AR-073

(73)

Public Service of New Hampshire

1000 Elm Street, Manchester, NH 03101

Public Service Company of New Hampshire
P.O. Box 330
Manchester, NH 03105-0330
(603) 669-4000

The Northeast Utilities System

March 6, 1998

D12191

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NH STATE PROGRAM UNIT

Fred Gay, NH NPDES Permit Coordinator
U.S. Environmental Protection Agency
New England Region
Office of Ecosystem Protection
J.F.K. Federal Building (CNH)
Boston, Massachusetts 02203

Subject: Schiller Station NPDES Permit No. NH0001473
Wastewater Treatment Plant Discharge (Outfalls 008 and 009)

Dear Fred,

During a review of the Schiller Station Draft NPDES Permit, you alerted me to the fact that the copper limitation at the wastewater treatment plant outfall would be reduced from 1.0 mg/l to a value less than 0.01 mg/l due to the lack of available dilution during low tides. Our discussion led to an action plan that involved submerging the outfall pipe and modeling the discharge to ensure adequate dilution. After evaluating the feasibility of extending the pipe, Normandeau Associates, Inc (NAI) was hired to perform the effluent monitoring. NAI was chosen due to their recent experience in modeling other discharges adjacent to Schiller Station.

Several outfall designs were provided to NAI's Jeffrey King who conducted numerous model iterations using the Cornell Mixing Zone Expert System (CORMIX). The final configuration chosen was to extend the outfall 25 feet with a 6-inch diameter pipe, with the discharge directed at a 75-degree angle from the river bottom. NAI's report and modeling results are attached. The dilution ratio provided by this installation is nearly 110, which fully meets NHDES policy guidelines and ensures that a considerable margin of safety exists to comply with water quality criteria and to protect aquatic life. It is worth noting that CORMIX was run using conservative input conditions, including slower river velocities from upstream sites, higher copper concentrations in the effluent, and no contribution from the two adjacent cooling water outfalls.

PSNH appreciates the opportunity to respond to this issue prior to permit issuance. The extension of the outfall now makes it possible to retain the existing technology-based copper limit of 1.0 mg/l. Please call me at (603)634-2439 to discuss this report further. Plans will be made to install the pipe, including wetlands permitting, following the receipt of agency approvals.

Very truly yours,

Allan Palmer

Allan Palmer
Senior Engineer

1997 BUSINESS OF THE YEAR THANK YOU NEW HAMPSHIRE

cc: JG Andrews; NHDES

OS6161 REV. 4-97

Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110-5500
(603) 472-5191
(603) 472-7052 (Fax)

NORMANDEAU ASSOCIATES

March 4, 1998

Allan Palmer
Public Service of New Hampshire
1000 Elm Street
Manchester, NH 03105-0330

Dear Allan:

Normandeau Associates has evaluated dilution associated with a wastewater discharge at the PSNH Schiller plant. The discharge is currently a 150,000 gpd discharge originating from a six-inch pipe but eventually enters the Piscataqua River through a 24 inch diameter pipe as a bank discharge. At low tide the pipe is exposed. The purpose of the evaluation is to design an outfall configuration that will be submerged at all times and achieve appropriate dilutions. This letter report summarizes the results of the dilution modeling efforts.

The outfall was evaluated using the Cornell Mixing Zone Expert System (CORMIX). According to the NHDES protocol for determining dilution factors in marine/estuarine waters, CORMIX is the modeling tool, which should be used for analysis. The CORMIX Modeling system allows for the analysis, prediction and design of toxic and/or conventional discharges into virtually any receiving water body. The primary emphasis of the model is on the shape and dilution characteristics of the discharged plume in the initial mixing zone and any specified regulatory mixing zone. The model uses three integrated subsystems depending on the type of discharge. For the Schiller Station discharge, CORMIX1, for submerged single port discharges, was used.

Input data for ambient conditions are described in the preliminary modeling letter report (NAI July 31, 1997). Ambient velocities were taken from previous field studies in the vicinity of the Pease Development Authority and the Simplex Wire outfalls upstream of the Schiller Station. This data will most likely result in conservative dilution estimates since velocities in the vicinity of the Schiller Station are somewhat higher. Higher ambient velocities typically enhance dilution by entraining more background water into the plume.

Available dilution was determined according to NHDES protocol. The lowest dilution obtained from the modeling analysis of the spring and neap tides (with an occurrence of approximately 1%) both at 15 minutes before and at 15 minutes after the slack low will be considered the available dilution. For industrial discharges the dilution must be obtained when the time of travel along the plume centerline is less than or equal to 15 minutes.

As a result of the preliminary modeling effort it was determined that the critical tide as defined by the NHDES protocol was at 15 minutes after the low slack during a spring tide with a 1% occurrence. Results of the preliminary modeling are summarized in Table 1. Copper concentrations, the pollutant of concern, were conservatively estimated at 200 ppb in the waste stream. An extension of the existing pipe (previously assumed at 18 inches in diameter) was modeled. As seen from the results, copper criteria (2.9 ppb for marine organisms) is met under all tidal conditions, however, discharge velocities are so low that intrusion into the pipe will most likely result.

Table 1. Results of Preliminary COMIX Modeling for the Schiller Station Discharge.

Tidal Run	Dilution	Copper Concentration (ppb)	Travel Distance of Plume (m)	Time of Plume Travel (min)
15 min before neap	119.6	1.67	41.77	6.6
15 min after neap	90.1	2.34	49.5	7.5
15 min before spring	217.4	0.92	69.56	6.4
15 min after spring	85.7	2.47	49.5	7.5

A final design was modeled in which the original 6-inch diameter pipe in the system would be extended 25 feet from the existing discharge location into the river. Modeling was conducted under the critical tidal conditions of 15 minutes after spring low slack. Ambient input velocity and salinity are the same as those used in the preliminary modeling. Depths at the proposed location were determined from a diver inspection of the outfall area. All input data are summarized in the CORMIX Session Report included as Attachment 1.

Several iterations were made using different port orientations to maximize dilution. The final configuration was a single port outfall with the port pointed downstream (toward the ocean) and angled up at a 75-degree angle off the bottom. The results of this final design are also included in Attachment 1 and are summarized below in Table 2.

Table 2. Dilution Characteristics of Final Design for Schiller Station.

Dilution	Copper Concentration (ppb)	Travel Distance of Plume (m)	Time of Plume Travel (min)
109.8	1.88	49.50	7.3

This outfall configuration results in a dilution of 110 in a travel time of only 7.3 minutes. According to NHDES protocol, dilutions for industrial discharges are determined within a travel time of 15 minutes. An additional eight minutes of travel time would provide additional dilution. The resulting copper concentration of 1.88 ppb (using a conservative estimate of 200 ppb as an initial copper concentration) is already well below the aquatic criteria of 2.9 ppb for marine organisms.

In summary, the proposed 25-foot outfall extension with a single port oriented at 75 degrees off the bottom will provide sufficient dilution for the protection of aquatic life. Results indicate that even with several conservative factors built into the analysis, a final dilution in excess of 100 is achieved well within the guidelines of the NHDES protocol for determining mixing zones associated with industrial discharges. In addition, modeling was conducted under worst case conditions, when the Schiller Station is offline (i.e. when there is no cooling water discharge from the canal). When the station is generating, cooling water is discharged from the cooling water discharge canal in the vicinity of the proposed outfall. This increases velocities substantially and will result in substantially more dilution.

If there are any questions regarding this analysis, please do not hesitate to call me.

Sincerely,
NORMANDEAU ASSOCIATES INC.

Jeffrey King

Jeffrey King
Water Quality Specialist

Attachment

ATTACHMENT 1

SCHILLER STATION WASEWATER DISCHARGE
FINAL DESIGN
CORMIX DILUTION MODELING RESULTS

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                  CORMIX: CORNELL MIXING ZONE EXPERT SYSTEM
                      CORMIX v.3.20    September 1996
SITE NAME/LABEL:                  schiller
  DESIGN CASE:                    6 inch at 25 ft 75 deg into current
  FILE NAME:                      sa25 6c
Using subsystem CORMIX1:          Submerged Single Port Discharges
  Start of session:               02/09/98--10:41:32
*******************************************************************************
SUMMARY OF INPUT DATA:
-------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                              = unbounded
  Average depth                     HA       =          2.5 m
  Depth at discharge                HD       =          2.4 m
  Darcy-Weisbach friction factor    F        =       0.0361
    Calculated from Manning's n              =         .025
  Wind velocity                     UW       =            2 m/s
TIDAL SIMULATION at time            Tsim     =          .25 hours
  Instantaneous ambient velocity    UA       =          .11 m/s
  Maximum tidal velocity            UaMAX    =         1.54 m/s
  Rate of tidal reversal            dUA/dt   =       0.4400 (m/s)/hour
  Period of reversal                T        =         12.4 hours
Stratification Type                 STRCND   = U
  Surface density                   RHOAS    =         1021 kg/m^3
  Bottom density                    RHOAB    =         1021 kg/m^3
-------------------------------------------------------------------------------
DISCHARGE PARAMETERS:               Submerged Single Port Discharge
  Nearest bank                               = left
  Distance to bank                  DISTB    =          7.6 m
  Port diameter                     D0       =          .15 m
  Port cross-sectional area         A0       =       0.0176 m^2
  Discharge velocity                U0       =         0.39 m/s
  Discharge flowrate                Q0       =         .007 m^3/s
  Discharge port height             H0       =          .15 m
  Vertical discharge angle          THETA    =           75 deg
  Horizontal discharge angle        SIGMA    =          180 deg
  Discharge density                 RHO0     =         1021 kg/m^3
  Density difference                DRHO     =            0 kg/m^3
  Buoyant acceleration              GP0      =        .0000 m/s^2
  Discharge concentration           C0       =              200 ppb
  Surface heat exchange coeff.      KS       =            0 m/s
  Coefficient of decay              KD       =            0 /s
-------------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  =       0.13 m         Lm  =       0.47 m           Lb  =          0.0 m
  LM  =    99999.0 m         Lm' =    99999.0 m           Lb' =      99999.0 m
UNSTEADY TIDAL SCALES:
  Tu  =     0.0422 hours     Lu  =       2.83 m           Lmin=         0.03 m
-------------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number    FR0      =    99999.0
  Velocity ratio                    R        =       3.60
-------------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                            = no
  Water quality standard specified           = no
  Regulatory mixing zone                     = no
```

```
  Region of interest                         =      1000.00 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   =      V2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth =          2.4 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):
-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
           7.6 m from the left bank/shore.
  Number of display steps NSTEP = 10 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at edge of NFR =           6.0164 ppb
  Dilution at edge of NFR                    =      33.2
  NFR Location:                            x =     13.09 m
    (centerline coordinates)               y =       .02 m
                                           z =      2.40 m
  NFR plume dimensions:        half-width =         1.02 m
                                thickness =         1.02 m
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is equal or about about equal to the surrounding
  ambient water density at the discharge level.
  Therefore, the effluent behaves essentially as NEUTRALLY BUOYANT.
-----------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
  Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                           x =     49.50 m
                                           y =       .02 m
                                           z =      2.40 m
  For this condition AFTER TIDAL REVERSAL, mixed water from the previous
  half-cycle becomes re-entrained into the near field of the discharge,
  increasing pollutant concentrations compared to steady-state predictions.
  A pool of mixed water formed at slack tide will be advected downstream
  in this phase.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ and no ambient water quality standard have been specified.
********************* FINAL DESIGN ADVICE AND COMMENTS **********************
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
*****************************************************************************
```

```
DESIGN CASE:                   6 inch at 25 ft 75 deg into current
FILE NAME:                     sa25 6c
Subsystem CORMIX1:             Submerged Single Port Discharges
END OF SESSION/ITERATION:      02/09/98--13:44:37
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

```
CORMIX1 PREDICTION FILE:
11111111111111111111111111111111111111111111111111111111111111111111111111111
                      CORNELL MIXING ZONE EXPERT SYSTEM
Subsystem CORMIX1:                                          Subsystem version:
 Submerged Single Port Discharges          CORMIX v.3.20     September 1996
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:          schiller
 Design case:              6^inch^at^25^ft^75^deg^into^current
 FILE NAME:                cormix\sim\sa25 6c .cx1
 Time of Fortran run:      02/09/98--10:42:14

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA     =      2.50  HD     =       2.40
 Tidal Simulation at TIME =         .250 h
 PERIOD=    12.40 h UAmax =       1.540 dUa/dt=        .440 (m/s)/h
 UA     =       .110 F      =        .036 USTAR = .7393E-02
 UW     =      2.000 UWSTAR= .2198E-02
 Uniform density environment
 STRCND=  U          RHOAM = 1021.0000

DISCHARGE PARAMETERS (metric units)
 BANK  =  LEFT       DISTB =        7.60
 D0     =       .150 A0     =        .018 H0     =        .15
 THETA =      75.00  SIGMA =     180.00
 U0     =       .396 Q0     =        .007         = .7000E-02
 RHO0  = 1021.0000  DRHO0 = .0000E+00  GP0    = .0000E+00
 C0     = .2000E+03  CUNITS=  ppb
 IPOLL =  1          KS     = .0000E+00  KD     = .0000E+00

FLUX VARIABLES (metric units)
 Q0     = .7000E-02  M0     = .2773E-02  J0     = .0000E+00  SIGNJ0=       1.0
 Associated length scales (meters)
 LQ     =       .13  LM     = 99999.00  Lm     =        .48  Lb     =        .00
                                        Lmp    =  99999.00  Lbp    =  99999.00
 Tidal:              Tu     =    .0423 h Lu     =      2.831 Lmin   =       .034

NON-DIMENSIONAL PARAMETERS
 FR0    = 99999.00  R      =       3.60

FLOW CLASSIFICATION
 111111111111111111111111111111111111111111
 1  Flow class (CORMIX1)       =     V2      1
 1  Applicable layer depth HS =      2.40   1
 111111111111111111111111111111111111111111

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     = .2000E+03  CUNITS=  ppb
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =    1000.00  XMAX  =    1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and below the center of the port:
         7.60 m  from the LEFT  bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 10 display intervals per module
```

BEGIN MOD101: DISCHARGE MODULE

X	Y	Z	S	C	B
.00	.00	.15	1.0	.200E+03	.08

END OF MOD101: DISCHARGE MODULE

BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

Jet-like motion in weak crossflow.

Zone of flow establishment: THETAE= 70.63 SIGMAE= .00
LE = .10 XE = .00 YE = .03 ZE = .25

Profile definitions:
B = Gaussian 1/e (37%) half-width, normal to trajectory
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)

X	Y	Z	S	C	B
.00	.00	.15	1.0	.200E+03	.08
.00	.03	.25	1.0	.200E+03	.08
.97	.03	.93	4.6	.437E+02	.24
2.19	.03	1.18	7.4	.271E+02	.31
3.41	.03	1.34	9.5	.211E+02	.36
4.65	.03	1.46	11.2	.178E+02	.39
5.88	.03	1.56	12.8	.157E+02	.42
7.11	.03	1.64	14.1	.142E+02	.44
8.35	.03	1.71	15.4	.130E+02	.47
9.59	.03	1.77	16.5	.121E+02	.48
10.82	.03	1.83	17.5	.114E+02	.50
12.06	.03	1.88	18.5	.108E+02	.52

Cumulative travel time = 96. sec

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

BEGIN MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

Control volume inflow:

X	Y	Z	S	C	B
12.06	.03	1.88	18.5	.108E+02	.52

Profile definitions:
BV = top-hat thickness, measured vertically
BH = top-hat half-width, measured horizontally in Y-direction
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic average (bulk) dilution
C = average (bulk) concentration (includes reaction effects, if any)

X	Y	Z	S	C	BV	BH	ZU	ZL
11.54	.03	2.40	18.6	.108E+02	.00	.00	2.40	2.40
11.70	.03	2.40	18.5	.108E+02	.65	.33	2.40	1.75
11.85	.03	2.40	18.5	.108E+02	.77	.46	2.40	1.63
12.01	.03	2.40	18.5	.108E+02	.84	.56	2.40	1.56
12.16	.03	2.40	19.0	.105E+02	.90	.65	2.40	1.50

12.32	.03	2.40	21.4	.936E+01	.94	.73	2.40	1.46
12.47	.03	2.40	24.6	.813E+01	.98	.80	2.40	1.42
12.63	.03	2.40	27.6	.726E+01	1.00	.86	2.40	1.40
12.78	.03	2.40	29.6	.676E+01	1.02	.92	2.40	1.38
12.94	.03	2.40	30.7	.652E+01	1.03	.98	2.40	1.37
13.09	.03	2.40	31.4	.638E+01	1.03	1.03	2.40	1.37

Cumulative travel time = 105. sec

END OF MOD131: LAYER BOUNDARY/TERMINAL LAYER APPROACH

** End of NEAR-FIELD REGION (NFR) **

BEGIN MOD141: BUOYANT AMBIENT SPREADING

Discharge is non-buoyant or weakly buoyant.
Therefore BUOYANT SPREADING REGIME is ABSENT.

END OF MOD141: BUOYANT AMBIENT SPREADING

Bottom coordinate for FAR-FIELD is determined by average depth, ZFB = -.10m

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BEGIN MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = .358E-02 m^2/s
Horizontal diffusivity (initial value) = .156E-02 m^2/s

Profile definitions:
BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
= or equal to layer depth, if fully mixed
BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
measured horizontally in Y-direction
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL
13.09	.03	2.40	31.4	.638E+01	1.03	1.03	2.40	1.37
32.96	.03	2.40	72.0	.278E+01	1.76	1.49	2.40	.64
49.50	.03	2.40	109.8	.188E+01	2.18	1.91	2.40	.22

Cumulative travel time = 436. sec

CORMIX prediction has been TERMINATED at last prediction interval.
Limiting time due to TIDAL REVERSAL has been reached.

END OF MOD161: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX1: Submerged Single Port Discharges End of Prediction File
1111111111111111111111111111111111111111111111111111111111111111111111111111

Public Service
of New Hampshire

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The Northeast Utilities System

December 22, 2004

D21944

Ms. Joy J. Hilton
U.S. Environmental Protection Agency
Region I
1 Congress Street, Suite 1100 (SEW)
Boston, MA 02114-2023

References:
1. NPDES Permit No. NH0001473, Schiller Station, Public Service Company of New Hampshire, issued September 11, 1990; modified May 31, 1991; modified January 24, 1995.
2. Noncompliance Notification (D21803), WH Smagula to JJ Hilton, dated November 24, 2004.

Dear Ms. Hilton:

In compliance with Part II, Section D.1.e., of the NPDES Permit (Reference 1.), Public Service Company of New Hampshire (PSNH) filed a noncompliance notification (Reference 2.) for high differential temperatures in the cooling water at Schiller Station located in Portsmouth, NH. This letter serves as a follow-up final report of our findings.

As noted in our previous correspondence, station operators noticed that daily reports from the data acquisition computer contained some incorrect information. Upon further review, it was learned that some of the data outputs had been frozen on the same readings for the last few days. This data included the cooling water differential temperatures for all three units. For further understanding, a description of the computer system and the temperature calculations are provided.

System instrumentation utilized throughout the station accumulates data, e.g., flow, temperature, pressure, and sends it to the data acquisition computer. The computer stores the data and in some cases, performs simple calculations such as averaging values. The plant computer continuously records all vital plant operation information on a 24 hour daily basis. On every midnight, all of the hourly data readings and calculated values are automatically printed for hard copy records of the day's operational data. Alarm values are established on some of the monitoring parameters to alert operators of potential malfunctions or deviations from normal conditions.

In the case of cooling water temperatures, the computer receives a reading every 30 seconds from each inlet and outlet side of the condenser piping. A calculation is performed to determine the average temperature based on the last 30 second reading. The differential temperature is then calculated. If the differential temperature value approaches 25°F, then an alarm will alert the Control Room Operator.