.

Local plans of development and conservation, as well as zoning, subdivision, and inland wetlands regulations, determine the density and type of development that can occur within the watershed. These regulations and land use plans can also help protect the quality of the region's ground and surface waters. The local wetland permitting process can require BMPs such as vegetated buffers which prevent many non-point source pollutants, such as road runoff, from entering valuable surface waters. Aquifer Protection Zones established in Southbury and Woodbury regulate activities above an aquifer to reduce the potential impacts to water resources. Instituting protection for riparian borders (the vegetation on either side of a body of water) in a watershed minimizes the amount of non-point source pollution that will reach a waterway and helps preserve fish and wildlife habitat. All of the three major watershed towns have erosion and sediment control regulations, which serve to minimize erosion at construction sites. The Town of Bethlehem currently does not have zoning regulations, though it does have some building guidelines in its subdivision regulations. Under its subdivision regulations, Bethlehem can require that a percentage of a subdivision (not less that 15%) remain open space.

Residential development is the most prevalent land use in the Pomperaug Watershed (Figure 16). The town centers, as in colonial times, are the focal points for most commercial and industrial activities. The land use and zoning regulations in the towns of Bethlehem, Southbury, and Woodbury, which compose 83% of the watershed, have the most direct effect on the quality of water. Land use patterns have changed significantly in Bethlehem, Southbury and Woodbury over the last several decades. Residential, commercial, and industrial land uses increased in all three towns between 1975-1990. Agricultural land use has decreased in Southbury and Woodbury, while Bethlehem has seen a rise in the number of acres devoted to agricultural use. Quarrying of the local glacial deposits, especially in the towns of Woodbury and Southbury, is another type of land use. In October of 2000, six earth material permits were in existence in Woodbury, and two gravel quarry permits existed in Southbury.

Figure 16


Generalized Land Use of the Pomperaug River Watershed
Morris
Washington
Bethlehem
Watertown
Woodbury
Roxbury
Middlebury
Southbury
Oxford
Residential
High Density
Medium Density
Low Density
Business
Commercial - Trades and Services
Industrial
Transportation / Utilities
Public & Institutional Uses
Community Facilities / Institutional
Open Space and Recreation
Other Uses
Agricultural
Resource Extraction / Production
Water
Vacant
Regional Arterial
Local Road
Municipal Boundary
Place Municipality Name
Prepared by the Council of Governments of the Central Naugatuck Valley
Long Meadow Pond
Bronson E. Lockwood Reservoir
Bethlehem Reservoir
Judd's Pond Reservoir
Bethlehem Town Center
Weekeepeemee River
Pomperaug River
Ricker Pond
Reichenbach Pond
Cat Swamp Pond
Woodbury Town Center
Hessely Meadow Pond
Radley Pond
Blair Pond
Woodbury Reservoir
Transylvania Pond
South Britain
Southbury Town Center
I-84
N
W
E
S
Not to Scale

Open Space

According to the land use surveys, open space in the three towns decreased between 1975 and 1990. As town populations increase, setting aside parcels of land as protected open space is critical to maintaining the rural character of a community, protecting natural resources and biodiversity, and providing recreational opportunities for the public. Even if a town is not excessively developed, only a fraction of its land may actually be classified as open space. *Public open space* is defined as land owned by the local, state, or federal government, which can be used for recreational purposes by the public. Such land may be partially developed, such as school properties, and may be subject to future development. In 1993, only 2% of Bethlehem and Woodbury and 4% of Southbury were designated as public open space.

Protected open space is land that has been set aside specifically to prevent future development from occurring on its premises. Protected open space can be owned as a public resource by the town, as a wildlife refuge by an environmental organization such as The Nature Conservancy or Audubon Society, or privately by a land trust. According to the Southbury Open Space Steering Committee, less than 10% of Southbury was protected open space in 1998. However, there have been significant open space acquisitions within the watershed since that time. Protecting open space from development, through conservation easement, purchase, or other method, is necessary in order to protect the quantity and quality of local water resources and preserve wildlife habitat. Moreover, preserving open space is less costly to taxpayers than residential development, which requires increased expenditures for schools, roads, fire and police, etc. If open space is set aside early in a town's development, it is easier to preserve greenways and wildlife corridors necessary for species migration, and connect existing open space parcels in an ecologically sensible fashion.

The primary function of land trusts is to acquire and protect open space. While these parcels are privately owned by the land trust, they are typically open to the public for hiking and other forms of passive recreation. The Southbury Land Trust, the Bethlehem Land Trust, and

Flanders Nature Center (Woodbury) are currently working with their towns to preserve open space; as does the Bent of the River Audubon Center in Southbury. The National Audubon Society is the largest single landowner along the Pomperaug River.

HABITAT

The Pomperaug River watershed provides habitat for a variety of birds, mammals and other wildlife. There are also a number of increasingly rare plants that occur within the rivers floodplain. Historically, the Pomperaug River was renowned for its trout populations and excellent fly-fishing. Protecting the local water resource is important for maintaining critical habitat for these species as well as protecting our primary source of drinking water.

According to the CTDEP website, the Natural Diversity Data Base (NDDB) is the central repository for information on the biology, population status and threats to the elements of natural diversity in the state of Connecticut. Information from biologic inventories of the state's species and habitats, conducted over the past ninety years by the Connecticut Geological and Natural History Survey, has been incorporated into the Natural Diversity Data Base. The Database currently contains information on the status of more than 1000 species of plant and animals, including invertebrates, and 45 significant natural communities, which includes the Endangered, Threatened or Special Concern species listed in Connecticut.

According to the NDDB map (Figure 17), there are numerous species that are listed as *Endangered, Threatened*, or *Of Special Concern* within the watershed. Although the general location of these plants and animals is noted on the map, the specific location and species name is omitted to prevent illegal collecting or destruction. At the Bent of the River National Audubon Center in South Britain section of Southbury, several listed species were recorded during on-going field research projects, including Bald Eagles, Eastern Box and Wood Turtles, Red Bats, and Red-shouldered Hawks. In all, 159 birds, 49 species of butterfly, 26 amphibians and reptiles, 29 species of mammal (including black bears and bobcats), and 22 species of fish have been recorded on the preserve. Three

Connecticut Endangered, Threatened, and Species of Special Concern in the Pomperaug River Watershed

Generated Areas of Endangered, Threatened, or Special Concern Species

Prepared by the Council of Governments of the Central Naugatuck Valley

Data Source: Connecticut Department of Environmental Protection, 1999

Not to Scale

of these are *Endangered*, two are *Threatened*, and fifteen are *Of Special Concern* in the state of Connecticut.

CONCLUSION

This report is an assessment of current conditions in the Pomperaug River watershed - a first step at quantifying the watershed's development and health. This information will be continually revised based on scientific studies in the watershed and input from The Pomperaug River Watershed Coalition, state and federal agencies, and the public.

All of the information and data in this report is available at the office of The Pomperaug River Watershed Coalition. For a list of this reference material and for contact information visit the Coalition's website at www.pomperaug.org.

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APPENDICES

APPENDIX 1 - Population Change In The Watershed and Oxford Connecticut.

Table One - Population Change in the Towns of the Pomperaug River Watershed and Oxford, Connecticut. From the Connecticut Office of Policy and Management, 1995.

Table Two - Percent Change in Population in the Towns of the Pomperaug River Watershed and Oxford, Connecticut. From the Connecticut Office of Policy and Management, 1995.

APPENDIX 2 - Registered and Permitted Diversions in the Watershed.

Pages 1-3: Water Diversion Permit Information from the Connecticut Department of Environmental Protection. This list may include errors and omissions, and some of the diversion quantities and locations are known to be inaccurate.

Pages 4-6: Diversion Registrations from the Connecticut Department of Environmental Protection. This list may include errors and omissions.

APPENDIX 3 - Leachate and Wastewater Discharge Sources Inventory.

From the Connecticut Department of Environmental Protection Leachate and Wastewater Discharges Sources Inventory. This list does not necessarily include all leachate and wastewater discharge sources.

Permit Applications For Water Diversions POMPERAUG RIVER 6800

DIV-88-01

Permit Holder LName: J. M. SCOTT ASSOCIATES, INC
Permit Holder FName:
Receipt Date: 01/06/1988 Applicant Name: J. M. SCOTT ASSOCIATES, INC
Status: PERMIT ISSUED App First Name:

Consumptive?: No
Permitted Withdrawal: 0.0000 Mgd
Number of Diversions: 1

SOUTH BROOK DIVERSION SOUTH BROOK

Location -Town: WOODBURY Basin: 6800
Expiration Date:

Authorized / Requested Activity

Diversion of South Brook in the Town of Woodbury back to its original channel." The authorized activity consists of replacing an existing undersized culvert with a twin 10' X 6" X 32' box culvert and redirecting the flow of South Brook into the new culvert." NO EXPIRATION DATE

DIV-86-25

Permit Holder LName: TRIANGULUM ASSOC
Permit Holder FName:
Receipt Date: 07/09/1986 Applicant Name: TRIANGULUM ASSOC
Status: PERMIT ISSUED App First Name:

Consumptive?: Yes
Permitted Withdrawal: 0.2230 Mgd
Number of Diversions: 1

HEATING & COOLING WELL GROUNDWATER

Location -Town: SOUTHBURY Basin: 6800
Expiration Date: Saturday, November 30, 1991

Authorized / Requested Activity

Diversion of groundwater for use in a heat pump system to supply the heating and cooling need of the Harrison Inn and Conference Center facility in the Town of Southbury, Connecticut." The authorized activity consists of withdrawing a maximum of 0.000223 million gallons of groundwater per day from a single well.

DIV-91-23

Permit Holder LName: HERITAGE INN
Permit Holder FName:
Receipt Date: 07/31/1991 Applicant Name: TRIANGULUM ASSOCIATES
Status: PERMIT ISSUED App First Name:

Consumptive?: No
Permitted Withdrawal: 0.3770 Mgd
Number of Diversions: 1

WELL #HI-1 GROUNDWATER

Location -Town: SOUTHBURY Basin: 6800
Expiration Date: Monday, December 24, 2007

Authorized / Requested Activity

Withdraw 0.28 mgd from well #HI-1; water supply for heating and cooling system at Heritage Inn

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DIV-88-15

Permit Holder LName: VASZAUSKAS
Permit Holder FName: RANDY
Receipt Date: 03/08/1988
Applicant Name: VASZAUSKAS
Status: PERMIT ISSUED
App First Name: RANDY

Consumptive?: Yes
Permitted Withdrawal: 0.0000 Mgd
Number of Diversions: 1

EXISTING POND DIVERSION
TRIBUTARY TO POMPERAUG RIVER
Location -Town: SOUTHBURY
Basin: 6800
Expiration Date:

Authorized / Requested Activity

Diversion of groundwater by excavating a four-acre pond at a location north of Crook Horn Road approximately 1000 feet west of the intersection of Crook Horn Road with Old Field Road in the Town of Southbury." The authorized activity consists of enlarging an existing one-acre dug pond by excavation to create a four-acre pond. The pond will still be used to supply irrigation water for agricultural purposes." NO EXPIRATION DATE

DIV-88-29

Permit Holder LName: WHITING-TURNER CONTRACTING COMPANY, INC.
Permit Holder FName:
Receipt Date: 06/10/1988
Applicant Name: WHITING-TURNER CONTRACTING COMPANY, INC.
Status: PERMIT ISSUED
App First Name:

Consumptive?: No
Permitted Withdrawal: 0.0000 Mgd
Number of Diversions: 1

SOUTH BRANCH BULLET HILL BROOK DIVERSION
SOUTH BRANCH BULLET HILL BROOK
Location -Town: SOUTHBURY
Basin: 6800
Expiration Date:

Authorized / Requested Activity

Diversion of the South Branch of Bullet Hill Brook located easterly of Route 67 in the Town of Southbury at the interstate Route 84 interchange." The diversion consists of stream channelization work which widened the channel bottom and lined the sides and bottom with rip rap and grouting, for purpose of erosion and flood control." The authorized activity is to maintain the existing diversion on the South Branch of Bullet Hill Brook which channelized approximately 500 feet of watercourse and lined the bottom and sides with rip rap and grouting." NO EXPIRATION DATE

DIV-87-05

Permit Holder LName: PROFESSIONAL PROPERTIES, INC

Permit Holder FName:

Receipt Date: 02/06/1987

Applicant Name: PROFESSIONAL PROPERTIES, INC

Status: PERMIT ISSUED

App First Name:

Consumptive?: No

Permitted Withdrawal: 0.0000 Mgd

Number of Diversions: 1

UNNAMED TRIBUTARY TRANSYLVANIA BROOK DIV

UNNAMED TRIBUTARY TRANSYLVANIA BRK

Location -Town: SOUTHBURY

Basin: 6806

Expiration Date:

Authorized / Requested Activity

Diversion of the waters of an unnamed tributary to Transylvania Brook." The authorized activity consists of constructing a storm water detention basin and berm to detain increased runoff generated from the expansion of Pierce Colonial Acres subdivision located directly east of Connecticut Rt. 172 one quarter mile south of its intersection with Rt. 67 in the Town of Southbury." The total disturbed land for the detention basin will be approximately 0.6 acres. Additionally, a stream flow control structure incorporating an inlet to the detention basin will be conducted." NO EXPIRATION DATE

DIVERSION REGISTRATIONS IN: POMPERAUG RIVER 6800

Registrant	Name of diversion	Registration #	Town	Registered Max Withdrawal Capacities Individual(MGD)	System(mgd)
BERRY FARM THE	POMPERAUG AT CROOK HORN FARM	6800-008-AGR-RI	WOODBURY	2.0000	
BERRY FARM THE	POMPERAUG RIVER AT BRINLY	6800-009-AGR-RI	WOODBURY	2.3000	
BERRY FARM THE	WIND SHIP POND	6800-010-AGR-IM	WOODBURY	3.3000	
BERRY FARM THE	CROOK HORN FARM IRR POND #1	6800-007-AGR-IM	WOODBURY	2.0000	
GENERAL WATER WORKS WOODBURY WATER COMPANY	WOODBURY WELL #2	6800-012-PWS-GR	WOODBURY	0.2160	
HERITAGE VILLAGE WATER COMPANY *	HV #2	6800-002-PWS-GR	SOUTHBURY	0.3888	
HERITAGE VILLAGE WATER COMPANY *	WELL FIELD HV #1-#5	6800-006-PWS-GR	SOUTHBURY	2.0520	2.0520
HERITAGE VILLAGE WATER COMPANY *	HV #5 (M #2)	6800-005-PWS-GR	SOUTHBURY	0.3240	
HERITAGE VILLAGE WATER COMPANY *	HV #3	6800-003-PWS-GR	SOUTHBURY	0.5040	
HERITAGE VILLAGE WATER COMPANY *	HV #1	6800-001-PWS-GR	SOUTHBURY	0.3312	
HERITAGE VILLAGE WATER COMPANY *	HV #4 (M #1)	6800-004-PWS-GR	SOUTHBURY	0.5040	
SOUTHBURY TOWN OF	PLAT PARK POND DAM ELEV=360'	6800-011-REC-IM	SOUTHBURY	0.0000	
WATERTOWN FIRE DIST WATER DEPT *	BETHLEHEM RESERVOIR	6801-001-PWS-IM	BETHLEHEM	0.8700	
WATERTOWN FIRE DIST WATER DEPT *	BRONSON LOCKWOOD RES	6801-002-PWS-IM	BETHLEHEM	0.8700	

DIVERSION REGISTRATIONS IN: NONEWAUG RIVER 6802

Registrant	Name of diversion	Registration #	Town	Registered Max Withdrawal Capacities Individual(MGD)	System(mgd)
GENERAL WATER WORKS WOODBURY WATER COMPANY	WOODBURY WELL #1	6802-013-PWS-GR	WOODBURY	0.1440	
MCDOUGALL DUNCAN	MCDOUGALL FARM POND	6802-001-AGR-IM	WOODBURY		
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 8	6802-009-PWS-GR	WOODBURY	0.1756	1.7300
WATERTOWN FIRE DIST WATER DEPT *	NONEWAUG R AT HART FARM	6802-012-PWS-RI	BETHLEHEM	0.4000	
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 9	6802-010-PWS-GR	WOODBURY	1.0080	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 7	6802-008-PWS-GR	WOODBURY	0.1670	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 6	6802-007-PWS-GR	WOODBURY	0.3960	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 5	6802-006-PWS-GR	WOODBURY	0.1870	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 4	6802-005-PWS-GR	WOODBURY	0.3096	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 3	6802-004-PWS-GR	WOODBURY	0.2736	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 2	6802-003-PWS-GR	WOODBURY	0.1940	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL # 1	6802-002-PWS-GR	WOODBURY	0.1150	1.7300
WATERTOWN FIRE DIST WATER DEPT *	HART FARM WELL FIELD 1-9	6802-011-PWS-GR	WOODBURY	1.7300	1.7300

DIVERSION REGISTRATIONS IN: HESSEKY BROOK 6805

Registrant	Name of diversion	Registration #	Town	Registered Max Withdrawal Capacities Individual(MGD)	System(mgd)
SOUTHBURY TOWN OF	TRANSYLVANIA POND	6805-001-REC-IM	SOUTHBURY	0.0000	
WOODLAKE WATER CO *	WOODLAKE WELL #3	6805-004-PWS-GR	WOODBURY	0.1037	
WOODLAKE WATER CO *	WOODLAKE WELL #1	6805-002-PWS-GR	WOODBURY	0.1800	
WOODLAKE WATER CO *	WOODLAKE WELL #2 (INACTIVE)	6805-003-PWS-GR	WOODBURY	0.0000	
CONNECTICUT DEPT OF MENTAL RETARDATION SOUTHBURY TRAINING SCHOOL	SOUTHBURY TRAINING SCHOOL WELL #3	6806-003-PWS-GR	SOUTHBURY	0.3600	
CONNECTICUT DEPT OF MENTAL RETARDATION SOUTHBURY TRAINING SCHOOL	SOUTHBURY TRAINING SCHOOL WELL #2	6806-002-PWS-GR	SOUTHBURY	0.2880	
CONNECTICUT DEPT OF MENTAL RETARDATION SOUTHBURY TRAINING SCHOOL	SOUTHBURY TRAINING SCHOOL WELL #1	6806-001-PWS-GR	SOUTHBURY	0.1440	