EXHIBIT F

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND - REGION I
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MASSACHUSETTS 02109-3912

FACT SHEET

DRAFT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT TO DISCHARGE TO WATERS OF THE UNITED STATES

NPDES PERMIT NUMBER: **MA0102440**

PUBLIC NOTICE START AND END DATES: September 21, 2012 thru November 19, 2012

NAME AND MAILING ADDRESS OF APPLICANT:

Town of Uxbridge
Sewer Commission
River Road
Uxbridge, MA 01569

NAME AND ADDRESS OF FACILITY WHERE DISCHARGE OCCURS:

Uxbridge Wastewater Treatment Facility
80 River Road
Uxbridge, MA 01569

RECEIVING WATER: **Blackstone River (MA51-05)**
USGS Hydrologic Code #01090003 – Blackstone River Watershed (51)

RECEIVING WATER CLASSIFICATION(S): **Class B – warm water fishery**

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List of Tables and Figures

Attachments:

I. Proposed Action, Type of Facility, and Discharge Location.

The above named applicant has applied to the U.S. Environmental Protection Agency ("EPA") for the reissuance of its NPDES permit to discharge into the designated receiving water. The facility is engaged in the collection and treatment of domestic wastewater and septage. The discharge from this secondary wastewater treatment facility is via Outfall 001 to the Blackstone River.

II. Description of Treatment System and Discharges

A quantitative description of the wastewater treatment plant discharge in terms of significant effluent parameters based on recent monitoring data is shown on **Table 1**. **Figure 1** shows the geographical location, and **Figure 2** shows the flow process diagram of the Uxbridge Wastewater Treatment Facility (WWTF).

The Uxbridge WWTF is a 2.5 million gallon per day (MGD) secondary wastewater treatment facility which serves a population of about 6618, according to the Town's permit application dated April 26, 2004. There is currently one industrial user contributing a small amount of non-contact cooling water to the WWTF. The collection system consists of separate sanitary sewers and there are no known combined sewers or combined sewer overflows. The facility accepts several thousand gallons per day of septage from within Uxbridge and may accept septage from other communities.

The WWTF's treatment process is shown in Figure 2. Influent wastewater flow is pumped to a headworks building where a mechanical bar rack and a shredder remove coarse sewage solids and other materials from the wastewater; heavier suspended solids are then removed in primary sedimentation tanks. Following primary sedimentation, sodium aluminate is added to the wastewater in a rapid mix tank to enhance phosphorus removal. The wastewater then enters aeration tanks, where it is mixed with sludge returned from the secondary sedimentation tanks, and undergoes biological treatment. Following aeration, the flow is discharged to secondary settling tanks where biological flocculant and fine solids are removed. The flow is then discharged to an effluent channel, where flow is measured with an ultrasonic Parshall flume, and then to a chlorine contact chamber, where the effluent is seasonally disinfected with liquid sodium hypochlorite, added in proportion to flow. The effluent is then discharged to the Blackstone River through a diffuser on the river bottom. The sludge handling facilities are described in Section VIII.

III. Receiving Water Description

The Uxbridge WWTF discharges to the Blackstone River in southeastern Uxbridge, MA. The Blackstone River is an interstate water which has its headwaters in Worcester. It flows south through Millbury, Sutton, Grafton, Northbridge, Uxbridge, Millville and Blackstone to the state line with Rhode Island, approximately five miles downstream of the Uxbridge discharge. The river then flows through Rhode Island to Pawtucket, where the Slater Mill Dam marks the boundary with the marine waters of the Seekonk River, the uppermost segment of Narragansett Bay. The Seekonk River joins the Providence River, which then flows into the main body of

Narragansett Bay. The Seekonk and Providence Rivers are estuaries and are classified as marine waters. The Blackstone River has a number of dams and related impoundments along its length. The closest downstream is the Tupperware Dam and associated "Millville Pond" impoundment at Blackstone, MA, approximately 3 miles downstream of the Uxbridge discharge.

Massachusetts Surface Water Quality Standards ("MA SWQS") list the Blackstone River, from its source to the Rhode Island border, as a Class B Warm Water Fishery. Its uses include habitat for fish, other aquatic life and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary (e.g., swimming) and secondary (e.g., fishing and boating) contact recreation. *See* 314 CMR 4. 05(3)(b) and 4.06 (Table 11). Such waters must have consistently good aesthetic value.

Rhode Island has classified the Blackstone River as a Class B1 water from the Massachusetts border to the Central Falls CSO outfall, and as a Class B1{a} water from the CSO outfall to the Seekonk River. The Seekonk River is designated as a Class SB1 water from the Blackstone to the confluence with the Providence River. The Providence River has been designated as a Class SB1{a} water from its confluences with the Seekonk and two other tributaries until a boundary extending between Warwick and East Providence, and a Class SB{a}water from that point until it reaches the Upper Narragansett Bay segment. Rhode Island Water Quality Regulations, July 2006, amended December 2009 ("RI WQR"), Appendix A.

Rhode Island Class B1 waters' designated uses include primary and secondary recreational uses and fish and wildlife habitat, except that primary contact recreational uses may be impacted by pathogens from approved wastewater discharges. RI WQR at Rule 8.B(1)(d). Rhode Island Class SB waters' designated uses include primary and secondary contact recreation; fish and wildlife habitat; shellfish harvesting; and must have good aesthetic value. Id. at Rule 8(B)(2)(b). Class SB1 waters share the same designated uses as Class SB, with the exception of shellfish harvesting. Id. at Rule 8(B)(2)(c). The {a} designation indicates partial use due to impacts from CSOs. RI WQR, Appendix A.

The Blackstone River is listed on the *Massachusetts Year 2010 Integrated List of Waters* (the "MA 303(d) list") as a water that is impaired (not meeting water quality standards) and requiring one or more Total Maximum Daily Loads (TMDLs). The segment of the Blackstone River that the Uxbridge WWTF discharges to, Segment MA51-05, is listed for impairments caused by unknown toxicity, priority organics, metals, nutrients, pH, flow alteration, pathogens, taste/odor/color, suspended solids and turbidity. The Blackstone River in Rhode Island is listed on Rhode Island's *2010 303(d) List of Impaired Waters* for impairments caused by cadmium, lead, total phosphorus, dissolved oxygen, fecal coliform, enterococcus, mercury and PCB in fish tissue, and benthic macroinvertebrate bioassessments (as well as non-native plant impairments not caused by pollutants). The Seekonk and Providence Rivers are listed for impairments caused by total nitrogen, low dissolved oxygen, and fecal coliform.

No TMDLs have been completed for these pollutants in either Massachusetts or Rhode Island. However extensive work has been completed to document and analyze these impairments, as set forth in the discussion of effluent limits derivation below.

IV. Limitations and Conditions

The effluent limitations and all other requirements described in Part VI of this Fact Sheet may be found in the draft permit.

V. Permit Basis: Statutory and Regulatory Authority

Congress enacted the Clean Water Act (CWA) "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." CWA § 101(a). To achieve this objective, the CWA makes it unlawful for any person to discharge any pollutant into the waters of the United States from any point source, except as authorized by specified permitting sections of the CWA, one of which is Section 402. *See* CWA §§ 301(a), 402(a).

Section 402(a) established one of the CWA's principal permitting programs, the National Pollutant Discharge Elimination System (NPDES). Under this section of the CWA, EPA may "issue a permit for the discharge of any pollutant, or combination of pollutants" in accordance with certain conditions. *See* CWA § 402(a). NPDES permits generally contain discharge limitations and establish related monitoring and reporting requirements. *See* CWA § 402(a)(1)-(2).

Section 301 of the CWA provides for two types of effluent limitations to be included in NPDES permits: "technology-based" limitations and "water quality-based" limitations. *See* §§ 301, 304(b); 40 CFR §§ 122, 125, 131. Technology-based treatment requirements represent the minimum level of control that must be imposed under Sections 402 and 301(b) of the Clean Water Act. For publicly owned treatment works (POTWs), technology based requirements are effluent limits based on secondary treatment as defined in 40 CFR 133.102.

EPA regulations require NPDES permits to contain effluent limits more stringent than technology-based limits where necessary to maintain or achieve federal or state water quality standards. Under Section 301(b)(1)(C) of the CWA, discharges are subject to effluent limitations based on water quality standards. The Massachusetts Surface Water Quality Standards (MA SWQS), 314 CMR 4.00, establish requirements for the regulation and control of toxic constituents and also require that EPA criteria, established pursuant to Section 304 (a) of the CWA, shall be used unless a site specific criteria is established. Massachusetts regulations similarly require that its permits contain limitations which are adequate to assure the attainment and maintenance of the water quality standards of the receiving waters as assigned in the MA SWQS, 314 CMR 4.00. *See* 314 CMR 3.11(3). EPA is required to obtain certification from the state in which the discharge is located that all water quality standards or other applicable requirements of state law, in accordance with Section 301(b)(1)(C) of the CWA, are satisfied, unless the state waives certification.

Section 401(a)(2) of the CWA and 40 CFR § 122.44(d)(4) require EPA to condition NPDES permits in a manner that will ensure compliance with the applicable water quality standards of a "downstream affected state," in this case Rhode Island. The RI WQR also establish designated uses of the State's waters, criteria to protect those uses, and an antidegradation provision to ensure that existing uses and high quality waters are protected and maintained.

In addition, a permit may not be renewed, reissued or modified with less stringent limitations or conditions than those contained in the previous permit unless in compliance with the anti-backsliding requirements of CWA § 303(d)(4) and 40 CFR §122.44(l). States are also required to develop antidegradation policies pursuant to 40 CFR § 131.12. No lowering of water quality is allowed, except in accordance with the antidegradation policy.

VI. Explanation of Permit's Effluent Limitations

A. Basis of current permit limits

The current permit was issued on September 30, 1999, and incorporated limits based on a waste load allocation (WLA) set forth in *Blackstone River Watershed Dissolved Oxygen Waste Load Allocation for Massachusetts and Rhode Island* (November 1997). This WLA was based on a dissolved oxygen (DO) mathematical model developed by the University of Rhode Island and funded by the EPA, the MassDEP and the Rhode Island Department of Environmental Management (RIDEM) which was calibrated and verified using water quality survey data collected in 1991. The water quality data and modeling report can be found in the *Blackstone River Initiative Report* (February 1998). Modeling results formed the basis for water quality based seasonal limits on biochemical oxygen demand (BOD_5), carbonaceous oxygen demand (CBOD), total suspended solids (TSS), phosphorus and ammonia nitrogen that were found necessary to achieve the minimum dissolved oxygen criterion of 5.0 mg/l for the Blackstone River.

The draft permit maintains the existing concentration-based limits on BOD_5, TSS and ammonia nitrogen while also expressing those limits as mass load limits. The CBOD limits in the current permit have been expressed as BOD limits in the draft permit at the permittee's request, in order to conserve laboratory resources due to the greater complexity of the CBOD laboratory methods. BOD is a more conservative measure than CBOD (CBOD should always be less than BOD), and BOD is equally consistent with the approved WLA. The draft permit also sets more stringent limits on total phosphorus and additional limits for total nitrogen, metals and bacteria. These are discussed in greater detail in the pollutant-specific sections that follow.

B. Effluent Limits Derivation

The effluent limits in the draft permit are established to ensure compliance with technology-based requirements, the MA SWQS, the approved WLA for dissolved oxygen, and RI WQR. In most cases the applicable water quality criteria for Massachusetts are similar to, and in some cases more stringent than, the applicable water quality criteria for Rhode Island, so that the effluent limits designed to meet the MA SWQS also ensure compliance with the RI WQR. This is not the case for the limits on total nitrogen and on bacteria in the winter months, and those limits are established solely to ensure compliance with the RI WQR.

1. Flow

The draft permit contains an annual average flow limit of 2.5 MGD, which is the long term average design flow of the facility. The flow limit in the current permit is expressed as a monthly average flow of 2.5 MGD. This change from a monthly average to an annual average is the result of MassDEP adopting a policy establishing flow limits in POTW permits as an annual average in order to account for seasonal flow variations, particularly those associated with high flow and high groundwater which commonly occur in the spring time. *See* MassDEP-DWM, *NPDES Permit Program Policies Related to Flow and Nutrients in NPDES Permits* (2000). Uxbridge's actual flow is routinely well below its design flow, averaging 0.91 MGD in 2009-2010. See Table 1.

2. Conventional Pollutants

a. BOD and TSS

The concentration-based effluent limits for these pollutants remain the same as in the current permit with the exception of the change from CBOD to BOD. For the period of November through May, effluent limitations for monthly and weekly average BOD_5 and TSS are based on secondary treatment requirements. CWA § 301(b)(1)(B); 40 CFR § 133.102. The BOD and TSS draft permit limits for the period from June to October (20 mg/l average monthly and 30 mg/l average weekly) are water-quality based limits based on the WLA. These water quality based effluent limits are more stringent than the technology-based limits for BOD and TSS of 30 mg/l average monthly and 45 mg/l average weekly. There were no CBOD, BOD or TSS violations between 2005 and December 2010.

Mass loading effluent limits for average monthly and average weekly BOD_5, BOD and TSS are found by multiplying the allowable effluent concentration in mg/l by the design flow in MGD and converting to units of pounds per day. The calculations are shown in Attachment A. The monitoring frequency is reduced from three to two times per week based on the facility's history of compliance; long term average concentrations of these pollutants are on the order of 2 mg/l, well below the permit average monthly limits of 20 and 30 mg/l.

b. Ammonia and DO

The draft permit limits for ammonia nitrogen and dissolved oxygen are the same as in the current permit. The permit limits for ammonia nitrogen (expressed in mg/l of nitrogen) were established in order to control both in-stream oxygen demand and the degree of toxicity associated with the discharge. The May limits (10 mg/l and 20 mg/l) and the June through October limits (5 mg/l and 10 mg/l) were based on the 1997 WLA for achieving minimum DO criteria. The November limits (10 mg/l and 20 mg/l) and the December thru April limits (15 mg/l) were based on a December 1999 ammonia criteria document for preventing toxic impacts associated with in-stream ammonia concentrations. *See* EPA, *1999 Update of Ambient Water Quality Criteria for Ammonia,* 822-R-99-014 (1999). There were no violations of the ammonia nitrogen limits from 2005 to 2010.

The minimum DO requirement of 5.0 mg/l has been continued in the draft permit with weekly monitoring, consistent with the State WQS for Class B waters. There were 12 violations of the minimum DO requirement from 2005 to 2010.

c. Bacteria

Limitations for bacteria are based upon state water quality standards and differ from those in the current permit in two respects. First, during the seasonal period of April to October, this permit transitions from fecal coliform to Escherichia coli (*E. coli*) as the bacterial indicator. Second, while the expired permit has seasonal bacteria limits, this permit includes year round limits to satisfy the RI WQR, which are in terms of enterococci.

There were no violations of the existing fecal coliform limits from 2005 to 2010.

E. coli limits

The draft permit includes seasonal (April 1st – October 31st) *E. coli* limitations which are based upon the *E. coli* criteria in the revisions to the MA SWQS, 314 CMR § 4.05(3)(b), approved by EPA in 2007. The monthly average limitation in the draft permit is 126 colony forming units (cfu) per 100 ml, and shall be expressed as a monthly geometric mean. The daily maximum limitation in the draft permit is 409 cfu/100 ml. These limitations are a State certification requirement and are consistent with EPA guidance recommending that no dilution be considered in establishing permit limits for discharges to rivers designated for primary contact recreation. EPA, *Memorandum re: Initial Zones of Dilution for Bacteria in Rivers and Streams Designated for Primary Contact Recreation*,(2008).

The monitoring frequency is maintained at two times per week. In addition, all bacterial samples shall be collected concurrently with one of the daily total residual chlorine (TRC) samples.

Enterococci bacteria limits

Rhode Island's water quality standard for bacteria in Class B waters is a year round criterion for enterococci bacteria. Enterococci concentrations are not to exceed a geometric mean value of 54 colonies/100 ml, with a single sample maximum of 61 colonies/100 ml. For permitting purposes RIDEM uses the geometric mean criterion to establish monthly average permit limit, and the 90% upper confidence level value for "lightly used full body contact recreation" of 175 colonies/100ml to set daily maximum permit limits. RIDEM, *Burrillville Wastewater Treatment Facility Permit Development Document* (January 2012).

To confirm whether water quality standards are in fact violated at the state line, EPA reviewed water quality data collected by USGS at a monitoring station in Millville, MA, upstream of the Tupperware Dam (close to the Rhode Island border) between 2007 and 2009. Monitoring data from the winter months show a median enterococci count of 104 cfu/100 ml, with seven of eleven counts above the single sample maximum (high of 1,160) cfu/100 ml, violating Rhode Islands WQR. Monitoring data from between April and October show a median of 42 cfu/100 ml, with six of fifteen data points above the single sample maximum (high of 1,167 cfu/100 ml), violating the single sample maximum standard. RIDEM, data transmittal (July 9, 2012). While

Uxbridge has not been monitoring bacteria levels in the winter months, the only significant source of bacteria in the river during dry weather is the upstream POTWs. Therefore, EPA has determined that the discharge from the Massachusetts POTWs, including Uxbridge, have a reasonable potential to cause or contribute to violations of Rhode Island's WQR, and that bacteria limitations designed to meet the RI WQR are necessary for these NPDES permits.

To establish the appropriate bacteria limit to meet the RI standard at the state line, EPA has estimated the amount of bacteria die-off that is expected to occur between Uxbridge and the state line. Die-off was estimated using a first order die-off equation as shown below and derived from Crane, S.R., and Moore, J.A., "Modeling enteric bacterial die-off: a review", *Water, Air and Soil Pollution*, 27, 411-39 (1986); and Illinois state water quality standards, Title 35, Subtitle C: Water Pollution; Part 378 (Effluent Disinfection Exemptions.).

$$N(t) = \{N(o)\}e^{-kt}$$

Where:

- N(t) = Predicted concentration of bacteria at travel time t, downstream, in #/100 ml
- N(o) = Bacteria concentration in the effluent of the source, in #/100 ml
- k = The first order die-off rate constant, in 1/day
- t = travel time to the point of interest below the source, in days

Although the value of N(o) would typically be the source, or effluent concentration of bacteria, by setting this value to 1 the value that is solved for, N(t), will be a fraction of the bacteria discharged at the source. This allows estimation of the percentage of the effluent concentration that is present at the downstream point (the State line). EPA assumed a river velocity of 1.0 feet per second, which was also used in the Northbridge permit. This value was within the range that was estimated for river flows consistent with this time of year by a USGS modeling effort. A travel distance of 5 miles, or 26400 feet was used, as estimated from the *Blackstone River Initiative Report* at 5-3 and 5-4. This distance is the difference between the river mile readings at Reach 14 of the Blackstone River in Uxbridge (23.2 miles) and that of Reach 16 which crosses over into Rhode Island (18.2). Using these values results in an estimated travel time of 0.31 days. EPA selected a decay rate (k) of 1.0/day from the literature. Mancini, J.L., "Numerical estimates of coliform mortality rates under various conditions", *Journal of Water Pollution Control Federation,* 50, (1978), pp 2477 – 2484. This results in a percentage of the bacteria count at the state line, or N(t), of 74% (0.74). In other words, 74% of the bacteria that is discharged at the Uxbridge WWTF would be present at the state line.

Using the die-off estimate of 26%, EPA has set the enterococci limits for the period of November 1 to March 31 at a monthly geometric mean of 73 colonies/100 ml and a daily maximum of 175 colonies/100 ml, as calculated below. The proposed limits are consistent with Rhode Island's WQR.

$$\frac{\text{Bacteria target at State line}}{\text{percent of discharge bacteria present at state line}} = \text{maximum discharged at WWTF}$$

Monthly average: (Geometric mean)	Daily maximum:
$\frac{54}{0.74}$ = **73 colonies/100 ml**	$\frac{175}{0.74}$ = **236 colonies/100 ml**

The draft permit limit does not take into account dilution consistent with EPA policy (*see EPA Memorandum, supra*), and because of the multitude of other sources of bacteria in the river that effectively eliminate the dilution benefit of the instream flow. Blackstone River data indicate that bacteria concentrations in the river exceed the Rhode Island criteria at various times of the year and under a variety of different flow conditions. *See, e.g.,* Louis Berger Group, Inc., *Water Quality – Blackstone River, Final Report 2: Field Investigations* (2008). Consequently, allowing for dilution would not ensure that the discharge does not cause or contribute to a violation of the RI WQR at the state line.

The monitoring frequency is established at one time per week. Enterococci samples shall be collected concurrently with the E. coli sample. This is a year-round limit, consistent with Rhode Island's year-round water quality standard. However, should monitoring data from the April to October period indicate that control of *E.coli* is sufficient to ensure adequate control of enterococci, the permittee may request that enterococci monitoring be reduced to winter only. Any such request must be based on a minimum of one year of concurrent monitoring and include a side by side comparison of all concurrent bacteria monitoring data.

d. pH

Limitations for pH are based upon State Certification requirements for POTWs under Section 401(d) of the CWA, 40 CFR 124.53 and 124.55, and water quality standards. Although the lower end of the pH range in the MA SQWS is 6.5 s.u., the permit limit was established at 6.0 s.u. in the 1999 permit. The permittee's historic pH data show levels in the 6.0 to 6.5 range, although there has been only one reported pH value below 6.5 since 2005. The low pH values were likely caused by the plant's nitrification efforts. Although it was not stated in the fact sheet accompanying the 1999 permit, it is assumed that the 6.0 s.u. at the effluent was determined not to have a reasonable potential to violate the instream standard of a minimum of 6.5 s.u., since there is considerable mixing available to the effluent. In addition, adding chemical to raise the pH to 6.5 in the absence of a reasonable potential to cause an exceedance of instream water quality standards would not be environmentally justified. The permit limit is also consistent with the technology based requirements of 40 CFR § 133.102. Therefore, the pH range will remain at 6.0 to 8.3 s.u.

3. Nutrients

Nutrients, such as phosphorus and nitrogen, are necessary for the growth of aquatic plants and animals to support a healthy ecosystem. In excess, however, nutrients can contribute to fish disease, brown tide, algae blooms and low DO. Excessive nutrients, generally phosphorus in freshwater and nitrogen in salt water, stimulate the growth of algae, which can start a chain of events detrimental to the health of an aquatic ecosystem. Algae inhibit sunlight from penetrating through the water column. Once deprived of sunlight, underwater plants cannot survive and are lost. Animals that depend on these plants for food and shelter leave the area or die. Large biomass of algae causes extreme diurnal swings in DO levels. In addition, as the algae decay, they further depress the DO levels in the water. Fish and shellfish are in turn deprived of oxygen, and fish kills can occur. Excessive algae may also cause foul smells and decreased aesthetic value, which could affect swimming and recreational uses.

a. Phosphorus

The draft permit contains a monthly average phosphorus limit of 0.2 mg/l from April to October to control this discharge's contribution to eutrophication in the Blackstone River. The current permit limit of 1.0 mg/l established through the WLA to meet minimum dissolved oxygen criteria in the Blackstone River is not sufficient to control cultural eutrophication.

i. Evidence of eutrophication and reasonable potential

The MA SWQS at 314 CMR 4.00 do not contain numerical criteria for total phosphorus. They include a narrative criterion for nutrients at 314 CMR 4.05(5)(c), which provides that "all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses." They also include a requirement that "[a]ny existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs" Id. MassDEP has interpreted the "highest and best practicable treatment" requirement in its standards as requiring an effluent limit of 0.2 mg/l (200 ug/l) for phosphorus.

Numerous reports and studies have documented the existence of cultural eutrophication in the Blackstone River reaches downstream of the Uxbridge discharge and have identified wastewater treatment plant discharges of phosphorus as the major cause. The *Blackstone River 1998 Water Quality Assessment Report* found the river segment where the Uxbridge WWTF discharge is located (MA51-05) to be non-supportive of aquatic life uses based on elevated nutrient levels and an impaired benthic macroinvertebrate community. Similar impairment to the benthic community was documented in MassDEP's 2003 assessment surveys. *Blackstone River Watershed 2003 Biological Assessment* (MassDEP 2006). The *Blackstone River Initiative Report* (2001), the product of a "multi-phased, interagency, interstate project to conduct the sampling, assessment, and modeling work necessary for the restoration of the river system," stated that "[p]hosphorus and its contribution to algal blooms in the river is a serious water quality concern" and linked the problem to "the cumulative effect from the combined input of all municipal discharges." *BRI Report* at 1-3 to 4. The Army Corps of Engineers' *Phase I: Water Quality Evaluation and Modeling of the Massachusetts Blackstone River, Draft* (March 2004), a followup study intended to expand and build upon the results from the Blackstone River Initiative, concluded that the reaches of the river below Sutton to the RI state line were characterized by "high productivity" and "a consistent rise in algae" as indicated by nutrient loss ratios and profiles of chlorophyll_a (an indicator parameter for algae).

Water quality monitoring data confirms the extensive phosphorus enrichment in the area of Blackstone River affected by this discharge. In 1998 MassDEP found total phosphorus concentrations of 0.34 mg/l upstream and 0.23 mg/l downstream of the discharge. MassDEP's monthly monitoring from May to October 2003 documented total phosphorus levels ranging from 0.16 to 0.69 mg/l in Northbridge, upstream of the discharge, and ranging from 0.11 to 0.37 mg/l downstream of the discharge in Millville. *Blackstone River Watershed 2003 DWM Water Quality Monitoring Data* (MassDEP 2005). While MassDEP has not yet released the results of its 2008 water quality monitoring, data from the Blackstone River Coalition Volunteer Water Quality Monitoring Program confirms continued high concentrations of phosphorus in the vicinity of the Uxbridge discharge, with dissolved phosphorus concentrations averaging 0.41 mg/l (and as high as 0.9 mg/l) between 2005 and 2008 at their monitoring site on the Blackstone River in Uxbridge, upstream of the Uxbridge WWTF. These values far exceed the recommended values contained in EPA's national technical guidance and the peer-reviewed scientific literature pertaining to nutrients. These sources recommend protective in-stream phosphorus values ranging from 0.024 mg/l (24 ug/l) to 0.1 mg/l (100 ug/l). *1986 Quality Criteria for Water* (EPA 1986); *Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria, Rivers and Streams in Nutrient Ecoregion XIV,* December 2000 (EPA- 822-B-00-022).

Given the condition of the receiving water described above, EPA has determined that the discharge of phosphorus from the Uxbridge WWTF under the current permit limit "will cause, have reasonable potential to cause, or contribute to" an excursion above the narrative criterion for nutrients. The Uxbridge plant currently discharges under a seasonal monthly average effluent limit of 1.0 mg/l, with concentrations averaging 0.55 mg/l during the 2009-10 phosphorus control seasons. Concentrations outside of the treatment season (indicative of the full potential of the facility to contribute to water quality exceedances) have been as high as 2.8 mg/l. These concentrations are well above the receiving water concentrations that have already been shown to be related to eutrophication in the Blackstone River. The receiving water does not provide substantial dilution under low flow (7Q10) conditions, as receiving water concentrations are already high due to the inputs from the numerous upstream POTWs and nonpoint sources. Therefore the setting of a more stringent effluent limit is required. 40 CFR § 122.44(d)(1)(ii) and (iii).

ii. Determination of effluent limitation

As noted above, the MA SWQS require the implementation of "highest and best practical treatment," interpreted by MassDEP as an effluent limit of 0.2 mg/l for POTWs, where necessary to control cultural eutrophication. EPA is also, however, required under the Clean Water Act to determine whether such an effluent limit is sufficient to ensure that the receiving water quality complies with all applicable water quality standards. 40 CFR § 122.44(d)(vii)(A). EPA must therefore determine whether an effluent limit of 0.2 mg/l is sufficiently stringent to ensure compliance with the standard that "all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses." 314 CMR 4.05(5)(c).

To determine whether the water quality standard is met, EPA interprets the Massachusetss narrative criterion in numeric terms by looking to nationally recommended criteria and other technical guidance documents. *See* 40 CFR 122.44(d)(1)(vi)(B). EPA has previously established a numeric target of 0.1 mg/l to meet the narrative criterion in the Blackstone River, based on the *1986 Quality Criteria for Water* ("Gold Book") recommendation of in-stream phosphorus concentrations of no greater than 50 ug/l in any stream entering a lake or reservoir, 100 ug/l for any stream not discharging directly to lakes or impoundments, and 25 ug/l within a lake or reservoir. This target is consistent with criteria and guidelines adopted by other states for total phosphorus, as well as other EPA Guidance, *see, e.g., Nutrient Criteria Technical Guidance Manual: Rivers and Streams* (EPA 2000), and EPA's choice of this standard has been upheld by the Environmental Appeals Board in *In re Upper Blackstone Water Pollution Abatement District*, 14 E.A.D. __ (2010).

To determine whether a 0.2 mg/l is sufficient to ensure that the instream level of 0.1 mg/l is met under 7Q10 low flow conditions, EPA calculated the projected instream concentration assuming all the contributing point sources are discharging at their effluent limits under design flow conditions. Design flows and effluent limits for these facilities are set forth in Table 2 below. It should be noted that this does not represent the current discharge concentrations to the Blackstone River, which are significantly higher, but rather the expected discharge concentrations after the facilities are brought into compliance with their newest permit limits.[1] Phosphorus levels in the base flow in the Blackstone River is also included, with a background concentration of 0.04 mg/l based on monitoring data upstream of UBWPAD collected by MassDEP in 2002 (near 7Q10 conditions). MassDEP, *Blackstone River 2003-2007 Water Quality Assessment Report*, at F-8 (2008).[2]

Table 2. Blackstone River POTW Phosphorus Limits

Source	Flow (MGD)	P limit
UBWPAD	56.0	0.1 mg/l
Grafton	2.4	0.2 mg/l*
Northbridge	2.0	0.2 mg/l
Douglas WWTF	0.6	1.2 lbs/day
Upton WWTF	0.4	0.2 mg/l
Uxbridge	2.5	0.2 mg/l*

* proposed

Instream concentration is determined using a mass balance equation as follows:

$$Q_rC_r = \Sigma\ Q_dC_d + Pload_{\text{Douglas}} + Q_sC_s$$

1 In the case of Grafton, a new permit limit of 0.2 mg/l has been proposed in a draft permit issued concurrently with this draft permit.

2 While these data are several years old they are consistent with more recent monitoring data from the Blackstone Watershed Coalition's volunteer monitoring program taken upstream of POTW influence. The BWC data indicates a median orthophosphate (as P) concentration of 0.033 mg/l in the Mumford River upstream of the Douglas WWTF in the period 2005 to 2008. Blackstone Watershed Coalition, *WQM Database* (April 2008).

Where

Q_r = receiving water flow downstream of the discharge (Σ Qd + $Q_{Douglas}$ + Qs)
C_r = total phosphorus concentration in the receiving water downstream of the discharge
Q_d = design flow from each facility (excluding Douglas)
C_d = total phosphorus concentration in each discharge (assumed to be permit limit)
$Q_{Douglas}$ = design flow from Douglas
$Pload_{Douglas}$ = mass load from Douglas (assumed to be permit load limit)
Q_s = Blackstone River base flow at 7Q10 = 22.75 cfs = 14.7 MGD[3]
C_s = phosphorus concentration in baseflow, from sampling upstream of all POTWs = 0.04 mg/l

Solving for C_r yields:

$$C_r = \frac{\Sigma\ Q_dC_d + Pload_{Douglas} + Q_sC_s}{Qr}$$

$$C_r = \frac{56*0.1 + 2.4*0.2 + 2.0*0.2 + 0.4*0.2 + 2.5*0.2 + 1.2/8.34 + 14.7*0.04}{78.4}$$

$$C_r = 0.10 \text{ mg/l}$$

This calculation indicates that an effluent limit of 0.2 mg/l, consistent with the "highest and best practical treatment" mandated under the MA SWQS, is sufficient to ensure that the narrative water quality standard for nutrients is met.

In addition to the seasonal phosphorus limit of 0.2 mg/l, the permit contains a winter period total phosphorus limit of 1.0 mg/l which will be in effect from November 1 through March 31. A higher phosphorus effluent discharge limitation in the winter period is appropriate because the expected predominant form of phosphorus, the dissolved fraction, lacking plant growth to absorb it, will likely remain dissolved and flow out of the system. Imposing a limit on phosphorus during the cold weather months is, however, necessary to ensure that phosphorus discharged during the cold weather months does not result in the accumulation of phosphorus in the sediments, and subsequent release during the warm weather growing season. To confirm that EPA's assumption of the anticipated behavior of dissolved and particulate phosphorus is correct, a monitoring requirement for orthophosphorus has been included for this winter period (November 1 - March 31) in order to determine the dissolved particulate fraction of phosphorus in this discharge. If future evaluations indicate that phosphorus may be accumulating in downstream sediments, the winter period phosphorus limit may be reduced in future permitting actions.

iii. UBWPAD modeling effort

EPA also notes that the UBWPAD has funded the development of an HSPF model of the Blackstone River, conducted by CDM Smith and the University of Massachusetts. EPA has

[3] Baseflow is calculated by subtracting upstream POTW flows from the total 7Q10 at Uxbridge (82.7 cfs) that was derived from the Wasteload Allocation Model. See Attachment B.

reviewed the model (including underlying model input files provided by CDM to EPA) and results to determine whether they form a basis for a different permit limit for phosphorus for this facility. For the reasons below, EPA has concluded that they do not.

First, EPA notes that this modeling effort is funded by the UBWPAD and is specifically designed to address the impacts of UBWPAD permit limits and potential alternatives in dam management and nonpoint source reduction. It clearly does not attempt to assess impacts of changes in permit limits and discharges from any of the other Massachusetts facilities downstream on the Blackstone River, which are assumed to be at their 1997-2005[4] discharges for all the future scenarios analyzed. *Review of Scenario Results Utilizing the Blackstone River HSPF Model 2010 Calibration* at 9 (April 2011). This is unfortunate, as substantial reductions in phosphorus concentrations were achieved by these facilities between 2000 and 2007, and since that time, in connection with permit limits implemented during this period.

As CDM Smith noted in a letter to EPA dated August 9, 2012, the modeled annual average discharge from the smaller MA plants was 25,986 lbs/yr[5], 33% more than the reported discharges in 2007 (19,538 lbs/yr) and 75% more than the 2010-11 discharges (14,944 lbs/yr). The difference would be even larger for the critical summer months when more stringent permit limits are in effect, and new limits on Uxbridge and Grafton are expected to reduce current loads by more than half. In scale the load reduction being implemented from the smaller MA facilities, which discharge directly upstream of the most impacted reaches in the modeling results, is comparable to the 20% NPS reduction scenario in the model (87,400 to 69,900 lbs/yr). *Blackstone River HSPF Model 2009 Scenario Report*, Tables 15 and 16 (2010).[6] The HSPF modeling effort appears to contain an implicit assumption that reductions in discharges from the other WWTPs on the Blackstone River are irrelevant, a position with which EPA disagrees. This makes the modeling results unsuitable for setting permit limits on these facilities.

The decision to focus on 2002 for presentation of results of all scenarios, based on the hydrological conditions during that year that approached 7Q10, exacerbates this issue. Not only are the 2002 phosphorus concentrations for Northbridge, Grafton and Uxbridge far above the current levels, but the Millbury WWTP was still operating in 2002. The scenario plots show a clear spike in phosphorus concentrations at the location of the (now discontinued) Millbury outfall, as well as noticeable spikes at the locations of Grafton and Northbridge (less so Uxbridge) that represent far greater phosphorus discharges than current loads, let alone the reductions that would be seen under new permit limits for Grafton and Uxbridge. These plots therefore do not plausibly reflect what actual conditions would be under the future scenarios.

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[4] While the model extends through 2007, the modeling team used year 2003 and 2000 data in lieu of actual discharges in 2006 and 2007. *Blackstone River HSPF Water Quality Model Calibration Report* at 4-4 (August 2008). This does not appear to have been updated in later refinements of the model, based on EPA's review of the model input files provided in connection with the UBWPAD permit modification request.

[5] This is a correction of the mass balance figures contained in the *Blackstone River HSPF Model 2009 Scenario Report*, Table 15 (2010) which stated that loads from the "other PS" in Massachusetts totaled 98,000 lbs/yr.

[6] As CDM Smith did not correct these figures in its letter of August 9, 2012, EPA assumes that the reported values are correct. We note that while CDM suggests that any review of the model be based on information provided with their modification request, and not the "older, more dated 2009 Scenario report", the updated modeling reports do not contain updated mass balance tables or any other data tables showing input loads.

Moreover, there are additional questions concerning the model itself, particularly the fact that the model does not incorporate periphyton; the consistent overprediction of chlorophyll-a concentrations by the model; and the large errors and paucity of validation data in the Rhode Island reaches. As the Technical Advisory Committee assembled to review the modeling effort stated, "the current HSPF model may be used with caution (because it gives a conservative prediction [too-high] of chlorophyll-a and ammonia concentrations) for evaluating relative in-stream benefits likely to be realized from alternative nutrient reduction scenarios for the UBWPAD discharge and other point and non-point source inputs to the river. However, we believe that improvements will need to be made in the model's ability to predict algal growth dynamics and nitrogen nutrient levels during the growing season, before it is appropriate for use in more detailed applications, such as for development of a nutrient Total Maximum Daily Load (TMDL)." *Technical Advisory Committee (TAC) Review Report on The Blackstone River HSPF Water Quality Model* at 2 (April 29, 2011).

In light of the above, EPA does not believe it is appropriate to use this model in the setting of permits limits for this facility. However, EPA notes that the modeling results on a general level support EPA's position that a high level control on all sources, not just the UBWPAD, is necessary to control eutrophication in the Blackstone River. That is the basis for EPA's implementation of phosphorus limits in this permit and those of the other downstream WWTPs. In addition, EPA is addressing nonpoint source and stormwater reduction efforts through grant funding, stormwater permitting for construction, industrial and municipal separate storm sewer system (MS4) sources, and other programs. EPA believes this multi-pronged approach is consistent with all available data regarding the necessary steps to achieve water quality standards in the Blackstone River.

In summary, the draft permit total phosphorus limit for the period of April 1 to October 31 is 0.2 mg/l and for the period of November 1 to March 31 is 1.0 mg/l. The monitoring frequency for the summer is 2/week, and the winter monitoring frequency is 2/month.

b. Nitrogen

The draft permit contains an effluent limitation of 8 mg/l total nitrogen in the summer months, in order to ensure that this discharge does not contribute to eutrophication in the Seekonk and Providence River estuaries. This requirement is imposed in order to meet the water quality standards of Rhode Island, an affected downstream state under 40 CFR § 122.44(d)(vii)(b)(4).

Rhode Island like Massachusetts, does not provide numeric criteria for nutrients. The relevant narrative criterion for nutrients provides:

> Nutrients: None in such concentration that would impair any usages specifically assigned to said Class, or cause undesirable or nuisance aquatic species associated with cultural eutrophication. Shall not exceed site-specific limits if deemed necessary by the Director to prevent or minimize accelerated or cultural eutrophication. Total phosphorus, nitrates and ammonia may be assigned site-specific permit limits based on reasonable Best Available Technologies.

RI WQR, Rule 8.D(3)(10)(Table 2); *see also* Rule 8.D(1)(d). The regulations also include requirements for minimum instantaneous DO levels and cumulative DO exposure, Rule 8.D(3) Table 3, and other applicable criteria including:

> At a minimum, all waters shall be free of pollutants in concentrations or combinations or from anthropogenic activities subject to these regulations that:
>
> i. Adversely affect the composition of fish and wildlife;
> ii. Adversely affect the physical, chemical, or biological integrity of the habitat;
> iii. Interfere with the propagation of fish and wildlife;
> iv. Adversely alter the life cycle functions, uses, processes and activities of fish and wildlife . . .

Rule 8.D(1).

i. Evidence of eutrophication and link to nitrogen discharges

Narragansett Bay, and particularly the Seekonk and Providence River estuaries which form its upper reaches, has suffered severe cultural eutrophication for many years. This cultural eutrophication results in periodic phytoplankton blooms, low DO levels and associated fish kills. Numerous studies have documented hypoxic conditions in the upper bay and Seekonk and Providence Rivers, with the worst conditions found at the upper boundary of the Seekonk River where the Blackstone River discharges. RIDEM, *Evaluation of Nitrogen Targets and WWTF Load Reductions for the Providence and Seekonk Rivers* (2004); Deacutis, et al., "Hypoxia in the Upper Half of Narragansett Bay, RI, During August 2001 and 2002," *Northeastern Naturalist*, 13 (Special Issue 4):173-198 (2006); Bergondo, et al., "Time-series observations during the low sub-surface oxygen events in Narragansett Bay during summer 2001," *Marine Chemistry*, 97, 90-103 (2005). In addition, important habitat has been destroyed: historic estimates of eel grass in Narragansett Bay ranged from 8,000 - 16,000 acres and current estimates of eel grass indicate that less than 100 acres remain. No eel grass remains in the upper two thirds of Narragansett Bay and the Providence River. Severe eutrophication is believed to be a significant contributor to the dramatic decline in eel grass. *See Governor's Narragansett Bay and Watershed Planning Commission, Nutrient and Bacteria Pollution Panel, Initial Report* (2004); RIDEM, *Evaluation of Nitrogen Targets and WWTF Load Reductions for the Providence and Seekonk Rivers* (2004); RIDEM, *Plan for Managing Nutrient Loadings to Rhode Island Waters* (2005).

It is clear that eutrophication in the Seekonk and Providence Rivers and Narragansett Bay has reached levels where it is adversely affecting the composition of fish and wildlife; adversely affecting the physical, chemical, and biological integrity of the habitat; interfering with the propagation of fish and wildlife; adversely altering the activities of fish and wildlife; and causing DO to drop well below allowable levels. The effects of eutrophication, including algae blooms and fish kills, are also interfering with the designated uses of the water. Eutrophication has, therefore, reached a point where it is causing violations of water quality standards.

Excessive loadings of nitrogen have been identified as the cause of the eutrophication. This link has been demonstrated by water quality data and by various studies and reports. The RIDEM report, titled *Evaluation of Nitrogen Targets and WWTF Load Reductions for the Providence and Seekonk Rivers* (December 2004), summarizes and references many of the studies and reports. RIDEM's 2004 report analyzes both water quality data and information about major discharges to the Providence and Seekonk Rivers. The report, drawing in part on data developed in earlier studies, divides the rivers into segments and analyzes pollutant loadings and specific water quality impairments in each segment. Much of the data used in the analysis is from a 1995 - 1996 study by RIDEM's Water Resources unit that consisted of measurements of nitrogen loadings from point source discharges and the five major tributaries to the Providence/Seekonk River system. The report also includes an analysis of data produced by a physical model of the Providence/Seekonk River system. That physical model was operated by the Marine Ecosystems Research Laboratory (MERL), and was part of an experiment to evaluate the impact of various levels of nutrient loading on the rivers and Narragansett Bay. EPA's guidance document *Nutrient Criteria Technical Guidance Manual, Estuarine and Coastal Marine Waters* (2001) cites the MERL experiments as compelling evidence that nitrogen criteria are necessary to control enrichment of estuaries.

The predominant sources of nitrogen loading in the Providence and Seekonk Rivers are municipal wastewater treatment facilities in Rhode Island and in Massachusetts. In 2006, the State of Rhode Island reissued several Rhode Island Pollutant Discharge Elimination System (RIPDES) permits for POTWs which discharge to the Providence and Seekonk Rivers and Narragansett Bay. These permits include limitations on the discharge of total nitrogen for a number of facilities, in order to address the cultural eutrophication in these waters and Narragansett Bay, consistent with the targets identified in the 2004 RIDEM Report. RIDEM, *Response to Public Comments Received on Proposed Permit Modification for the Fields Point, Bucklin Point, Woonsocket and East Providence WWTFs* (2006) In addition smaller Rhode Island facilities, not identified in the 2004 RIDEM Report, have had nitrogen optimization and other requirements placed in their permits as they have been (re)issued. *See* RIPDES Permit No. RI0100455, Burrillville WTP (2006).

The 2004 RIDEM Report also concluded that substantial reductions in loadings from the three largest Massachusetts POTWs on the Blackstone and Ten Mile Rivers would be necessary to achieve water quality standards in the Seekonk River and Upper Narragansett Bay. After reviewing the RIDEM studies and other relevant material and performing its own analysis, EPA agreed that nitrogen discharges from the Upper Blackstone Water Pollution Abatement District (UBWPAD) facility (on the Blackstone River) and the Attleboro and North Attleboro WWTFs (on the Ten Mile River) are contributing to impairments in Rhode Island. EPA therefore imposed effluent limits on those facilities that are designed to ensure attainment of water quality standards and are consistent with the 2004 RIDEM Report and Rhode Island's regulation of its in-state facilities. RIDEM updated this analysis to include other Massachusetts POTWs on these rivers, including the Uxbridge WWTF, in 2005 (see section 3(b)(ii)(a)(1) below); limits for these facilities are being analyzed as their permits are reissued. Requirements on these facilities will be implemented in order to achieve equitable regulation of WWTF discharges across the region, to reduce nutrient impacts and achieve acceptable levels of dissolved oxygen.

Monitoring reports submitted by the Uxbridge WWTF confirm that the facility discharges nitrogen to the Blackstone River, which flows into the Seekonk River where the greatest impairments in the Narragansett Bay Basin have been measured. Therefore EPA must determine whether the Uxbridge discharge "will cause, have reasonable potential to cause, or contribute to" a violation of water quality standards. 40 CFR §122.44(d)(1)(i). In doing so, EPA considers "existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, . . . and where appropriate, the dilution of the effluent in the receiving water." 40 CFR §122.44(d)(1)(ii).

Under the current permit the Uxbridge WWTF reports its discharges of ammonia and of "NO2 + NO3". Together these represent the dissolved inorganic nitrogen ("DIN") component of the facilities nitrogen discharges. While effluent limits are generally set in terms of total nitrogen, DIN was in fact the parameter used for analysis of the impact of nitrogen loadings in the RIDEM studies, and can be used to assess the facility's contribution to effects in the Seekonk River. The average DIN concentration in the Uxbridge discharge from 2005 through 2010, based on the DMRs, was 11.1 mg/l, giving a total load at design flow of 105 kg/day (231 lbs/day).

The Uxbridge discharge is located approximately 21 miles upstream of the impaired reaches in the Seekonk River, so EPA considered whether its nitrogen loading is significantly reduced by in-stream attenuation. There is conflicting evidence concerning the extent of attenuation, if any, within the Blackstone River, with estimates ranging from zero to 23%. *See* Nixon, et al., "Investigation of the Possible Attenuation of Dissolved Inorganic Nitrogen and Phosphorus in the Lower Blackstone River," *Anthropogenic Nutrient Inputs to Narragansett Bay – A Twenty-Five Year Perspective*, Appendix B (2005)); RIDEM, *Nutrient Permit Modifications – Response to Comments* (2005). For this analysis, EPA is applying the 13% attenuation rate used for UBWPAD discharges in the RIDEM 2004 Report based on 1995-96 monitoring data, adjusted proportional to the relative distance along the Blackstone River. This results in an attenuation rate of 6% for the Uxbridge discharge. Based on the studies and analyses previously referenced, EPA believes that this rate is a reasonable estimate. At this attenuation rate, the effective loading from the Uxbridge discharge to the Seekonk River is 99 kg/day (218 lbs/day).

To determine the impact of this loading on the Seekonk River, EPA considers the areally distributed load (load divided by area) in order to allow comparison to the results of the MERL experiment applied in the RIDEM 2004 Report. The MERL enrichment gradient experiment included a study of the impact of different loadings of nutrients on dissolved oxygen and chlorophyll a. *See* Oviatt, et al., "Patterns of Productivity During Eutrophication: A Mesocosm Experiment", *Marine Ecology* (1986); 2004 RIDEM Load Reduction Evaluation. The MERL enrichment gradient experiments consisted of 9 tanks (mesocosms). Three tanks were used as controls, and were designed to have regimes of temperature, mixing, turnover, and light similar to a relatively clean Northeast estuary with no major sewage inputs. The remaining six mesocosms had the same regimes, but were fed reagent grade inorganic nutrients (nitrogen, phosphorus and silica) in ratios found in POTW effluent discharged to the Providence River. The six mesocosms were fed nutrients in multiples of the estimated average sewage inorganic effluent nutrient loading to Narragansett Bay. For example the 1X mesocosm nitrogen loading was 40.3 mg/m^2/day, representing the average nutrient loading in the Narragansett Bay as a whole. The 2X was twice that (80.6 mg/m^2/day) and so on (4X, 8X, 16X) up to a maximum load of 32X. During the study, dissolved oxygen, chlorophyll, and dissolved inorganic nutrients were measured in the water column and benthic respiration was also measured. Id. From the collected data the investigators produced times series for oxygen, pH, temperature, nutrients, chlorophyll and system metabolism. Id. The study documented precipitous drops in dissolved oxygen levels with loadings above the 4X gradient, along with increasing and highly variable chlorophyll levels indicative of eutrophic conditions.

The areally distributed loading to the Seekonk River from the Uxbridge discharge alone is 35.2 $mg/m^2/day$. This compares to a "1X" loading in the MERL experiments of 40.3 $mg/m^2/day$, and indicates that even as one of the smaller wastewater plants discharging to this reach, the Uxbridge WWTF alone has the potential to contribute nitrogen levels to the Seekonk nearly matching the background areally distributed load to the bay as a whole. The Seekonk River is already the most enriched portion of the Narragansett Bay under natural conditions, with estimated natural background nitrogen inputs at the 4X level. RIDEM 2004. This makes this area especially vulnerable to overenrichment from wastewater treatment plant sources, and indeed the addition of the Uxbridge to background sources alone would be expected to reduce minimum DO levels from 3.0 mg/l to 2.75 mg/l under MERL experiment conditions. *See* RIDEM 2005 (Figure 4). Of course, the Seekonk River is far from background levels, with loadings as of 2005 estimated at the 24X level, indicating extreme over-enrichment. Effluent limits that have been placed on other wastewater treatments plants in Rhode Island and Massachusetts are expected to achieve an areal load equivalent to the 6.5X condition at current flows, and 10X at 90% design flows. However, this goal will not be reached if the Uxbridge discharge is not controlled.

Based on the available evidence, the Uxbridge discharge "will cause, have reasonable potential to cause, or contribute to" a violation of water quality standards in the Seekonk River and an effluent limit must be set.

ii. Nitrogen Effluent Limit

Having found that the discharge has a reasonable potential to cause an excursion over Rhode Island's narrative standard for the nutrient nitrogen, EPA is required to set an effluent limit for this pollutant. 40 CFR § 122.44(d)(vi). In setting a limit, EPA must ensure that:

> (A) The level of water quality to be achieved by limits on point sources established under this paragraph is derived from, and complies with all applicable water quality standards; and
>
> (B) Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with the assumptions and requirements of any available wasteload allocation for the discharge prepared by the State and approved by EPA pursuant to 40 CFR 130.7.

40 CFR § 122.44d(vii).

While Rhode Island DEM has not developed a TMDL or other wasteload allocation that has been approved pursuant to 40 CFR 130.7, RIDEM has performed a load allocation analysis that incorporates the Grafton and Uxbridge discharges and has proposed an effluent limit (8 mg/l) based on that analysis. While EPA is not bound by this analysis, EPA has reviewed the technical basis and allocation method applied in the RIDEM analysis and has determined that it generally represents a sound and technically valid approach. EPA has therefore agreed to process Massachusetts permits in a manner consistent with the RIDEM analysis. *See* EPA and RIDEM, *Performance Partnership Agreement Between the Rhode Island Department of Environmental Management and US Environmental Protection Agency Region 1* (2006), Appendix B. In doing so, however, EPA has an independent obligation both to ensure that the load allocation analysis remains valid, particularly in light of changes in circumstances since the initial analysis was developed five years ago, and to ensure that the level of water quality that will be achieved complies with the applicable water quality standards. We consider these questions in turn below.

a. RIDEM load allocation analysis and EPA Update

(1) RIDEM analysis

RIDEM's approach to allocating nitrogen loads has been to require higher removal rates from larger facilities than from smaller facilities (e.g. 5 mg/l for NBC Bucklin Point and UBWPAD; 8 mg/l for Attleboro and North Attleboro). RIDEM, *Evaluation of Nitrogen Targets and WWTF Load Reductions for the Providence and Seekonk Rivers* (2004) ("2004 RIDEM Report"). This is an accepted approach under EPA guidance for wasteload allocations. *See* EPA, *Technical Support Document for Water Quality-based Toxics Control*, EPA/505/2-90-001, at 69. In RIDEM's initial analysis of nitrogen loads, facilities as small as Grafton and Uxbridge were not considered in the analysis, with North Attleboro (at 4.6 MGD) the smallest facility included. *See* 2004 RIDEM Report. Subsequently, in 2005, RIDEM updated its analysis to incorporate three additional facilities on the Blackstone River – the Uxbridge, Grafton and Millbury WWTFs – based on a calibrated/validated Qual2e model. This analysis is summarized in the 2005 *Response to Comments Received on Proposed Permit Modifications for the Fields Point, Bucklin Point, Woonsocket and East Providence WWTFs*, Appendix A ("2005 RIDEM RTC"). *See* Michaelis, B., *Dissolved Oxygen Dynamics in a Shallow Stream System,* Dissertation in Civil and Environmental Engineering at the University of Rhode Island (URI 2005). That analysis indicated that under design flows and 2005 permit limits for ammonia and phosphorus, the load at the MA/RI state line from the MA POTWs discharging to the Blackstone was expected to be 4,319 lbs/day. Figure 3. Uxbridge contributes 295 lbs/day (7% of the total) of this load.

The 2005 RIDEM RTC does not specifically set forth the loading target in the Seekonk River to be achieved at the proposed permit limits, but this can be calculated from the proposed effluent limits and design flows as shown in Table 3 below, giving a target load allocation to Massachusetts facilities of 1488 lbs/day DIN at the MA/RI state line. This represents a 65% reduction in loads at design flow from the Massachusetts facilities on the Blackstone River (e.g. 4319 to 1488 lbs/day), consistent with the RIDEM assertion in the 2005 RIDEM RTC that the proposed limits will reduce the total loading to the Seekonk River by 62%.

Figure 3: Table from Rhode Island load analysis

Table 3. Percent delivery and percent contribution of MA WWTF to the MA/RI state line under DWS3 at design flows and currently required permit limits for ammonia and phosphorus.

			At MA/RI state line	
Point Source	Initial Load at end of pipe (lb/day)	Final Load at MA/RI state line (lb/day)	Delivery (%)	Contribution (%)
UBWPAD	3780	3493	92	79
Millbury WWTF	336	312	93	7
Grafton WWTF	239	219	92	5
Uxbridge WWTF	300	295	98	7
Total WWTF	4655	4319	93	98

* Note "DWS3" indicates the model run under flow conditions from August 2005 ("dry weather survey 3").

Table 3. Load Allocation at State Line per RIDEM Analysis

						At MA/RI State Line	
Point Source	Design flow (MGD)	90% of Design Flow (MGD)[1]	Proposed total N permit limit (mg/l)	DIN component of permit limit (mg/l)[2]	DIN load discharged at limit (lb/day)	DIN load at MA/RI state line	Delivery Factor (%)[3]
UBWPAD	56	50.4	5	3	1261	1165	92%
Millbury WWTF	2.7	2.43	8	6	122	113	93%
Grafton WWTF	2.4	2.16	8	6	108	99	92%
Uxbridge WWTF	2.5	2.25	8	6	113	111	98%
Total WWTF					1603	1488	93%

[1] Loads are calculated using 90% of design flow consistent with RIDEM's methodology in the 2004 RIDEM Report

[2] Non-DIN component of total N assumed to be 2 mg/l per the 2004 RIDEM Report.

[3] Delivery factors from the 2005 RIDEM RTC; for discussion of delivery factors see Attachment C.

(2) EPA Update of RI analysis

In applying this load allocation analysis to the reissuance of permits to the Grafton and Uxbridge WWTFs, EPA notes that (1) several other facilities on the Blackstone River and its tributaries were not explicitly considered by RIDEM in its analysis; and (2) the Millbury WWTF is no longer discharging, having tied into UBWPAD. Table 4 shows the current MA dischargers to the Blackstone River system and their seasonal loads based on monitoring data from 2007-09.

Table 4. Current DIN Loadings to Blackstone River from WWTFs

POTW	May-Oct, 2007 to 2009 DMR data Flow (MGD)	DIN (mg/l)	DIN load discharged (lb/day)
UBWPAD	33.5	7.35	1995
Douglas	0.3	5.5	15
Grafton	1.8	10.5	186
Hopedale[1]	0.4	10.7	32
Northbridge	0.9	11.3	75
Upton	0.19	14.9	24
Uxbridge	0.8	10.9	67
		TOTAL:	2,394

[1] The Hopedale facility monitors total N only; DIN calculated by subtracting 2 mg/l from total N per 2004 RIDEM Report.

The omission of Douglas, Hopedale, Northbridge and Upton from RIDEM's analysis was presumably based RIDEM's conclusion that these contributions are *de minimis*, based on the size of the discharger and/or location of the discharger on a tributary to the Blackstone River. While EPA agrees with this determination with respect to Douglas, Hopedale and Upton, we note that it does not appear that the Northbridge WWTF contribution is negligible. Northbridge's current flow, effluent DIN concentration and DIN loads are higher than those of Uxbridge, and while Northbridge discharges to a tributary it is less than 200 yards from the mainstem Blackstone River, unlikely to substantially reduce the delivery of nitrogen to the Blackstone River. For these reasons EPA is including Northbridge in its updated load allocation analysis. The revised load analysis, excluding Millbury WWTF but including Northbridge, is set forth in Table 5.

Table 5. Updated Load Analysis at State Line Using RIDEM Methodology

Point Source	Design flow (MGD)	90% of Design Flow (MGD)[1]	Proposed total N permit limit (mg/l)	DIN component of permit limit (mg/l)[2]	Initial DIN load (lb/day)	At MA/RI State Line: Final DIN load at MA/RI state line	Delivery (%)[3]
UBWPAD	56	50.4	5	3	1261	1165	92%
Grafton WWTF	2.4	2.16	8	6	108	99	92%
Uxbridge WWTF	2.5	2.25	8	6	113	111	98%
Alternatives for Northbridge discharge:							
1. Northbridge at current concentration				Current DIN from DMR			
Northbridge	2	1.8	--	11.3	170	155	92%
Total WWTF						1530	
2. Northbridge with permit limit of 8 mg/l			N limit	DIN component			
Northbridge	2	1.8	8	6	90	83	92%
Total WWTF						1458	

[1] Loads are calculated using 90% of design flow consistent with RIDEM's methodology in the *2004 RIDEM Report*

[2] Non-DIN component of total N assumed to be 2 mg/l per the *2004 RIDEM Report.*

[3]Delivery factors from the 2005 RIDEM RTC; for further discussion of delivery factors see Attach. C

As shown in Table 5, the load allocation target is not met if Northbridge discharges at design flow at its current DIN levels, but would be met if Northbridge had an effluent limit similar to that proposed for Grafton and Uxbridge. EPA will consider whether to impose a limit on Northbridge, including conducting further analysis of the appropriate delivery factor, upon reissuance of the Northbridge WWTF permit.

For the purposes of the Grafton and Uxbridge permits, the analysis shows that the RIDEM load allocation can be met and that effluent limits on these discharges consistent with the RIDEM proposal are necessary in order to meet that load allocation. While the Millbury discharge has been tied into UBWPAD and therefore is accounted for in the UBWPAD load allocation, the need to account for the Northbridge discharge eliminates any load reduction that might be achieved eliminating an allocation for Millbury. Therefore it is EPA's intent that the permit limits in the Grafton and Uxbridge reissued permits will be consistent with the load allocation analysis above.

b. Water Quality Analysis

EPA is also obligated to ensure that the proposed effluent limits will achieve a level of water quality that complies with the applicable water quality standards. Since the load allocation analysis discussed above is not from an approved TMDL or waste load allocation, EPA as the permitting authority must independently demonstrate that this standard is met. In doing so, EPA draws from the analysis set forth in connection with the issuance of the UBWPAD permit. *See* EPA, *Fact Sheet, Upper Blackstone Water Pollution Abatement District*, NPDES No. MA0102369 (2006); EPA, *Response to Comments, Upper Blackstone Water Pollution Abatement District*, NPDES No. MA010 (2008); *In re Upper Blackstone Water Pollution Abatement District*, 14 E.A.D. __ (2010).

(1) Loading rate to meet water quality standards

In the UBWPAD permit issuance, EPA concluded that an overall loading rate from all facilities (MA and RI) equivalent to the "6.5X" MERL experiment gradient under current flows, or 1,624 lbs/day[7] was appropriate to ensure that water quality standards in the Seekonk River were met. This conclusion was based on guidance documents, studies of the Seekonk and Providence Rivers and Narragansett Bay, and on an analysis of the application of the MERL experiment results to the Seekonk River. *See* EPA, *Response to Comments, UBWPAD*, at 28-29 and documents cited. It should be noted that the effluent limit established to meet that water quality target was challenged by both the UBWPAD (as too stringent) and by the Conservation Law Foundation (as too lenient) and was upheld on appeal by the Environmental Appeals Board. 14 E.A.D __ (slip op. at 23).

EPA's application of the MERL experiments to determine an acceptable loading for the Seekonk River is based on its conclusion that those experiments provide a suitable analog to the actual river system. As EPA noted in the UBWPAD Response to Comments:

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[7] Calculated from the 1X MERL load of 4.032×10^{-5} kg/m^2/day, times the area of the Seekonk River ($2.81 * 10^6$ m^2), times the conversion factor (2.2046 lbs/kg), times 6.5. See 2004 RIDEM Report.

> The basic relationship demonstrated by the MERL tank experiments between the primary causal and response variables relative to eutrophication corresponds to what is actually occurring in the Providence/Seekonk River system. Both the MERL tank experiments and the data from the Providence/Seekonk River system indicate a clear correlation between nitrogen loadings, dissolved oxygen impairment and chlorophyll *a* levels.

Response to Comments, UBWPAD at 29; *see also id.* at 47-49.

EPA has also noted that the MERL experiments do not perfectly replicate the physical system, and accounted for that fact in applying the MERL loading analysis to determine a water quality target. This also was discussed in connection with the UBWPAD permit:

> EPA recognized, however, that the MERL tank experiments cannot completely simulate the response of chlorophyll *a* and dissolved oxygen to nitrogen loadings in a complex, natural setting such as the Providence/Seekonk River system, and thus does not yield a precise level of nitrogen control required to restore uses in the system. For example, dissolved oxygen in Narragansett Bay is influenced by stratification, which was not simulated in the MERL tank experiment, in which waters were routinely mixed. In a stratified system there is little vertical mixing of water, so sediment oxygen deficits are exacerbated, due to the lack of mixing with higher DO waters above. In addition, the flushing rate used in the MERL tanks is not the same as seen in the Bay. Because the physical model does not generate a definitive level of nitrogen control that can be applied to a real world discharge, but instead a range of loading scenarios which are subject to some scientific uncertainty, EPA was required to exercise its technical expertise and scientific judgment based on the available evidence when translating these laboratory results and establishing the permit limit.

Response to Comments, UBWPAD at 49. Thus, while RIDEM has suggested that the MERL experiments might indicate a 4X condition as a goal for the Seekonk River, 2004 RIDEM Report at 25, EPA concluded that the differences between the MERL experiments and the actual physical system, particularly the difference in flushing rates, indicated that the 6.5X target was appropriate.

EPA continues to believe that the water quality target established in the UBWPAD permit development represents an appropriate level of water quality to ensure that standards are met in the Seekonk and Providence River, based on the best available current information. Therefore, EPA applies the 6.5X load target to determine whether the load allocation will comply with water quality standards.

(2) Effluent limits required to meet water quality standards

To determine whether the proposed effluent limits will meet the 6.5X target under current flows, EPA calculates the total load to the Seekonk River assuming that effluent concentrations are at the permit limits and flows are equal to the 2007 to 2009 May to October flows from the facilities' DMR submissions. Current flows are used in this analysis consistent with the analysis of the UBWPAD permit limit that has been upheld on appeal. *See In re Upper Blackstone Water*

Pollution Abatement District, 14 E.A.D. __(2010). A delivery factor is applied to account for attenuation in the Blackstone River (and the Ten Mile River for Attleboro and North Attleboro) before discharge to the Seekonk River; the derivation of these delivery factors is discussed in Attachment C. The contribution of each facility and the total load to the Blackstone River is shown in Table 6. Consistent with Table 5 showing the RIDEM load analysis update, totals are shown both with and without limits on Northbridge since Northbridge was originally omitted from the RIDEM analysis.

Table 6. Effluent limits to meet water quality standard

Source	Current Flow (MGD)	Limit (mg/l)	DIN component (mg/l)	DIN (lbs/day)	Delivery factor[1]	DIN load to Seekonk River (lbs/day)
UBWPAD	33.5	5	3	838	87%	729
Woonsocket	6.3	3	1	53	96%	50
Bucklin	17.9	5	3	448	100%	448
Attleboro	3.8	8	6	190	61%	116
North Attleboro	3.42	8	6	171	61%	104
Grafton WWTF	1.74	8	6	87	90%	78
Uxbridge WWTF	0.8	8	6	40	94%	38
Alternatives for Northbridge Discharge						
1. Northbridge at current concentration			Current DIN from DMR			
Northbridge	0.88	---	11.3	83	91%	75
			Total DIN load at mouth of Blackstone:			**1639**
2. Northbridge with permit limit of 8 mg/l			DIN component of limit			
Northbridge	0.88	8	6	44	91%	40
			Total DIN load at mouth of Blackstone:			**1604**
[1] For Blackstone River delivery factors, see Appendix A; Attleboro and North Attleboro delivery factors from 2004 RIDEM Report						

Given the water quality target loading of 1,624 pounds per day, this analysis indicates that effluent limits on Uxbridge, Grafton and Northbridge are necessary to meet the water quality target at current flows.

c. Nitrogen Effluent Limit

As demonstrated above, an effluent limit of 8 mg/l on the Grafton and Uxbridge discharges satisfies both the RIDEM load allocation and the water quality target identified by EPA in the UBWPAD permit proceedings. Therefore, the draft permit includes a limit of 8 mg/l total nitrogen for the period May to October. The draft permit for Grafton WWTF, which is being issued concurrently with this draft permit, also establishes total nitrogen limit of 8 mg/l.

4. Total Residual Chlorine

Chlorine and chlorine compounds produced by the chlorination of wastewater can be extremely toxic to aquatic life. Effluent limits are based on water quality criteria for total residual chlorine (TRC) which are specified in EPA water quality criteria established pursuant to Section 304(a) of the Clean Water Act. The most recent EPA recommended criteria are found in National Recommended Water Quality Criteria: 2002 (EPA-822-R-02-047). The fresh water aquatic life criteria for TRC are 11 ug/l for protection from chronic toxicity and 19 ug/l for protection from acute toxicity.

The 1999 Fact Sheet, issued in connection with the existing permit, lists the 7Q10 flow of the Blackstone River at the Uxbridge WWTF as 53.3 MGD, or 82.7 cfs. This figure was based on the Waste Load Allocation model, as shown in the Response to Comments issued in connection with the current permit. See Attachment B. EPA will continue to use a 7Q10 Flow of 53.3 MGD to calculate the dilution factor for this facility. The dilution factor is calculated as follows:

$$\frac{\text{plant design flow} + \text{7Q10 river flow}}{\text{plant design flow}} = \frac{2.5\text{ MGD} + 53.3\text{ MGD}}{2.5\text{ MGD}} = 22$$

The 7Q10 dilution multiplied by the chronic and acute criteria provides the appropriate TRC limits. Thus:

11 ug/l(chronic criterion) * 22 (dilution factor) = 242 ug/l or **0.24 mg/l** (avg mnthly limit)
19 ug/l (acute criterion) * 22 (dilution factor) = 418 ug/l or **0.42 mg/l** (max daily limit)

These are the same as the effluent limits contained in the current permit.

EPA and MassDEP recognize that there are limitations in using grab sampling for determining compliance with the chlorine limit. There are complexities and variability associated with the chlorine demand of wastewater as well as the complexities associated with controlling and coordinating the dosing of chlorine and dechlorination chemicals. Therefore, an alarm requirement has been established in this draft permit to assure that a proper range of chlorination is maintained at all times. See footnote 7 on Page 4 of the draft permit.

5. Whole Effluent Toxicity

National studies conducted by EPA have demonstrated that domestic sources contribute toxic constituents to POTWs. These constituents include metals, chlorinated solvents and aromatic hydrocarbons among others. The Region's current policy is to include toxicity testing requirements in all municipal permits, while Section 101(a)(3) of the CWA specifically prohibits the discharge of toxic pollutants in toxic amounts.

Based on the potential for toxicity resulting from domestic and industrial contributions, the low level of dilution at the discharge location, water quality standards, and in accordance with EPA regulation and policy, the draft permit includes acute toxicity limitations and monitoring requirements. (*See, e.g.*, "Policy for the Development of Water Quality-Based Permit

Limitations for Toxic Pollutants", 50 Fed. Reg. 30,784 (July 24, 1985); *see also*, EPA, *Technical Support Document for Water Quality-Based Toxics Control*). EPA Region I has developed a toxicity control policy. The policy requires wastewater treatment facilities to perform toxicity bioassays on their effluents. The MassDEP requires bioassay toxicity testing for state certification.

Pursuant to EPA Region 1 policy, discharges having a dilution ratio of between 20:1 and 100:1 are required to perform acute toxicity testing. The principal advantages of biological techniques are: (1) the effects of complex discharges of many known and unknown constituents can be measured only by biological analyses; (2) bioavailability of pollutants after discharge is best measured by toxicity testing including any synergistic effects of pollutants; and (3) pollutants for which there are inadequate chemical analytical methods or criteria can be addressed. Therefore, toxicity testing is being used in conjunction with pollutant specific control procedures to control the discharge of toxic pollutants.

Semiannual whole effluent toxicity (WET) testing has been conducted during the past five years. Results during the monitoring period have consistently shown an LC50 of 100%. The requirement to test the vertebrate species, *Pimephales promelas* was removed with the permit modification of May 18, 1993. The testing frequency was reduced with this modification from four to two tests per year due to past results which met the permit limits. The draft permit requires that the Town continue to conduct WET testing for Outfall 001 effluent two times per year and that each test include the use of the daphnid, *Ceriodaphnia dubia*, in accordance with EPA Region I protocol found in **Attachment A.**

By letter of October 18, 1990, the EPA granted the Town of Uxbridge the authorization to use an alternate dilution water to the Blackstone River water for its WET testing. The Blackstone River water was found to be unreliable for use as a dilution water for WET testing. In recent WET testing where receiving water controls were carried out, the receiving water has met test acceptability criteria for use as a dilution water. Therefore the draft permit requires the use of the receiving water for dilution. Procedures for substituting an alternate dilution water are available should toxicity issue arise again, as discussed in Footnote 11 on Page 5 of the permit. If alternate dilution water tests are conducted, the permittee must use a minimum of two controls, one of which must be Blackstone River water. Chemical analyses must be provided for the Blackstone River water as well as the effluent.

6. Other Toxic Pollutants

The draft permit includes a new monthly average effluent limit for aluminum.

The segment of the Blackstone River to which the Uxbridge WWTF discharges is listed on the Massachusetts 303(d) list for an impairment caused by "metals." Examination of effluent analysis conducted in connection with WET testing in the past five years indicates that the Uxbridge WWTP discharges have included detectable levels of the metals aluminum, copper, lead and zinc. EPA therefore analyzed the available data on effluent and receiving water concentrations to determine whether these pollutants "are or may be discharged at a level that causes, has reasonable potential to cause, or contributes to an excursion above" the water quality standard. 40 CFR 122.44(d)(1)(i). Since there have been no discharges of cadmium above the detection limit, and the single lead result above the detection limit was below the water quality criteria, there is no reasonable potential for the Uxbridge effluent to contribute to excursion above the water quality criteria for cadmium and lead.

Table 5 shows the concentrations of metals in the Uxbridge effluent from April 2005 through April 2011, along with receiving water analyses beginning November 2009. Prior to 2010, Uxbridge's analyses were performed using insufficiently sensitive methods for metals, especially a concern with respect to cadmium and lead. Upon notice from EPA, Uxbridge corrected the issue with their contract laboratory. EPA has concluded that the data provided is sufficient for its analysis of effluent limits for this permit reissuance.

Table 7. Whole Effluent Testing Analytical Data and Water Quality Criteria

	Effluent Analytical Data[1]					Receiving Water Analytical Data[1]				
	Al	Cd	Cu	Pb	Zn	Al	Cd	Cu	Pb	Zn
	ug/l	$ug/l_{total\ recoverable}$[2]				ug/l	$ug/l_{total\ recoverable}$[2]			
4/26/2005	240	ND-5	13	ND-10	50					
11/15/2005	120	ND-5	20	ND-10	ND-50					
5/9/2006	198	ND-5	17	ND-10	74					
11/14/2006	210	ND-5	16	ND-10	ND-50					
5/15/2007	ND-100	ND-5	ND-10	ND-10	ND-50					
12/12/2007	120	ND-5	ND-10	ND-10	ND-50					
12/16/2008	270	ND-5	10.2	ND-10	ND-50					
1/23/2009	ND-100	ND-5	ND-10	ND-10	ND-50					
5/5/2009	120	ND-5	10	ND-10	ND-50					
11/3/2009	170	ND-5	12	ND-10	ND-50	120	ND-0.5	ND-10	ND-10	ND-50
5/11/2010	73	ND-0.2	10.9	ND-0.5	37.9	172	0.6	18.4	5.9	2.8
11/16/2010[2]	98	ND-0.5	10.6	ND-0.5	40	124	ND-0.5	8	2.2	19.7
4/26/2011	50	ND-0.2	6.4	ND-0.5	35	114	0.3	1.7	2.5	32
10/25/2011	76	ND-0.5	10.6	0.3	37.8	122	0.3	9.8	2.8	25.7
5/1/2012	32	ND-0.2	5	ND-1.0	37	324	0.6	13	6	24
Median	120	ND	10.6	ND	50	123	0.50	9.9	4.4	24.9
Max	270	ND	20	ND	74					

	Water Quality Criteria				
	ug/l	$ug/l_{dissolved}$[3]			
Chronic Criterion[4]	87	0.2	18.1	1.6	82.4
Acute Criterion[4]	750	1.3	27.2	41.0	83.0

[1] Non-detects noted as " ND - [minimum detection level]"

[2] Samples for effluent and receiving water were switched in initially submitted reports; these are corrected data

[2] Water quality criteria are expressed in terms of the dissolved fraction, while analytical results and permit effluent limits are expressed in terms of total recoverable metal; these are related by a conversion factor as set forth in EPA, National Recommended Water Quality Criteria 2002 ("NRWQC 2002")

[3] Criteria for Cd, Pb and Zn are hardness dependent and calculated using the formulas set forth in the NRWQC 2002 at a hardness of 66 (based on minimum hardness at low flow in Millville, MA from Louis Berger Report).

For aluminum, the effluent and receiving water monitoring data clearly indicate the need for an effluent limit. More than half of the effluent monitoring results indicate aluminum levels above the chronic water quality criterion of 87 ug/l. The receiving water is also above the chronic water quality criterion, as all of the receiving water samples were above 87 ug/l.

The receiving water does not provide dilution for discharges of aluminum, so the draft permit includes monthly average effluent limits set at the chronic criterion of 87 ug/l. The data does not indicate a reasonable potential to exceed the acute criterion for aluminum, so no maximum daily limit is set.

For copper and zinc, a more detailed analysis must be performed to determine the upper bound expected concentration and determine if the discharge has a reasonable potential to cause a violation. EPA bases its determination of "reasonable potential" on a characterization of the upper bound of expected effluent concentrations based on a statistical analysis of the available monitoring data. As noted in the *Technical Support Document for Water Quality Based Toxics Control* (EPA 1991) ("TSD"), "[a]ll monitoring data, including results for concentrations of individual chemicals, have some degree of uncertainty associated with them. The more limited the amount of test data available, the larger the uncertainty." Thus with a limited data set, the maximum concentration that has been found in the samples may not reflect the full range of effluent concentration. On the other hand, individual high data points may be outliers or otherwise not indicative of the normal range of effluent concentrations.

To account for this, EPA has developed a statistical approach to characterizing effluent variability in order to reduce uncertainty in the process. As "experience has shown that daily pollutant discharges are generally lognormally distributed," *TSD* at App. E, EPA uses a lognormal distribution to model the shape of the observed data, unless analysis indicated a different distributional model provides a better fit to the data. The model parameters (mean and variance) are derived from the monitoring data.

The lognormal distribution generally provides a good fit to environmental data because it is bounded on the lower end (i.e. you cannot have pollutant concentrations less than zero) and is positively skewed. It also has the practical benefit that if an original lognormal data set X is logarithmically transformed (i.e. Y = ln[X]) the resulting variable Y will be normally distributed. Then the upper percentile expected values of X can be calculated using the z-score of the standardized normal distribution (i.e. the normal distribution with mean = 0 and variance = 1), a common and relatively simple statistical calculation. The p^{th} percentile of X is estimated by

$$X_p = \exp(\mu_y + z_p\,\sigma_y),$$

where μ_y = mean of Y
σ_y = standard deviation of Y
$Y = \ln[X]$

For the 95^{th} and 99^{th} percentiles, $z_{95} = 1.645$ and $z_{99} = 2.326$, so that

$$X_{95} = \mu_y + 1.645\,\sigma_y$$
$$X_{99} = \mu_y + 2.326\,\sigma_y$$

These upper percentile values are used to determine whether a discharge has a reasonable potential to cause or contribute to an exceedance of a water quality standard. For reasonable potential to exceed the acute criterion, which is based on acute effects with one hour of exposure to the pollutant, the 99th percentile is used to represent the maximum expected pollutant level. For the chronic criterion, representing a four day exposure, the 95th percentile value is used. The combination of these upper bound effluent concentrations with dilution in the receiving water is calculated to determine whether the water quality criteria will be exceeded. The *TSD* also includes a procedure for determine such percentiles when the dataset includes non-detect results, as is the case for Uxbridge, based on a delta-lognormal distribution.

The statistical analyses for copper and zinc in Uxbridge's discharges are set forth in Attachment D. For copper, the 95th percentile expected concentration is 20.1.8 ug/l, while the 99th percentile is 26.4 ug/l. For zinc, the 95th percentile expected concentration is 59.8 ug/l, while the 99th percentile is 73.6 ug/l.

The receiving water concentration is calculated taking into account dilution at 7Q10 conditions, through a mass balance equation that accounts for concentrations in the Blackstone River upstream of the discharge as reported in the facility's WET test reports:

$$\text{Receiving water concentration } (C_r) = \frac{(C_d * Q_d + C_s * Q_s)}{(Q_d + Q_s)} \quad \text{; where}$$

C_d = upper bound effluent concentration data (99th percentile for acute criteria; 95th percentile for chronic criteria)
Q_d = Design flow of facility
C_s = Median concentration in Blackstone River upstream of discharge
Q_s = 7Q10 streamflow in Blackstone River upstream of discharge

Table 8 shows the result of the mass balance equations. The predicted receiving water concentration ($Cr_{dissolved}$) is less than the relevant criterion for each of these metals. Therefore the Uxbridge discharge does not present a reasonable potential to exceed water quality standards for these pollutants, and no effluent limits are required.

Table 8. Mass Balance calculations

	Qd	Cd	Qs	Cs	Qr = Qd+Qs	Cr_{tr}= (QdCd+QsCs)/Qr	$Cr_{dissolved}$	Criterion
Cu chronic	2.5	20.07	53.3	9.9	55.8	10.4	9.9	18.1
Cu acute		26.41		9.9		10.6	10.2	25.7
Zn chronic		59.82		24.9		26.5	26.1	79.9
Zn acute		73.59		24.9		27.1	26.5	79.2

VII. Sewer System Operation and Maintenance

EPA regulations set forth a standard condition for "Proper Operation and Maintenance" that is included in all NPDES permits. *See* 40 CFR § 122.41(e). This condition is specified in Part II.B.1 (General Conditions) of the draft permit and it requires the proper operation and maintenance of all wastewater treatment systems and related facilities installed or used to achieve permit conditions.

EPA regulations also specify a standard condition to be included in all NPDES permits that specifically imposes on permittees a "duty to mitigate." *See* 40 CFR § 122.41(d). This condition is specified in Part II.B.3 of the draft permit and it requires permittees to take all reasonable steps – which in some cases may include operations and maintenance work - to minimize or prevent any discharge in violation of the permit which has the reasonable likelihood of adversely affecting human health or the environment.

Proper operation of collection systems is critical to prevent blockages and equipment failures that would cause overflows of the collection system (sanitary sewer overflows, or SSOs), and to limit the amount of non-wastewater flow entering the collection system (inflow and infiltration or I/I[8]). I/I in a collection system can pose a significant environmental problem because it may displace wastewater flow and thereby cause, or contribute to causing, SSOs. Moreover, I/I could reduce the capacity and efficiency of the treatment plant and cause bypasses of secondary treatment. Therefore, reducing I/I will help to minimize any SSOs and maximize the flow receiving proper treatment at the treatment plant. MassDEP has stated that the inclusion in NPDES permits of I/I control conditions is a standard State Certification requirement under Section 401 of the CWA and 40 CFR § 124.55(b).

Therefore, specific permit conditions have been included in Part I.B. and I.C. of the draft permit. These requirements include mapping of the wastewater collection system, preparing and implementing a collection system operation and maintenance plan, reporting unauthorized discharges including SSOs, maintaining an adequate maintenance staff, performing preventative maintenance, controlling infiltration and inflow to the extent necessary to prevent SSOs and I/I related-effluent violations at the wastewater treatment plant, and maintaining alternate power where necessary. These requirements are intended to minimize the occurrence of permit violations that have a reasonable likelihood of adversely affecting human health or the environment.

Several of the requirements in the draft permit are not included in the current permit, including collection system mapping, and preparation of a collection system operation and maintenance plan. EPA has determined that these additional requirements are necessary to ensure the proper operation and maintenance of the collection system and has included schedules for completing these requirements in the draft permit.

VIII. Sewage Sludge Information and Requirements

According to its permit application, the Uxbridge WWTF generates about 262 dry metric tons of sludge per year. The sludge is aerated and then sent through a gravity thickener. This processed sludge is hauled to the Synagro site in Woonsocket, Rhode Island where it is dewatered and

[8] "Infiltration" is groundwater that enters the collection system through physical defects such as cracked pipes, or deteriorated joints. "Inflow" is extraneous flow entering the collection system through point sources such as roof leaders, yard and area drains, sump pumps, manhole covers, tide gates, and cross connections from storm water systems.

incinerated. In February 1993, (EPA promulgated standards for the use and disposal of sewage sludge. The regulations were promulgated under the authority of §405(d) of the (CWA. Section §405(f) of the CWA requires that these regulations be implemented through permits. This permit is intended to implement the requirements set forth in the technical standards for the use and disposal of sewage sludge, commonly referred to as the Part 503 regulations. Section 405(d) of the CWA requires that sludge conditions be included in all municipal permits. The sludge conditions in the draft permit satisfy this requirement and are taken from EPA's Standards for the Disposal of Sewage Sludge at 40 CFR Part 503. These conditions are outlined in the draft permit.

IX. Essential Fish Habitat Determination (EFH)

Under the 1996 Amendments (PL 104-267) to the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801 et seq. (1998)), EPA is required to consult with the National Marine Fisheries Services (NMFS) if EPA's action or proposed actions that it funds, permits, or undertakes, may adversely impact any EFH such as: waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. § 1802 (10)). Adversely impact means any impact which reduces the quality and/or quantity of EFH (50 C.F.R. § 600.910 (a)). Adverse effects may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

EFH is only designated for species for which federal fisheries management plans exist (16 U.S.C. § 1855(b) (1) (A)). EFH designations for New England were approved by the U.S. Department of Commerce on March 3, 1999. A review of the relevant essential fish habitat information provided by NMFS indicates that EFH has been designated for 33 managed species within the NMFS boundaries encompassing Narragansett Bay, which the Blackstone River discharges to, via the Seekonk River and the Providence River. *See* NOAA, Summary of Essential Fish Habitat, Narragansett Bay, RI (http://www.nero.noaa.gov/hcd/ri1.html). It is possible that a number of these species utilize the downstream Rhode Island waters for spawning, while others are present seasonally.

Based on the relevant information examined, EPA finds that the reissuance of this permit will adequately protect EFH for the following reasons:

- The Uxbridge discharge is located more than 20 miles upstream of designated EFH habitat;
- The dilution factor at the point of discharge is 22:1, and effective dilution in the area of EFH designated habitat will be significantly greater;
- The draft permit contains new nitrogen limits to ensure that the discharge does not contribute to nutrient-related water quality violations in the Seekonk and Providence River;
- The permit is designed to ensure that all water quality standards are met in the receiving water, both in Massachusetts and Rhode Island.

EPA believes that the draft permit limits adequately protect all designated EFH, and therefore additional mitigation is not warranted. If adverse impacts to EFH are detected as a result of this permit action, or if new information is received that changes the basis for our conclusion, NOAA Fisheries will be notified and an EFH consultation will be initiated.

X. Endangered Species Act

Section 7(a) of the Endangered Species Act (ESA) of 1973, as amended grants authority to and imposes requirements upon Federal agencies regarding endangered or threatened species of fish, wildlife, or plants ("listed species") and habitat of such species that has been designated as critical (a "critical habitat"). The ESA requires every Federal agency, in consultation with and with the assistance of the Secretary of Interior, to insure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The U.S. Fish and Wildlife Service (USFWS) typically administers Section 7 consultations for bird, terrestrial, and freshwater aquatic species. NMFS typically administers Section 7 consultations for marine species and anadromous fish.

EPA has reviewed the list of federal endangered or threatened species of fish, wildlife, and plants to see if any such listed species might potentially be impacted by the reissuance of this NPDES permit and has not found any such listed species in the vicinity of the discharge. Therefore, EPA does not need to formally consult with NMFS or USFWS in regard to the provisions of the ESA.

XI. Monitoring and Reporting

The effluent monitoring requirements have been established to yield data representative of the discharge under authority of Section 308 (a) of the CWA in accordance with 40 CFR §§122.41 (j), 122.44 (l), and 122.48.

The Draft Permit requires that the permittee submit all monitoring data and other reports required by the permit to EPA using NetDMR. NetDMR is a national web-based tool for regulated CWA permittees to submit DMRs electronically via a secure Internet application to U.S. EPA through the Environmental Information Exchange Network. NetDMR allows participants to discontinue mailing in hard copy forms under 40 CFR § 122.41 and § 403.12. NetDMR is accessed from the following url: http://www.epa.gov/netdmr. Further information about NetDMR, including contacts for EPA Region 1, is provided on this website.

The Draft Permit requires the permittee to report monitoring results obtained during each calendar month using NetDMR, no later than the 15th day of the month following the completed reporting period. All reports required under the permit shall be submitted to EPA as an electronic attachment to the DMR. Permittees must continue to send hard copies of reports other than DMRs to MassDEP until further notice from MassDEP.

XII. State Certification Requirements

EPA may not issue a permit unless MassDEP certifies that the effluent limitations included in the permit are stringent enough to assure that the discharge will not cause the receiving water to violate State water quality standards, or waives certification. EPA has requested permit certification by the State pursuant to 40 CFR §124.53 and expects the draft permit will be certified.

XIII. Comment Period, Public Hearing, and Procedures for Final Decisions

All persons, including applicants, who believe any condition of the permit is inappropriate must raise all issues and submit all available arguments and all supporting material for their arguments in full by the close of the public comment period to Susan Murphy, U.S. Environmental Protection Agency, 5 Post Office Square, Suite 100 (OEP06-1), Boston, MA 02109. At the request of the applicant, the Regional Administrator finds significant public interest for the holding of a public hearing on this permit, scheduled for October 25, 2012 at the Uxbridge Senior Center. In reaching a final decision on the draft permit the Regional Administrator will respond to all significant comments and make these responses available to the public at EPA's Boston office.

Following the close of the comment period, and after the public hearing, if held, the Regional Administrator will issue a final permit decision and forward a copy of the final decision to the applicant and to each person who has submitted written comments or requested notice.

XIV. EPA and MassDEP Contacts

Requests for additional information or questions concerning the draft permit may be addressed Monday through Friday, between the hours of 9:00 a.m. and 5:00 p.m., to :

Susan Murphy
U.S. Environmental Protection Agency
5 Post Office Square, Suite 100 (OEP06-1)
Boston, MA 02109
Telephone: (617) 918-1534 Fax: (617) 918-0534
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Kathleen Keohane
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627 Main Street, 2nd Floor
Worcester, MA 01608
Telephone: (508)-767-2856 Fax: (508) 791-4131
Email: Kathleen.Keohane@state.ma.us

September 2012
Date

Stephen Perkins, Director
Office of Ecosystem Protection
U.S. Environmental Protection Agency

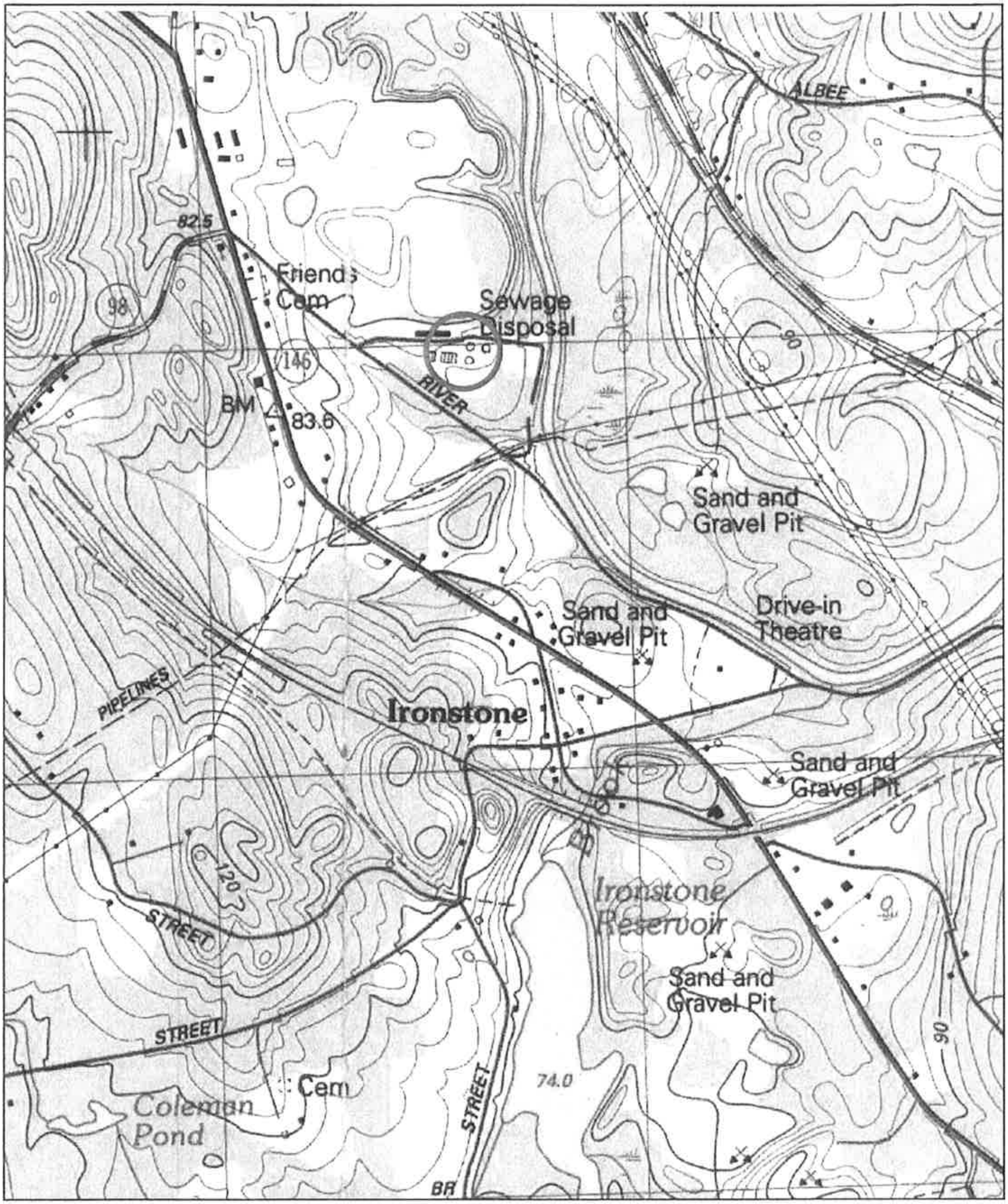
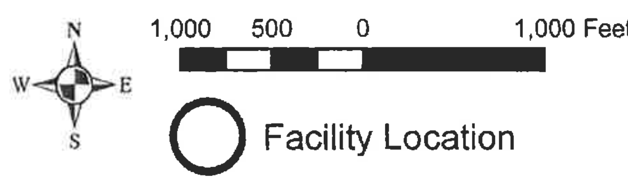
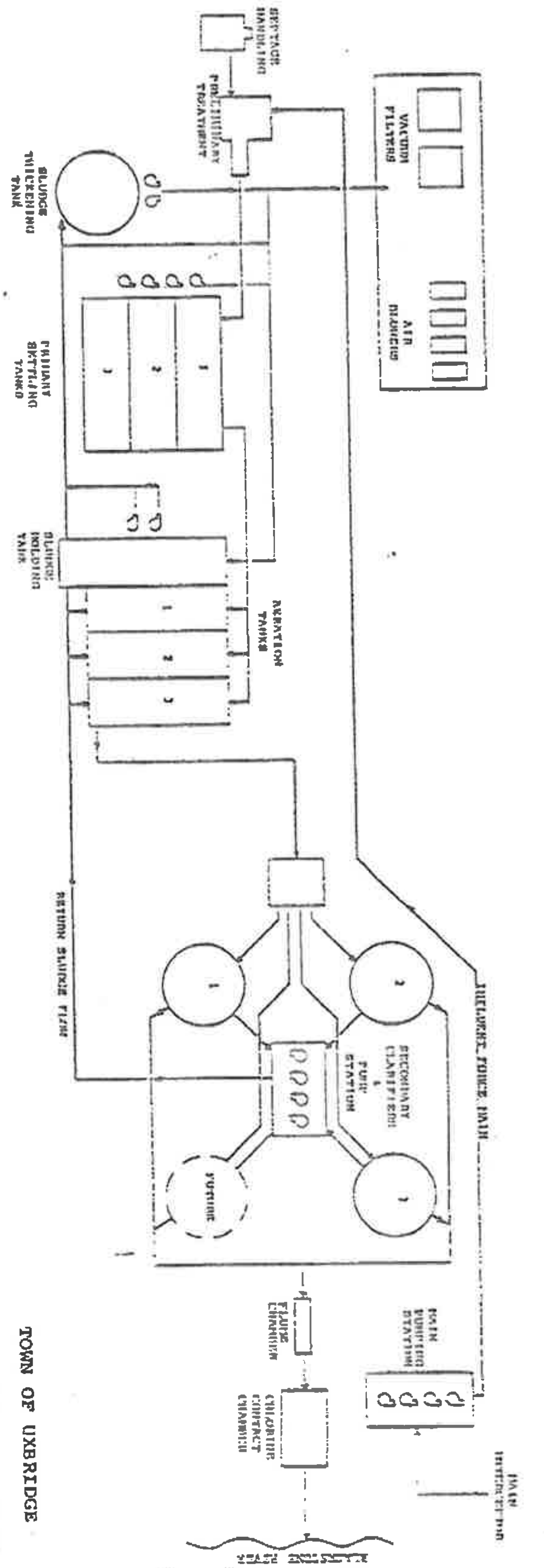


Figure 1. Location Map
Uxbridge WWTF
NPDES No. MA0102440



Uxbridge WWTF
Fact Sheet NPDES MA 0102440
Figure 2



TOWN OF UXBRIDGE
WASTEWATER TREATMENT
FACILITY
SYSTEM SCHEMATIC
FIGURE 1-1

1-4

Uxbridge Wastewater Treatment Facility
NPDES Permit No. MA0102440

Table 1 (page 2 of 2)
Two year facility DMR Data

	pH		NH3	NO2 + NO3	DO	Total P	TRC		fecal coliform	
	min (SU)	max (SU)	mo avg (mg/l)	mo avg (mg/l)	min (mg/l)	avg (mg/l)	avg (mg/l)	max (mg/l)	mo avg (cfu/100 ml)	max (cfl/100 ml)
	6	8.3	5/10/15 (seasonal)	Report	5	1.0 (seasonal)	0.24	0.42	200	400
January 2009	7.19	7.47	0.03	10.1	6.2					
February	7.16	7.47	0.04	10.4	5.84					
March	7.1	7.4	0.04	10.1	7					
April	7.15	7.5	0.04	10	7.09	0.53	0.2	0.75	8.6	373.3
May	7.15	7.68	0.04	10.3	6	0.37	0.15	0.23	14.58	160
June	7.3	7.6	0.03	10.7	5.4	0.6	0.16	0.32	25.2	193.3
July	7.3	7.8	0.15	10.3	5.2	0.5	0.18	0.4	12.7	53.3
August	7.37	7.78	0.04	1	4.4	0.5	0.13	0.2	90.4	393.3
September	7.3	7.8	0.04	15.1	4.8	0.7	0.11	0.27	139.5	353.3
October	7.49	7.81	0.04	12.21	5.02	0.53	0.15	0.26	27.9	346.7
November	7.2	7.6	0.03	7.4	5.26					
December	7.1	7.5	0.04	7.6	5.6					
January 2010	7.1	7.6	0.04	6.9	6.1					
February	7.1	7.5	0.05	6.7	6.58					
March	7	7.5	0.64	6.5	6					
April	7.1	7.5	0.1	7.2	6.5	0.54	0.17	0.34	8.6	360
May	7.2	7.7	0.03	10.9	5.2	0.8	0.16	0.27	3.7	20
June	7.18	7.68	0.04	9.92	5.12	0.69	0.11	0.14	5.38	43
July	7.59	7.76	0.07	7.8	4.04	0.54	0.12	0.2	7.12	30
August	7.18	7.8	0.05	8.17	4.37	0.47	0.13	0.28	4.1	26.7
September	7.38	7.74	0.05	9.61	4.47	0.56	0.12	0.29	8.5	305
October	7.46	7.73	0.05	9.21	4.74	0.43	0.15	0.39	51.12	335
November	7.24	7.57	0.34	11.61	5.94					
December	7.05	7.39	0.4	14.5	6.6					
Average:			0.10	9.34		0.55	0.15		29.10	
Maximum:	7.0 (min)	7.81 (max)			4.04 (min)			0.75		393.30

Uxbridge Wastewater Treatment Facility
NPDES Permit No. MA0102440

Table 1 (page 1 of 2)
Two year facility DMR Data

	Flow	BOD			CBOD		TSS		
	12mo avg (MGD)	mo avg (mg/l)	avg wkly (mg/l)	% rem	mo avg (mg/l)	avg wkly (mg/l)	mo avg (mg/l)	avg wkly (mg/l)	% rem
Effluent Limit	2.5	30	45	85	20	30	30	45	85
January 2009	1.06	2	2	99.1			1.1	2.4	99.8
February	1	2.2	2.5	99			2.1	2.9	99.7
March	1.08	2.3	2.9	98.9			2.2	3.2	99.7
April	1.05	3.5	4	98.4			3.3	3.9	99.4
May	0.89	2.4	3	99.2			2.4	3.4	99.6
June	0.78			99.2	2.1	2.3	1.9	2.6	99.7
July	0.86			99	2.2	2.8	2.2	2.9	99.4
August	0.8			99.2	2.1	2.2	2.4	5.1	99.5
September	0.73			99.4	2	2	1.7	2.6	99.6
October	0.78			99.64	1.18	1.63	1.38	1.93	99.99
November	0.86	2	2.8	99.4			1.1	2.2	99.8
December	0.96	1.3	1.6	99.5			1.1	2	99.9
January 2010	0.92	1.2	1.6	99.5			1.1	1.8	99.8
February	0.96	2.2	3.4	99.1			2.1	3.6	99.6
March	1.44	4	7.2	97.6			2.2	4.2	99.3
April	1.53	1.7	2.3	99.1			1.4	1.9	99.6
May	0.96	1.4	2.1	99.4			1	1.6	99.9
June	0.86			99.44	1.24	2.7	1.11	1.77	99.7
July	0.71			99.9	0.47	0.97	0.89	1.44	99.9
August	0.68			99.9	0.56	0.9	0.52	0.93	99.9
September	0.67			99.9	0.4	0.6	0.51	1.1	99.9
October	0.73			99.78	0.98	1.75	1.03	1.55	99.87
November	0.77	3.47	7.25	99.07			2.24	4.63	99.66
December	0.83	1.1	1.7	99.9			0.9	1.6	99.7
Average:	0.91	2.2		99.3	1.3		1.6		99.7
Maximum:			7.25			2.80		5.10	

ATTACHMENT A

CALCULATION OF MAXIMUM ALLOWABLE LOADS FROM CONCENTRATION-BASED LIMITS

Calculations of maximum allowable loads for average monthly and average weekly $CBOD_5$, BOD_5, TSS, ammonia, phosphorus, nitrogen and metals were calculated based on the following equation:

$L = C \times Q_D \times 8.34$ where:

L = Maximum allowable load in lbs/day
C = Maximum allowable effluent concentration for reporting period in mg/l
(Reporting periods are average monthly, average weekly, and daily maximum.)
Q_D = Design flow of facility in MGD = 2.5 MGD
8.34 = Factor to convert effluent concentration in mg/l and design flow in MGD to lbs/day

Therefore:

BOD, TSS (Nov-May):
(Concentration limit) [45] X 8.34 (Constant) X 2.5 (design flow) = 938 lbs/day
(Concentration limit) [30] X 8.34 (Constant) X 2.5 (design flow) = 626 lbs/day
CBOD, TSS (June-Oct):
(Concentration limit) [30] X 8.34 (Constant) X 2.5 (design flow) = 626 lbs/day
(Concentration limit) [20] X 8.34 (Constant) X 2.5 (design flow) = 417 lbs/day
Ammonia:
(Concentration limit) [5] X 8.34 (Constant) X 2.5 (design flow) = 104 lbs/day
(Concentration limit) [10] X 8.34 (Constant) X 2.5 (design flow) = 208.5 lbs/day
(Concentration limit) [15] X 8.34 (Constant) X 2.6 (design flow) = 313 lbs/day
Total phosphorus:
(Concentration limit) [.2] X 8.34 (Constant) X 2.5 (design flow) = 4.2 lbs/day
(Concentration limit) [1] X 8.34 (Constant) X 2.5 (design flow) = 21 lbs/day
Total nitrogen:
(Concentration limit) [8] X 8.34 (Constant) X 2.5 (design flow) = 167 lbs/day

Attachment B: 7Q10 and baseflow calculations

The 7Q10 flow in the Blackstone River was calculated based on the modeling study performed in connection with the Blackstone River Initiative, which was calibrated and validated using data from July and August of 1991 that were at near-7Q10 flows. The model generated a 7Q10 flow at Uxbridge of 117.15 cfs that included all upstream POTWs operating at design flow. The boundary conditions for the 7Q10 conditions of the model-generated flow are as follows:

Sources	Flow (cfs)
Headwaters	6.53
Quinsigamond R	3.03
Mumford R	5.89
West R	3.22
UBWPAD	86.6
Millbury	1.85
Grafton	2.46
Northbridge	2.77

Blackstone River Initiative, Table 5-18.

Calculating dilution factor

The model results were used in the 1999 permit issuance to determine dilution in the Blackstone River at Uxbridge for purposes of determining total residual chlorine limits and appropriate whole effluent toxicity testing requirements. As actual flows are not at design, the design flow from each facility was subtracted from the model-generated total flow to determine the base flow under 7Q10 conditions. Then, dry weather flows from each facility were calculated and added to the baseflow to determine current receiving water flow. The calculation was set forth in the Response to Comments in connection with the current permit as follows:

7Q10 @ Blackstone River near Uxbridge =

Blackstone River upstream flow –

(UBWPAD permitted flow – UBWPAD summer flow) –

(Milbury permitted WTP flow – Milbury summer flow) –

(Grafton permitted WTP flow – Grafton summer flow) –

(Northbridge WPCF permitted flow – Northbridge summer flow)

= 117.15 cfs – 32.35 cfs – 0.76 cfs – 0.13 cfs – 1.22 cfs

= **82.7 cfs (53.3 MGD)**

In table format this calculation can be displayed as below:

	Design Flow (cfs)	Summer Flow (cfs)	(Design Flow-Summer Flow)
7Q10 from WLA model at design flow	117.15	82.69	---
UBWPAD	86.6	54.25	32.35
Millbury	1.85	1.09	0.76
Grafton	2.46	2.33	0.13
Northbridge	2.77	1.55	1.22
Remaining flow at 7Q10	23.47	23.47	---

The resulting 7Q10 flow upstream of Uxbridge, including the existing upstream POTW flows, is 82.7 cfs. This value was used to calculate the dilution factor and the chlorine effluent limit. During the time period since the current permit was issued, the Millbury WWTP discharge was terminated and its flows were tied into UBWPAD. For purposes of determining the dilution factor for this permit it is assumed that these flows are now simply added to the UBWPAD flow and the dilution factor remains the same as in the current permit.

The calculations also indicate that 7Q10 flow in the Blackstone River, when the four major treatment plants are excluded, equals 23.47 cfs. This figure includes flows from two smaller treatment plants, Upton and Douglas, that are also upstream of Uxbridge. For purposes of calculating instream phosphorus concentrations, in which loads from the smaller treatment plants are specifically included based on their permit limits, a 7Q10 baseflow was calculated by subtracting the summer flow from Upton and Douglas. The resulting "Blackstone River baseflow" is 22.75 cfs, or 14.7 MGD.

ATTACHMENT C. Delivery Factors

In order to determine the appropriate delivery factors in the Blackstone River, EPA reviewed the available evidence from the RIDEM studies and other sources. In the 2004 RIDEM Report, RIDEM applied a delivery factor of 87% (i.e. 13% of the nitrogen is removed by uptake or denitrification) to both the UBWPAD and Woonsocket nitrogen loadings in calculating the resulting loads in the Seekonk River. This figure was based on RIDEM sampling in 1995 and 1996 as compared to monthly average WWTF monitoring data. 2004 RIDEM Report at 18.

Subsequent studies have produced conflicting evidence as to the extent of attenuation in the Blackstone River. A URI study based on biweekly sampling in the lower Blackstone River between April and August 2004 found "no direct evidence of DIN attenuation or removal in the lower Blackstone," with about a 20% increase in DIN that was not accounted for by WWTF discharges. The team also concluded that "[n]or can the results of a mass balance analysis unequivocally exclude DIN removal processes in the river itself," as non-WWTF inputs such as atmospheric deposition, individual septic system inputs or other sources could be in excess of the 20% increase and mask in-stream removal processes. Nixon, et al., "Investigation of the Possible Attenuation of Dissolved Inorganic Nitrogen and Phosphorus in the Lower Blackstone River" (April 2005), in *Anthropogenic Nutrient Inputs to Narragansett Bay - A Twenty Five Year Perspective* (2005), Appendix B. In contrast, the 2005 RIDEM RTC reported attenuation rates derived from a Qual2E water quality model, modified as part of a dissertation project at URI, that predicted an attenuation rate of 8% from the UBWPAD discharge to the state line, and an additional 21% from the state line to the mouth of the river, for a combined 27% attenuation. Total attenuation of the Woonsocket discharge was predicted to be 14%. 2005 RIDEM RTC, citing Michaelis, *Dissolve Oxygen Dynamics in a Shallow Stream System*, Dissertation in Civil and Environmental Engineering at the University of Rhode Island (2005).

Additional insight into the issue is provided in a regional study conducted by the U.S. Geological Service, which indicates that there is no significant attenuation of nitrogen in New England rivers with discharges greater than 2.83 m^3/s (100 cfs) or in reservoirs. Moore, et al., *Estimation of Total Nitrogen and Phosphorus in New England Streams Using Spatially Referenced Regression Models*, USGS Scientific Investigations Report 2004-5012. This study applied a water-quality model called SPARROW (Spatially Referenced Regressions on Watershed Attributes), a "spatially detailed, statistical model that uses regression equations to relate total nitrogen and phosphorus (nutrient) stream loads to nutrient sources and watershed characteristics." The regression analysis utilized a wide array of data sources, including nitrogen monitoring data from 65 sites, to derive coefficients in-stream loss as well as for source loading from particular land uses, point and atmospheric sources and for land-to-water delivery. As applied to the Blackstone River, the SPARROW model predicts no attenuation on an annual average basis based on its average annual flow.

The UBWPAD permit analysis was based on an estimated attenuation rate for the UBWPAD discharge of 13%, and EPA continues to believe that this represents the most reasonable and appropriate estimate of attenuation in the Blackstone River. While the 2005 RIDEM RTC suggests a higher rate, that modeling indicated that uptake of nitrogen decreased as phosphorus to the system are reduced. This would indicate that attenuation rates will be lower under the new

UBWPAD permit limit of 0.1 mg/l total P (as well as new limits on other WWTFs), as opposed to the limit of 0.75 mg/l total P that was used in the model. On the other hand, while the Nixon and USGS studies indicate there may be less than 13% attenuation even under current conditions, both studies leave open the possibility that some level of attenuation is occurring. The Nixon Report specifically notes that the results do not exclude the existence of in-stream removal processes, while the USGS study does not specifically address the potential for attenuation during occasional periods when river flow falls below the 100 cfs threshold (in the Blackstone, this occurs approximately 20% of the time at Northbridge and less than 3% of the time at Woonsocket, based on USGS gage data from those locations). The attenuation rate of 13% is thus squarely within the range of the possible values based on currently available information.

For these reasons, EPA has applied delivery factors to each discharge that are consistent with 13% attenuation of the UBWPAD discharge. In the absence of other information, we assume that attenuation is proportional to the distance traveled, as calculated in Table B.1. The resulting delivery factors are applied to determine the load to the Seekonk River.

Table B.1. Delivery Factors

Calculated from: $A_i = A_{UB} * Rm_i/RM_{UB}$

Source	River Mile	Attenuation	Delivery Factor
UBWPAD	44.4	13.0%	87%
Millbury	40.6	11.9%	88%
Grafton	35.4	10.4%	90%
Northbridge	29.2	8.5%	91%
Uxbridge	22.0	6.4%	94%
Woonsocket	12.4	3.6%	96%

Date	Cu* (ug/l)	lnCu (ug/l)	$(y_i - u_y)^2$	# samples per month
4/26/2005	13	2.5649	0.0109962	1
11/15/2005	20	2.9957	0.2869163	1
5/9/2006	17	2.8332	0.1392236	1
11/14/2006	16	2.7726	0.0976576	1
5/15/2007	ND-10			1
12/12/2007	ND-10			1
12/16/2008	10.2	2.3224	0.018961	1
1/23/2009	ND-10			1
5/5/2009	10	2.3026	0.0248067	1
11/3/2009	12	2.4849	0.000616	1
5/11/2010	10.9	2.3888	0.0050871	1
11/16/2010	8	2.0794	0.1448906	1
4/26/2011	6.4	1.8563	0.3645606	1

Daily Maximum Concentration - 99th percentile (some measurements < detection limit)

Detection Limit** =		10.000
u_y = Avg of Nat. Log of daily Discharge (mg/L) =		2.46009
$\Sigma (y_i - u)^2$ =		1.09372
k = number of daily samples =		13
r = number of non-detects =		3
σ_y^2 = estimated variance = $(\Sigma[(y_i - u_y)^2]) / (k-r-1)$ =		0.12152
σ_y = standard deviation = square root σ_y^2 =		0.34860
δ = number of nondetect values/number of samples =		0.23077
z=z-score[(0.99-δ)/(1-δ)] =	z-score of	0.98700
	=	2.226211769

RP analysis/Limit calculation:

99th percentile daily max limit = $\exp(u_y + \text{z-score}*\sigma_y)$

Daily Max Limit* = **25.44 ug/l**

TSD-Table E-1, 99th percentile with ND

Average Monthly Concentration - 95th percentile (some measurements < detection limit)

Number of samples per month, n =		1
$E(x)$ = Daily Avg = $\delta D + (1-\delta)\exp(u_y + 0.5\,\sigma_y^2)$ =		11.87627
$V(x)$ = Daily Variance = $(1-\delta)\exp(2u_y + \sigma_y^2)[\exp(\sigma_y^2)-(1-\delta)] + \delta(1-\delta)D[D-2\exp(u_y + 0.5\sigma_y^2)]$ =		16.43609
$A = V(x)/[n(E(x)-\delta^n D)^2]$ =		0.179516334
$B = -[\delta^n D^2(1-\delta^n)]/(E(x)-\delta^n D)^2$ =		-0.193883136
$C = (2\delta^n D)/(E(x)-\delta^n D)$		0.482348176
σ_n^2 = Monthly Average variance = $\ln\{(1-\delta^n)[1+A+B+C]\}$		0.12152
σ_n = Monthly Average standard deviation = σ_n^2^(0.5) =		0.34860
u_n = n-day monthly average = $\ln[(E(x)-\delta^n D)/(1-\delta^n)] - 0.5\sigma_n^2$ =		2.46009
z=z-score[(0.95-δ)/(1-δ)] =	z-score of	0.93500
	=	1.514101888

RP analysis/Limit calculation:

95th percentile monthly average limit = $\exp(u_n + \text{z-score}*\sigma_n)$

Monthly Avg Limit* = **19.84 ug/l**

TSD-Table E-2, 95th percentile with ND

Date	Zn* (ug/l)	lnZn (ug/l)	$(y_i - u_y)^2$	# samples per month
4/28/2005	50	3.9120	0.0550474	1
11/15/2005	ND-50			1
5/9/2006	74	4.3041	0.3927077	1
11/14/2006	ND-50			1
5/15/2007	ND-50			1
12/12/2007	ND-50			1
12/16/2008	ND-50			1
1/23/2009	ND-50			1
5/5/2009	ND-50			1
11/3/2009	ND-50			1
5/11/2010	37.9	3.6350	0.001802	1
11/16/2010	19.7	2.9806	0.4855059	1
4/26/2011	35	3.5553	0.014897	1

Daily Maximum Concentration - 99th percentile (some measurements < detection limit)

Detection Limit** =	10.000
u_y = Avg of Nat. Log of daily Discharge (mg/L) =	3.67740
$\Sigma (y_i - u)^2$ =	0.94996
k = number of daily samples =	13
r = number of non-detects =	8
σ_y^2 = estimated variance = $(\Sigma[(y_i - u_y)^2]) / (k-r-1)$ =	0.23749
σ_y = standard deviation = square root σ_y^2 =	0.48733
δ = number of nondetect values/number of samples =	0.61538
z=z-score[(0.99-δ)/(1-δ)] = z-score of	0.97400
=	1.943133751

RP analysis/Limit calculation:

99th percentile daily max limit = exp (u_y + z-score*σ_y)

Daily Max Limit* = 101.94 ug/l

TSD-Table E-1, 99th percentile with ND

Average Monthly Concentration - 95th percentile (some measurements < detection limit)

Number of samples per month, n =	1
E(x) = Daily Avg = $\delta D + (1-\delta)\exp(u_y + 0.5\sigma_y^2)$ =	23.28048
V(x) = Daily Variance = $(1-\delta)\exp(2u_y + \sigma_y^2)[\exp(\sigma_y^2)-(1-\delta)] + \delta(1-\delta)D[D-2\exp(u_y + 0.5\sigma_y^2)]$ =	486.62777
A = $V(x)/[n(E(x)-\delta^n D)^2]$ =	1.659024921
B = $-[\delta^n D^2(1-\delta^n)]/(E(x)-\delta^n D)^2$ =	-0.080691783
C = $(2\delta^n D)/(E(x)-\delta^n D)$	0.71862884
σ_n^2 = Monthly Average variance = $\ln\{(1-\delta^n)[1+A+B+C]\}$	0.23749
σ_n = Monthly Average standard deviation = σ_n^2^(0.5) =	0.48733
u_n = n-day monthly average = $\ln[(E(x)-\delta^n D)/(1-\delta^n)] - 0.5\sigma_n^2$ =	3.67740
z=z-score[(0.95-δ)/(1-δ)] = z-score of	0.87000
=	1.126391129

RP analysis/Limit calculation:

95th percentile monthly average limit = exp (u_n + z-score*σ_n)

Monthly Avg Limit* = 68.47 ug/l

TSD-Table E-2, 95th percentile with ND

*Take dilution and ambient conc into consideration to determine potential conc after mix, if conc after mix > criteria, then RP exists

**detection limit =0.003

***TSD Table 3-1

****TSD Table 3-2