Appendix 2

Outstanding Resource Value Report: Watershed Hydrology

Eightmile River Watershed Management Plan

Eightmile River Watershed Outstanding Resource Values: **Watershed Hydrology**

June 2, 2005

Why Watershed Hydrology Is Important

Watershed hydrology describes the journey of water through a watershed system. The processes that move water through the system such as precipitation, evapotranspiration, groundwater infiltration and surface water flow all have significant affects on overall ecosystem health.

Instream flow, the amount of surface water flowing in a river or stream at any given time, has been called the "master variable"[1] in a river system. Instream flow affects a multitude of river ecosystem functions including aquatic life and its related habitat, nutrient cycling, sediment transport, water temperature, river bank stability, groundwater recharge, and a host of other features. Water from river and groundwater sources also plays an important role in sustaining human health by providing drinking water, agricultural irrigation, fire protection, recreational opportunities and wastewater assimilation of discharges from sewage treatment plants and other sources. Table 1 below lists the physical and biological resource features that are affected by instream flow. The ability to balance instream needs with out-of-stream uses is a difficult challenge endemic to the whole country, and certainly Southern New England and Connecticut.

Table 1. Water Resource Features Affected By Instream Flow[2]

Physical	Biological
water temperature	migratory fish passage
dissolved oxygen	macroinvertebrate production
effluent dilution	juvenile fish development
effluent assimilation	endangered species
groundwater recharge	amphibians
sediment transport	reproduction
salinity intrusion	vegetation encroachment
aesthetics	riparian wetlands
channel morphology	fish egg incubation
bank stability	
substrate composition	

[1] *Ecological Applications,* 13(1), 2003, pp. 206–224, q 2003 by the Ecological Society of America

[2] Table 1from Appendix A - Water Allocation Task Force Report 7/2/02 Draft, Ecological Needs Section ECOLOGICAL NEEDS - NEED FOR A CT INSTREAM FLOW STANDARD - DRAFT VERSION (excerpt of sections 1 and 2) - Prepared by: James G. MacBroom, P.E., Milone & MacBroom, Inc. and Richard A. Jacobson, C.F.S., Department of Environmental Protection

Impacts to River Flow in the Eightmile Rive Watershed
The flow of a river can be described using five variables: magnitude – the volume of water going down the river at any one time; duration – the length of time a certain magnitude is sustained; frequency – how often different flow levels are achieved; timing- what time of year various flow conditions occur; and rate of change – how quickly flow conditions change.[3] All of these components play a role in supporting the aquatic habitat and life found today in the Eightmile River.

The five variables that describe river flow can be influenced by human activity in a number of ways, including: (1) diversions of water out of the river by either direct withdrawals or groundwater wells; (2) alteration of flow from dams; (3) discharges of effluent into the river from treatment plants, industrial sources and stormwater pipes; and (4) influence of impervious cover, such as roadways, parking lots and roof tops, that both generates stormwater runoff and interrupts the important connection between surface water and groundwater including the important recharge function of vegetation, wetlands and soils to maintain a stable flow regime.

Such human influences and corresponding alterations to natural surface and groundwater flows are to a large extent absent in the Eightmile Watershed, suggesting this watershed is a naturally functioning hydrologic system. Following is a summary of the status of such influences.

Water Diversions
In Connecticut water diversions are either categorized as being permitted or registered. Permitted water diversions are those diversions greater than 50,000 gallons per day that have received a review and permit by the CT DEP in accordance with CGS §22a-373 The CT Water Diversion Policy Act. As of 2000 there were 354 permitted diversions in Connecticut. Registered diversions are those diversions that existed at the time the Diversion Act came into effect in 1982 and were allowed to be grandfathered without an environmental impact review. There are1,842 registered diversions in Connecticut.

Diversions can be categorized further as consumptive or non-consumptive. Consumptive diversions are those that take water, use it and do not put it directly back into the river system, such as drinking water or irrigation withdrawals. Non-consumptive diversions are those that take water, use it and put it back into the river system such as cooling water for a power plant or a hydroelectric facility.

A summary of the diversions within the Eightmile River Watershed is in Table 2.

[3] The Case For Natural Flow Variability In River Basin Management – The Nature Conservancy

Table 2 Diversions in the Eightmile River Watershed[4]

Diverter	Description	Type	Consumptive?	Withdrawal Size
East Haddam Fish & Game Club	6 Recreation Ponds	Registered	No	None – impoundments
New London Water Dept.	Emergency Public Water Supply	Registered	Yes	None – needs permit for actual withdrawal
Lyme Hydroelectric Project	Run of River Hydroelectric Generator	Registered	No	Run of river operation – not a withdrawal - 59 million gallons per day maximum through turbine
Fox Hopyard Golf Course	2 Groundwater Wells for Irrigation	Permit	Yes	150,000 gallons/day maximum

As can be seen there are almost no impacts in the Eightmile River Watershed from the small amount of diversion activity that exists (see Map A for locations). The only active consumptive diversion in the watershed is for two golf course irrigation wells that are limited to withdrawing a combined 150,000 gallons per day. Analysis from the diversion permit application for the wells suggests this may contribute to a nearly 2% reduction in average stream flow in the Eightmile River upstream of the confluence with the East Branch during the low flow months of July, August and September.[5]

The other diversions on record for the Eightmile are not consumptive in nature and consist primarily of small historic recreational ponds used by the East Haddam Fish & Game Club to augment fishing opportunities. It does not appear any of the ponds regulate flow. The registered diversion of the New London Water Department is for Bond Reservoir in Salem. The reservoir is an inactive emergency public water supply. Any actual withdrawals from the reservoir would require a diversion permit from CT DEP.[6]

The Lyme Hydroelectric generator, a run of river operation associated with Moulson Pond and the Rathbun Dam, is not consumptive and is not currently in

[4] Source: CT DEP

[5] "An Evaluation of the Potential Effects of Groundwater Pumping for the Proposed Fox Hopyard Golf Course on the Fisheries of Cranberry Meadow Brook and Eightmile River" Philip C. Downey, Ph.D., CFS, Aquatec Biological Sciences, South Burlington, VT, March 1999.

[6] CT DEP Registered Diversion Database

operation. There are plans to operate the 20 kilowatt facility in the near future after the completion of some repairs. The electricity generated would be used for home use, with excess being sold back to the electric utility. To ensure adequate instream flow downstream of the dam an arrangement exists between the operator of the flume and the CT Department of Environmental Protection to pass the first 20 cubic feet per second downstream over the dam.[7] This understanding ensures the 1,400 foot stretch of river, between the dam and where the tailrace sluiceway re-enters the river, always has sufficient water.

Dams

There are thirty-eight dams listed by CT DEP in the Eightmile River Watershed.[8] Almost all of the dams are either off stream, small with very low head, or no longer in existence.[9] Because the dams are small and none currently regulate flow the overall impact to natural flow is minimal. The two dams of significance, Moulson Pond Dam on the mainstem in Lyme and Ed Bill's Pond Dam on the East Branch in Salem both have fish ladders and no active efforts to regulate flow through store and release operations. Two additional dams of some significance, one in East Haddam and the Zemko Dam in Salem, have active efforts underway to achieve their removal.

An assessment of the biological and physical attributes of the Eightmile River Watershed conducted in the summer of 2004 by the University of Massachusetts' Northeast Instream Habitat Program found elevated water temperatures as a result of shallow impoundments and limited canopy cover on the East Branch. While not impairing overall river quality, it appears the elevated temperatures coupled with a deficiency of woody debris along the river corridor has resulted in a paucity of cold water fish species in certain areas of the watershed.[10]

Table 4 is a list of dams provided by CT DEP. Map A provides detail as to the location of the dams and diversions. Some on the list and on the map are no longer in existence.

Discharges

Any person or municipality in CT that discharges water or substances into any surface waters, ground waters, sanitary sewers or stormwater systems of certain sizes are required to be permitted by the state as a part of the Clean Water Act's National Pollution Discharge Elimination System (NPDES).

Such discharges, whether from municipal sewage treatment plants, industrial processes, or storm water systems can have significant impacts on the variables

[7] The Gazette, Vol. 8, No. 26, Dec. 2, 1981, "Lyme Hydro Power Plan Gets DEP Approval"
[8] CT DEP Bulletin 37
[9] Steve Gephard, CT DEP Personal Communication, 9/12/03
[10] Northeast Instream Habitat Program, Dept. of Natural Resources Conservation, University of Massachusetts, Diana L. Walden and Dr. Piotr Parasiewicz, "Integrative Assessment of Biological and Physical Attributes of the Eightmile River", Draft, February 2005,

that define natural flow. The Eightmile River Watershed does not have any permitted discharges that have an effect on watershed hydrology.

Land Use - Impervious Cover

Impervious surfaces such as roads, rooftops, and parking lots can have profound impacts on the flow regime of a river. Impervious surfaces break the connection between surface water and groundwater and interrupt the natural water cycle, causing a host of impacts, including: increased volume and velocity of runoff; increased frequency and severity of flooding; peak storm flows many times greater than in natural basins; loss of natural runoff storage capacity in vegetation, wetlands and soil; reduced groundwater recharge; and a decrease in the groundwater contribution to stream flow, causing streams to become intermittent or dry, and in turn affecting water temperature.[11]

Numerous studies have shown a relationship between the level of imperviousness in a watershed and degradation of that watershed's stream quality. Scientific research suggests that in watersheds of up to 10 square miles stream quality can degrade when impervious cover is just 10% of the total watershed area. For certain sensitive aquatic species, such as brook trout, impervious cover of as little as 4% can cause major population declines.
Of the 84 subwatersheds in the Eightmile River Watershed all are less than 4.6 square miles in size, with 94% under 2 square miles in size. Of these, 80 subwatersheds, representing 99.7% of the watershed area, have imperviousness levels of less than 7%. Forty-seven of the subwatersheds representing over 58% of the total watershed area have very low impervious cover levels of less than 3%. When considering the entire 62 square mile watershed, current imperviousness totals 3.3%. Table 3 provides a summary of impervious cover by sub-watershed.

[11] UCONN Cooperative Extension NEMO Program Fact Sheet #3, Impacts of Development on Waterways. 1993

Table 3. Impervious Cover Eightmile River Subwatersheds

Impervious Cover	# of Subwatersheds	Total Area Square Miles	% of Total Watershed Represented
0 – 1 %	0	0	0.0%
1.1 – 2%	12	6.7	10.7%
2.1 – 3%	35	29.7	47.7%
3.1 – 4%	19	14.6	23.4%
4.1 – 5%	7	5.8	9.2%
5.1 – 6%	4	4.1	6.6%
6.1 – 7%	3	1.3	2.1%
7.1 – 8%	1	0.1	0.1%
8.1 – 9%	1	0.1	0.2%
9.1 – 10%	1	> 0.01	0.0%
> 10%	1	> 0.01	0.0%
Total	84	62.4	100%

With relatively low levels of impervious cover throughout the Eightmile River Watershed, conditions are very favorable for supporting a naturally functioning hydrologic system.

Land Use – Forest Cover and Wetland Recovery

When impervious cover is less than 10% in a watershed, The Center for Watershed Protection reports its effect is "relatively weak compared to other potential watershed factors, such as percent forest cover, riparian continuity, historical land use, soils, agriculture, acid mine drainage or a host of other stressors." [12]

The Eightmile River Watershed is over 80% forest cover where as the whole state of Connecticut is less than 60% forest cover. In addition, only 7% of the watershed is considered developed, while statewide development stands at nearly 19%. When looking closer at the riparian corridor land area within 100 feet of the 160 miles of rivers and streams in the watershed, only 6% is considered developed, with 4% in grass or agriculture and 89% in essentially a natural undisturbed condition.[13]

An assessment of the biological and physical attributes of the Eightmile River system done by the University of Massachusetts Northeast Instream Habitat Program has shown significant stabilization in low flow patterns within the East Branch of the Eightmile River over the last 67 years. Data from the U.S. Geological Survey gauge on this stretch of river indicates that extreme low water conditions aren't happening as often, and the duration of overall low flow

[12] Center for Watershed Protection Impacts of Impervious Cover on Aquatic Systems, Watershed Protection research Monograph No. 1, March 2003

[13] UCONN CLEAR Data 2002

conditions are shorter than in the past. One of the major factors identified by UMASS for this phenomenon is the recovery of wetland systems in the watershed, a strong indicator of an ecosystem recovering from an intensive agricultural past.[14]

Overall, the landscape conditions in the Eightmile River Watershed are at present compatible with sustaining a naturally functioning hydrologic system.

Summary

Overall, the Eightmile River Watershed has:

- One small consumptive groundwater diversion
- No direct point source discharges impacting hydrology
- Very low levels of impervious cover
- High levels of forest cover coupled with low levels of developed area
- No dams that are currently regulating flow.

Combining all these factors it is apparent the Eightmile River Watershed hydrologic regime is operating without major impediments and as such is a naturally functioning system. It is extremely rare in Connecticut, especially along the coast, to have a watershed system of this size with a natural intact flow regime in place. As such the Eightmile River Watershed can be considered a unique example of how a natural hydrologic system in Connecticut functions and is considered an outstanding resource value based on such exemplary characteristics.

[14] UMASS Northeast Instream Habitat Program, Diana L. Walden, Dr. Piotr Parasiewicz, "Integrative Assessment of Biological and Physical Attributes of the Eightmile River", March 2005.

Map A – Dams and Diversions of the Eightmile River Watershed

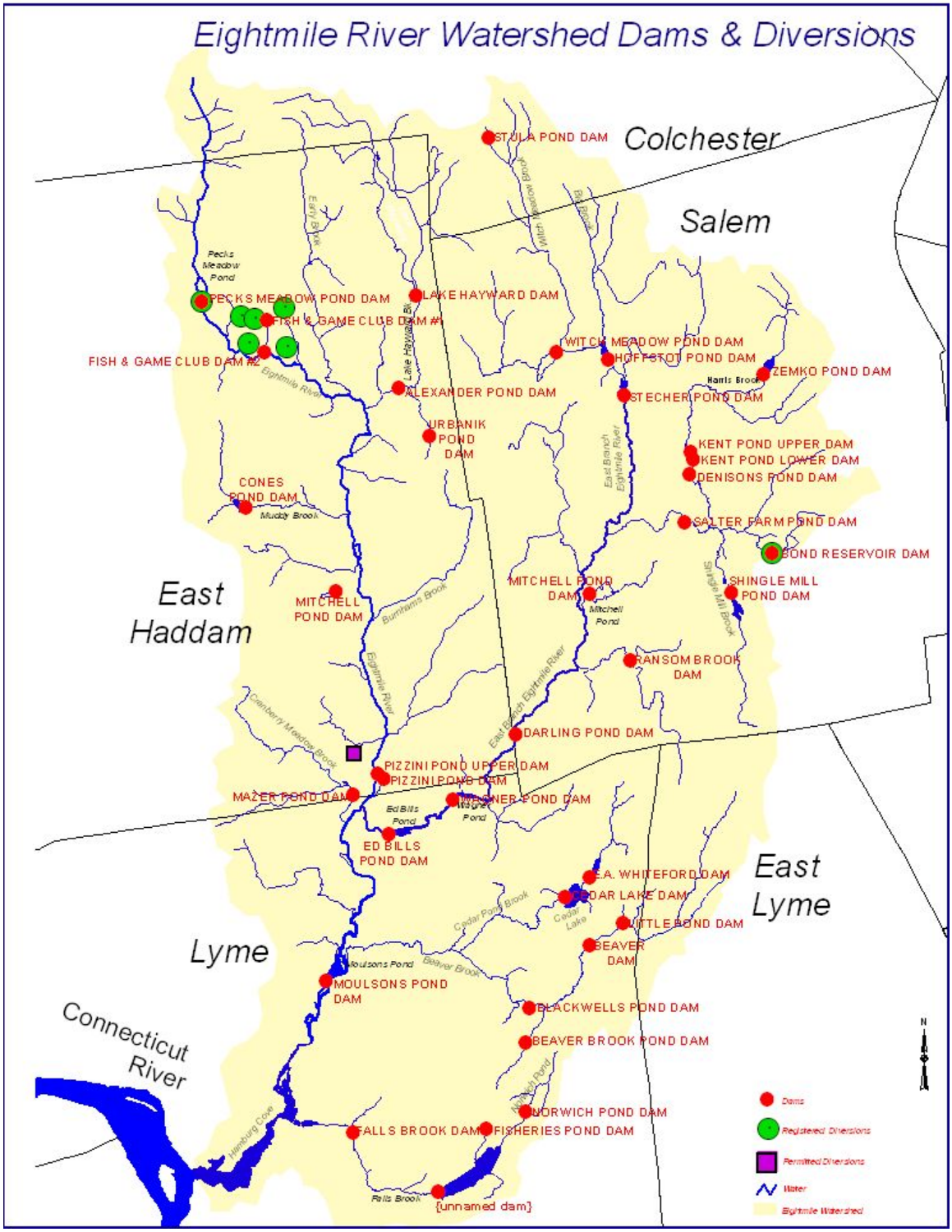

Table 4
Dams in the Eightmile River Watershed

Dam Name	Location
Stula Pond Dam	Colchester
Lake Hayward Dam	East Haddam
Pecks Meadow Pond Dam	East Haddam
Fish & Game Club Dam #1	East Haddam
Fish & Game Club Dam #2	East Haddam
Witch Meadow Pond Dam	Salem
Hoffstot Pond Dam	Salem
Zemko Pond Dam	Salem
Alexander Pond Dam	East Haddam
Stecher Pond Dam	Salem
Urbanik Pond Dam	East Haddam
Kent Pond Upper Dam	Salem
Kent Pond Lower Dam	Salem
Denisons Pond Dam	Salem
Cones Pond Dam	East Haddam
Salter Farm Pond Dam	Salem
Bond Reservoir Dam	Salem
Mitchell Pond Dam	East Haddam
Shingle Mill Pond Dam	Salem
Mitchell Pond Dam	Salem
Ransom Brook Dam	Salem
Darling Pond Dam	Salem
Pizzini Pond Upper Dam	East Haddam
Pizzini Pond Dam	East Haddam
Mazer Pond Dam	East Haddam
Wagner Pond Dam	Lyme
Bills Pond Dam	Lyme
E.A. Whiteford Dam	Lyme
Cedar Lake Dam	Lyme
Little Pond Dam	Lyme
Beaver Dam	Lyme
Moulsons Pond Dam	Lyme
Blackwells Pond Dam	Lyme
Beaver Brook Pond Dam	Lyme
Norwich Pond Dam	Lyme
Fisheries Pond Dam	Lyme
Falls Brook Dam	Lyme
{unnamed dam}	Lyme