of proposed and registered diversions on the particular water resource under consideration, resulting in lengthy delays as staff and the applicant attempt to gather such information. Second, the Department's diversion program has never been adequately staffed. Therefore, the Department seeks both the legislative authority to gather necessary data and support for the staffing required to more expeditiously process permit applications.

This report contains recommendations to move the State toward adoption of a comprehensive water allocation policy. Developing such a policy will require legislative changes as well as major planning efforts among the Department, other state agencies and additional stakeholders including the water utility industry, agriculture industry and environmental groups.

The Department has drafted proposed legislation to establish a Water Policy Task Force. This legislation will require the Commissioner to convene a task force consisting of interested parties and stakeholders to evaluate this report and develop legislative proposals to implement its recommendations and to assist in the development of a scientifically sound and predictable water allocation process.

II. CONNECTICUT'S WATER RESOURCES AND WATER USES

A "water allocation methodology" is a means of dividing up available water among multiple users. Such a methodology balances the competing needs for water among all the users. Although Connecticut *as a whole* has sufficient water to meet drinking water needs, environmental requirements, and the demands of other water users, the water is not always available *where* or *when* it is needed. To help determine how water can be provided when and where it is needed, one must understand Connecticut's water resources.

Stony Brook Reservoir, Montville, CT

A. Connecticut's Water Resources

Connecticut enjoys relatively abundant water resources. The state has approximately 5,800 miles of rivers and streams, virtually all of which eventually discharge to Long Island Sound. There are more than 2,300 lakes, ponds and reservoirs, and roughly 15% of the land surface is either inland or tidal wetlands. Ground water is present everywhere in the state, generally at depths of less than 20 feet from the land surface.

The ground water and surface water systems in Connecticut are hydraulically connected. In general, the direction of ground water flow and the location of ground water divides tend to mimic surface topography, coinciding with surface water drainage divides. Ground water generally recharges surface water, providing the baseflow for streams. However, the surface water system can recharge ground water, particularly following extended periods of precipitation or when wells adjacent to a stream are pumped. When large production wells pump steadily for extended periods, the water produced by those wells is water induced directly from the surface water system, and groundwater that would normally recharge nearby surface waters.

The amount of water available for use in ground and surface water systems at any given time is a complex function of numerous factors including but not limited to: precipitation, evaporation from the surface of water bodies, transpiration by plants, runoff across the land surface, and how much water is being withdrawn by existing water users. Connecticut's average annual precipitation is approximately 47 inches, and is fairly evenly distributed throughout the year. Approximately 50% of the annual precipitation is returned to the atmosphere through evaporation and transpiration (collectively called evapotranspiration), 30% runs off into surface water bodies (streams and lakes), and 20% enters the ground water system. Water entering the ground water system moves slowly through the ground, eventually discharging to a surface water body.

The relative percentages of evapotranspiration, runoff, and recharge to ground water vary seasonally over the course of a year. During the growing season, essentially April through September, evapotranspiration rates are high, and much of the precipitation that falls during this period is lost through evapotranspiration or flows to streams as overland runoff. Consequently, precipitation that falls during this period is generally unavailable for recharging ground water due to its uptake in the root zone of plants, and ground water levels decline. When ground water levels drop, the discharge of ground water that provides baseflow to streams also drops, resulting in decreased streamflow. Minimum ground water levels and streamflows are generally observed in late summer and early fall, toward the end of the growing season. During the winter and early spring months, when evapotranspiration is low, more precipitation generally recharges the ground water system, ground water levels rise, and the resulting baseflow discharged to streams is greater. Overall, more water is available in the ground water and surface water resource for use during the winter than during the summer months.

Man's activities also have a direct impact on ground water levels and streamflow. Intensive development results in an increase in impervious surfaces (rooftops and pavement). Impervious surfaces prevent precipitation from soaking into the ground, instead shunting the water into storm drainage systems which often discharge directly to surface water bodies. This causes rapid increases in streamflow (and possible flooding) during precipitation events, and subsequent rapid declines in streamflow once the precipitation event is over. In addition,

Tractor-mounted pump with pipeline to the river, used for an agricultural diversion, Quinnipiac River

withdrawals of water from the surface or ground water systems for uses such as public water supply, evaporative cooling and irrigation, directly reduce ground water levels and streamflow and possibly change hydrology in adjacent wetlands and watercourses. Such impacts can severely reduce aquatic habitat, and may affect instream water quality to the detriment of these resources' ability to support aquatic life. In general, ground water withdrawals along urbanized streams have an additive effect on those resources, further accelerating the periods of extreme low flow. As witnessed during the summer drought of 1999, the combined effects of these various factors which effect streamflow in Connecticut may not be obvious until a drought occurs.

There are also two basic types of watersheds - *regulated* and *unregulated*. Regulated watersheds are watersheds in which stream flows are largely determined by amounts of water released from upstream impoundments. In unregulated watersheds, stream flows are not determined by flow releases from upstream impoundments; rather stream flows in such watersheds are the result of climatic conditions.

B. Water Uses in Connecticut

There are essentially two broad categories of water use: *non-consumptive* and *consumptive*. Non-consumptive (instream) use takes place within a water body such as a lake, river or stream for the purpose of navigation, recreation, construction-related activities, waste assimilation (e.g., assimilation of treated wastewater discharges), fish and wildlife habitats, and flood storage.

Consumptive (out-of-stream) uses involve the withdrawal (or diversion) of water from a ground water or surface water source for human domestic uses (i.e., drinking, cooking, and sanitation), irrigation for agriculture, lawns and golf courses, evaporative cooling, and industrial processes. These uses are consumptive in nature, although a portion of water withdrawn may be returned to a water body located near—though in some cases far away from—the point of withdrawal.

There are 151 public water supply reservoirs and roughly 6,600 public water supply wells in Connecticut. Reservoirs provide the majority of public water, serving an estimated 70% of the population. Public water supply wells serve an estimated 14% of the people. The remaining 16% of Connecticut residents use an estimated 250,000 privately owned wells for their water supply.

It is important to note that "public water supplies" not only provide potable drinking water, but also provide water for other non-potable needs. The United States Geological Survey[3] estimates that 49% of water distributed by public water suppliers is used for domestic purposes with the remaining 51% used for either other customer needs such as industrial processes, commercial and industrial cooling, and landscape irrigation, or lost through water leakage from water supply distribution systems.

Other large water use diversions include: fossil or nuclear fuel power plants and other industrial "once through" water cooling systems (water returns to the resource from which it is withdrawn); fossil fuel power plants with evaporative cooling systems (several proposals under review); and irrigation systems associated with agriculture, large lawns and golf courses. The least amount of water use information is available on irrigation water use.

3 United States Department of the Interior, U.S. Geological Survey, Fact Sheet FS-043-98, May, 1998.

C. Competing Uses for Finite Supply

Despite the relative abundance of water resources in Connecticut, there is not always enough water supply to meet the demands of the public in certain areas, particularly during the summer months. For example, during the summer of 1999 some water companies were forced to implement strict conservation measures while others had more than enough reserves. There are a number of factors contributing to this situation, the most important of which are the following:

(1) Seasonal variation in water availability: As previously discussed, both streamflow and ground water levels vary seasonally, and typically are highest during the spring and lowest during the late summer and early fall. Streamflow and ground water levels are a function of recent climatic conditions, and thus the amount of water available for instream and out-of-stream uses also varies with climatic conditions. Unfortunately, a user's need for water may be relatively constant throughout the year (such as the need for industrial processing water), or may be greatest during the time of year when available water is lowest (such as the need for irrigation water). Most water users have limited ability to vary their water needs in response to the amount of water naturally available.

(2) Growth and shifting demand: Connecticut continues to grow and change, and its economic expansion naturally results in changes in *how much* water is needed and *where* it is needed. Residential, commercial, industrial and agricultural development have had significant effects on our naturally occurring surface and ground waters as evidenced by stream flow depletion concerns raised in the Department's 1998 report, "List of Impaired Waterbodies." While population projections prepared by the Office of Policy and Management (draft version 91.2, prepared for public water supply planning purposes) indicate that statewide population growth over the next forty years is not likely to be significant, people continue to leave the cities and move to suburban and rural areas, thereby creating new or additional demands for public drinking water in areas traditionally served by private residential wells.

Mattabessett River, Berlin, CT. Compare streamflows in the summer (above) and winter (below) along the same stretch of the river. Note the bent tree trunk on the right bank of the river, visible in both photographs, for scale and comparison of the width, and the rocks in the streambed for comparison of depth of the river.

In sum, many users with diverse needs are presently competing for an increasingly limited amount of water. Given the extent of existing registrations, some basins simply have no water available for additional diversions. In view of increasing demands, localized water quality problems and periodic water shortages, it is more important than ever to ensure wise and efficient management of our water resources. Economic and social prosperity and the overall quality of life here in Connecticut depend on strengthening our ability to balance the need for water with the capacity and quality of our resources. It is critical that the state plan for efficient future use by assessing past and present supply and demand.

D. Environmental Conditions

The short supply of water in certain areas has caused adverse environmental impacts, as there is often not enough water in particular water bodies to support a healthy fishery, resource, recreational boating, swimming, and other needs. For example, in the water use pilot study of the Quinnipiac River and seven of its main tributaries (see Appendix D), the Department compared baseflow[4] to maximum authorized diversions;[5] (see Figure 8, Appendix D). Natural stream flow in these tributaries during dry periods is predominately groundwater recharge. The study show that authorized diversions *exceed baseflow* for Sodom Brook, Broad Brook, and Muddy River and *approach* baseflow for Eightmile River, Misery Brook and Broad Brook. Thus, authorized diversions can significantly depress stream flows of six of the seven main tributaries in the Quinnipiac River watershed during dry periods.

In early August 1999, completely dry stream channels were observed in sections of Misery Brook and Sodom Brook, and, where agricultural diversions were operating, a 50% reduction of flow was observed in the lower Muddy River.

During July and August 1999, Department staff made weekly observations of three sites located on the upper portion of Muddy River, one site located on Patton Brook, and one site located on Roaring Brook, a headwater tributary of the Eightmile River. Throughout the observation period the volume of water remained fairly constant at these sites. Muddy River and

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4 As calculated by the United States Geological Survey (“USGS”).
5 i.e., permitted and registered diversions.

Sodom Brook, Meriden, CT, August, 1999. The combined withdrawals from numerous registered diversions within the basin exceed baseflow, causing the steam to go completely dry during the summer

Patton Brook appeared to have standing water conditions, as much of the water present in the channel was retained in shallow runs or pool sections, with little visible water flow between sections. Roaring Brook was completely dry from 7/29/99 through 9/20/99. Additional observations made in September found little change in stream channel width and depth at these sites, although precipitation had resumed and flow levels in other areas had returned to more normal flows. Thus the flows observed in July and August of 1999 may not be solely due to the drought.