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August 24, 2006

Ms. Donna Hanscom
Assistant Public Works Director/Laboratory Manager
City of Keene New Hampshire
350 Marlboro Street
Keene, NH 03431

Dear Ms. Hanscom:

As you have requested, CDM has reviewed certain elements of the draft NPDES permit issued by the Environmental Protection Agency to the City of Keene.

We have prepared comments with respect to this permit, copies of which are attached hereto, along with supporting information and documentation.

Should you have any questions on these matters, please do not hesitate to contact me at 617-452-6246

Sincerely,

CAMP DRESSER & McKEE Inc.

John J Gall, Jr.
Vice President

CDM

City of Keene, New Hampshire

Review of Draft NPDES Permit

August 2006

Analysis and Comments of Draft NPDES Permit NH0100790
City of Keene, NH

I. EPA erroneously characterizes information contained in the Gold book.

EPA indicates that a value of 0.1 mg/l P is the water quality criteria for flowing streams as presented in the 1986 Water Quality Criteria Guidance Document (the Gold Book). Fact Sheet at Page 18. This is incorrect; the Gold Book clearly indicates that there is no such criterion. See relevant portions of the Gold Book, attached hereto as Exhibit A , specifically the discussion on Phosphate Phosphorus, which concludes with the following:

> No national criterion is presented for phosphate phosphorus for the control of eutrophication

While the document does describe a variety of approaches that could be considered, including concentration values, Vollenweider loading rates, and a generic description of the factors influencing eutrophication induced by phosphorus, none of the approaches are criterion in the context of the EPA's Quality Criteria for Water.

Indeed, if phosphorus levels were so simple a matter to deal with, then phosphorus limits would have been incorporated into permits long ago, beginning as far back as 1986, including limits for the Keene discharge. However, the issue of phosphorus is not so simple, which is the reason that EPA has moved forward on the development of regional ecosystem guidance, and has required individual states to develop strategies for the development of nutrient water quality criteria. Any thoughtful evaluation of the impacts of phosphorus needs to be undertaken in the context of the various sources and the many physical, chemical and biological reactions that control the fate and impacts of phosphorus in the receiving waters. The TMDL and waste load allocation currently being developed by the New Hampshire DES is the appropriate vehicle for such an undertaking.

II. EPA erroneously characterizes NH's "Level of Concern".

EPA characterizes NH's 0.05 mg/l total P level of concern in such as way as to infer that is somehow a criterion. See Fact Sheet, page 16. However, a more accurate description of the 0.05 level is presented in the documents cited by EPA. For example, the Volunteer River Assessment Program for 2002 for the Ashuelot says

> Phosphorus can be an indicator of sewage, animal manure, fertilizer, erosion, and other types of contamination. *There is no surface water quality standard for phosphorus due to the high degree of natural variability and the difficulty of pinpointing the exact source.* However 0.05 mg/L total phosphorus is typically used

as a level of concern, which means DES pays particular attention to readings above this level. See NHDES, New Hampshire Volunteer River Assessment Program 2002 Ashuelot River Water Quality Report at p. 10 (attached hereto as Exhibit B.)

Thus, while New Hampshire may use 0.05 mg/l to identify waters of concern for nutrient management, the state has expressly disavowed this as a criterion. NH's approach to nutrient management is described more fully below.

III. EPA Ignores NH's Stated Nutrient Management Strategy

EPA makes reference to national (*Ambient Water Quality Criteria Recommendations, Information Supporting the Development of State and Tribal Nutrient Criteria, Rivers and Streams in Ecoregion VIII*) and draft regional (Mitchell, Liebman, Ramseyer, and Card, draft 2004) studies of phosphorus levels in reference streams to infer that numeric water quality criteria ought to be even lower than the recommendations of the Gold Book, sometimes as low as 0.01, or 0.02 mg/l, to prevent eutrophication . Fact Sheet at page 16.

But as EPA assuredly knows, many states, including New Hampshire have eschewed the use of this approach to the development of nutrient criteria. Ever since EPA directed the States to develop numeric nutrient criteria in November 2001, New Hampshire has indicated its intention to develop their own criteria. Under New Hampshire's approach, chlorophyll a is proposed as the standard for assessing use impairment due to cultural nutrient enrichment, either aquatic life use support or recreational. New Hampshire's rational for developing a different approach is that

> the statistical approach recommended by EPA ... do[es] not (in our [DES'] opinion) directly relate to use support, whereas the Clean Water Act water quality standards process explicitly provides for "setting criteria necessary to protect the uses" (40 CFR 131.2). DES-WMB Policy No. 3 dated Nov. 14, 2002 at p. 1, attached hereto as Exhibit C.

This approach has been part of DES' Performance Partnership Agreement with EPA every year since FFY 2004. (See 2004 DES Comprehensive Action and Assessment Workplan, attached hereto as Exhibit D.)

Not only has EPA been advised of this approach, but it has implicitly approved it, through the approval of the State's List of Impaired Waters. That document explicitly characterizes 15 ug/l as the water quality criteria for Chlorophyll a that is used as a metric for assessing nutrient enrichment impairment of designated uses. See *2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology, NHDES-R-WD-04-5*, pages 3-33 to 3-37, relevant portions of which are attached hereto as Exhibit E. Because the State has formulated a chlorophyll a standard for assessing use support, EPA cannot supplant it with its own version of this standard.

IV. EPA's analysis of Chlorophyll a data is erroneous.

EPA uses chlorophyll-a concentrations as an indicators of algal activity, and extrapolates this indicator to suggest that there are problems with respect to the achievement of the State's narrative water quality standard for nutrients and that it presages problems with respect to attainment of the state dissolved oxygen standards. The data do not support the Agency's conclusions.

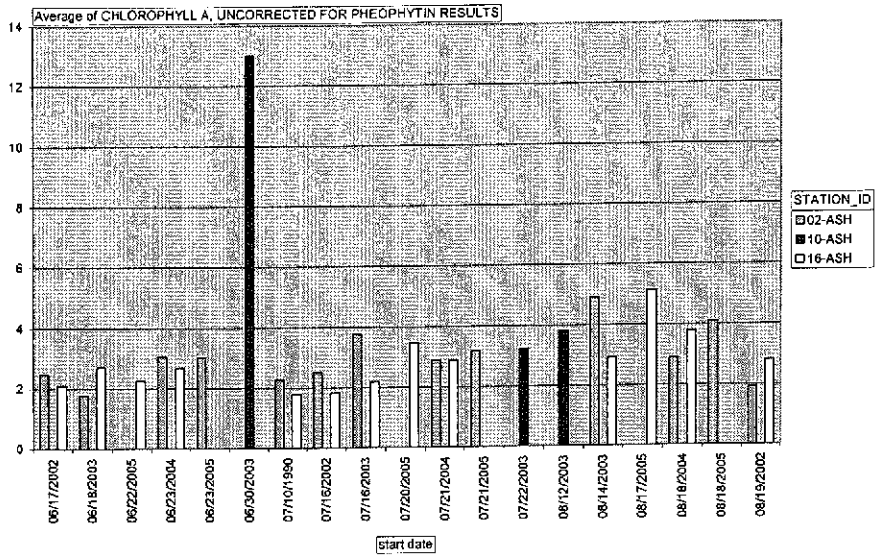
Based on Chlorophyll-*a* data taken during sampling events of 2001 and 2002 EPA concludes that "the Ashuelot River would be considered, at a minimum mesotrophic, and thus at risk for eutrophication, and eutrophic". Fact Sheet, page 16. The trophic status – oligotrophic, mesotrophic, eutrophic or hypereutrophic refers to increasing levels of biological productivity. Oligotrophic waters have the lowest productivity, low nutrients and usually high clarity. Eutrophic waters have higher levels of nutrients and biological productivity and are often less clear. EPA uses various sources to characterize the condition of the river including a value of 0.63 ug/l chlorophyll-a as derived from studies of reference sites, and a suite of chlorophyll-a values to characterize the trophic status of the river, as presented in their Table 4. This is erroneous for several reasons:

First, NH has established a *de facto* chlorophyll-a criterion of 15 ug/l, as part of the development of their impaired waters list. This effectively serves as the state's interpretation of their narrative water quality standard for nutrients. It is thus improper for EPA to ignore the State's interpretation of the State's narrative water quality standard.

Secondly, the segments to which Keene discharges, and that are immediately downstream are shown by the data in the Fact Sheet to be oligotrophic. Chlorophyll-a concentrations in these segments as presented in EPA's Table Three are less than 4 ug/l, consistent with the character of oligotrophic waters as presented in EPA's Table 4. Only below the Swanzey wastewater treatment plant do the chlorophyll-a levels rise above the NH criterion of 15 ug/l chlorophyll-a.

In addition, more data from the State's ambient River Monitoring Program for the period 2002 through 2005, which was available to EPA, supports the classification of the system as oligotrophic. The data for this period is included in Exhibit F. The following chart, Figure 1, shows chlorophyll-a values for various stretches of the Ashuelot River, including segments directly downstream of Keene (16-ASH), and segments further downstream (10-ASH and 02-ASH). As with the data presented in EPA's Fact Sheet, this confirms that as measured by chlorophyll-a, these segments are oligotrophic according to EPA's approach.

Figure 1



Additionally, the data upon which EPA relies are suspect with respect to chlorophyll-a. The 2001/2002 TMDL studies showed that the Swanzey WWTF discharged very high concentrations of chlorophyll-a, ranging from 7 to well over 200 ug/l. This is not inconsistent with the type of treatment provided. However, Swanzey also chlorinates its effluent, and had effluent residual chlorine concentrations of from 1.7 to 3 mg/l in August of 2001 and .5 to 1.7 mg/l in August, 2002. See Exhibit G, excerpts from Swanzey Permit Fact Sheet and effluent quality from EPA's ECHO database. This likely kills the algae contained in its effluent. This is important because the tests used for chlorophyll-a were nor corrected for pheophytin, and thus are measuring both live and dead algae. The existence of dead algae in the stream from a point source would not be indicative of an algae problem in the River itself.

Finally, EPA's implied argument that high levels of algal activity are indicators of dissolved oxygen problems are contravened by the data. As discussed below, the Ashuelot River regularly complies with the state's dissolved oxygen water quality standards, except for those periods when the quality of water upstream of Keene's discharge violates the standards.

V. EPA's Analysis of Dissolved Oxygen is Flawed

EPA attempts to support its arguments with respect to cultural eutrophication by evaluating DO data from the period 1990 through 1995, 1997 and 1998 for station 16-ASH, below the Keene gage. EPA gives a range of saturation values, with a maximum of 114 %, and an average of 88 %. EPA concludes that "...although this data is [sic] limited, it indicates that supersaturated conditions occur and serve as another indictor of eutrophic conditions in the Ashuelot River." Fact Sheet, pages 16 and 17.

There is no evidence presented to suggest that any level of saturation above 100 % is indicative of a water quality problem as the Fact Sheet implies. Since algae are natural constituents of a functioning ecosystem (the algae are food for higher forms of life), some incidental supersaturation should be expected. References to acceptable levels of supersaturation are few; but a University of Wisconsin report states the following:

> Values between 90% and 110% of saturation are good. Supersaturated (over 100%) values may sound good but they can also indicate problems, such as excessive plant growth. High day-time levels of D.O. are often countered with low night-time levels due to respiration and the cessation of photosynthesis. See **Water Action Volunteers Factsheet Series, 2003,** attached hereto as Exhibit H.

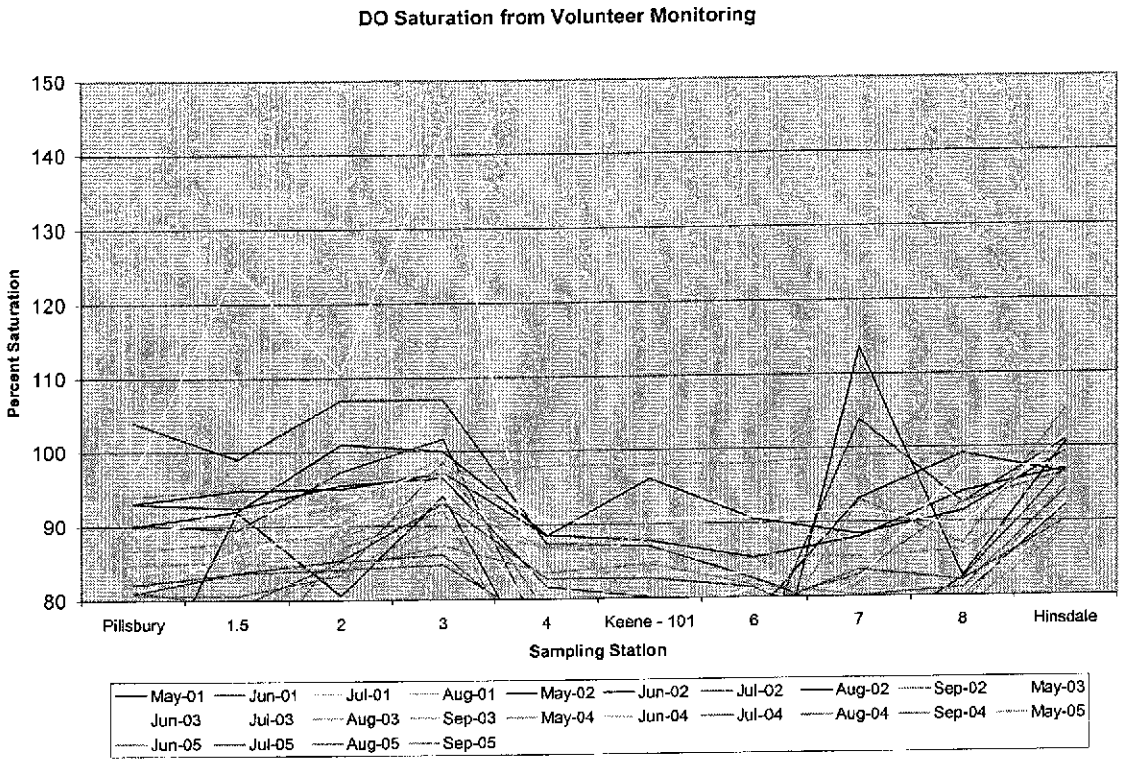
In addition, work conducted by the Oklahoma Conservation Commission on Lake Creek indicates that they use 125 % as a level of saturation that they considered "supersaturation" and "may indicate high levels of primary productivity resulting from elevated nutrient levels". See Lake Creek Demonstration Project, Oklahoma Conservation Commission, at page 7, included in Exhibit H

As discussed above, the chlorophyll-a data indicate that the receiving waters do not suffer from excessive plant growth, and thus should not suffer from high day time DO values and low night time levels that would be associated with unacceptable levels of phosphorus. Continuous recording DO data discussed below show that within-day variability does not exhibit wide fluctuations in dissolved oxygen that would normally be associated with excessive algal growth.

For some reason, EPA ignores DO data collected more recently, including the 2001/2002 TMDL data, portions of which are referenced elsewhere in the document, and the volunteer river monitoring program data, also referenced in the Fact Sheet. In particular, the volunteer monitoring data, included in Exhibit F, clearly shows that supersaturated conditions exist above the Keene discharge, where P concentrations are well below EPA's suggested criteria value – which is evidence that these levels of supersaturation are not indicative of a phosphorus-related problem. Figure 2, below shows the oxygen saturation values using data from the volunteer program for the period May, 2002 to September, 2005.

In addition, the volunteer monitoring clearly indicates that supersaturation is an infrequent event; of the 240 sampling events spanning 5 years, supersaturation was evidenced only 13 times.

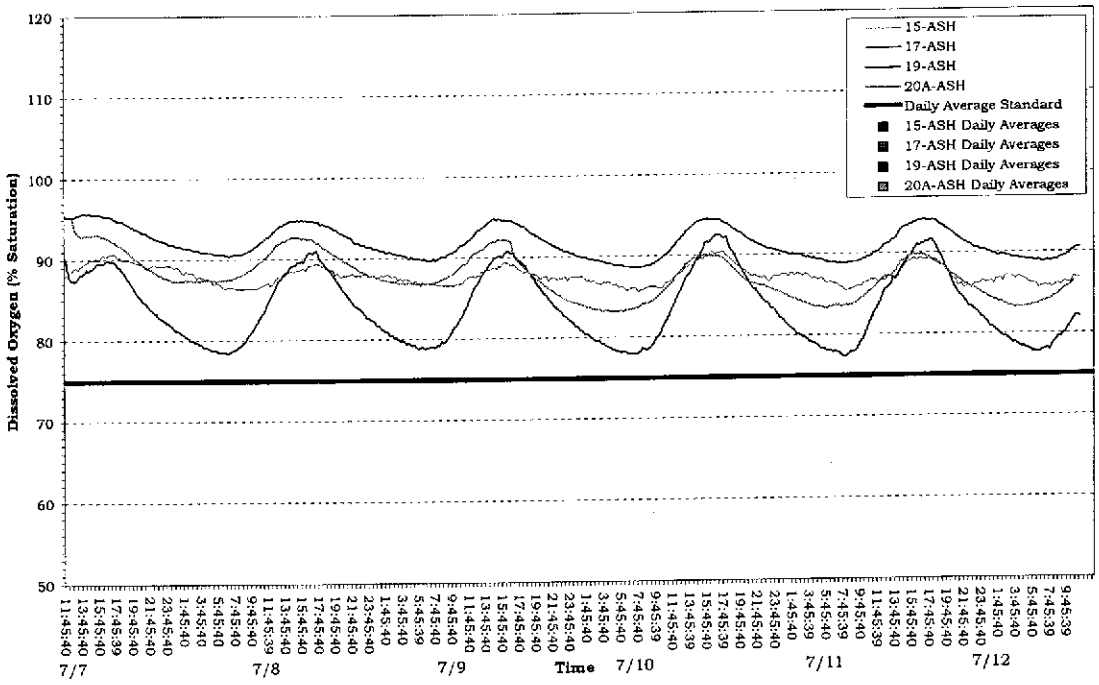
Figure 2



As part of DES' 2001/2002 TMDL studies (attached hereto as Exhibit I), continuously recording DO and temperature instruments were deployed at several locations along the River, including the impoundment of the Homestead Mill Dam at 15-ASH. The State, in its 1989 Waste Load Allocation Study (relevant portions of which are attached hereto as Exhibit J) had expressed concern that algae might have adverse oxygen impacts in this impoundment. Inspection of the 2001/2002 data (see 2002 Ashuelot TMDL Data Report, NHDES, at Section 5, Exhibit I) indicate that there have never been any violations of the State's 5 mg/l DO water quality criteria in the impoundment, and that the only time that oxygen saturation fell below the 75 % saturation criterion was when far upstream sources were well below standards. Thus the TDML data indicate that algae have no particular adverse impacts on the dissolved oxygen regimen of the Ashuelot.

More current data, recently provided by the New Hampshire DES and shown below, demonstrates a comparable conclusion: that DO in the Ashuelot is well with the State's saturation criteria. At most stations dissolved oxygen varies between 87 and 95 % saturation. The dissolved oxygen values at station 19-ASH, above the Keene discharge, exhibit the greatest variability, and drop to the lowest levels. As with other data discussed in this document, this indicates that conditions above the Keene WWTP discharge are having significant impacts on the dissolved oxygen conditions of the River. (NHDES 2006 Data Logger Data, Preliminary Plots. Personal Communication from Ted Walsh to Donna Hanscom, attached hereto as Exhibit K.)

Figure 4. Dissolved Oxygen Saturation Statistics for the Ashuelot River
July 7 - 12, 2006, NHDES VRAP



EPA's analysis of the system ignores the most significant data from the TMDL that shows that sampling points upstream of the Keene discharge clearly violate State water quality Standards. For example, data collected at station 19-ASH, adjacent to Tenant Swamp and upstream of the WWTF discharge, shows dissolved oxygen values below the 5 mg/l state standard, and saturations below the state's 75 % requirement. The influence of these observations on downstream DO has not been evaluated by EPA.

New Hampshire's listing of the Ashuelot River on its EPA-approved 2004 303(d) listing disputes EPA's analysis. EPA's analysis of the dissolved oxygen conditions in the river is focused entirely on phosphorus in Keene's discharge. However, the State, in listing section 11 of the Ashuelot River in its 303(d) list characterizes the source of the dissolved oxygen saturation problem as Municipal (Urbanized High Density Area). See page 134 of Final 2004 List of Threatened or Impaired Water That Require A TMDL, included in Exhibit I. In contrast, when the State suspects the source of the problem to be a treatment plant, it specifically says so. See the listing for the Cocheco River, page 75 where municipal point source discharges are specifically identified as a suspected source of nonattainment.

EPA's claim of impaired waters is confounded by the fact that phosphorus levels in Keene's discharge have historically been significantly above the limit the agency proposes, yet the receiving waters do not exhibit significant impairment. Over the past 8 years the City's discharge has average 2.7 mg/l and 68.7 pounds per day of phosphorus in its discharge. These represent, respectively, 13 and 7 times the amount of phosphorus allowed under the proposed permit. With loadings almost 10 times as much as EPA

claims is necessary to protect the receiving water quality, one would naturally expect extreme problems in the receiving waters. Yet as the data discussed above shows, the dissolved oxygen levels in the Ashuelot consistently meets the state's standards.

VI. EPA Fails to Consider Ongoing Actions

EPA's analysis has failed to consider complementary, ongoing actions that could serve to lessen any impacts from phosphorus contained in the Keene effluent discharge and improve the overall quality of the river. In particular, EPA fails to acknowledge that it is quite likely that the Homestead Mill Dam in West Swanzey will be removed in the very near future, resulting in potentially substantial water quality benefits. Documentation included in Exhibit L indicates that removal of that dam is imminent.

This impoundment behind this dam was an area of particular concern noted in DES' 1989 waste load allocation study. That study indicated that :

> ...since the extent of algal influences before the dam in West Swanzey (station 15-ASH) are not entirely known, a study to assess the impact algae on the Ashuelot River within this reservoir needs to be conducted. A diurnal DO/water temperature/chlorophyll a study should be made during low flow, high temperature and no precipitation conditions to see if stream standards are being met on a 24 hour basis.

(See Exhibit J at p. 46).

The reason that the impoundment behind the dam is of concern is because it provides habitat for the growth of algae – notably in the form of increased temperatures and residence times not otherwise naturally available in the River. Removal of the dam would eliminate the impoundment, and minimize residence times and temperature effects which serve to stimulate the growth of algae.

Dams along the Ashuelot have been a particular focus of natural resource management agencies for some time. Both of the dams downstream of the Homestead Dam have been removed in the recent past. According to the New Hampshire DES Dam Bureau, The McGoldrick Dam in Hinsdale was removed in 2001, and the Winchester Dam was removed in 2002. See Exhibit M. These actions served to open up portions of the river to migrating anadramous fisheries, and to eliminate potential water quality degradation in the impoundments behind the dam. Studies on the Homestead Dam completed in 2005 concluded that removal of the dam, in addition to being the most cost effective option, "...provides the greatest ecological and water quality restoration benefits..." and would serve to enhance salmon, shad and alewife fisheries and to improve the habitat of endangered the dwarf wedge mussel, a federally endangered species (Homestead Dam Final Report, pages 15 and ES-11 respectively, attached hereto as Exhibit N).

EPA also fails to properly consider that the State is in the process of conducting a TMDL on this River section in order to analyze the dissolved oxygen conditions in the River and

to develop strategies to address any identified problems. Because there is significant uncertainty that any problem exists, or will exist after the completion of complementary ongoing activities, the TMDL is the most appropriate vehicle for addressing the future quality of the River, especially as it relates to the discharge from the wastewater treatment facility. It provides a reasoned, scientific basis for assessing the conjunctive impacts of enhanced phosphorus treatment as is now being provided by The City through the use of Polyaluminium chloride, removal of the Homestead Dam, correction of water quality problems (including low DO) in the upper watershed and correction of potential nonpoint pollution sources throughout the watershed.

The City believes that EPA should await the completion of the TMDL, not simply because it believes that EPA's logic for the new permit limits is flawed, but also because (1) data collected from 2001 to the present indicates that there is no significant water quality impairment that presents an imminent threat to the River's ecosystem, and (2) proceeding without the benefit of the TMDL could lead to the unwise expenditure of it's rate payers money. Studies conducted on behalf of the City by Stantec, Inc concluded that process technologies that the City might use to meet various levels of phosphorus control could range up to $17 Million in today's dollars . Even at these higher costs, some of the technologies are only now emerging, and their application in full scale operation is limited. It is inappropriate to expend such significant sums of money to address an issue that is not well documented, potentially with technologies not well proven.

VII. EPA incorrectly calculates required level of treatment.

EPA's calculations of the required level of treatment are based on a dilution factor of 2.08. That dilution factor is derived from the annual 7 day 10 year low flow in the river, and reflects low flow conditions in the deep summer. The Region then applies this value to the April through October time frame, generally reflecting the growing season for New England's climate. In contrast, flows during other times of year are substantially higher, and afford greater dilution. This greater dilution lowers in-stream nutrient concentrations, which serves to protect the quality of the receiving waters. This is especially true during the spring, when low temperatures and shorter days (resulting in less energy for photosynthesis) also serve to suppress algal growth and thus protect in stream water quality. Preliminary estimates of monthly 7Q10 flows for each month of the period April through October have been developed, as well as estimated dilutions and effluent limits, assuming the application of EPA's 0.1 mg/l "criterion" value. The data from which these results were obtained are included in Exhibit O. The results are presented in Table 1, below

Table 1

Month	Monthly 7Q10 at Gage	At Discharge	Available Dilution	Phosphorus Limit Mg/l
April	321.83	153.93	15.80	1.58
May	177.60	84.95	9.12	0.91
June	65.86	31.50	3.95	0.39
July	46.23	22.11	3.04	0.30
August	25.49	12.19	2.08	0.21
September	28.71	13.73	2.23	0.22
October	51.76	24.76	3.30	0.33

Flow Data from West Swanzey Gage

New Hampshire's Water Quality regulations (Env-Ws 401.17(c)) specifically allow considerations such as these in the development of permits.

Failing the elimination of phosphorus limits, or adoption of effluent limits as suggested above, the effluent limits should be based on mass emission rates. Concentration based limits need not be applied to this discharge, and would be overly protective of the receiving water quality. The State requires that effluent limits be calculated using 7Q10 (see Env-Ws 1705.02 Low Flow Conditions.) Concentration limits are not needed at flows above 7Q10 because at these flows there is additional dilution available to accommodate that mass. This results in in-stream concentrations lower than EPA's "criterion" and are thus protective of the receiving water. By requiring calculation of permit limits at 7Q10 the State is effectively acknowledging that the State standards do not apply at flows below 7Q10. At River flows lower than 7Q10 the instream concentrations from permissible levels of discharge will, by simple mathematics, exceed the criterion value, because there is less dilution available. Thus, there is no need for a concentration limit for flows below 7Q10.

John Gall
Vice President
Camp Dresser & McKee, Inc.

QUALIFICATIONS SUMMARY

Mr. Gall, an environmental engineer with a diverse background in the planning, economic evaluation, and management of public facilities, and brings an intimate understanding of the regulatory process to CDM.

EXPERIENCE

Mr. Gall is the Vice President of CDM with over 37 years experience in the water and wastewater field. His primary focus has been on the planning of public facilities, the assessment of the impacts of proposed facilities on water resources and the public presentation of complicated technical projects. His responsibilities on projects typically includes: project management, staff assignment and scheduling, contract administration and client liaison, as well as technical analysis.

Mr. Gall is a senior technical advisor in CDM's Cambridge-based Water Resources group, which provides consulting services worldwide to clients in the areas of hydraulics, hydrology, flood control, dam safety, water quality management and the regulatory requirements associated with such activities. This group provides extensive services in the area of data management, numerical simulation models for the evaluation and control of small and large scale hydrologic systems, and is fully familiar with both public domain and proprietary systems for analysis of control of these systems.

Through his work with clients on issues of regulatory matters he has become familiar with the regulatory community in New England. He served on the Commonwealth of Massachusetts External Water Quality Standards Advisory Committee , was a member of the Massachusetts Department of Environmental Protection's Policy and Fees Advisory Committee, was a member of the Commonwealth's NPDES Delegation Study Advisory Committee and is the past co-chairman of the Massachusetts Clean Water Council's Regulatory Affairs subcommittee.

Mr. Gall has assisted a number of CDM clients in the area of water quality evaluations, field sampling and analysis programs and NPDES permitting. These assignments have typically included negotiations with EPA on permit terms and limits, development of formal comments on draft NPDES permits, and support in litigation with respect to permits. Relevant assignments include:

> For the Upper Blackstone Water Pollution Abatement District, Mr. Gall has served as project manager for the evaluation of wasteload allocation and TMDL studies conducted by others, and for the negotiations of NPDES permit limits and conditions. This work has also included the coordination of pollution abatement strategies of the District with the

CSO control strategy of the City of Worcester, the District's largest customer and in the development of dynamic models of the water quality of the Blackstone River. 1995 to Present.

Mr. Gall has worked with the five project sponsors of the Merrimack River Comprehensive Watershed Assessment Studies. He helped guide the communities through the Section 22 PAS activities that led to the development of the scope of the assignment; has worked with them to secure local and federal funding for the project; and has met with regulators and stakeholders to understand the full dimensions of their interests in this project. He is presently serving as a senior technical advisor in the conduct of this multi-million dollar watershed level assessment study. 1999 to present.

The MWRA's Deer Island Secondary Treatment Facilities Planning Studies, where he served as project manager for over $4 million in applied science in support of outfall siting decisions. This assignment included the direction and management of 12 subconsultants in the conduct of a major environmental sampling, analysis and evaluation program to site the largest ocean outfall in New England. Because of the high visibility of this project, monthly project coordination meetings were conducted with the regulatory community and other interested stakeholders. 1986 to 1988.

Mr. Gall served as project manager for the Environmental and Engineering Feasibility and Assessment Study of the Way Forward for the Harbour Area Treatment Scheme for the Hong Kong Special Administrative Region of the People's Republic of China. In this role he was responsible for the conduct of near and far field water quality modeling of major coastal discharges, with a specific emphasis on the potential for eutrophication driven anoxia, the development of water quality criteria and analysis tools for the evaluation of alternatives and the engineering and environmental assessment of four alternatives proposed by an international panel of experts. 2001 to 2004.

Mr. Gall served as the project manager for the development of a watershed toolkit for the Commonwealth of Massachusetts. This project involved the development of a GIS based interactive program for the acquisition, storage, display and analysis of water resources related data. Conceptually similar to EPA's BASINS tool, this toolkit focused on enhanced graphical display of data and model output, incorporating digital orthphotos, as well as scanned USGS maps. The toolkit also included an embedded expert system which allows the user to select the model most appropriate for their particular application, taking into consideration the nature of the problem, the extent of available data and the expertise of the user. 1996 to 1997.

In addition to the project worked referenced above he has provided assistance to numerous communities concerning their NPDES permits. These assignments typically include evaluation of permit limits, development of negotiation strategies and development of comments and testimony. Mr. Gall's NPDES clients include:

The Massachusetts Water Resources Authority
The City of Woonsocket, RI
The South Essex Sewerage District, MA
The City of Haverhill, MA
The City of Manchester, NH
The City of Marlboro, MA
The Pease Development Authority, Portsmouth, NH
The City of Worcester, MA
The City of New Bedford, MA
The Lynn Water and Sewer Commission, MA
The City of Leominster, MA
The Town of Webster, MA
The Town of Northbridge, MA
The Town of Uxbridge, MA
The City of Brockton, MA
The City of Attleboro, MA
The Municipality of Metropolitan Seattle
The City of Santa Fe, New Mexico
The Louisville and Jefferson County MSD, KY
Logan International Airport

EDUCATION B.S. - Civil Engineering, Merrimack College, 1969

COMMITTEES AND SOCIETIES

Massachusetts Clean Water Council, Past Co-chairman Regulatory Affairs Committee.
American Public Works Association