2.0 Ecological Setting

2.1 Mount Hope Bay - Physical Setting

Mount Hope Bay is a shallow estuary that is an offshoot of Narragansett Bay (Figure 2.1-1). A portion of the bay is located in the state of Rhode Island, while the rest is in the state of Massachusetts. Several rivers drain into the bay including the Taunton, the Kickamuit, the Cole, the Lee (also known as Lees or Lee's) and the Quequechen. The bay itself is connected to Narragansett Bay by the Narragansett Bay East Passage and the Sakonnet River. Mount Hope Bay is 7 miles in length along the north-south axis (USGenNE, 2001) and has a surface area of 13.6 mi^2 and a volume of 53 billion gallons at mean low water (Chinman and Nixon, 1985).

In general, the bay is relatively shallow with an average depth of 18.7 ft (Chinman and Nixon, 1985). Most of the northern portion of the bay is shallower than this, as the deeper portions of the bay tend to be in the south, the shipping channel along the east side and the connections to Narragansett Bay. Furthermore, 70% of the bay is less than 6 meters deep at mean low water (NEP, 1998).

2.2 Hydrology

Water circulation in Mount Hope Bay is primarily influenced by tidal flow, wind and freshwater river flow. The Taunton River delivers a significantly greater quantity of water to the bay than the other four rivers combined. The long term average flow of the Taunton is 7,846 gal/sec., while the long term average for the Cole is 214 gal/sec and the long term averages for the Lee, Kickamuit and Quequechen are even less (Ries, 1990).

Tidal currents are generally between 0.3-0.8 ft^3/sec with a mean tidal range of 4.4 ft (Spaulding and White, 1990). Tides are the primary source of circulation in the bay with 7.9 billion gallons of water being flushed through the bay twice a day (USGenNE, 2001).

2.3 Water Quality

Water quality in Mount Hope Bay has been of great interest to the Technical Advisory Committee (TAC)[1] as it potentially could have direct bearing on fish distributions. Water

[1] The Brayton Point TAC was formally made up of "the active biologists of those regulatory agencies which have responsibility for the aquatic community in Mount Hope Bay," including those from the U.S. EPA Region 1, the U.S. EPA Narragansett Laboratory, U.S. National Marine Fisheries Service, the Massachusetts Division of Water Pollution Control, the Massachusetts Division of Marine Fisheries, Massachusetts Coastal Zone Management. EPA

temperature and dissolved oxygen have been two parameters in particular that have been the focus of a substantial amount of study in the bay. Both of these parameters can have direct effects on fish at the metabolic, individual and population levels. These effects will be discussed in the Section 316(a) portion of this document.

2.4 Temperature

Water temperature in Mount Hope Bay fluctuates greatly with season. The average monthly temperature in February is 35.6° F, while the average monthly temperature in August is 75.2° F (USGenNE, 2001). Several researchers have documented a long-term increase in water temperatures across both Mount Hope Bay and Narragansett Bay. This research is discussed in detail below. At the same time, satellite imagery analyzed by Dr. Jack Mustard of Brown University shows that the surface water of Mount Hope Bay is on average 1.5° F warmer in the summer and fall than comparable shallow parts of Narragansett Bay (Mustard et al., 2001). Thermistor data collected simultaneously with the satellite imagery showed that the satellite was recording the temperature of approximately the top 6 feet of the water column (Mustard et al., 2001). In general, thermistor data showed that water temperatures then declined gradually from the 6 foot depth until the bottom (Turner, 2001).

2.5 Dissolved oxygen

Dissolved oxygen (DO) concentrations in Mount Hope Bay have been measured by numerous investigators with various methodologies over the past 20 years. From 1985 to 1988, the Massachusetts Department of Environmental Protection conducted a series of cruises collecting DO measurements at 24 sampling locations in Mount Hope Bay. DO was measured using a Seacat SBE-19 Profiler to produce a depth profile of DO concentrations at each station. In August 1996, the permittee deployed continuous DO recorders at two locations in Mount Hope Bay for 30 days. Dissolved oxygen concentrations were measured at a meter below the surface and a meter above the bottom. Since 1999, MA CZM has deployed continuous DO recorders in the lower Taunton River and mid-bay at the state line. In addition, the Narragansett Bay project has conducted nighttime Narragansett Baywide DO surveys 2 or 3 times a summer for the past 3 years. This sampling effort is spatially intensive, with over 20 sampling locations within Mount Hope Bay itself. In this survey, instantaneous measurements are taken with a YSI meter to produce a depth profile of DO concentrations at each station.

In general, DO varies seasonally in the bay with minimum values occurring in August and

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Fact Sheet for BPS Draft NPDES Permit No. MA003654 (June 11, 1993), p. 10. The TAC grew to include representatives from Rhode Island's Department of Environmental Management and Coastal Zone Management Office, who also have responsibilities for the aquatic resources of Mount Hope Bay. TAC meetings have also typically included representatives of the permittee and other interested members of the public, such as from interested environmental organizations.

September. Surface DO concentrations are generally greater than concentrations deeper in the water column, though data from the 1996 continuous DO meters show periods where surface DO is depressed relative to DO at depth (Figures 2.5-1 and 2.5-2). The continuous DO meters and the instantaneous profiles taken around Mount Hope Bay have seen periods of extremely low dissolved oxygen (< 2 mg/l) (Figures 2.5-1 and 2.5-2).

Sampling of the benthic community by EPA Narragansett's lab has revealed that the lower Taunton River and areas around Spar Island have productive benthic communities consisting of ampelisca amphipods (Cinchetti, 2001). These amphipods are very sensitive to low DO and excessive carbon loading and are good indicator organisms. This suggests that the low DO concentrations measured in Mount Hope Bay are not likely severe enough in magnitude or duration to compromise the benthic community, an important foraging resource for many demersal fish species.

2.6 Status of Fish Populations

As a requirement of previous permits, Brayton Point Station has been required to collect finfish abundance data from several fixed trawl stations in Mount Hope Bay. These surveys have been conducted with consistent methodology since 1972. In addition, the University of Rhode Island (URI) and the Rhode Island Division of Fish and Wildlife (RI DFW) also conduct regular trawling surveys in Narragansett Bay, including two stations in Mount Hope Bay. In 1996, Mark Gibson of RI DFW issued a final report which brought information from these three separate sampling efforts together and looked at the historical trends in fish abundance in Mount Hope Bay. Gibson's report painted a bleak picture of the condition of most of the fish stocks in Mount Hope Bay. In 16 of the 21 species examined, the rate of decline in Mount Hope Bay was greater than in neighboring Narragansett Bay. For winter flounder, windowpane, tautog and hogchoker, the differences in the rate of decline were statistically greater in Mount Hope Bay than in adjacent Narragansett Bay. Winter flounder abundance in Mount Hope Bay declined from an average of approximately 34 fish/tow from 1972 to 1984 to 2 fish/tow from 1985 to 1998 (USGenNE, 1999). Windowpane abundance declined from about 5 fish/tow to about 0.5 fish/tow in the same time period (USGenNE, 1999). Tautog declined from 0.9 fish/tow to 0.14 fish/tow during the same time (USGenNE, 1999). Hogchoker was only sampled from 1979, but declined from 1.4 fish/tow from 1979 to 1984 to 0.28 fish/tow from 1985 to 1998 (USGenNE, 1999). Gibson (1996) states aggregate resource abundance declined significantly in Mount Hope Bay (Figure 2.6-1) and a reduction of species diversity occurred. Gibson (1996) correlates plant coolant flow with finfish abundance in the trawl surveys and shows a dramatic increase in coolant flow starting in 1984 coincides with the dramatic fish abundance decline in Mount Hope Bay (Figure 2.6-2). Gibson (1996) concludes that: "The most parsimonious hypothesis to explain the decline is that the large change in coolant flow has modified environmental conditions in Mt. Hope Bay to the detriment of the fish population."

Subsequent analysis by Gibson (1996a) shows that the statistical fit between heat rejection from the plant (in trillions of British Thermal Units (BTUs)) and fish abundance is slightly better than

the fit for strictly coolant flow and fish abundance, though the statistical fit for both data sets is excellent (R^2>0.85). This means that 85% of the variation of observed fish abundance could be explained by coolant flow or heat rejection. Coolant flow and heat rejection are linked and are both direct measures of plant operations. Thus, it would be surprising if they did not have similar statistical fits. While these analyses looked at coolant flow and heat rejection separately, EPA concludes that these two parameters most likely exert a combined effect on fish populations, along with other stressors.

Mark Gibson solicited comments on his report from numerous fishery biologists. EPA asked the Brayton Point TAC and several independent experts to also review the Gibson report. In general, the vast majority of reviewers agreed with the two main points of Gibson's report: the fish populations in Mount Hope Bay had suffered a sudden and dramatic decline and the increased coolant flow at Brayton Point Station likely triggered this change. Gibson and large numbers of the reviewers point out that this analysis does not scientifically prove cause and effect. Establishing cause and effect in a true scientific fashion would require a complete shut down of the facility, a complete recovery of the fish stocks and then a controlled experiment of starting the plant up again and documenting a second decline. Obviously, this is not practical and other types of analyses have been used as surrogates.

The prior owners of Brayton Point Station (New England Power) did not initially acknowledge a decline in fish abundance in Mount Hope Bay. They attributed changes in fish abundance to sampling gear differences. After some debate, however, they changed their view and acknowledged the existence of a problem with the fish stocks. The current owners of Brayton Point Station (USGenNE) acknowledge the dramatic decline of fish abundance in Mount Hope Bay starting in 1984 (USGenNE, 2001). Thus, the existence of a problem with fish populations in Mount Hope Bay is no longer in debate.