APPENDIX 1

MIXING ZONE AND DISPERSION THEORY

MIXING ZONE THEORY

Regardless of how an effluent is discharged, the effluent will be mixed with the receiving stream in several distinct hydraulic mixing zones, as illustrated in Figure A1-1. These zones can be described as follows:

1. Jet Momentum or Entrainment Zone (JMZ) – mixing occurs almost exclusively due to the energy or initial momentum of the effluent discharge;

1A. Restratification Zone – the plume restratisfies due to residual density differences (seldom occurs);

2. Buoyant or Density Spreading Zone (BSZ) – transition zone where mixing occurs due to residual excess effluent energy (momentum), density gradient between the effluent and the river, and ambient river diffusion; and

3. Far-Field Zone – longitudinal, lateral, and vertical mixing due to ambient river diffusion alone.

1. Jet Momentum Zone

In regulatory language, the JMZ is commonly referred to as the Zone of Initial Dilution (ZID), or the zone of rapid and immediate mixing. The ZID, or JMZ, is where the maximum reduction in effluent concentration occurs. The size of the JMZ is directly related to the difference between the initial effluent velocity and the ambient river velocity (in the discharge area), the geometry of the discharge structure, the initial densimetric Froude number, and the initial density gradient between the effluent and the river. Lee and Jirka (1980) define this near-field mixing zone as occurring within a distance described by them as “of order of the diffuser length” (i.e., meaning within ½ to 1½ diffuser length) downstream from the discharge structure, for low to stagnant ambient currents. Higher ambient velocities can extend the near-field mixing zone to distances greater than one diffuser length.

1A. Restratification Zone

Once the effluent plume has lost its jet momentum into the receiving stream, the remaining density differences between the plume and the river can cause the plume to restratify or form a density wedge. This can occur for strongly positively or negatively buoyant plumes, but generally not for plumes that are essentially neutral in density following the JMZ. The effect of restratification is to restrict the exchange of new water with the plume through physical density gradients.

2. Buoyant Spreading Zone

Dispersion processes in the BSZ arise due to the buoyant forces caused by the density difference of the mixed flow relative to the ambient density (Fickian diffusion). Buoyant spreading, defined as “the horizontally transverse spreading of the mixed effluent flow while it is being advected downstream by the ambient current” (Doneker and Jirka, 1990), will normally not occur in the cases of weakly-buoyant or non-buoyant plumes. The buoyant spreading region occurs between the JMZ or restratification zone and the far-field zone, and is a difficult to define zone of transition.

3. Far-field Zone

Far-field dispersion is totally dependent upon, and driven by, ambient river diffusion. Parameters such as river velocity, morphology, and lateral and vertical dispersion coefficients, determine the rate and extent of ambient diffusion. Eventually, the effluent will become completely mixed laterally and vertically across the river by the far-field dispersive forces. The distance to total mixing with the river is usually measured in miles, rather than in feet. The total regulatory mixing zone encompasses a portion of the total far-field mixing zone. Based on this study, the Noveon *regulatory* total mixing zone extends somewhere between 553 feet and 1,090 feet downstream from the diffuser.

HYDRAULIC MIXING ZONES

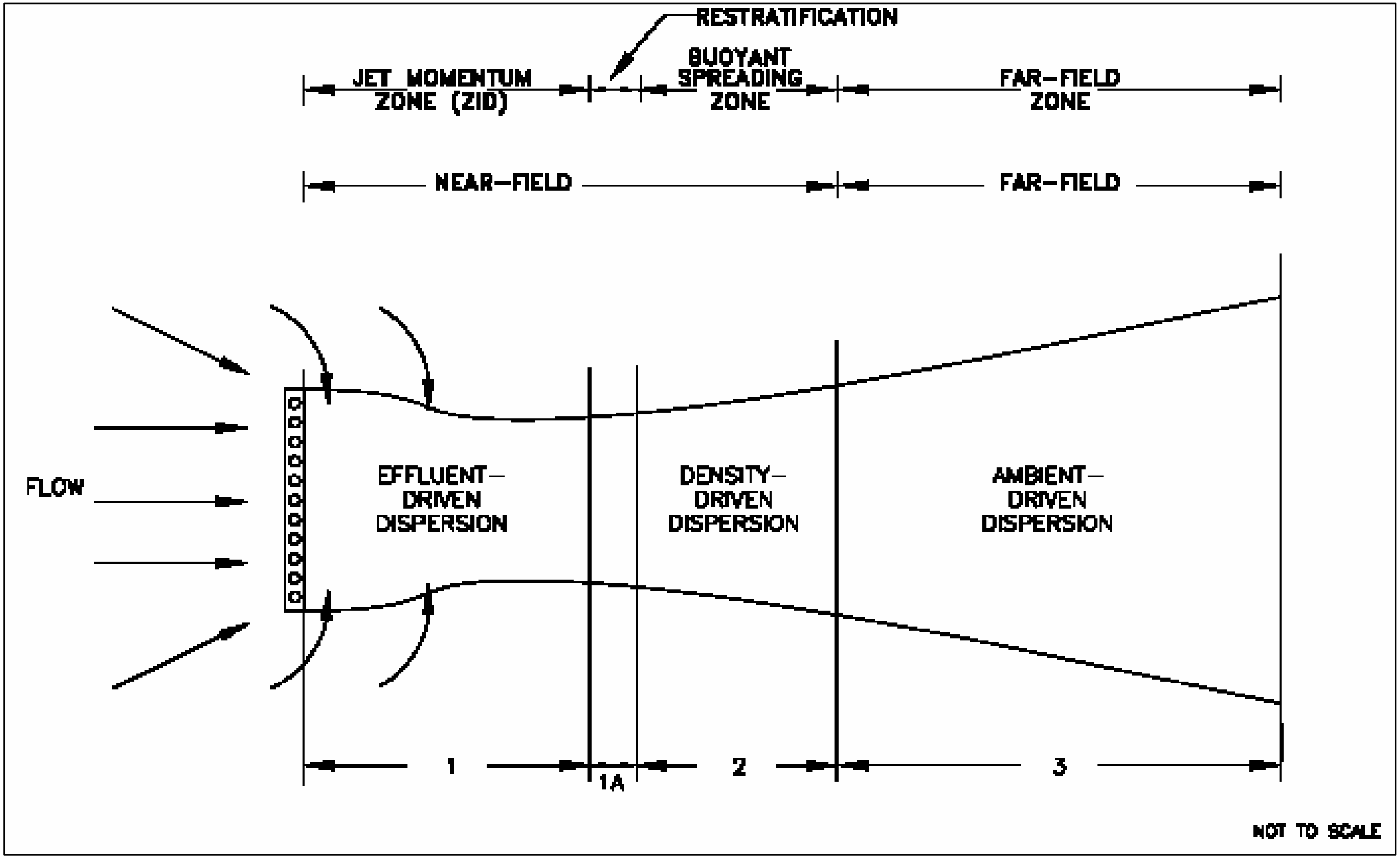

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FIGURE A1-1 - HYDRAULIC MIXING ZONES

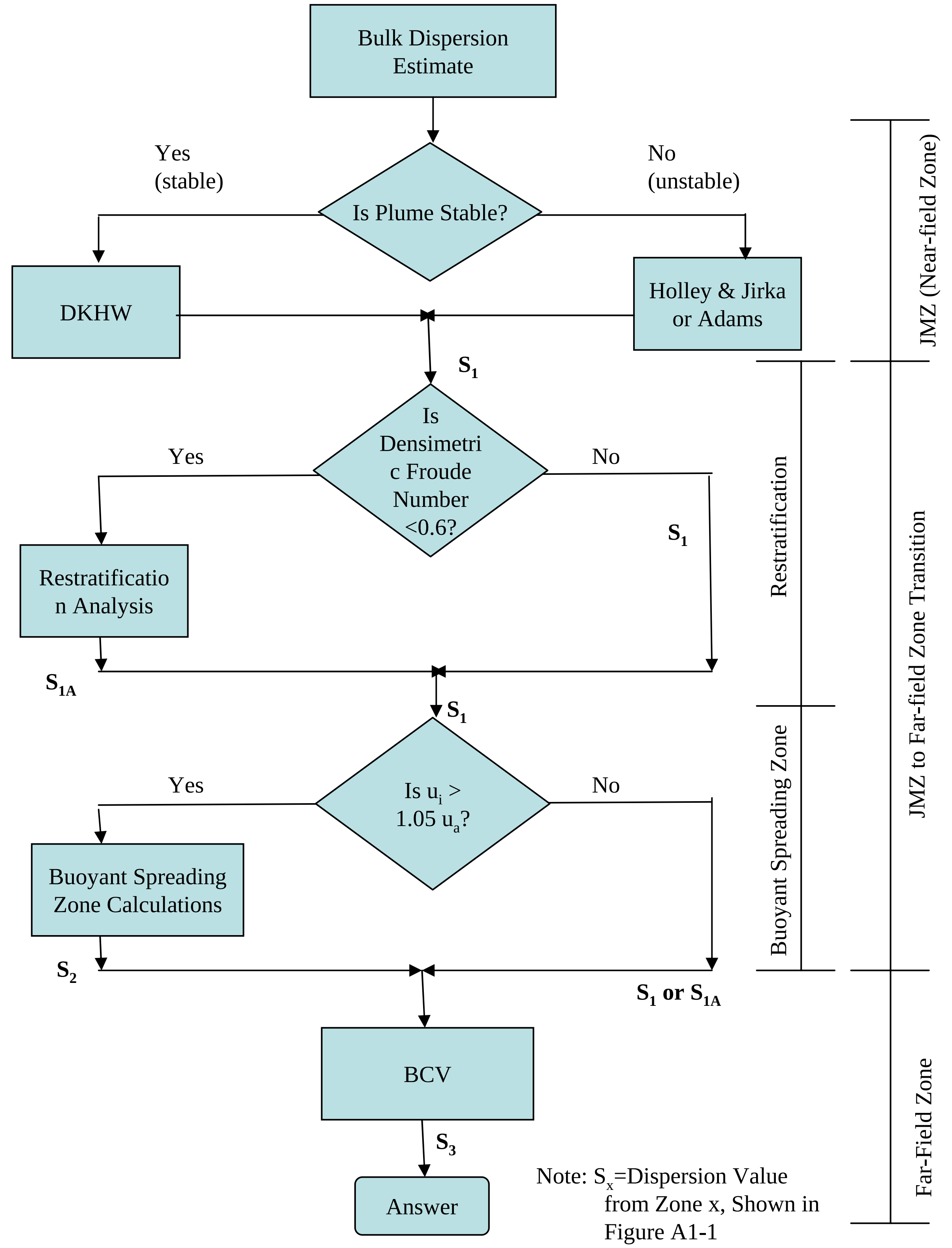
ANALYTICAL APPROACHES TO MIXING ZONE THEORY PROJECTIONS OF PLUME DISPERSION

In general, there are two broad approaches to analyzing diffuser dispersion performance: 1) Independent Analysis of each zone, calibrating against field data, and applying best engineering judgment, theory, and experience on a case-by-case basis; or 2) employing an "Expert System" approach, such as CORMIX 2. The analytical processes of both approaches are illustrated in Figures A1-2 and A1-3.

In the "Independent Analysis" approach, presented in Figure A1-2, well established theoretical and experimental hydraulic principles are used to evaluate the impacts on dispersion of each zone (where applicable). This approach permits correlation of theory with "the real world," by allowing calibration of modules to site-specific field conditions. Essentially, if theory predicts "oranges," but one observes "apples" in the field, then allowance must be made for the impacts of field conditions on the predictions. Models and theory are functions of idealized conditions, and cannot account for all possible actual conditions. Calibration and interpretation, using experience and engineering judgement, become necessary at each step in the analytical process.

Using the Expert System approach, as in Figure A1-3, appears to simplify the process considerably. Unfortunately, all calculations and theory are locked inside the model, and calibration to field conditions is made virtually impossible. If situations approaching ideal conditions are encountered, the expert system can be a reliable tool. However, the further a site departs from "ideal" conditions, then the less reliable and accurate the results obtained from the Expert System approach will be.

In the following pages, the approaches to analyzing diffuser performance illustrated in Figures A1-2 and A1-3 are explored in greater detail and evaluated for the appropriateness for the Noveon site. An approach is selected and then used for model calibration and model projections at a critical condition.



Note: S_x=Dispersion Value from Zone x, Shown in Figure A1-1

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FIGURE A1-2

INDEPENDENT ANALYSIS PATHWAY

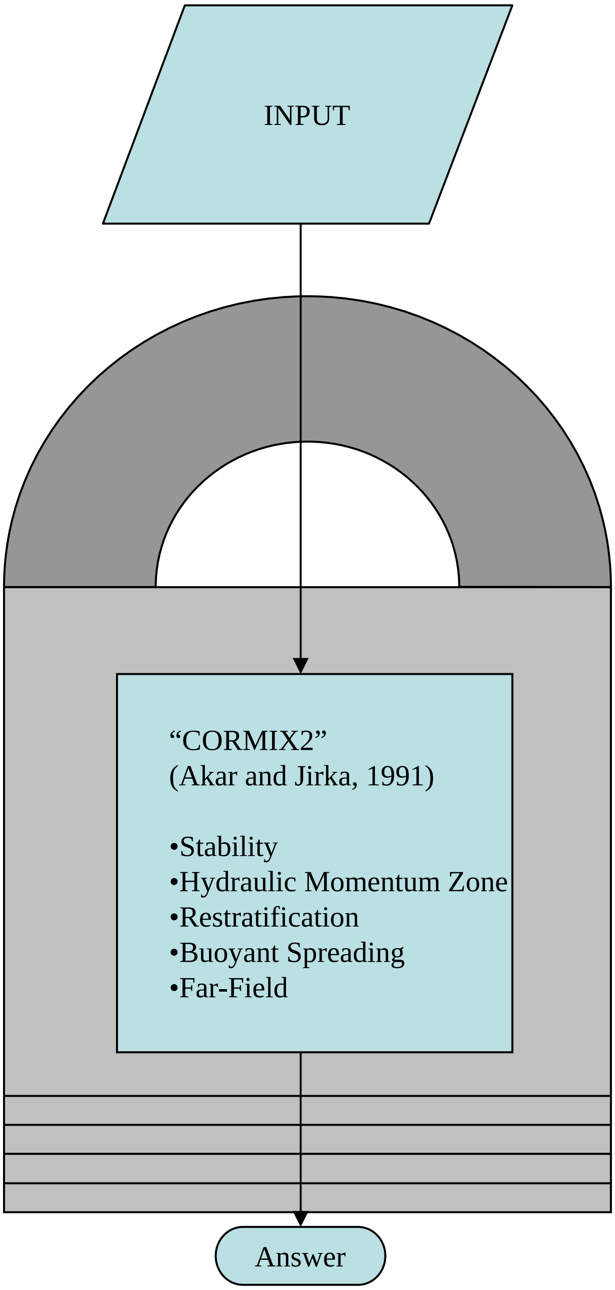

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FIGURE A1-3

**“EXPERT SYSTEM”
APPROACH**

INDEPENDENT ANALYSIS APPROACH

Near-Field Bulk Dispersion Estimate

The near-field bulk dispersion estimate provides a reality check to compare with results from various other analyses, such as the “Expert System” approach.

Dispersion, S, also called mixing, is defined as:

$$S = \frac{total\ volume\ of\ the\ sample}{volume\ of\ effluent\ in\ sample} \qquad \text{(A1-1)}$$

Steady-state conditions are assumed in river analyses, hence flow, mass, or concentration can be used in place of volume in this definition of dispersion. The mixing that occurs in the JMZ (near-field) can be crudely estimated by a bulk dispersion analysis of a one-second snap-shot of the system, as shown in Figure A1-4. During the one-second interval being studied, the effluent mixes with the volume of water that passes over the discharge. Changing Equation A6-1 into a usable format with variables yields the following equation:

$$S = \frac{Q_{eff} + Q_{riv}}{Q_{eff}} \qquad \text{(A1-2)}$$

where: S = Dispersion (__:1, dimensionless)
Q_{riv} = river flow (ft^3/sec, or volume/time)
Q_{eff} = effluent flow (ft^3/sec, or volume/time.)

By plugging values measured in the field into equation A1-2, an estimated bulk dispersion in the JMZ can be calculated.

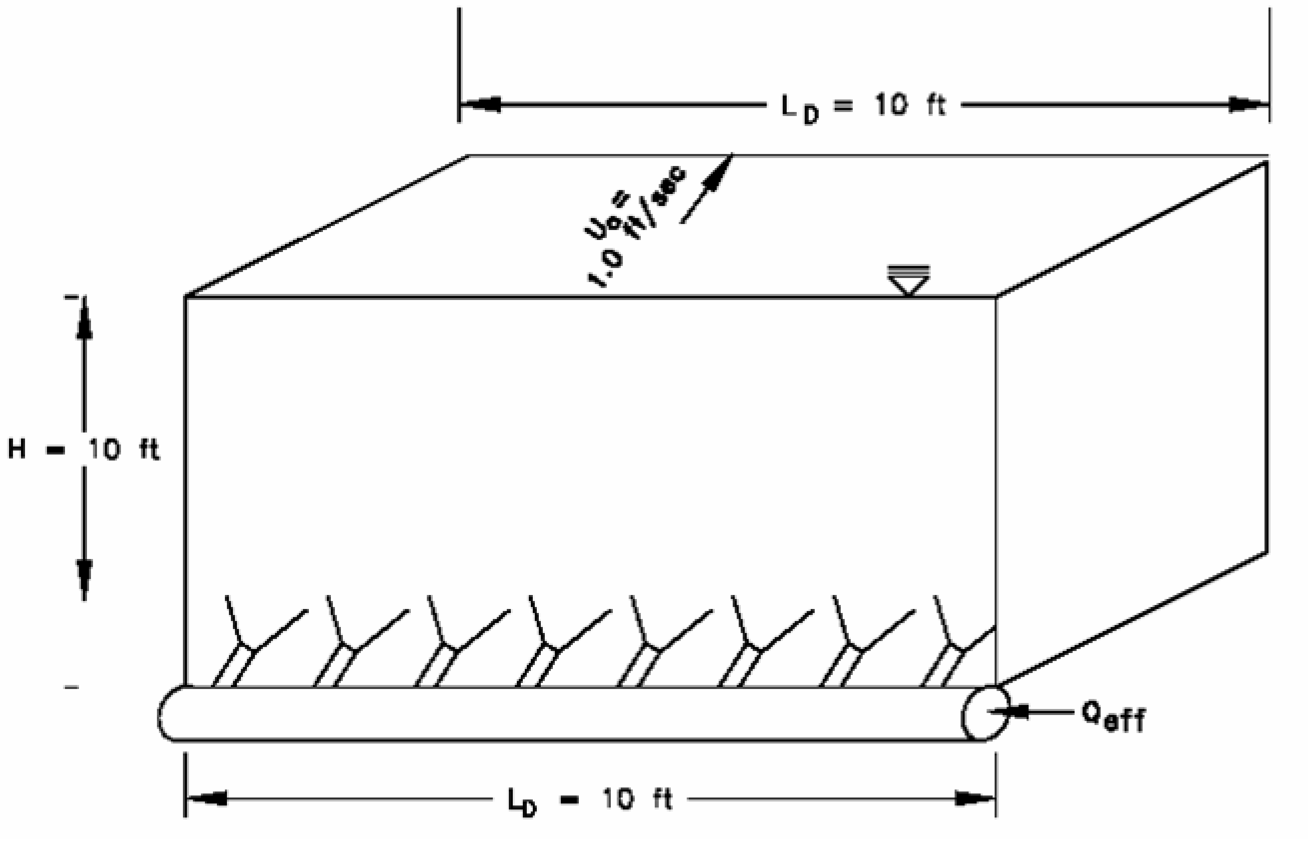

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FIGURE A1-4 – BULK DISPERSION ANALYSIS

$$S = \frac{(Diffuser\ length)(River\ Height)(River\,Velocity) + 1.29mgd * 1.547\frac{cfs}{mgd}}{1.29mgd * 1.547\frac{cfs}{mgd}}$$

$$S = \frac{(12\ ft)(11\ ft)(0.45\ ft/sec) + 1.9956cfs}{1.9956cf}$$

$$S = \frac{59.4cfs + 1.9956cfs}{1.9956cfs}$$

$$S = 30.77$$

$$\therefore S = 30.8:1$$

This analysis assumes complete mixing and ignores entrainment of water from the side and from behind the diffuser. In actuality, the relatively high velocity of the effluent exiting the diffuser (compared to ambient velocity) creates a "vacuum" and entrains, or pulls, water into the plume from bordering waters, as illustrated in Figure A1-5. This entrained water has the effect of increasing dispersion, as more water is made available for the effluent to mix with.

The bulk dispersion analysis presented above is an oversimplification of a quite complex plume development and mixing process. However, it is a "back of the envelope" method to estimate the order of magnitude of achievable dispersion. Actually, diffuser effluent flow induced entrainment of additional waters can typically increase dispersion 10% to 30%, or more, over the dispersion available due to river water passing directly over the diffuser. The initial plume behavior, and hence the resultant JMZ dispersion, is dependent upon the stability of the plume in the receiving body of water. Two general methods of solving for dispersion (that account for entrainment) exist for a multiport diffuser with a flowing ambient current:

1. Unstable discharge domain (shallow-water conditions) where flow recirculation and breakdown occur; and

2. Stable discharge domain (deep-water conditions).

In order to determine whether an unstable plume analysis or a stable plume analysis technique is appropriate for determining effluent dispersion, the plume stability must first be determined.

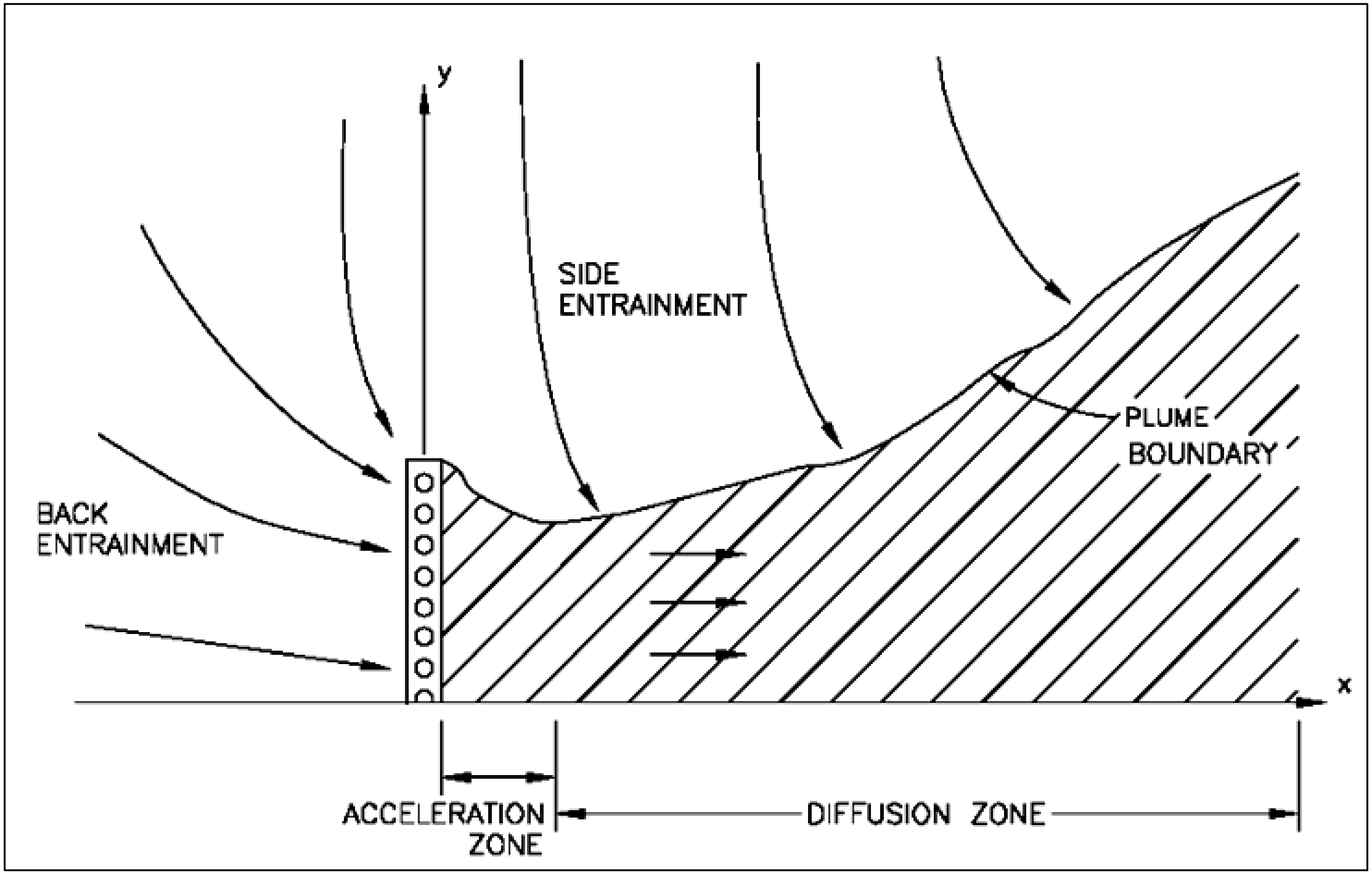

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FIGURE A1-5 – ENTRAINMENT OF WATER (1/2 PLUME)

Plume Stability Analyses

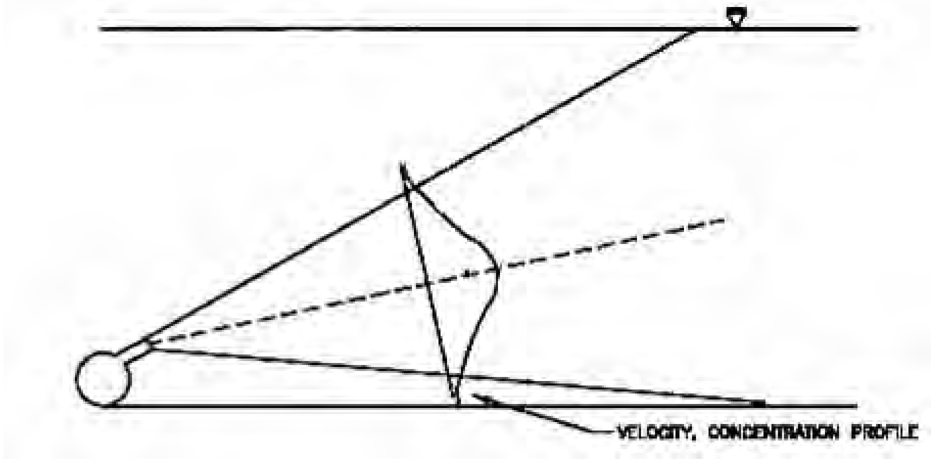
Discharge flow patterns in the immediate diffuser vicinity are strongly dependent upon a combination of ambient conditions, discharge characteristics, and diffuser geometry. The purpose of plume stability analysis is to predict under what combination of conditions the effluent plume will exhibit stable or unstable characteristics. The stability classification, when compared to observed field plume behavior, can give credence to, or disqualify from application, the various predictive dispersion equations or computer models available.

The definitions of stability and instability given by Jirka (1982) illustrate two broad classes of expected flow behavior, depending on the combination of factors as mentioned above:

> A *stable* near field is defined as one in which a buoyant surface layer is formed which does not communicate with the initial buoyant jet zone…The near field is defined as *unstable* whenever the layered flow structure breaks down in the discharge vicinity, resulting in recirculating zones or mixing over the entire water depth…"

In simple terms, a stable plume is one which propagates downstream in a well-defined conical fashion, growing in size until the effluent is mixed top-to-bottom over the entire water column. A stable plume is typically described by a Gaussian profile, as illustrated in Figure A1-6. An unstable plume, on the other hand, will demonstrate a turbulent, and sometimes oscillatory, centerline trajectory with a tendency to mix top-to-bottom within a very short distance (on the order of one diffuser length) downstream from the diffuser. An unstable plume may appear as in Figure A1-6. Vlachos has used the analogy of a garden hose discharging into a swimming pool (stable plume, slowly mixing), or into a one-gallon bucket (unstable plume, rapid and turbulent complete mixing) to illustrate the concept of plume stability. The various mathematical equations that have been proposed to calculate bulk dispersion rely on knowledge of plume stability. The Adams (1982) equation for bulk dispersion, for instance, is valid for shallow water plumes which are mixed top-to-bottom. By extension to the definition of stability, the Adams bulk dispersion analysis is applicable only to unstable plume situations. CORMIX2 incorporates a rigorous flow classification scheme, categorizing

STABLE (GAUSSIAN) PLUME



VELOCITY CONCENTRATION PROFILE

UNSTABLE PLUME

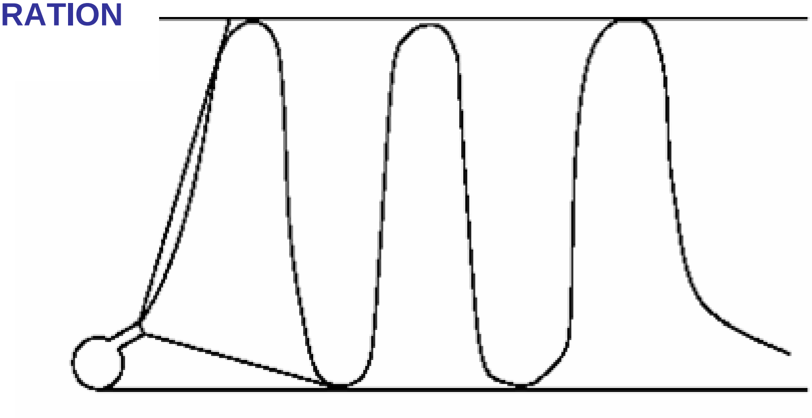


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FIGURE A1-6 – PLUME STABILITY ANALYSIS

the flow into one of 31 classes, depending on plume momentum and buoyancy as well as ambient velocity and depth. If the plume is stable, dispersion is calculated by simulating the plume as a two-dimensional wall jet (plane source). If the plume is unstable (and the diffuser is unidirectionally co-flowing), CORMIX2 calculates bulk dispersion based on the equations developed by Adams (1982). DKHW always assumes a stable plume, and approximates a Gaussian distribution for projecting the effluent dispersion.

Holley and Jirka have described a stable plume as presented in Figure A1-7. The longitudinal cross-section that is presented in Figure A1-7 is fairly representative of the plume from Noveon's diffuser. The plume during the field study was fully mixed in the water column at the end of the jet mixing/buoyant spreading zone before the far field mixing zone.

Early work in dispersion modeling dealt primarily with positively buoyant plumes, such as those emanating from cooling water discharges. A stability criterion reported by Jirka (1982) during this early work, and still widely used is:

$$\frac{m_o}{p_o^{2/3} * H} + \frac{m_a + m_o * \cos\theta_o}{p_o^{2/3} * H} = 0.54 \qquad \text{(A1-3)}$$

where: m_o = discharge momentum flux
m_a = ambient momentum flux
p_o = buoyancy flux
H = water depth
θ_o = discharge angle

If the left hand side (LHS) of equation A1-3 is greater than or equal to 0.54, then the plume is said to be unstable. A closer examination of Equation A1-3 shows that both the discharge momentum flux and any ambient momentum flux act as destabilizing agents. The tendency to instability is further increased if the discharge momentum also has a horizontal component ($m_o * \cos \Theta_o$).

A slightly different form of Equation A1-3 is used by Adams (1982) and Jirka (1973, 1982).

LONGITUDINAL CROSS-SECTION OF A STABLE PLUME THEORIZED BY HOLLEY & JIRKA

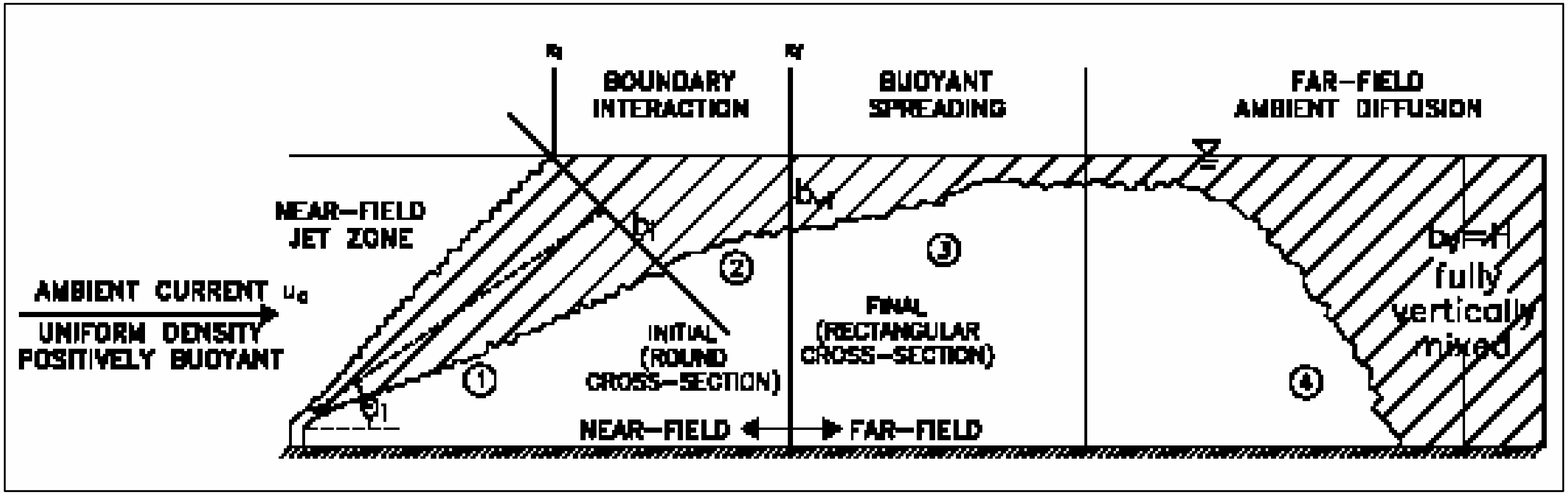

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FIGURE A1-7 – LONGITUDINAL CROSS-SECTION

$$\frac{m_o * \left(1 + \cos^2 \theta_o\right) + m_a}{p_o^{2/3} * H} = 0.54 \qquad \text{(A1-4)}$$

Again, the criterion for instability is if the LHS of Equation A1-4 is greater than or equal to 0.54.

The CORMIX2 computer model, developed by Akar and Jirka (1991), uses modified forms of Equation A1-4 in their rigorous flow classification scheme, depending on plume buoyancy. As stated previously, most early work dealt only with positively buoyant plumes. In the case of positively buoyant plumes, an ambient current momentum flux (m_a) will tend to accelerate the spreading of the plume, and promote rapid top-to-bottom mixing. In this sense, ambient momentum flux does play a destabilizing role, and thus m_a is added to the LHS of Equations A1-3 and A1-4. In the case of negatively buoyant plumes, however, an ambient current will act more in a stabilizing role; that is, an ambient current will moderate the tendency of the jet plume to oscillate and mix rapidly top-to-bottom. The following stability criterion from CORMIX2 accounts for the difference in plume and ambient densities, as well as the height of the diffuser from the water body floor:

$$\text{POSITIVE:} \qquad \frac{m_o * \left(1 + \cos^2 \theta_o\right)^2 + m_a - 0.1 * h_o * \frac{m_a}{m^o} * p_o^{2/3}}{p_o^{2/3} * H} = 0.54 \qquad \text{(A1-5)}$$

$$\text{NEGATIVE:} \qquad \frac{m_o * \left(1 + \cos^2 \theta_o\right)^2 - m_a}{\left|p_o^{2/3}\right| * H} = 0.54 \qquad \text{(A1-6)}$$

where: h_o = elevation of discharge port above bottom

The significant difference between Equation A1-4 and Equations A1-5 and A1-6 is the role played by the ambient momentum flux (m_a): that is, whether m_a is stabilizing ($+m_a$) or destabilizing ($-m_a$).

It is instructional to determine the theoretical stability of the Noveon plume, as it existed during the October field study. The effluent plume did not immediately mix top-to-bottom, as would have been expected if the plume had been unstable. Rather, dispersion was accomplished gradually, with the effluent plume surfacing approximately

20 feet downstream from the diffuser. The plume was mixed top to bottom within 100 feet downstream of the diffuser, however. The plume appears to have been stable, especially if one considers the ambient water depth, the river current and the discharge exit velocity. It is interesting to compare this intuitive plume classification to the theoretical classification computed by Equation A1-6.

$$\frac{m_o * \left(1+\cos^2\theta_o\right)^2 - m_a}{\left|p_o^{2/3}\right| * H} \Rightarrow < 0.54 = \textit{unstable}, \geq 0.54 = \textit{stable}$$

where:

m_a = ambient momentum flux
= $u_a^2 H$
= $(0.45\ \text{ft/sec})^2 * (11\ \text{ft})$
= $2.2275\ \text{ft}^3/\text{sec}^2$
u_a = ambient current velocity
H = water depth
g_o’ = initial buoyant acceleration
= $g(\rho_a - \rho_o)/\ \rho_a$
= $32.2\ \text{ft/sec}^2 * (62.36-62.77)/\ 62.36$
= $-0.212\ \text{ft/sec}^2$
ρ_a, ρ_o = ambient, discharge density

q_o = volume flux
= Q_o/L_D
= $(2.00\ \text{ft}^3/\text{sec})(15\ \text{ft})$
= $0.133\ \text{ft}^2/\text{sec}$
L_D = diffuser length
Q_o = total discharge flow
g = acceleration of gravity

m_o = discharge momentum flux
= $q_o u_o$
= $(0.133)*(10.24)$
= $1.36\ \text{ft}^3/\text{sec}^2$
q_o = discharge port exit velocity, ft/sec

p_o = buoyancy flux
= $q_o g_o$’
=$(0.133)*(-0.212)$
= $-0.028\ \text{ft}^3/\text{sec}^2$

therefore:

$$\frac{1.36*\left(1+\cos^2 45\right)^2 - 2.2275}{\left|-0.028^{2/3}\right| * 11} \Rightarrow < 0.54 = \textit{stable}, \geq 0.54 = \textit{unstable}$$

$$\frac{1.36*\left(1+\cos^2 45\right)^2 - 2.2275}{\left|-0.028^{2/3}\right| * 11} = \frac{1.36*\left(1+0.5\right)^2 - 2.2275}{\left|-0.092\right| * 11}$$

$$\frac{1.36*\left(1+\cos^2 45\right)^2 - 2.2275}{\left|-0.028^{2/3}\right| * 11} = \frac{0.8325}{1.012}$$

$$\frac{1.36*\left(1+\cos^2 45\right)^2 - 2.2275}{\left|-0.028^{2/3}\right| * 11} = 0.82$$

$0.82 \geq 0.54$

$\therefore$ *Plume is unstable*

Since the LHS of Equation A1-6 is greater than the criterion of 0.54, theory predicts that the plume is unstable. However, the field measurements showed that the plume had more of a stable plume geometry at the first two stations downstream, 20 and 37 feet. The discrepancy with the theoretical calculation is in part because the LHS of Equation A1-6, although greater than 0.54, was on the same order of magnitude as 0.54. Real world plumes behave more like the theoretical calculation when the numbers are orders of magnitude apart. Additionally, the effects of ambient and effluent temperatures have not been accounted for here which would tend to bring the effluent and River densities closer.

JMZ Stable Plume Analysis

Adams (1982), Jirka (1982), and Holley and Jirka (1986) present analyses based on Adams's (1982) work, that takes the simple bulk dispersion a step further by accounting for back entrainment. The Holley and Jirka equation is:

$$S = \frac{1}{2}V + \frac{1}{2}\left(V^2 + \frac{2m_oH}{q_o^2}\cos\theta_o\right)^{0.5} \qquad \text{(A1-7)}$$

where: S = bulk dispersion (__:1, dimensionless);
V = volume flux ratio, or ambient mixing due to ambient current;
= u_aH/q_o
H = water depth (ft);
q_o = discharge flux per unit length (ft^2/sec^2);
= u_oa_o/L;
m_o = momentum flux (ft^3/sec^2);
= $u_o^2a_o/L$;
L = port spacing (ft);
a_o = port area;
u_o = port exit velocity (ft/sec); and
θ_o = port discharge angle.

It should be noted that Adams calculates the discharge momentum flux as a function of the total diffuser length, whereas Holley and Jirka define this discharge momentum flux as a function of port spacing. For long diffusers, these two methods give similar results. The Noveon diffuser is not a long diffuser, however, so care should be taken when calculating with this equation. The port spacing is 3 feet, and the effective diffuser length is 12 feet. The dispersion predicted by this equation during the study is calculated by plugging values into Equation A1-7.

$$S = \frac{1}{2}V + \frac{1}{2}\left(V^2 + \frac{2m_oH}{q_o^2}\cos\theta_o\right)^{0.5}$$

$$S = \frac{1}{2}\frac{u_a*H}{q_o} + \frac{1}{2}\left(\left(\frac{u_a*H}{q_o}\right)^2 + \frac{2\frac{u_o^2a_o}{L}H}{q_o^2}\cos\theta_o\right)^{0.5}$$

$$S = \frac{1}{2}\frac{u_a*H}{\frac{u_oa_o}{L}} + \frac{1}{2}\left(\left(\frac{u_a*H}{\frac{u_oa_o}{L}}\right)^2 + \frac{2\frac{u_o^2a_o}{L}H}{\left(\frac{u_oa_o}{L}\right)^2}\cos\theta_o\right)^{0.5}$$

$$S = \frac{1}{2}\frac{0.45*11}{\frac{10.165*0.049}{3}} + \frac{1}{2}\left(\left(\frac{0.45*11}{\frac{10.165*0.049}{3}}\right)^2 + \frac{2\frac{10.165^2*0.049}{3}11}{\left(\frac{10.165*0.049}{3}\right)^2}\cos 45\right)^{0.5}$$

$$S = \frac{1}{2}\frac{0.45*11}{\frac{10.165*0.049}{3}} + \frac{1}{2}\left(\left(\frac{0.45*11}{\frac{10.165*0.049}{3}}\right)^2 + \frac{2\frac{10.165^2*0.049}{3}11}{\left(\frac{10.165*0.049}{3}\right)^2}\cos 45\right)^{0.5}$$

$$S = \frac{1}{2}\frac{4.95}{0.166} + \frac{1}{2}\left(\left(\frac{4.95}{0.166}\right)^2 + \frac{2*1.6877*11}{(0.166)^2}\cos 45\right)^{0.5}$$

$$S = 14.91 + 0.5(889.189 + 1347.4\cos 45)^{0.5}$$

$$S = 14.91 + 0.5(1841.94)^{0.5}$$

$$S = 14.91 + 0.5*42.92$$

$$S = 36.37$$

The actual dispersion achieved during the diffuser performance study was 39.8:1, which is an increase of approximately a 9% increase over the dispersion predicted by Equation A1-7. This slight increase over the predicted dispersion is in keeping with previous diffuser performance studies.

The Equation that was developed by Adams, which is not included here, results in a dispersion of 36.31. Thus, according to the Holley and Jirka model, a dispersion of 36.37 could have been achieved within about the first 12 to 18 ft (1 to 1.5 diffuser lengths) downstream from the diffuser. This dispersion is approximately a 15% increase in the dispersion predicted by Equation A1-2. The 15% increase in dispersion is the result of entrainment of additional water by the plume. As ambient river velocity decreases, the effect of entrainment is magnified, and can approach 100% of the dispersion at zero river velocities. The measured values showed a dispersion of 39.8 was achieved at 20.5 feet downstream from the diffuser. This is approximately a 9% increase over the value predicted by Equation A1-7. This is a result of more water being entrained than is predicted by this model. Reducing ambient flow to zero in Equation A1-7 reduces the volume flux ratio, V, also to zero. Thus, the dispersion that occurs at this condition is entirely dependent upon entrainment, as shown by the following equation:

$$S = \frac{1}{2}\left(\frac{2m_o H}{q_o^2}\cos\theta_o\right)^{0.5} \tag{A1-8}$$

$$S = \frac{1}{2}\left(\frac{2m_o H}{q_o^2}\cos\theta_o\right)^{0.5}$$

$$S = \frac{1}{2}\left(\frac{2\frac{u_o^2 a_o}{L}H}{q_o^2}\cos\theta_o\right)^{0.5}$$

$$S = \frac{1}{2}\left(\frac{2\frac{u_o^2 a_o}{L}H}{\left(\frac{u_o a_o}{L}\right)^2}\cos\theta_o\right)^{0.5}$$

$$S = \frac{1}{2}\left(\frac{2\frac{10.165^2 * 0.049}{3}11}{\left(\frac{10.165 * 0.049}{3}\right)^2}\cos 45\right)^{0.5}$$

$$S = \frac{1}{2}\left(\frac{2 * 1.688 * 11}{0.166^2}\cos 45\right)^{0.5}$$

$$S = \frac{1}{2}(1347.66\cos 45)^{0.5}$$

$$S = \frac{1}{2}(952.94)^{0.5}$$

$$S = \frac{1}{2} * 30.87$$

$$S = 15.44$$

The unstable plume analysis for high ambient currents gives results close to the simple bulk dispersion analysis because entrainment becomes a minor percentage of the water in the JMZ, in comparison to the total volume of water crossing directly over the diffuser.

JMZ Stable Plume Dispersion Analysis

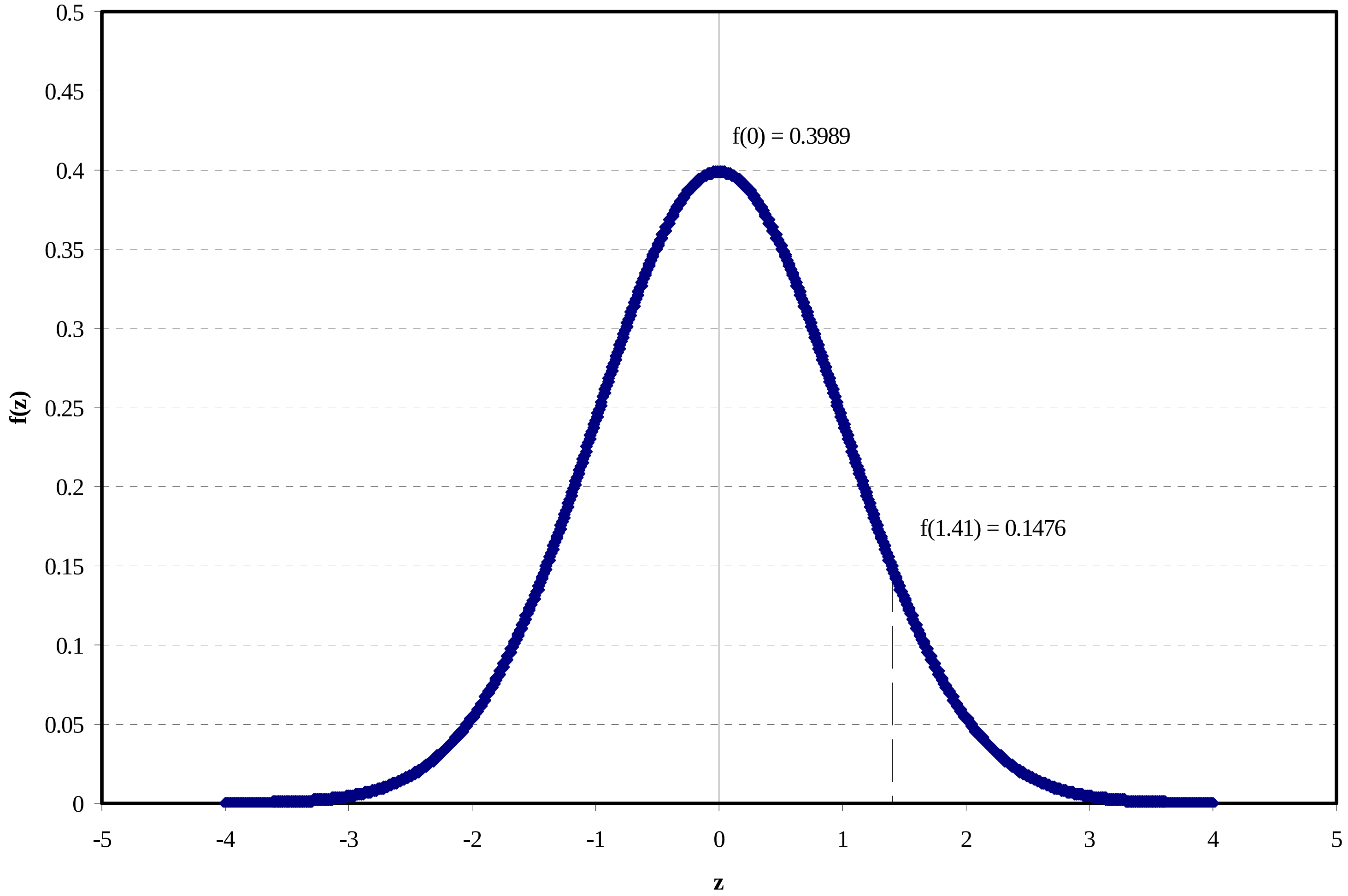
There are two separate computer models that can be used to predict stable plume dispersion: 1) DKHW (Frick, et al., 199); and 2) CORMIX2. DKHW projects the stable plume as increasing Gaussian cones until plumes merge, whence it reverts to a power profile analysis. CORMIX2 projects the plumes as a series of merged rectangular area source that widens vertically through the entire water depth.

DKHW computes a plume centerline maximum concentration as well as a flux average dispersion (FAD). In the JMZ, the FAD is the average dispersion across the plume face. The plume face can be defined as the width of the diffuser plus one water depth, at the distance where plume height equals water depth. Shirazi and Davis (1974) and Prych (1977) suggested that the average concentration across a Gaussian plume can be estimated using $(2)^{1/2}\sigma$ (1.41σ) for plume boundaries (i.e., plume extending 1.41 standard deviations). This is equivalent to approximately 84% of the plume area (mass) in the JMZ (near-field). Once the plume has established its approximate Gaussian profile, the FAD computed by DKHW is approximately 75% of the centerline concentration where plume height equals water depth. Prior to this point, the centerline concentration in DKHW can be 200% to 400% less than the FAD. Therefore, the use of 1.41σ provides a very conservative estimate for converting the observed centerline concentration to FAD concentrations for comparison with DKHW results.

A normal Gaussian distribution is illustrated in Figure A1-8, and is mathematically defined by the following expression:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \qquad \text{A1-9}$$

Normal Gaussian Distribution
(mean = 0, variance = 1)



AquAeTer

CLIENT: Noveon
LOCATION: Henry, Illinois
PROJECT/FILE: 051415

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FIGURE A1-8 – NORMAL GAUSSIAN DISTRIBUTION

where: f(x) = value of the normal distribution at any point;
σ = standard deviation;
x =
μ = mean.

Transforming the equation yields:

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}(z)^2} \qquad \text{A1-10}$$

An example of a normal distribution with a mean of 0 and a variance of 1 is presented in Figure A1-8. The maximum value of f(z) occurs at z = 0, or at the centerline. This corresponds with the peak plume concentration:

$$\begin{aligned} &z = 0 \quad f(z) = \frac{1}{\sqrt{2\pi}} e^{0} \\ &f(0) = 0.3989 \end{aligned}$$

This value thus represents 100% of the maximum value of f(z). As stated earlier, several researchers have defined the Gaussian effluent plume in the JMZ as extending to √2σ (z = ±1.41, or at 1.41 standard deviations):

$$\begin{aligned} &z = 1.41 \quad f(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{(1.41)^2}{2}} \\ &f(1.41) = 0.1476 \end{aligned}$$

The value of the normal distribution at the edge of plume is at f(1.41), which represents 37% of the maximum value as calculated by:

$$\frac{f(1.41)}{f(0)} = \frac{0.1476}{0.3989} = 0.37$$

The FAD is calculated by recognizing that the area under the curve for z = ±1.41 accounts for 84.14% of the total area of the standard normal distribution f(z) (from standard normal distribution tables). Therefore, the normal distribution mass (area under the curve) represented by the area of ±1.41σ can be approximated as a rectangular of equivalent area, with a width of ±1.41σ and a height calculated as follows:

$$Height = \frac{Area}{Width} \equiv FAD$$

where: Area = defined from normal distribution tables for 2σ; and
Width = 2σ (i.e., 2 * 1.41)

$$FAD = \frac{0.8414}{2(1.41)} = 0.2984$$

Consequently, in this case the FAD corresponds to the average height of f(z) between z = ±1.41.

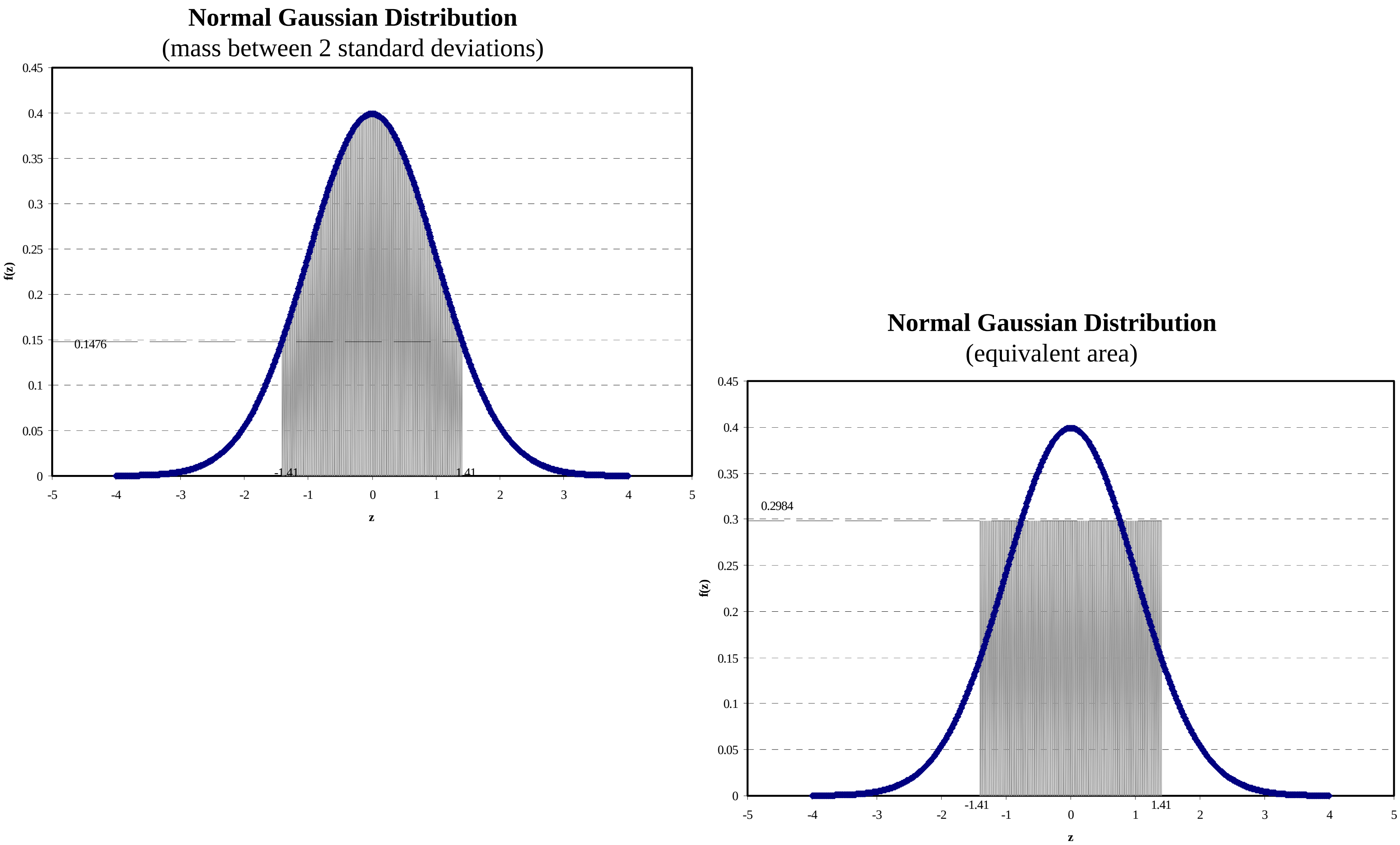
The concept of FAD and “equivalent area” and “average box height” are illustrated in Figure A1-9.

The FAD represents 74.81% of the maximum centerline value (0.2984 / 0.3989 = 0.7481). Therefore, the maximum centerline concentration (or minimum centerline dispersion) divided by 0.7481 gives the FAD across the plume face. The dispersion at the edge of the plume is calculated as the minimum centerline dispersion divided by 0.37. This analysis allows translation between observed maximum centerline concentrations to finite edge of plume limits and to a flux average concentration in the main body of the plume.

Restratification

Once the effluent plume has lost its jet momentum into the receiving stream, the remaining density differences between the plume and the river can cause the plume to restratify, which would cause slower dispersion in the field. This could occur for strongly positively or negatively buoyant plumes. Holley and Jirka (1986) and Akar and Jirka (1991) give equations for determining if restratification will occur. From Holley and Jirka, restratification will occur if the densimetric Froude number is less than a critical value as follows:

$$\frac{u_a}{\sqrt{|g'|H}} < 0.6 \; to \; 0.7 \qquad \text{(A1-11)}$$



AquAeTer

CLIENT: Noveon
LOCATION: Henry, Illinois
PROJECT/FILE: 051415

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FIGURE A1-9 – NORMAL GAUSSIAN DISTRIBUTION AND EQUIVALENT AREA

where: u_a = ambient velocity (ft/sec);
$|g'|$ = buoyant acceleration (ft/sec^2);
= $|g \, \Delta \, \rho \, / \, \rho_a|$;
$\Delta \, \rho$ = $| \, \rho_a - \rho| \, / \, S$
ρ_a = ambient density;
g = acceleration due to gravity (ft/sec^2)
= 32.2 ft/sec^2;
S = dispersion at the end of the JMZ, adjusted by FAD;
S = $S_{JMZ}/0.7481$
H = water depth (ft).

Hence, for Equation A1-11:

$$LHS = \frac{u_a}{\sqrt{|g'|H}}$$

$$LHS = \frac{u_a}{\sqrt{|g * \Delta\rho / \rho_a|H}}$$

$$LHS = \frac{u_a}{\sqrt{|g * ((\rho_a - \rho)/S)/\rho_a|H}}$$

$$LHS = \frac{0.45}{\sqrt{|32.2 * ((0.999 - 1.0055)/(36.37/0.7481))/0.999|11}}$$

$$LHS = \frac{0.45}{\sqrt{|32.2 * (-1.338 * 10^{-4})|11}}$$

$$LHS = \frac{0.45}{\sqrt{0.00431 * 11}}$$

$$LHS = \frac{0.45}{0.218}$$

$$LHS = 2.06$$

$$2.06 > 0.6$$

$$\therefore \textit{No restratification}$$

Since the densimetric Froude number is greater than the criterion, no restratification is expected and none was observed during the study. Because the plume comes to the surface before beginning to fall, this ensures adequate mixing top-to-bottom within the water column, which helps minimize the chance of restratification.

Buoyant Spreading Zone or Transition Zone

Once the plume has lost the majority of its jet momentum (outside the near-field mixing zone), the residual buoyancy outside the near-field mixing zone can induce lateral spreading perpendicular to the ambient flow. Adams (1982) and Lee and Jirka (1980) discuss the shape of the plume at the end of the JMZ. At low to stagnant currents, the effluent plume will contract due to side entrainment of the receiving water into the plume, as shown previously in Figure A1-5, to a width equivalent to about one-half the diffuser length. At higher ambient velocities, this entrainment becomes negligible and the plume width at the end of the JMZ is on the order of one diffuser length.

At the end of the JMZ, the plume maintains some excess velocity over the ambient river velocity. In this intermediate zone, the excess velocity and the slight buoyancy differences between the plume and the ambient waters cause the plume to spread laterally. As the plume slows to ambient velocities (e.g., due to boundary friction with the bottom), passive ambient diffusion or far-field mixing becomes the dominant mixing force. Lee and Jirka (1980) developed an analysis to compute buoyant spreading in this transition zone between the JMZ and the far-field.

The residual plume velocity at the end of the JMZ can be calculated by the following equation:

$$u_i = \frac{2S_iQ_e}{L_DH} \tag{A1-12}$$

where:
u_i = plume velocity at the end of the JMZ (ft/sec);
S_i = Dispersion at the end of the jet momentum zone;
Q_e = Effluent flow in (ft^3/sec);
L_D = Diffuser length (ft);
H = Local water depth (ft).

Thus, the plume velocity at the end of the JMZ during the October field study can be calculated using the following conditions:

S_i = 36.37/0.7481 = 48.62;
Q_e = 1.29 mgd = 2.00 cfs
L_D = 15 ft;
H = 11 ft.

$$u_i = \frac{2 * 48.62 * 2.00}{15 * 11}$$
$$u_i = 1.179\ ft/sec$$

For comparison, the ambient current was 0.45 ft/sec and the port exit velocity was 10.165 ft/sec. Thus, the plume had slowed from its exit velocity to about 1.179 ft/sec at the edge of the JMZ. CORMIX2 predicts that the edge of the JMZ is 6 feet downstream from the diffuser (i.e., arbitrarily set at ½ diffuser length).

The Lee and Jirka equations are for low to stagnant ambient velocities, which can be considered as around 0.25 ft/sec to 0.30 ft/sec (typical lower range for measuring velocity using a pygmy or Price AA current meter). Calculations from these equations for river conditions with greater ambient velocities are considered an approximation, but the results are consistent with the intermediate zone decreasing in aerial extent or not existing at higher ambient velocities (river turbulence becomes more of a dominant factor.) For the conditions existing during the October field study, a buoyant spreading region would be expected, since the ambient velocity in the area is approaching the minimum velocity. The plume velocity, plume width, and plume dispersion can be calculated according to the Lee and Jirka equations.

Intermediate zone mixing is driven by excess plume velocity and frictional interaction. A realistic means of defining the end of the intermediate zone is to determine the distance at which the plume velocity has been reduced to approximately the ambient velocity. A value of within ±5% of the ambient velocity, based on USGS discharge measurement techniques, is used to define the end of this intermediate zone. That is, velocity measurements and subsequent flow calculations using a Price AA current meter can be made to ±2% to 10% accuracy with 5% being typical. For instance, the average ambient velocity on October 25 was about 0.45 ft/sec, and therefore the end of the intermediate zone has been set at the distance where the plume velocity is 1.05 * 0.45 ft/sec, or 0.47 ft/sec.

The following equation is used to determine the plume velocity at the end of the buoyant spreading regions:

$$u = u_i e^{-\phi(x-x_i)}\left[1+\beta\left[1-e^{-\phi(x-x_i)}\right]\right]^{-0.5} \qquad \text{(A1-13)}$$

where: u = velocity at the end of the BSZ (ft/sec);
u_i = velocity at the end of the JMZ (ft/sec);
ϕ = f_o / (8H);
f_o = Moody friction factor = 0.035;
H = Local water depth;
ϕ = 0.035 / (8 * 11);
ϕ = 0.0003977 ft^{-1};
x = distance downstream from x_i;
x_i = distance at end of JMZ (ft);
β = $2a_2 / (I_i b_i \phi)$;
a_2 = entrainment coefficient = 0.068;
I_i = $\sqrt{\pi} / 2$;
b_i = 0.5 L_D;
L_D = diffuser length = 15 ft.

The objective is to determine the distance x when u is within 5% of the ambient river velocity. Equation A1-13 was implemented on an Excel® spreadsheet, and through an iterative process, x was found to be 222 feet downstream from the edge of the JMZ, or 228 feet downstream from the diffuser.

The plume width at the end of an intermediate zone are calculated according to the following equation:

$$b = b_i \left[e^{-\phi(x-x_i)} * (1+\beta) - \beta \right] \tag{A1-14}$$

where: b = plume width at end of BSZ(ft);
b_i = plume width at the end of the JMZ (ft).

The dispersion at the end of the BSZ can be calculated using the following equation:

$$S = S_i \left[1 + \beta \left(1 - e^{-\phi(x-x_i)} \right) \right]^{0.5} \tag{A1-15}$$

where: S = dispersion at end of BSZ;
b_i = dispersion at the end of the JMZ.

CORMIX2 predicted a plume width of 9.777 feet at the end of the JMZ. Substituting this into Equation A1-14, yields a plume width at the end of the BSZ of 45 feet. Using the calculated FAD at the end of the JMZ of 48.62 in Equation A1-15 yields a dispersion of 100:1 at the end of the BSZ, 228 feet downstream from the JMZ.

The dispersion required within the mixing zone was 99:1, which is shown to be reached at the end of the buoyant spreading zone by this equation.

Illinois Department of
Natural Resources
One Natural Resources Way • Springfield, Illinois 62702-1271
http://dnr.state.il.us

Rod R. Blagojevich, Governor
Joel Brunsvold, Director

February 22, 2005

SUBJECT: Application for Permit #20054006

Noveon, Inc.
15550 County Road 1450N
Henry, Illinois 61537-9706

Gentlemen :

Receipt of your application for an Illinois Department of Natural Resources, Office of Water Resources permit is acknowledged. Review of your proposed project to ensure its compliance with the Rivers, Lakes and Streams Act, 615 ILCS 5, will be completed by Office of Water Resources' permit engineer, Mike Diedrichsen (217/782-4426). **No work on the project should be initiated until an IDNR/OWR permit has been received.**

We are forwarding a copy of your application for permit form to the Illinois Historic Preservation Agency (IHPA) for their review. In accordance with Section 4 of the Illinois State Agency Historic Resources Preservation Act, 20 ILCS 3420/4 (1994 State Bar Edition), and the resulting IHPA "Rules for Review of State Agency Undertakings" (17 Ill. Adm. Code 4180), we are delegating to you responsibility to provide to IHPA any additional necessary documents regarding compliance of the project with the aforementioned Act. IHPA will contact you and this office regarding their jurisdiction within 30 days of their receipt of the forwarded application form. If you have any questions in this regard, please contact IHPA at 217/785-5027.

We are also providing a copy of your application to this agency's Office of Realty and Environmental Planning (OREP). Consultation with that office may be required regarding your project's compliance with the Illinois Endangered Species Protection Act, 520 ILCS 10 (1994 State Bar Edition), and the resulting rules for "Consultation Procedures for Assessing Impacts of Agency Actions on Endangered and Threatened Species" (17 Ill. Adm. Code 1075). If any further action regarding consultation is necessary, OREP will notify you within 30 days.

You are also advised that OREP reviews U. S. Army Corps of Engineers Sections 10 and 404 permit activities. If your project requires a Corps permit, you may receive comments or recommendations from OREP, primarily related to the biological effects of the work, which may be outside the purview of the Illinois Department of Natural Resources, Office of Water Resources permit process.

Sincerely,

Michael L. Diedrichsen, Acting Section Manager
Downstate Regulatory Programs

MLD:crw
Enclosures
cc: Illinois Historic Preservation Agency w/encl.
OREP w/encl.
AquAeTer, Inc. (Michael R. Corn, P.E. (IL), President)

JOINT APPLICATION FORM

1. Application Number (to be assigned by agency)
20054006

2. Date
28 January 2005
Day Month Year

3. For agency use only (Date Received)
January 31, 2005

4. Name and address of applicant

Dave Giffin
Noveon, Inc.
1550 County Road 1450N
Henry, Illinois 61537-9706

Telephone no. during business hours A/C A/C (309) 364-9411

5. Name, address, and title of authorized agent

Michael R. Corn, P.E. (IL), President
AquAeTer, Inc.
215 Jamestown Park, Suite 100
Brentwood, TN 37027

Telephone no. during business hours A/C A/C (615) 373-8532

6. Project Description and Remarks: Describe in detail the proposed activity, its purpose, and intended use. Also indicate the drainage area at the watershed to the downstream limit use attachments if needed.

Please see attachment 1 for a description of the proposed activity.

[illegible] RESOURCES
DIV
PG ✓

7. Names, addresses, and telephone numbers of all adjoining and potentially affected property owners, including the subject property if different from applicant.

Property Owner:
City of Henry
Daryl Fountain, Mayor
426 East Park Row
Henry, Illinois 61537
(309) 364-3056

Downstream property owner:
Koch Nitrogen
Larry Martin
1559 County Road 1400N
Henry, Illinois 61537
(309) 364-3055

8. Location of activity

Legal Description:
E½W½ - Sec 3 – T13N-R10E-4PM Marshall Co., Illinois
SE¼ - Sec 3 – T13N-R10E-4PM Marshall Co., Illinois
1/4 Sec. Twp. Rge. P.M.

Name of waterway at location of the activity: Illinois River

Address: 1550 County Road 1450N
Street, road, or other descriptive location

In or near city or town: Henry

Name of Local Governing Community: City of Henry

County: Marshall

State: Illinois

Zip Code: 61537-9706

9. Date activity is proposed to commence: June 1, 2005 Estimated Time of Construction: 150 Days

10. Is any portion of the activity for which authorization is sought now complete? X Yes ___ No If answer is "Yes" give reasons in Item 6.

Month and Year the activity was completed: Estimated July 1957 Indicate the existing work on drawings

11. List all approvals or certifications required by other federal, interstate, or local agencies for any structures, construction, discharges, deposits, or other activities described in this application. If this form is being used for concurrent application to the Corps of Engineers, Illinois Department of Natural Resources, and Illinois Environmental Protection Agency, these agencies need not be listed.

Issuing agency	Type Approval	Identification No.	Date of Application	Date of Approval
Not Applicable				

12. Has any agency denied approval for the activity described herein or for any activity directly related to the activity described herein? ___ Yes X No (If "Yes", explain in Item 6)

13. Application is hereby made for authorizations of the activities described herein. I certify that I am familiar with information contained in the application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities.

Michael R. Corn
Signature of Applicant or Authorized Agent

Michael R. Corn, P.E. (IL)
Typed or Printed Name of Applicant or Authorized Agent

NCR FORM 426
10 AUG 95

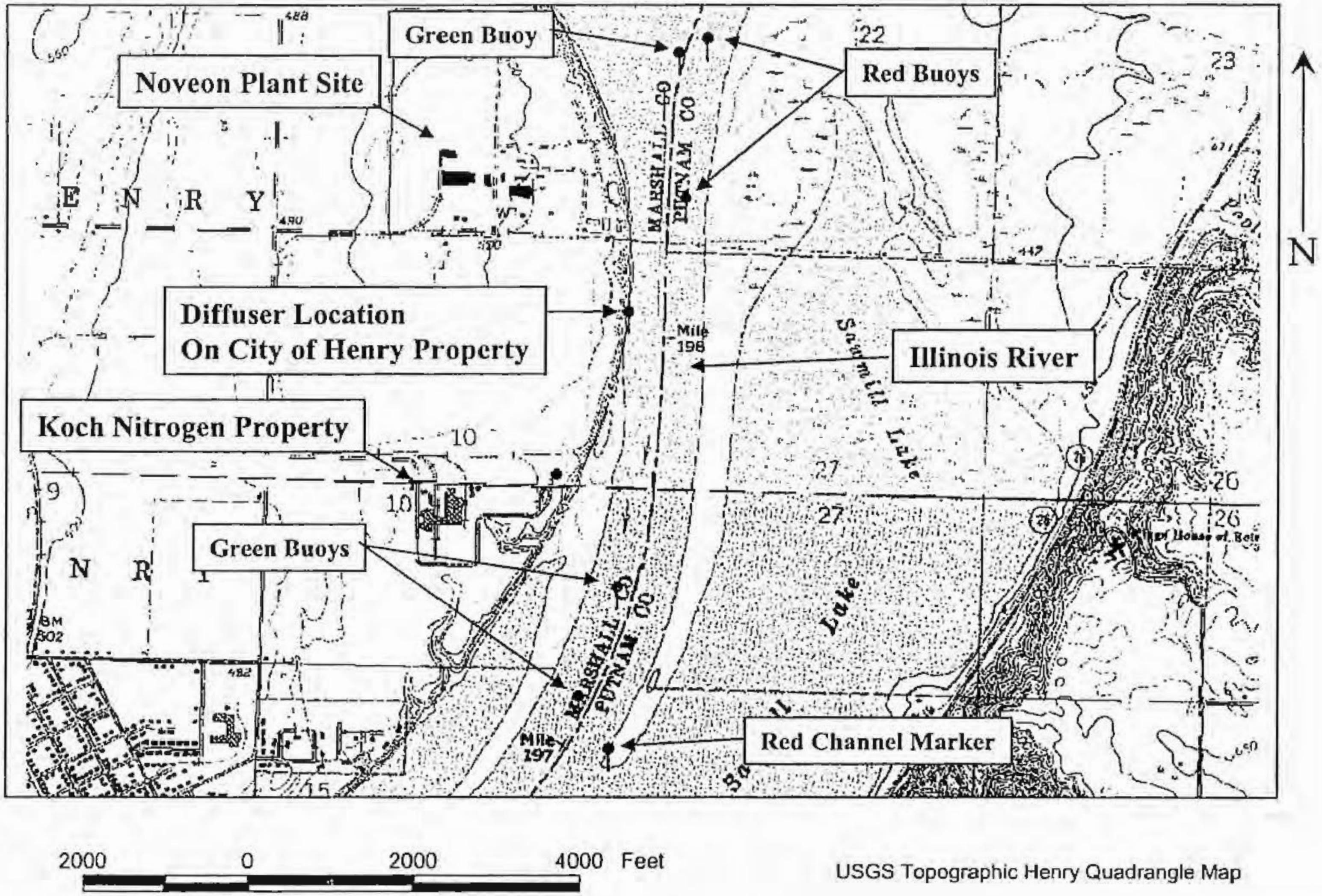
IDNR/OWR COPY

ATTACHMENT 1 – Answer to No. 6 – Project Description

Noveon has been ordered by the Illinois Pollution Control Board to install a multiport diffuser into the Illinois River at about Illinois River mile (IRM) 198. The order is presented in Attachment 2. The discharge will have an average flow of 1.3 million gallons per day (mgd) and a maximum flow of 1.75 mgd. The Noveon treated effluent is about 1 mgd on average and the City of Henry Publicly Owned Treatment Works (POTW) will also discharge through this diffuser at an average flow of around 0.3 mgd. The drainage area is approximately 13,543 square miles based on the USGS gage at Henry (IRM 196.0).

Noveon has an effluent pipeline that runs from its wastewater treatment facility about ½ mile south to the Illinois River at about IRM 198. The pipeline discharges the Noveon treated effluent and the City of Henry POTW treated effluent through a single port diffuser that is located about 25 feet offshore in about 4 feet of water. The diffuser is pointed perpendicular to the river flow.

IN THE VICINITY OF THE PROPOSED DIFFUSER ON ILLINOIS RIVER



USGS Topographic Henry Quadrangle Map

AquAeTer

CLIENT: Noveon, Henry
LOCATION: Illinois River at Henry, Illinois
PROJECT/FILE: 041401

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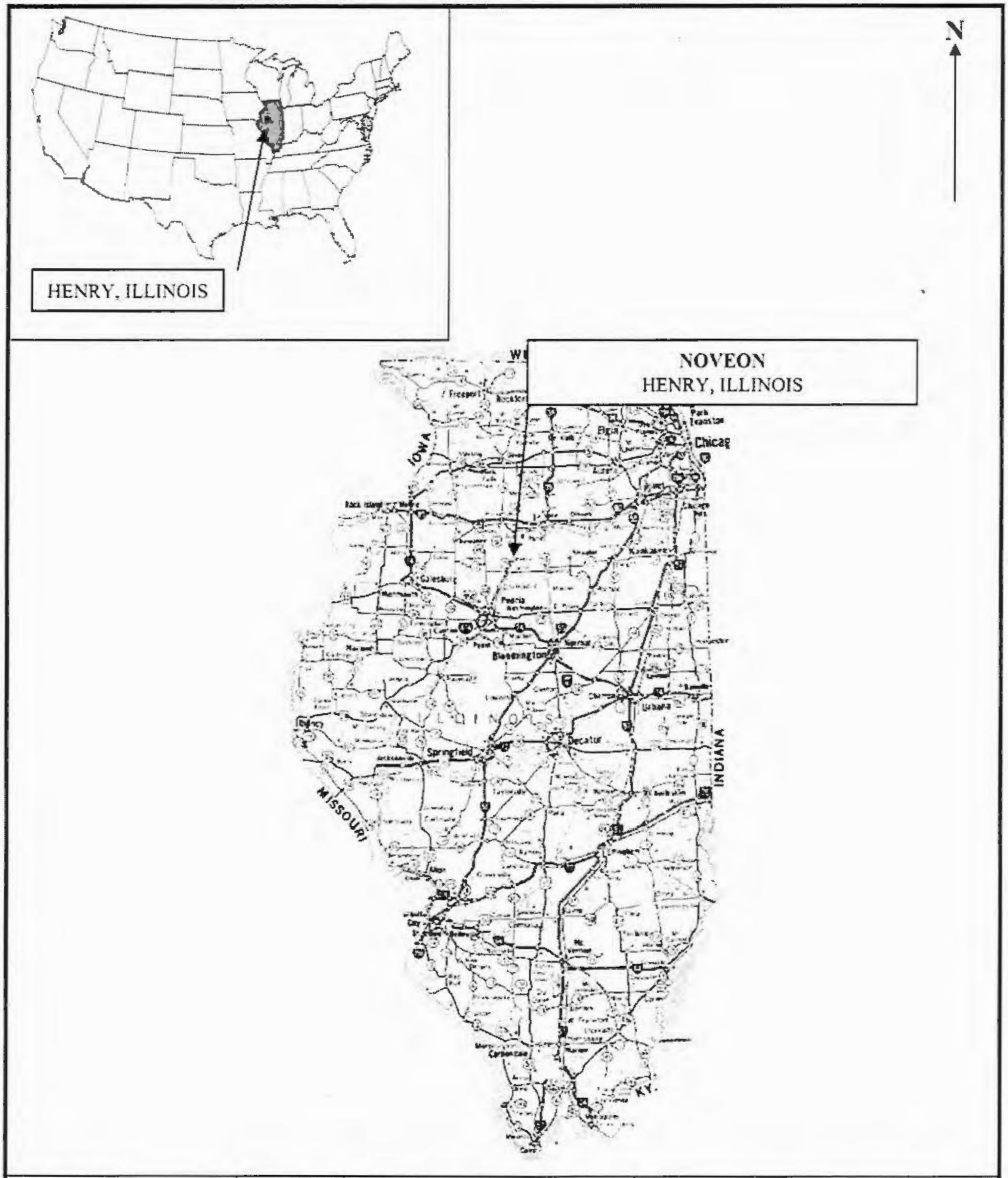
FIGURE 2 OF 7

AREA MAP



CLIENT:	NOVEON
LOCATION:	Henry, IL
PROJECT/FILE:	041401

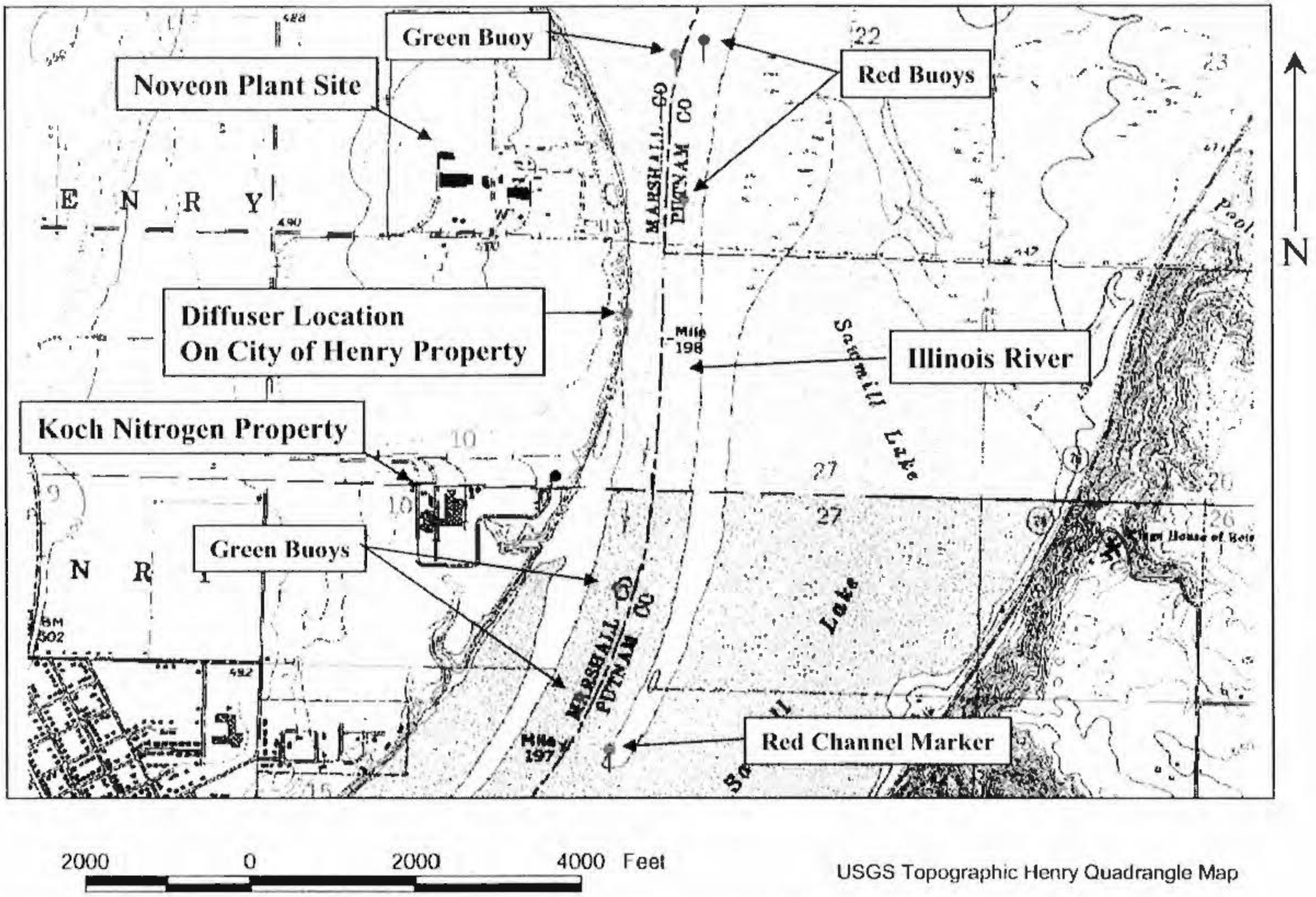
AquAeTer

FIGURE 1 of 7

LOCATION MAP

NOVEON - HENRY, ILLINOIS

IN THE VICINITY OF THE PROPOSED DIFFUSER ON ILLINOIS RIVER



USGS Topographic Henry Quadrangle Map

AquAeTer

CLIENT: Noveon, Henry
LOCATION: Illinois River at Henry, Illinois
PROJECT/FILE: 041401

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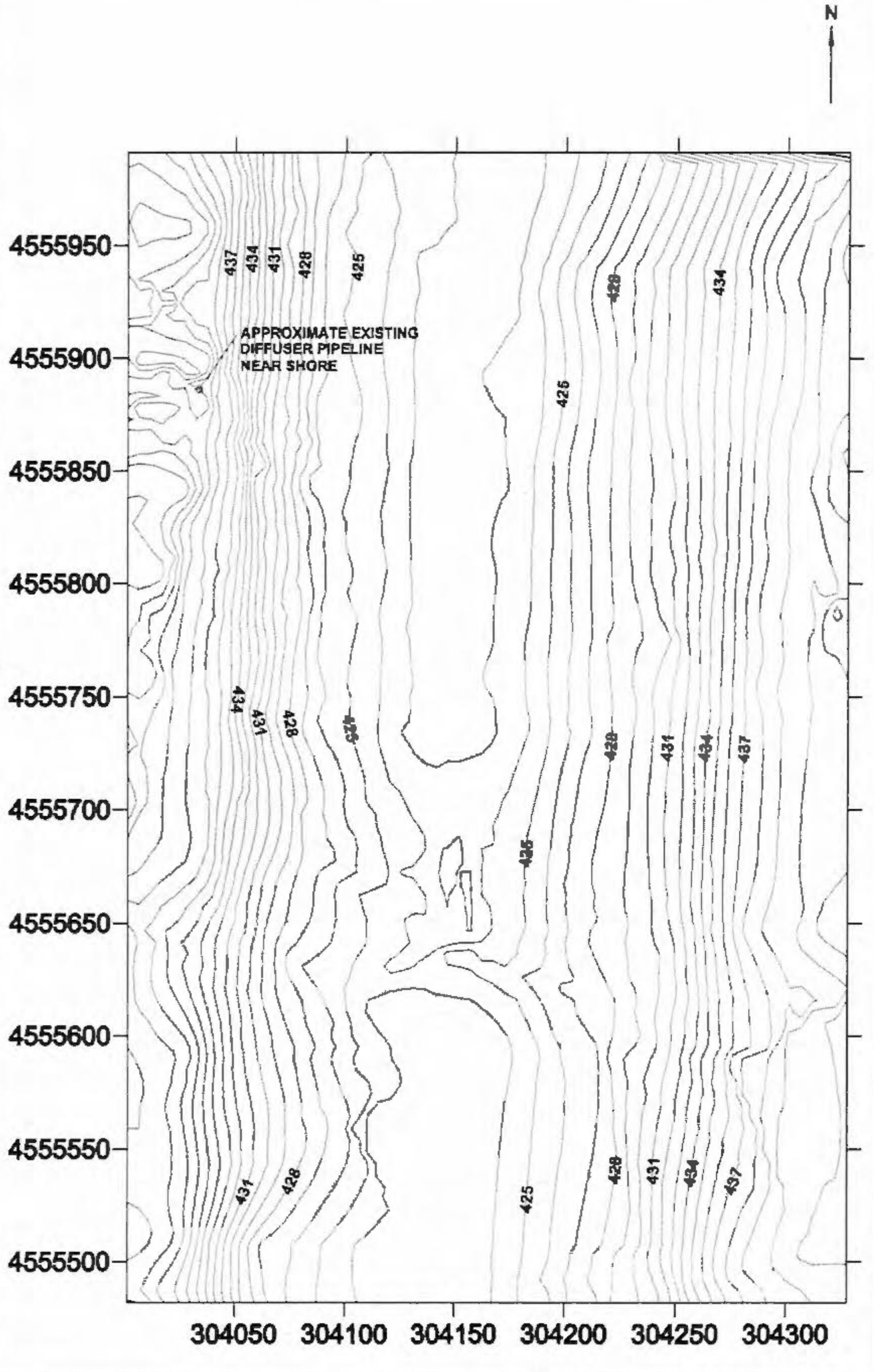
FIGURE 2 OF 7

AREA MAP



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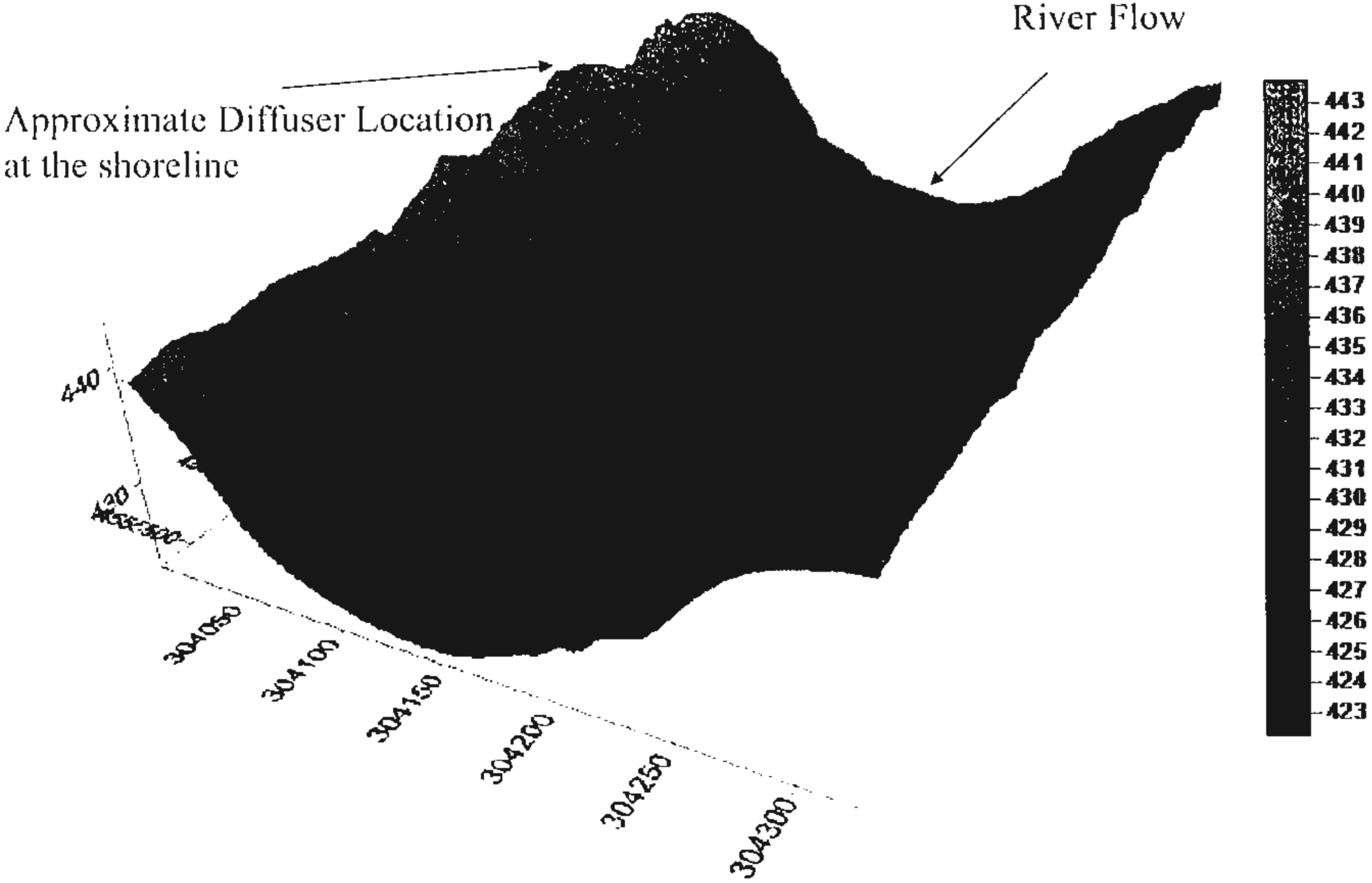
SCALE

1 50'

FIGURE 3 of 7

RIVER TOPOGRAPHY

ILLINOIS RIVER BATHYMETRY UPSTREAM FROM HENRY, ILLINOIS



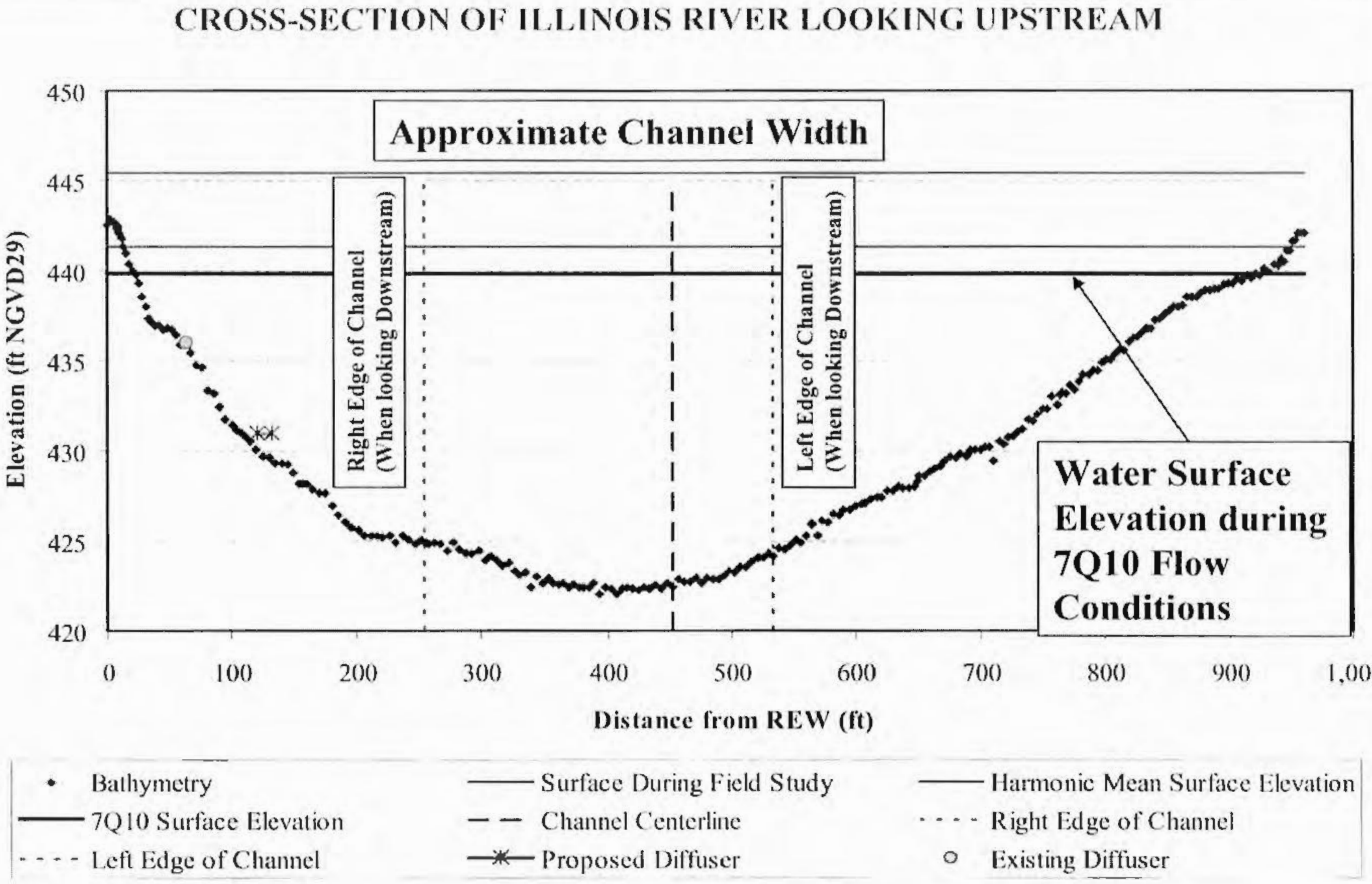
AquAcTer

CLIENT: Noveon, Inc.
LOCATION: Henry, Illinois
PROJECT FILE: 041401

optimizing environmental resources : water, air, earth

FIGURE 4 OF 7

RIVER BOTTOM



AquAeTer

CLIENT: Noveon, Henry
LOCATION: Illinois River at Henry, Illinois
PROJECT/FILE: 041401

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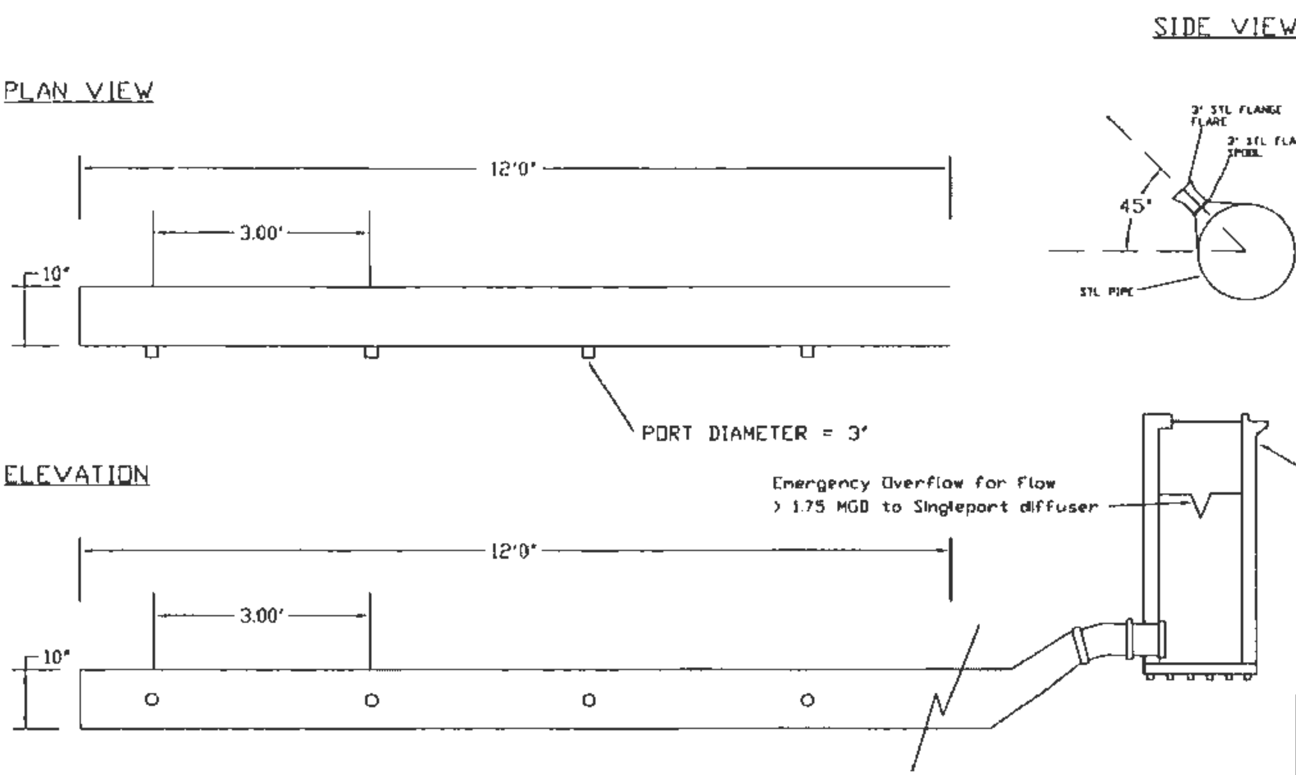
FIGURE 5 OF 7

ILLINOIS RIVER BATHYMETRY

Number of Ports	4
Port Spacing	3.00 ft
Diffuser Dia.	10 in
Diffuser Length	15 ft
Port Diameter	3 in
Port Angle	45°
Design Flowrate	1.3 mgd



Top of River Control Structure > 462 ft NGVD
100-year Flood Elevation = 461.4 ft NGVD

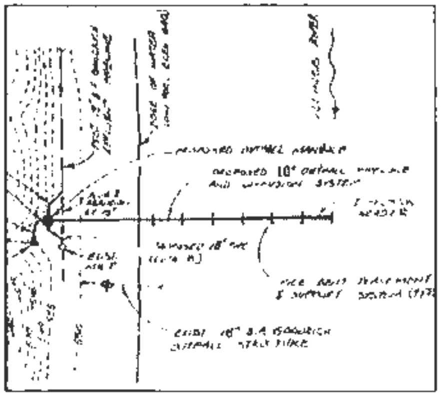


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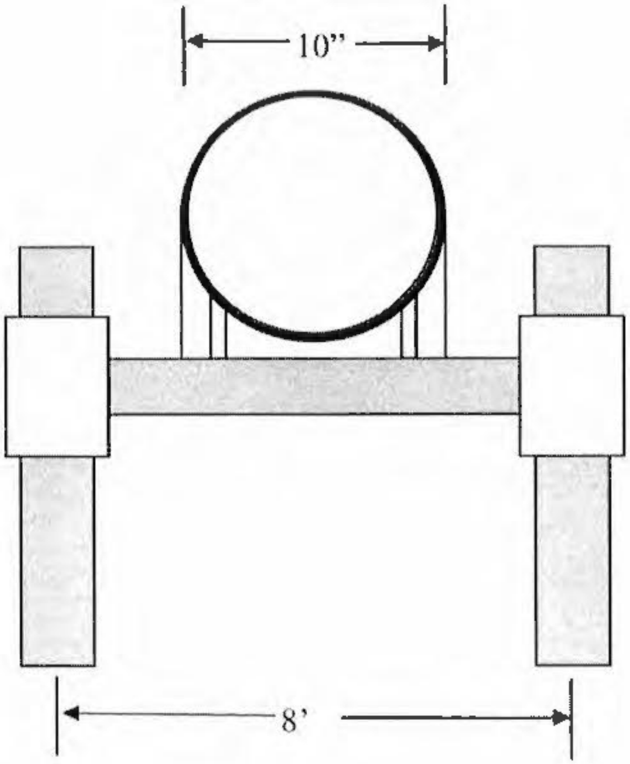
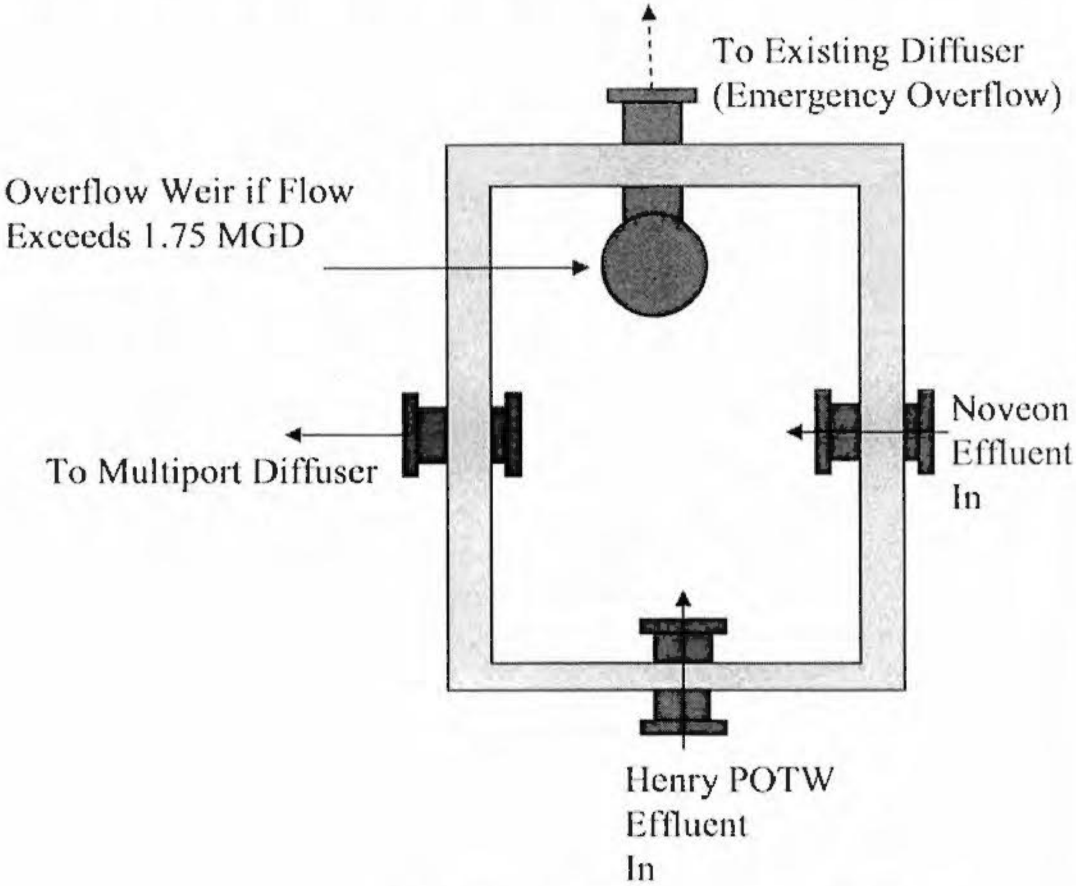
FIGURE 6 of 7

DIFFUSER SCHEMATIC

CONCEPTUAL DETAILS OF DIFFUSER SUPPORT AND RIVER CONTROL STRUCTURE



Diffuser Support Structure



Plan View River Control Structure

AquAeTer

CLIENT: Noveon, Henry
LOCATION: Illinois River at Henry, Illinois
PROJECT/FILE: 041401

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FIGURE 7 OF 7

DIFFUSER DETAILS

Illinois State Permit Applicants

Illinois State Law requires individuals to certify that they are not delinquent in the payment of child support before State agencies can accept applications for State permits, certifications, etc. You must complete the following statement and include it with copies of the joint permit applications you send to the Illinois Department of Natural Resources and the Illinois Environmental Protection Agency. The Corps of Engineers does not require a copy of this statement.

WARNING: Failure to fully complete one of the following certifications will result in rejection of this application. Making a false statement may subject you to contempt of court.

I hereby certify, under penalty of perjury, that I am not more that 30 days' delinquent in complying with a child support order [5 ILCS 100/10-65(c)].

________________________ ______________________________

Applicant's Signature Applicant's Social Security Number

OR

I hereby certify, under penalty of perjury, that the permit applicant is a governmental or business entity and, therefore, not subject to child support payment requirements.

____

Applicant's Name

____

Applicant's Representative Signature and Title

JOINT APPLICATION FORM

1 Application Number (to be assigned by agency)

2. Date

28 January 2005
Day Month Year

3 For agency use only (Date Received)

4. Name and address of applicant

Dave Giffin
Noveon, Inc.
1550 County Road 1450N
Henry, Illinois 61537-9706

Telephone no. during business hours A/C A/C (309) 364-9411

5. Name, address, and title of authorized agent

Michael R. Corn, P.E. (IL), President
AquAeTer, Inc.
215 Jamestown Park, Suite 100
Brentwood, TN 37027

Telephone no. during business hours A/C A/C (615) 373-8532

6. Project Description and Remarks: Describe in detail the proposed activity, its purpose, and intended use. Also indicate the drainage area at the watershed to the downstream limit Use attachments if needed.

Please see attachment 1 for a description of the proposed activity.

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426 East Park Row
Henry, Illinois 61537
(309) 364-3056

Downstream property owner:
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Larry Martin
1559 County Road 1400N
Henry, Illinois 61537
(309) 364-3055

8. Location of activity

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SE¼ - Sec 3 – T13N-R10E-4PM Marshall Co , Illinois
1/4 Sec. Twp. Rge. P.M.

Illinois River
Name of waterway at location of the activity

Address: 1550 County Road 1450N
Street, road, or other descriptive location

Henry
In or near city or town

City of Henry
Name of Local Governing Community

Marshall	Illinois	61537-9706
County	State	Zip Code

9. Date activity is proposed to commence June 1, 2005 Estimated Time of Construction 150 Days

10 Is any portion of the activity for which authorization is sought now complete? X Yes ___ No If answer is "Yes" give reasons in item 6.

Month and Year the activity was completed Estimated July 1957 Indicate the existing work on drawings

11. List all approvals or certifications required by other federal, interstate, or local agencies for any structures, construction, discharges, deposits, or other activities described in this application. If this form is being used for concurrent application to the Corps of Engineers, Illinois Department of Natural Resources, and Illinois Environmental Protection Agency, these agencies need not be listed.

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Signature of Applicant or Authorized Agent

Michael R. Corn, P.E. (IL)
Typed or Printed Name of Applicant or Authorized Agent

NCR FORM 426
10 AUG 95

APPLICANT'S COPY

ATTACHMENT 1 – Answer to No. 6 – Project Description

Noveon has been ordered by the Illinois Pollution Control Board to install a multiport diffuser into the Illinois River at about Illinois River mile (IRM) 198. The order is presented in Attachment 2. The discharge will have an average flow of 1.3 million gallons per day (mgd) and a maximum flow of 1.75 mgd. The Noveon treated effluent is about 1 mgd on average and the City of Henry Publicly Owned Treatment Works (POTW) will also discharge through this diffuser at an average flow of around 0.3 mgd. The drainage area is approximately 13,543 square miles based on the USGS gage at Henry (IRM 196.0).

Noveon has an effluent pipeline that runs from its wastewater treatment facility about ½ mile south to the Illinois River at about IRM 198. The pipeline discharges the Noveon treated effluent and the City of Henry POTW treated effluent through a single port diffuser that is located about 25 feet offshore in about 4 feet of water. The diffuser is pointed perpendicular to the river flow.

ATTACHMENT 2

ILLINOIS POLLUTION CONTROL BOARD ORDER

ILLINOIS POLLUTION CONTROL BOARD
November 4, 2004

IN THE MATTER OF:	)	
	)	
PETITION OF NOVEON, INC. FOR AN	)	AS 02-5
ADJUSTED STANDARD FROM 35 ILL.	)	(Adjusted Standard)
ADM. CODE 304.122	)	

RICHARD J. KISSEL, MARK LATHAM, SHEILA H. DEELY, GARDNER, CARTON & DOUGLAS, APPPEARED ON BEHALF OF PETITIONER; and

DEBORAH J. WILLIAMS APPEARED ON BEHALF OF THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY.

OPINION AND ORDER OF THE BOARD (by N.J. Melas):

Noveon, Inc. (Noveon) is a specialty chemicals manufacturer, and requests relief from the Board's ammonia nitrogen effluent limits as those limits pertain to Noveon's discharge of wastewater into the Illinois River. On May 22, 2002, Noveon filed a petition for an adjusted standard from 35 Ill. Adm. Code 304.122. Noveon's facility is located at 1550 County Road, 850 North in Henry, northwestern Marshall County. In the petition, Noveon requested a hearing, which was held February 17, 18, and 19, 2004. On June 18, 2003, the Illinois Environmental Protection Agency (Agency) filed a recommendation that the Board deny Noveon's petition.

This petition relates to Noveon's National Pollutant Discharge Elimination System (NPDES) permit appeal recently decided by the Board, docketed as Noveon, Inc. v. IEPA, PCB 91-17. In the permit appeal, Noveon contested a condition imposed by the Agency requiring Noveon to meet the ammonia effluent limit found at Section 304.122(b) of the Board's rules. 35 Ill. Adm. Code 304.122(b). Noveon states it filed this petition for an adjusted standard in the alternative to the NPDES permit appeal. Noveon requested that if the Board determined that the Agency properly applied Section 304.122(b), the Board grant Noveon an adjusted standard from that section. Also assuming Section 304.122(b) applies, Noveon requests that the Board grant Noveon a mixing zone calculated in accordance with federal and state regulations. Pet. at 2.

On September 16, 2004, the Board issued a final opinion and order affirming the Agency's issuance of Noveon's NPDES permit, finding that the Agency properly applied Section 304.122(b) to Noveon's effluent.

Based on the record before it, the Board finds that Noveon has provided sufficient justification for each of the Section 28.1 factors. The Board grants Noveon's petition for an adjusted standard from the Board's ammonia effluent limitation subject to conditions outlined in this order.

ADJUSTED STANDARD PROCEDURE

The Environmental Protection Act (Act) (415 ILCS 5/1 *et seq.* (2002)) and Board rules provide that a petitioner may request, and the Board may grant, an environmental standard that is different from the generally applicable standard that would otherwise apply to the petitioner and the regulated community. *See* 35 Ill. Adm. Code 104.400(a). This is called an adjusted standard. The general procedures that govern an adjusted standard proceeding are found at Section 28.1 of the Act and Part 104, Subpart D of the Board's procedural rules. 415 ILCS 5/28.1 (2002); 35 Ill. Adm. Code 104.400 *et al.*

The Board rules for the content requirements of the petition and Agency recommendation are found at Section 104.406 and Section 104.416, respectively. 35 Ill. Adm. Code 104.406, 104.416.

PROCEDURAL BACKGROUND

On May 22, 2002, Noveon filed this petition (Pet.), with the Board for an adjusted standard from the ammonia effluent limitations. On May 29, 2002, Noveon published notice of the petition in the *Henry News Republican*, and filed the certificate of publication with the Board on June 11, 2002. The Agency filed its recommendation (Rec.) that the Board deny Noveon's requested relief on June 18, 2003.

On February 17, 2004, Hearing Officer Bradley Halloran conducted a hearing in this matter at 122 North Prairie Street, Lacon, Marshall County. Six witnesses testified on behalf of the petitioner: Mr. Michael Corn of AquAeTer, Inc.; Mr. Houston Flippin, consultant from the firm of Brown and Caldwell; and Mr. William Goodfellow of AE Engineering; Ms. Linda Shaw, an employee of Noveon, and Mr. Guy Davids, a recent plant manager at the Henry facility. Mr. Robert Mosher and Mr. Richard Pinneo testified on behalf of the respondent. Hearing Officer Halloran found all witnesses credible.

At hearing, Noveon renewed a motion to enter the transcript of a related matter, a permit appeal filed by Noveon docketed as PCB 91-17, into the record. In the alternative, Noveon moved to enter the testimony of the witnesses from PCB 91-17 into this record.[1] 2004 Tr. at 15.

The Board has received six written public comments regarding Noveon's request for relief. Mr. Doug Hermann presented an oral public comment at hearing on behalf of Illinois River Holdings (IRH), and later filed the section of the hearing transcript containing his oral comment with the Board. Mr. Hermann stated that IRH is concerned about aquatic toxicity problems caused by Noveon in the IRH property, located 500 feet downstream of the existing Noveon diffuser. Mr. Hermann stated that IRH is planning a port development on the Illinois River that will ship sand and gravel as well as various other commodities. 2004 Tr. at 501. Mr. Brian Maubach and Mr. John Maubach, both landowners in Henry, submitted the second and third public comments, respectively, in opposition of the adjusted standard. The fourth public comment was submitted by Mr. Thomas Wilkinson, who is in favor of the adjusted standard. Mr. Wilkinson stated he worked at the plant as a pipefitter and mechanical contractor for 32

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[1] The Board cites to the transcript of the hearings held in this matter from February 17, 2004 through February 19, 2004, collectively, as "2004 Tr. at __."

years and believes that the Noveon employees are environmentally responsible. Mr. Thomas Newby, the Henry Plant Controller, submitted the fifth public comment in favor of the adjusted standard. Finally, the sixth public comment, favoring the adjusted standard, was filed by Mr. Stephen Saunders, engineer and Operations Manager at the Henry Plant.

In addition, Mr. Richard Janssen, a former B.F. Goodrich employee from 1970 to 1997, gave an oral public comment at hearing opposing the adjusted standard. Mr. Janssen stated that in his opinion, B.F. Goodrich became progressively more concerned about increasing production than treating wastewater at the Henry Plant in the 1980s. 2004 Tr. at 257-58.

Noveon filed a post-hearing reply memorandum on April 29, 2004 (Nov. Memo). On June 1, 2004, the Agency also filed a post-hearing memorandum (Ag. Memo). Noveon replied on July 14, 2004 (Nov. Reply).

As discussed above, on September 16, 2004, the Board issued a final opinion and order in a related matter, PCB 91-17, affirming the Agency's issuance of Noveon's NPDES permit. Included in Noveon's permit is Condition 4, which limits Noveon's ammonia effluent in accordance with Section 304.122(b) of the Board's effluent limits.

PRELIMINARY MATTER

Before hearing, Noveon moved the Board to incorporate the entire transcript of hearings and exhibits in the related permit appeal, PCB 91-17, into this record. The Agency objected to Noveon's motion and Hearing Officer Halloran denied the motion. At hearing, Noveon renewed its motion to incorporate the transcript, and submitted a redacted version of the transcript of 1991 hearings, removing material that Noveon believed was unrelated to the application of Section 304.122 to Noveon. Noveon argued that the testimony from the 1990 permit appeal hearing regarding ammonia nitrogen would help the Board in deciding this matter. 2004 Tr. at 324. The Agency objected to the motion stating that the motion was untimely and that the material submitted would not aid the Board in making its decision. 2004 Tr. at 325. The Agency notes that while Noveon claims it removed the unrelated material from the 1991 transcript, the material submitted and accepted as an offer of proof contains 131 pages of the 160 total pages of the transcript and all of the exhibits. 2004 Tr. at 324.

Hearing Officer Halloran denied Noveon's renewed motion, but stated he would accept the transcript as an offer of proof. 2004 Tr. at 326. At the end of hearing, Noveon submitted the *entire* transcript, including the 2004 hearing testimony, and it was accepted as an offer of proof. 2004 Tr. at 508-09; 2004 Tr. Exh. 38.

In its post-hearing memorandum, Noveon moves the Board to overturn the ruling by hearing officer Halloran. According to Noveon, Section 101.306(a) sets forth a lenient standard for incorporating a transcript from another Board proceeding into the record of another proceeding. 35 Ill. Adm. Code 101.306(a). Noveon further argues that the burden is more stringent in an NPDES permit appeal than for an adjusted standard, so therefore, the Agency can claim no prejudice from incorporating the transcripts from PCB 91-17 into this proceeding. Ag. Memo at 12.

The Agency opposes Noveon's motion, contending that portions of the testimony are not relevant and other portions were based on information not available at the time Noveon's NPDES permit was issued. Ag. Memo at 12. For these reasons, the Agency urges the Board to affirm the hearing officer's ruling. Ag. Memo at 13.

The Board reverses Hearing Officer Halloran's ruling and accepts the transcript in PCB 91-17 as evidence. The Board finds that much of the transcript in PCB 91-17 is relevant because at issue in both the permit appeal and adjusted standard are the same facility, discharge, ammonia effluent limits, and NPDES permit. Accordingly, the Board accepts the offer of proof, Hearing Exhibit 38, as evidence in this adjusted standard proceeding.[2]

FACTUAL BACKGROUND

The Facility

The Noveon Henry Plant is located on the West Branch of the Illinois River north of the City of Henry, at 1550 County Road, 850 N. in Northwestern Marshall County. Until 1993, the facility was owned and operated by B.F. Goodrich. Pet. at 9. When the NPDES permit was issued, the Henry Plant had two manufacturing units: (1) a specialty chemicals manufacturing unit, which began manufacturing rubber chemicals in 1958; and (2) a polyvinyl chloride (PVC) resins unit that began operating in 1965. The resins unit, divested in 1993, is now known as PolyOne Corporation, and the specialty chemicals unit, sold in February 2001, became Noveon, Inc. *Id.* At the specialty chemicals unit, Noveon produces two general kinds of products: (1) rubber accelerators that are used in the vulcanizing process of the tire-curing process for the tire industry; and (2) plastic and rubber antioxidants, which are additives used to prevent the degradation of the material from light and heat in products such as rubber baby bottle nipples. The Henry Plant is classified as industrial and currently employs 75 people. 2004 Tr. at 22.

Wastewater Treatment

Noveon operates the wastewater treatment facilities for both Noveon and PolyOne. Ag. Memo. at 3. The facility treats discharges from production processes, the cooling tower, boiler blowdown, and well water treatment, as well as stormwater. Ag. Memo at 4. The combined process and non-process water discharged per day from the two facilities is approximately 800,000 gallons. Pet. at 9.

Noveon treats wastewater in several steps. The first step involves equalization of all influent wastewaters. Pet. at 12; Nov. Memo at 5. All wastewaters from Noveon, excluding those from rubber accelerator (Cure-Rite 18 or C-18) manufacturing, discharge directly into equalization tank (PC Tank). The wastewater from C-18 manufacturing is pretreated prior to discharge into a separate equalization tank (C18 Tank). Similarly, all wastewaters from PolyOne production areas, except for waste stream from 213 manufacturing, discharge into an equalization tank (PVC Tank). *Id.* Wastewater from 213 manufacturing is pretreated prior to

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[2] The Board cites to the transcript of hearings held in the permit appeal, PCB 91-17, held on November 19, 1991 and December 10, 1991, collectively, as "1991 Tr. at __."

discharge into the same equalization tank. The PolyOne equalization tank also receives backwash water from sand filter, filtrate from sludge dewatering, and, potentially primary sludge from primary clarifier. *Id.* at 5-6; 2004 Tr. at 36, 37. The wastewater from all equalization tanks is combined in a pH adjustment tank prior to primary treatment. In addition to these wastestreams, the non-process wastewater, including non-contact cooling water, stormwater, water from the boilerhouse demineralizer and water treatment works is discharged to a holding tank. The non-process water is then either sent to primary treatment or pumped directly to sand filter to remove solids prior to discharge through the outfall.

Primary treatment involves the removal of settleable solids from the combined pH adjusted wastewater. The combined wastewater is sent to primary clarifier after adding coagulant and polymer. The solids removed during primary treatment are dewatered and sent to a landfill. The wastewater from the primary clarifier is pumped to the four aeration basins for secondary activated sludge treatment, which involves the removal organic compounds. The effluent from the secondary clarifier is sent through a sand filter prior to discharge through the outfall. This final treatment step is termed as tertiary treatment. Nov. Memo at 5; Pet. Exh. 7, at 5, 6.

Discharge from the City of Henry's publicly owned treatment works combines with Noveon's effluent and is discharged through Noveon's outfall into the Illinois River pursuant to NPDES Permit No. IL0001392. Pet. at 14. Noveon's outfall (Outfall 001) is located between mile 198 and 199 on the Illinois River. Ag. Memo at 5. The effluent is discharged through an 18-inch, single-port submerged diffuser into the main channel of the Illinois River. Noveon states that the Henry Plant sits on a bluff, 80-90 feet above the Illinois River. Nov. Memo at 9; 2004 Tr. at 189. As a result, Noveon asserts the discharge enters the river with a velocity that causes rapid and immediate mixing. Pet. at 14.

Modifications

Noveon's wastewater treament plant was upgraded in 1987 by adding two above ground biotreators, two above ground equalization tanks, and a tertiary filtration system. Pet. at 10. Noveon states it added a third biotreator in 1989 and a fourth in 1998. *Id.* In 1997, Noveon increased aeration tank capacity by 100 percent, or one million gallons, to accommodate expanded production. 2004 Tr. at 57. Noveon states it has attempted to reduce ammonia in its discharge through both source reduction and end-of-pipe discharge controls. 2004 Tr. at 41.

In 2000, Noveon modified the east biotreator by converting it to a temporary air stripper using its normal air diffusion system and also by the installation of a floating aerator in the Noveon waste tank or the PC tank. 2004 Tr. at 40.

Ammonia Discharge

PolyOne discharges a small amount of ammonia into the wastewater system in the form of ammonium laurate, a dispersing agent. Nov. Memo at 6. Noveon's manufacturing processes do not discharge any significant ammonia nitrogen directly to the wastewater treatment system. Pet. at 15. However, Noveon processes discharge organic nitrogen compounds tertiary butyl amine, mercaptobenzothiazole (MBT) and morpholine. Nov. Memo at 6. Noveon has determined that ammonia is generated by the degradation of organic nitrogen compounds in the activated sludge treatment process. Nov. Memo at 8. Further, a significant amount of ammonia nitrogen released during the wastewater treatment process remains in the effluent because ammonia is not nitrified during the treatment process. According to Noveon, although the Henry Plant is constructed similarly to municipal wastewater treatment plants to nitrify ammonia, the plant does not achieve nitrification. Nov. Memo at 6-7.

The parties agree that nitrification does not occur at the Henry Plant for several reasons, including: the inhibition of growth of nitrifying bacteria by specific inhibitory compounds in Noveon's wastestream (2004 Tr. at 448), insufficient oxygen due to poor oxygen transfer rates, and the need for additional alkalinity to be chemically added (2004 Tr. at 433, 447).

The parties agree that Noveon's discharge of ammonia nitrogen to the Illinois River exceeds 100 pounds per day. 2004 Tr. Exh. 38 at 68. Noveon's 1981 NPDES permit application indicated that the facility's maximum daily discharge of ammonia nitrogen was 34 milligrams per liter (mg/L). 2004 Tr. Exh. 38, Exh. 3, 4. Then in 1989, Noveon's permit application indicated a maximum daily discharge of 230 mg/L ammonia, or 1,933 lbs/day, in the effluent. 2004 Tr. Exh. 38, Exh. 6, V-1. Noveon's renewed NPDES permit, issued by the Agency on December 28, 1990, indicated that the facility discharged approximately 80 to 120 mg/L ammonia. 2004 Tr. Exh. 38; Exh. 9. In a memo regarding ammonia-nitrogen treatment alternatives at the Henry Plant, Mr. Houston Flippin estimated the average ammonia effluent value at 909 lbs/day, derived from wastestream data gathered in 1995 and effluent data gathered in 1999 through 2000. Pet. Exh. 7.

STANDARD OF REVIEW/ BURDEN OF PROOF

The regulation of general applicability at 35 Ill. Adm. Code 215.301 does not specify a level of justification for an adjusted standard. Pet. at 11; Rec. at 7. Therefore, pursuant to Section 28.1(c) of the Act, the burden of proof is on the petitioner to demonstrate that:

1. Factors relating to that petitioner are substantially and significantly different from the factors relied upon by the Board in adopting the general regulation applicable to that petitioner;

2. The existence of those factors justifies an adjusted standard;

3. The requested standard will not result in environmental or health effects substantially and significantly more adverse than the effects considered by the Board in adopting the rule of general applicability; and

4. The adjusted standard is consistent with any applicable federal law. 415 ILCS 5/28.1(c) (2002); 35 Ill. Adm. Code 104.426(a).

The burden of proof in an adjusted standard proceeding is on the petitioner. 35 Ill. Adm. Code 104.426. Noveon must also justify its request pursuant to the requirements of Section

27(a) of the Act. *Id.*; 415 ILCS 5/28.1(a) (2002). Under Section 27(a), the Board considers the existing physical conditions, the character of the surrounding area including the nature of the receiving body of water, and "the technical feasibility and economic reasonableness of measuring or reducing the particular type of pollution." 415 ILCS 5/27(a) (2002).

CURRENT APPLICABLE STANDARDS

Section 301.345 defines population equivalent as:

> "Population Equivalent" is a term used to evaluate the impact of industrial or other waste on a treatment works or stream. One population equivalent is 100 gallons (380 l) of sewage per day, containing 0.17 pounds (77 g) of BOD_5 (five day biochemical oxygen demand) and 0.20 pounds (91 g) of suspended solids. The impact on a treatment works is evaluated as the equivalent of the three highest parameters. Impact on a stream is the higher of the BOD_5 and suspended solids parameters.

Section 304.122 of the Board's effluent standards for ammonia nitrogen provides:

> a) No effluent from any source which discharges to the Illinois River, the Des Plaines River downstream of its confluence with the Chicago River System or the Calumet River System, and whose untreated waste load is 50,000 or more population equivalents shall contain more than 2.5 mg/L of total ammonia nitrogen as N during the months of April through October, or 4 mg/L at other times.
>
> b) Sources discharging to any of the above waters and whose untreated waste load cannot be computed on a population equivalent basis comparable to that used for municipal waste treatment plants and whose total ammonia nitrogen as N discharge exceeds 45.4 kg/day (100 pounds per day) shall not discharge an effluent of more than 3.0 mg/L of total ammonia nitrogen as N.
>
> c) In addition to the effluent standards set forth in subsections (a) and (b) of this Section, all sources are subject to Section 304.105.

NOVEON'S PROPOSED ADJUSTED STANDARD

In the petition, Noveon proposed the following three alternatives of adjusted standard language for adoption by the Board:

Alternative #1

> Noveon, Inc. ("Noveon") is hereby granted an adjusted standard from 35 Ill. Adm. Code 304.122. Pursuant to this adjusted standard, 35 Ill. Adm Code 304.122 shall not apply to the discharge of effluent into the Illinois River from the Noveon plant located at 1550 County Road, 850 N., in Henry, Illinois as regards

ammonia nitrogen. The granting of this adjusted standard is contingent upon the following conditions:

A. Noveon shall not discharge calculated un-ionized ammonia at concentrations greater than 3.5 mg/l during the months of April through October and 7.9 mg/l during the months of November through March from its Henry, Illinois plant into the Illinois River.

B. Discharge into the Illinois River shall occur through a diffuser that is at least 15 ft. in length, with 9 two-inch ports, angled at 60 degrees from horizontal, co-flowing with the river, designed to achieve an effluent dispersion of 43:1.

Alternative #2

Noveon, Inc. ("Noveon") is hereby granted an adjusted standard from 35 Ill. Adm. Code 304.122. Pursuant to this adjusted standard, 35 Ill. Adm Code 304.122 shall not apply to the discharge of effluent into the Illinois River from the Noveon plant located at 1550 County Road, 850 N., in Henry, Illinois as regards ammonia nitrogen. The granting of this adjusted standard is contingent upon the following conditions:

A. The water quality standards will be met by Noveon Henry plant limiting its total ammonia nitrogen discharge to 1200 pounds per day during the months of April through October and 1735 pounds per day during the months of November through March.

B. Discharge into the Illinois River shall occur through a diffuser that is at least 15 ft. in length, with 9 two-inch ports, angled at 60 degrees from horizontal, co-flowing with the river, designed to achieve an effluent dispersion of 43:1.

Alternative #3

Noveon, Inc. ("Noveon") is hereby granted an adjusted standard from 35 Ill. Adm. Code 304.122. Pursuant to this adjusted standard, 35 Ill. Adm. Code 304.122 shall not apply to the discharge of effluent into the Illinois River from the Noveon plant located at 1550 County Road, 850 N., in Henry, Illinois as regards ammonia nitrogen. The granting of this adjusted standard is contingent upon the following conditions:

A. Noveon shall not discharge calculated total ammonia nitrogen at concentrations greater than 155 mg/l during the months of April through October and 225 mg/l during the months of November through March from its Henry, Illinois plant into the Illinois River.

B. Discharge into the Illinois River shall occur through a diffuser that is at least 15 ft. in length, with 9 two-inch ports, angled at 60 degrees from horizontal, co-flowing with the river, designed to achieve an effluent dispersion of 43:1.

However, in its April 29, 2004 closing brief, Noveon withdraws proposed alternatives 1 and 2, and instead seeks a daily maximum limit for ammonia of 225 mg/L by modifying its proposed alternative 3. Nov. Memo at 42. Noveon explains that an Agency memo conceding that with using the multi-port diffuser Noveon's daily limits would approximate 237.2 mg/L during the summer and 398 mg/L during the winter. *Id.*; Pet. Exh. 37. The following is Noveon's amended proposed language:

> Noveon, Inc. ("Noveon") is hereby granted an adjusted standard from 35 Ill. Adm. Code 304.122. Pursuant to this adjusted standard, 35 Ill. Adm Code 304.122 shall not apply to the discharge of effluent into the Illinois River from the Noveon plant located at 1550 County Road, 850 N., in Henry, Illinois as regards ammonia nitrogen. The granting of this adjusted standard is contingent upon the following conditions:
>
> A. Noveon shall not discharge total ammonia nitrogen at concentrations greater than 225 mg/L from its Henry, Illinois plant in the Illinois River.
>
> B. Discharge into the Illinois River shall occur though a diffuser that it at least 15 ft. in length, with 9 two-inch ports angled at 60 degrees from horizontal, co-flowing with the river, designed to achieve an effluent dispersion of 43:1.

Agency Response to Noveon's Proposed Alternatives

The Agency argues that if the Board grants Noveon's requested relief, the adjustment should not include relief from Section 304.122(c). Subsection (c) requires compliance with the Board's water quality standards. The Agency contends that Noveon has provided no justification for relief from that section. Ag. Memo at 9.

The Agency also states that Noveon's request for a Board determination that the ammonia water quality standards will be met with the zone of initial dilution (ZID) and mixing zone as calculated by Noveon is "inappropriate, unnecessary, and possible an attempt to gain relief from the water quality standard into the future without requesting or justifying such relief directly." Ag. Memo at 10.

In assessing the four alternatives of adjusted standard language, the Agency states it cannot support Noveon's request for an even higher limit in the summer months than originally requested at this late date. Ag. Memo at 10-11.

EFFORTS TO ACHIEVE COMPLIANCE AND ALTERNATIVES

Noveon states that it hired consultant Brown and Caldwell, f/k/a/ Eckenfelder Inc., beginning in the late 1980s to investigate whether the Henry Plant could nitrify, or oxidize ammonia to nitrates. Pet. at 16. Noveon asserts that two different studies demonstrated that the Henry Plant could not achieve single-stage nitrification under existing waste loads and optimum conditions. *Id.* The reason was due to inhibition of nitrifying bacteria by the PC tank and C-18 tank content flows.

Noveon investigated various other technologies that would help it control and/or reduce ammonia in its discharge, including: (1) reducing ammonia-nitrogen in various processes; (2) pretreating the wastestream; and (3) post-treating the wastestream. Pet. at 16-17. In sum, Noveon indicates that it investigated eleven potential treatment alternatives, but investigations proved that no alternative is both technically feasible and economically feasible that would bring the Henry Plant into compliance with the ammonia-nitrogen limits. Pet. at 24; Nov. Memo at 13.

Reducing Organic Nitrogen in Production

Noveon asserts that it investigated whether it could eliminate amines or recover and recycle the precursors to ammonia in its production processes. Pet. at 17. Noveon concluded it could not eliminate amines since they are an essential element to many of its production processes. *Id.*

Noveon contends that the recycle and reuse alternative was also rejected because the recycled material was of inferior quality and would not guarantee a high quality product. Further, Noveon explains that the material generated in the recycling process would be classified as a hazardous waste. Noveon notes that amines are recovered from some processes at the Henry Plant where recovery methods produce reusable materials and are not cost prohibitive. Pet. at 17. However, Noveon did not indicate how much is reused or in which processes.

Pretreatment of the Wastestream

Noveon investigated several pretreatment options, including norpholine recovery, TBA recovery and a liquid extraction process. Noveon states that none of the pretreatment options would bring Noveon into compliance with the ammonia effluent standard. Pet. at 17. Noveon added that these alternatives also raised plant personnel safety issues. Pet. at 18.

Post-treatment of the Wastestream

After analyzing the alternatives discussed above Brown and Caldwell, investigated six post-treatment alternatives for Noveon. The post-treatment alternatives include the following: (1) alkaline air stripping; (2) struvite precipitation from the combined wastestream influent; (3) effluent breakpoint chlorination; (4) single-stage biological nitrification of non-PC wastestream combined with separate biological treatment of the PC tank discharge; (5) biological nitrification of combined influent wastestream; and (6) ion exchange treatment of final effluent. Pet. at 18. Present costs were estimated for each including capital and operating and management costs. After its initial evaluation, Brown and Caldwell further investigated ozonation, tertiary nitrification, and activated carbon. In addition to providing present worth costs of each of the full-scale operations, Brown and Caldwell also looked at increments of removal and the associated costs. Brown and Caldwell concluded that the same reliability ratings and pros and cons would apply. Tr. 2004 at 497-98; citing Exh. 12.

Alkaline Air Stripping

This process requires increasing the pH of a wastewater stream and then removing the resulting ammonia gas. Noveon attempted air stripping at three different points: (1) within the PC tank; (2) within the PVC tank; and (3) at the secondary clarifier effluent. Pet. at 18; citing Pet. Exh. 6 at 2-1 to 2-2.

The test results, stated Noveon, showed that air stripping would result in some ammonia reduction. However, the level of ammonia reduction was low, meaning that air stripping in both the PC tank and PVC tank would not reduce ammonia enough to meet the effluent limitation of Section 304.122(b). Further, Noveon stated the present worth capital and operation and maintenance costs totaled $2.3 million for PC tank treatment and $14.1 million for PVC tank treatment. Pet. at 19-20.

In the secondary clarifier, Noveon states ammonia removal surpassed 95% using packed tower air stripping technology. Pet. at 20. The disadvantages of this technology is that it would increase total dissolved solids (TDS) by more than 20%, which could lead to aquatic toxicity of the effluent, as well as high costs of installation, operation, and maintenance. Noveon calculated the present worth of this technology at $14 million. Pet. at 20; Pet. Exh. 7 at pp. 2-3. Noveon explains that the costs of this alterantive are so high because additional equipment is required to remove ammonia from the gases produced. Pet. at 20.

Struvite Precipitation

This alternative reduces ammonia by precipitating a struvite from the combined wastestreams of Noveon and PolyOne. Pet. at 20; citing Pet. Exh. 6 at 2-2 to 2-4. This alternative, states Noveon, would only reduce the average final effluent ammonia level by 24%, while at the same time increasing TDS in the effluent. Noveon estimates the present worth cost at $5.1 million. Pet. at 20-21.

Effluent Breakpoint Chlorination

Brown and Caldwell also tried adding chlorine gas together with caustic soda to the secondary clarifier wastewater in a reaction tank in order to maintain a higher pH (approximately 6.9). Pet. at 21. This alternative could cause the discharge to meet the ammonia effluent limits. Pet. at 21; Exh. 6 at 3-4. The problem with this alternative, states Noveon, is that its present worth cost is $9.7 million, making it economically unreasonable to employ at the Henry Plant. As with some of the other alternatives discussed, Noveon notes that this alternative will also dramatically increase effluent TDS and may likely result in the formation of chlorinated organics in the effluent. *Id.*

Single-stage Biological Nitrification of Non-PC Wastewater

Noveon states that the consultant's results showed that this alternative reduced ammonia by only 47% and had a present worth cost of $4.9 million. As a result, Noveon determined that this alternative was not technically feasible. Pet. at 22.

Biological Nitrification of Combined Wastewater

This alternative employed pH reduction to two of the PC tank discharges, then the addition of river water and combined single-stage nitrification with non-PC wastestreams. The results of the analysis by Noveon's consultant showed that this alternative is technically feasible, but that it would not allow Noveon to reliably achieve compliance. Pet. at 22. Noveon explains that biological nitrification of the combined wastewater stream is unreliable because it is sensitive to the variable characteristics inherent in the wastewater produced by the different batch processes. *Id.* Further, Noveon states this is an exceptionally costly alternative, estimating the present worth cost at $11.7 million. Pet. at 22; citing Pet. Exh. 7 at pp. 2-3.

Ion Exchange

Brown and Caldwell also researched an ion exchange resin, using clinoptilolite, an ammonia selective exchange resin, to treat the secondary clarifier effluent. Pet. at 22. The test results showed that 50 pounds (lbs.) of clinoptilolite would be required to remove each pound of ammonia, but that this alternative could meet the ammonia effluent standard. Noveon's consultant concluded that the poor removal efficiency was due to competing ions in the effluent. Pet. at 22; citing Pet. Exh. 6 at 3-4. The present worth cost of this alternative, determined Noveon, was $5.1 million. Pet. at 23.

Ozonation

Ozonation was evaluated as an alternative that could meet compliance but was rejected due to its present worth cost of $20.3 million. Pet. at 23. Further disadvantages would be a significant increase in the TDS effluent concentration, and an increase in effluent BOD, potentially causing violations of BOD effluent limits. *Id.*

Tertiary Nitrification

Tertiary nitrification involves pumping the effluent through an aeration basin containing a fixed filter that nitrifying bacteria grows on. Brown and Caldwell determined that this process was technically feasible, but lacked reliability for the same reasons that biological nitrification of the combined wastewater lacked reliability. Pet. at 23. The present worth costs were estimated at $11.4 million. *Id.*

Powdered/Granulated Activated Carbon

At hearing, Mr. Flippin testified that Noveon considered powdered and granulated activated carbon (GAC) as ammonia treatment alternatives, but determined that both would be infeasible. Mr. Flippin stated that Noveon's discharge would require a dose of 5,000 mg/L of powdered activated carbon. A dose proportional to the actual flow would total approximately 17 tons a day of carbon. Mr. Flippin stated that GAC is about twice as efficient, but would still require as much as eight and a half tons per day, or approximately 119,000 tons of the material per week. 2004 Tr. at 490-91. Implementation of this alternative would require additional treatment such as a solids separation step or a polymer addition. Two additional problems that arise from using GAC as an alternative are scaling, resulting from too much salt, and biofouling from lime and biomass as a result of too much BOD. 2004 Tr. at 492.

Agency Response

While conceding that some of the alternatives are quite expensive, the Agency contends that evidence in the record clearly shows that there are technically feasible alternatives available for the treatment of ammonia at Noveon's facility. Ag. Memo at 17-18. Regarding Noveon's assertion that it will replace the current single-port diffuser with a multi-port diffuser, the Agency clarifies that the change is necessary in order to bring Noveon into compliance with the water quality standards, not a form of treatment to reduce its ammonia discharge. Ag. Memo at 18. After reviewing the treatment alternatives that Noveon presented, the Agency concluded that the capital costs presented by Noveon are not economically unreasonable based on the large quantity of ammonia that would be removed from the discharge. *Id.* at 20. There exist treatments, argues the Agency, that could allow the Henry Plant to achieve at least partial compliance with 304.122(b) for an economically reasonable cost. However, the Agency notes, "it is not the role of the Illinois EPA or the Board to select Noveon's treatment system." *Id.* at 22.

The Agency argues that Noveon should propose to reduce ammonia in its effluent to levels that would achieve the greatest reductions while still being economically reasonable in order to minimize the environmental impact from the discharge of ammonia. Instead, the Agency asserts, Noveon is taking an all or nothing approach. Ag. Memo at 24. The Agency claims that Noveon is not willing to implement any of the alternatives that it investigated, claiming that none are economically reasonable and technically feasible. *Id.*

SUBSTANTIALLY DIFFERENT FACTORS

Noveon contends that the factors relied on by the Board in promulgating Section 304.122 were substantially different than those that currently apply to the Noveon Henry Plant. Noveon states Section 304.122 (a) and (b) were motivated by both the available technology to treat ammonia and the desire to address the dissolved oxygen demand in the Illinois River. Pet. at 28; citing Water Quality Standards Revisions, R72-4 (Nov. 8, 1973).

Noveon concedes that technology to help Noveon meet the ammonia limit of Section 304.122(b) is available, but that no alternative is both technologically feasible and economically reasonable. Specifically, Noveon discusses three factors that make it difficult for Noveon to comply with the ammonia nitrogen limit. Nov. Memo at 11. First, Noveon states "[t]hrough no absence of equipment or flaw in design, the wastewater treatment facility simply does not perform the treatment that it would absent influent bio-inhibiting compounds." Nov. Memo at 21. Noveon explains that it uses a compound in production that prevents nitrification: MBT.

Noveon states that as a result, its waste stream requires pretreatment to remove bio-inhibiting compounds so the treatment process can adequately remove BOD. Nov. Memo at 11. The reduced nitrification, states Noveon, also requires Noveon to add alkalinity, in contrast to a POTW, where most of the alkalinity required for nitrification is already found in the wastewater.

Second, Noveon claims that its waste stream contains compounds that reduce its oxygen transfer capacity to approximately half of what a POTW experiences, requiring Noveon to provide twice the amount of aeration to satisfy the same oxygen demand of its wastewater. *Id.* Third, Noveon claims that another primary toxicant in its effluent is salt. *Id.* Noveon continues that because all treatment processes for removing significant amounts of ammonia nitrogen require the addition or release of salt, ammonia nitrogen removal would increase levels of this toxicant.

Noveon also contends that since the promulgation of Section 304.122, the technical justification for removing ammonia nitrogen has changed. According to Noveon, it has since been determined that the dissolved oxygen sags were caused by sediment oxygen demand rather by the discharge of ammonia nitrogen as previously thought. Pet. at 29. Noveon asserts that the ammonia Noveon discharges has a minimal impact upon the level of dissolved oxygen in the Illinois River. For these reasons, Noveon argues that the factors the Board relied upon in promulgating 304.122(b) are significantly different than those that currently apply to the Noveon Henry Plant.

Agency Response

The Agency disagrees with Noveon's contention that the technological factors or cost of reducing ammonia are substantially different than what was contemplated by the Board in promulgating the ammonia nitrogen limit. Ag. Memo at 32. The Agency asserts that while some factors make Noveon's discharge more difficult to treat for ammonia than many other industries, those distinctions do not justify the requested relief. The requested relief would grant Noveon an effluent ammonia concentration limit of 75 times that contained in the rule of general applicability. Ag. Memo at 34.

ADJUSTED STANDARD JUSTIFICATION

Noveon contends the primary factor that justifies its requested relief is economic reasonableness. Pet. at 29. Noveon asserts that the current ammonia standard was adopted based upon balancing potential adverse impact on dissolved oxygen against the cost and ease of reducing ammonia. *Id.* According to Noveon, economic reasonableness weighs in its favor. Noveon argues that the high cost of technically feasible control technology and minimal environmental benefit that such technology would provide warrants the requested relief. *Id.*

IMPACT ON THE ENVIRONMENT

Noveon argues that granting the requested relief will not result in any adverse environmental impact. Pet. at 25. Noveon contends the Board's basis for adopting the ammonia-nitrogen limitations was that larger dischargers were contributing to dissolved oxygen sags. However, Noveon contends that rationale was refuted when researchers discovered that dissolved oxygen sags occurred because of three primary oxygen demand sinks instead: carbonaceous BOD, nitrogenous BOD, and sediment oxygen demand. Pet. at 26; Nov. Memo at 31; citing Site Specific Exception to Effluent Standards from the Greater Peoria Sanitary District and Sewage Disposal District, R87-21 (Oct.6, 1988). Noveon argues that the two most important criteria the Board should consider are: (1) whether Noveon is contributing to the limitation or reducing dissolved oxygen of the Illinois River; or (2) whether Noveon is contributing to the Board's water quality standards regarding aquatic toxicity. 2004 Tr. at 12.

Noveon's expert, Mr. Corn, ran a wasteload allocation model with Noveon's organic loadings and high ammonia loadings, both oxygen-depleting substances. Nov. Memo at 32. According to Noveon, the results showed that during critical periods of low flow and high temperatures, the DO concentration downstream from the Noveon discharge (7.5 mg/L) meets the existing standards for DO (5 mg/L). Nov. Memo at 32; 35 Ill. Adm. Code 302.206. Noveon therefore concludes that the discharge does not adversely impact DO levels downstream of its discharge.

Regarding impact on aquatic life from the discharge, Noveon maintains there is none. Noveon asserts that Agency testimony that the entire upper Illinois River has improved notwithstanding Noveon's discharge supports this conclusion. Nov. Memo at 34; citing 1991 Tr. at 117-18.

As part of its requested relief, Noveon also requests a mixing zone designation in the Illinois River. According to Noveon, the mixing zone and zone of initial dilution are critical aspects of the relief that Noveon requests. Noveon asserts that Section 302.102 governs allowed mixing, mixing zones and zones of initial dilution and that Noveon's proposal will meet each of the 12 requirements set forth in Section 302.102(b). 35 Ill. Adm. Code 302.102. Accordingly, Noveon contends that its requested adjusted standard will not adversely impact the environment or human health.

Noveon states that if it is granted the requested relief, it will install a multi-port diffuser. Nov. Memo at 36. Noveon defines the multi-port diffuser as "an engineered structure that enhances the mixing of an effluent into a receiving stream." *Id.* Noveon asserts a multi-port diffuser could achieve a dispersion rate of 43:1, as compared to 13:2:1 for the single-port diffuser. *Id.*

Agency Response

The Agency contests Noveon's assertion that the requested relief will have no adverse environmental impacts. Ag. Memo at 25. The Agency points to its own testimony that Noveon's effluent is the single most toxic remaining discharge to the waters of the State of Illinois. Ag. Memo at 25-26; citing 2004 Tr. at 350. The Agency asserts that Noveon has performed no in-stream studies looking at the actual impact of its discharge on the aquatic life downstream from its discharge, but nevertheless concluded there would be no adverse impact. Ag. Memo at 26.

The Agency also disputes Noveon's contention that the requested relief would have no measurable impact on the environment or human health. Ag. Memo at 34. The Agency notes that the Henry Plant is still not currently able to meet water quality standards for ammonia at the edge of a mixing zone or ZID. Ag. Memo at 35. The Agency maintains that Noveon has not proposed to reduce the amount of ammonia in its discharge by any amount. Accordingly, the Agency argues that Noveon has not justified the requested relief and must continue to ask the board to deny Noveon's request. *Id.*

Regarding Noveon's requested mixing zone, the Agency states that under Section 304.102 of the Board's regulations, Noveon must show that it is providing the best degree of treatment (BDT). Section 304.102 also prohibits using dilution to meet effluent standards. Ag. Memo at 27. The Agency asserts this Section is relevant to the discussion of a mixing zone because it has consistently claimed that Noveon is not providing BDT for ammonia. Further, the Agency states that it never applied a mixing zone to Noveon's discharge because the Agency's program post-dates Noveon's most recently issued NPDES permit. Ag. Memo at 29. However, the Agency and Noveon agree that with the adjusted standard relief and a multi-port diffuser, Noveon would have an adequate mixing zone to achieve water quality standards. *Id.*

CONSISTENCY WITH FEDERAL LAW

Both the Agency and Noveon agree that the requested relief from Section 304.122(b) is consistent with federal law. Pet. at 30. However, the Agency asserts that the Board must limit any relief granted to Section 304.122(a) or (b), because relief from subsection (c) would require approval from the United States Environmental Protection Agency (USEPA). Ag. Memo at 35-36.

Noveon states there are no applicable federal numeric effluent standards or water quality standards for ammonia. Noveon contends that federal regulations direct states to adopt water quality standards that protect the uses, public health or welfare, enhance the quality of water and serve the purposes of the Act. 40 C.F.R. §131.2. According to Noveon, granting this adjusted standard will not impair any beneficial or existing use of the receiving stream. Noveon continues that applicable water quality standards will be met. Pet. at 31; Nov. Resp. at 1.

DISCUSSION

Relief from the Ammonia Nitrogen Effluent Limits

Noveon seeks relief from the State's ammonia-nitrogen limitation found at Section 304.122(b) in the form of an adjusted standard. The Agency recommends that the Board deny Noveon's request for relief.

The Board finds that Noveon's request for relief from the ammonia-nitrogen standard meets the statutory "fundamentally different" factors set forth at Section 28.1(c) of the Act. Noveon has demonstrated that: (1) factors relating to it are substantially and significantly different from the factors relied upon by the Board in adopting the general regulation; (2) the existence of these factors justifies an adjusted standard; (3) the requested standard will not cause substantially or significantly more adverse environmental or health effects than the effects considered by the Board in adopting the rule of general applicability; and (4) the adjusted standard is consistent with applicable federal laws. 415 ILCS 5/28.1(c) (2002). The Section 28.1(c) factors are discussed in turn.

Substantially Different Factors

The Board adopted the ammonia effluent limit, now Section 304.122(a), on January 6, 1972, as "Rule 406" to address the impact of ammonia nitrogen in municipal wastewater on dissolved oxygen demand in the receiving stream. R70-8, R71-14, and R71-20 (Jan 6, 1972). What became subsection (b) of Section 304.122, was adopted as an amendment to Rule 406 on June 28, 1973, in R72-4. Water Quality Standards Revisions, R72-4. The amendment extended the ammonia nitrogen effluent limits to non-municipal wastewater dischargers, mainly industrial dischargers, but did not address the issue of available treatment technologies.

The Board finds that the quality and composition of the discharge that Noveon produces in its manufacturing process is substantially and significantly different than wastewaters of other industries and POTWs. The presence of MBT, a building block chemical used in Noveon's processes, inhibits the growth of nitrifying bacteria. The presence of degradable organic nitrogen compounds generates large amounts of ammonia nitrogen during secondary treatment of Noveon's wastewater. Further, Noveon's wastewater is very low in alkalinity, thus requiring addition of alkalinity to achieve nitrification. Although Noveon's wastewater treatment plant is designed, constructed, and operated similarly to a POTW that achieves nitrification, the Henry plant is unable to achieve nitrification because of the unique characteristics of Noveon's wastewater. The Board did not anticipate the specialty chemicals manufacturing processes that Noveon employs at the Henry Plant when it promulgated the ammonia effluent limit at Section 304.122(b), applicable mainly to other industrial dischargers, in 1972.

Justification for Relief

Noveon bases its justification for the requested relief on the lack of an economically reasonable and technically feasible alternative for removing ammonia nitrogen. Noveon argues that the cost of technically feasible control technology is extremely high and yields a minimal environmental benefit. Since Noveon is unable to nitrify ammonia in its existing wastewater treatment plant, Noveon examined several treatment alternatives to reduce ammonia in its effluent. The Board notes that the costs per pound of ammonia removed for the various alternatives that Noveon investigated are significantly less than technologies investigated and implemented in other site-specific rulemakings by facilities that reduced their effluent ammonia concentrations to more acceptable levels. *See* Petition of PDV Midwest Refining, L.L.C. for a Site-Specific Rulemaking Amendment to 35 Ill. Adm. Code 304.213, R98-14 (Dec. 17, 1998); Site-Specific Petition of Mobil Oil Corp. for Relief From 35 Ill. Adm. Code 304.122, Ammonia Nitrogen Effluent Standards, R97-28 (Jan. 22, 1998). However, the overall cost of reducing ammonia nitrogen would be significantly higher due to the large quantity of ammonia that Noveon must remove to meet the ammonia effluent limit.

The present worth cost of alternatives with an ammonia nitrogen removal rating above 90 percent range from $5.8 million to $ 14.1 million. Some of these alternatives such as effluent stripping with off-gas control, combined single-stage nitrification, effluent ion exchange have low performance reliability. Some alternatives also contributed to higher TDS levels or chlorinated organics in the effluent. Pet. at 19-24. Moreover, the financial information presented by Noveon indicates that implementing any one of the viable alternatives would significantly affect the company's return on revenue, and return on net plant, property and equipment. The resulting return on revenue would be very small or negative for the evaluated treatment alternatives. 2004 Tr. at 285. After considering all of these factors, the Board finds that no treatment alternative investigated is economically reasonable, although some of them are technically feasible.

Environmental Impact

The Board finds that Noveon's discharge does not have an adverse environmental impact on the receiving stream. Noveon submitted modeling in support of its argument that the requested relief will not result in adverse environmental or health effects because the modeling shows that DO concentration in the Illinois River downstream from Noveon's outfall during critical flow (7Q10) is above the current DO standard of 5 mg/L. Noveon has also submitted test results showing that, other than ammonia and salinity, no other toxic parameters exist in its effluent. The test is called the Toxicity Identification Evaluation (TIE), and provides information on organic toxicity, metal toxicity, oxidane toxicity, and reducible compounds. Nov. Reply at 25. Further, Noveon argues that with installation of the multi-port diffuser, the discharge will meet the ammonia acute water quality standard at the edge of the ZID and the ammonia chronic water quality standard at the edge of the mixing zone.

The Board finds these demonstrations provide assurance that Noveon's discharge will not adversely impact aquatic life. However, the Board shares the Agency's concern that Noveon has not provided any in-stream monitoring studies to assess the actual impact of its discharge on aquatic life. Ag. Memo at 26. Special Condition 6 of Noveon's NPDES permit, recently affirmed in docket PCB 91-17, requires Noveon to prepare a preliminary plan for, and perform biomonitoring of, at least two trophic levels of aquatic species; fish and invertebrates. Condition 6 requires Noveon to conduct these tests on a monthly basis for six months and submit the results to the Agency within a week after they are available to Noveon.

Accordingly the Board will not order biological studies because biomonitoring is already a condition of Noveon's NPDES permit. Considering that Noveon discharges over 900 pounds of ammonia per day into the Illinois River, biomonitoring will provide a quantification of biological impact, if any, of Noveon's discharge from its outfalls on aquatic life.

Condition 4 of the NPDES permit also requires Noveon to monitor and report the pounds per day of ammonia discharged from its outfalls. Pursuant to the permit, Noveon must submit the results to the Agency on a monthly basis. Further, since the Board's finding concerning the impact on aquatic life is partly premised on Noveon's compliance with the ammonia nitrogen water quality standards, the Board orders Noveon to demonstrate compliance with the applicable ammonia nitrogen water quality standards at the edge of the mixing zone and ZID, as will be defined by the Agency. The Board requires Noveon to monitor ammonia nitrogen in the Illinois River in accordance with Board regulations on a quarterly basis. These monitoring requirements are included as conditions to the adjusted standard, and will apply only after Noveon installs the multi-port diffuser.

Throughout the duration of this adjusted standard, the Board encourages Noveon to research and propose means, beyond the wastewater treatment plant and multi-port diffuser, of providing environmentally beneficial improvements to the Illinois River in Marshall County. The Board has incorporated voluntary environmental projects proposed by petitioners into adjusted standards in the past. Petition of Illinois American Water Company's (IAWC) Alton Public Water Supply Replacement Facility Discharge to the Mississippi River for an Adjusted Standard from 35 Ill. Adm. Code 302.203, 304.106, and 304.124, AS 99-6 (Sept. 7, 2000) (petition for an adjusted standard for offensive discharges and conditions, and discharges of total suspended solids and iron); Petition of City of East Moline and IEPA for an Adjusted Standard from 35 Ill. Adm. Code 304, AS 91-9 (May 19, 1994); Petition of City of Rock Island for an Adjusted Standard from 35 Ill. Adm. Code 304, AS 91-13 (Oct. 19, 1995). In IAWC's adjusted standard, IAWC was allowed to discharge directly into the Mississippi in exchange for IAWC's financial support of nearby non-point source sediment loading reduction projects. The projects were implemented by a charitable non-profit trust, the Great Rivers Land Trust, whose goal it is to protect the watersheds in the area.

Any project that Noveon researches and proposes must improve, restore or protect the Illinois River in Marshall County and reduce risks to public health and the environment beyond what is ordered by this adjusted standard. While research of potential improvements is not part of the Board's order, the Board will consider proposals by Noveon should Noveon choose to renew this adjusted standard at a future date.

Consistency with Federal Law

Finally, the parties agree, and the Board finds, there is no inconsistency between granting Noveon's requested relief from Section 304.122(b) and federal law. Accordingly, the Board grants an adjusted standard from the Board's ammonia effluent limits and defines the mixing zone applicable to Noveon's discharge, but does not grant Noveon relief from the Board's water quality standards.

Best Degree of Treatment and Mixing Zone

The Board has found above that no investigated alternative is both technologically feasible and economically reasonable, and has determined that Noveon has adequately supported its petition for relief from the ammonia effluent limit. As discussed below, the Board further finds that Noveon provides BDT at the Henry Plant and, thus, qualifies for a mixing zone and ZID pursuant to Section 302.102 of the Board's mixing zone regulations. Nonetheless, the Board does not designate a mixing zone and ZID as part of the granted relief.

Under the "allowed mixing concept," a discharger that is unable to comply with the requirement of not causing or contributing to water quality violations, "after making every effort to fulfill the obligations of the discharger . . . and given the limits imposed by the nature of the receiving water body and the character of the outfall(s), is entitled to use a limited portion of the receiving body of water to effect mixing of the effluent with the receiving water. Within this limited portion of the receiving body of water, the discharger is excused from compliance with 304.105." Marathon Oil Co. v. IEPA, PCB 92-166 (Mar. 31, 1994).

Although the Board has the authority to designate a mixing zone in an adjusted standard,[3] here the Board leaves that designation for the Agency to make in Noveon's NPDES permit. The Illinois Supreme Court has stated that the mixing zone is formally defined by the Agency in the NPDES permitting process and, if granted, is included as a condition in the permittee's NPDES permit. Granite City Steel, Co. v. PCB, 155 Ill. 2d 149, 160, 613 N.E.2d 719 (1993). The Board acknowledges that the Agency is typically charged with reviewing an NPDES permit application requesting recognition of a mixing zone pursuant to its responsibilities as permitter. *See* Amendments to Title 35, Subtitle C (Toxics Control), R88-21(A) (Jan. 25, 1990). It is then the Board's position to resolve disputes between permit applicants and the Agency.

A mixing zone is "an area for allowed mixing which is formally defined by the Agency in the NPDES permitting process and, if granted, is included as a condition in the permittee's NPDES permit." Granite City Division of National Steel Co., *et al.* v. PCB, 155 Ill. 2d 149, 613 N.E.2d 719 (1993); *see also* 35 Ill. Adm. Code 302.102(d). "A ZID is likewise formally defined and granted by the Agency during the permitting process and, if granted, is included in the discharger's mixing-zone permit condition." *Id.*

Depending on the Agency's permit decisions about the mixing zone, the permittee may use mixing as a means of compliance with the Board's water quality standards. *See* 35 Ill. Adm. Code 302.102(g), (h). Board regulations state that a mixing zone is available where the discharger has made every effort to comply with 304.102, which requires all dischargers to provide BDT. 35 Ill. Adm. Code 302.102(a). The regulations further provide that BDT must be consistent with technological feasibility, economic reasonableness and sound engineering judgment. 35 Ill. Adm. Code 304.102(a). Where a permit is silent as to mixing, the discharger has the burden of proof to show compliance with the general allowed-mixing regulations. 35 Ill. Adm. Code 302.102(i).

Until now, the Agency has not applied a mixing zone to Noveon's discharge because the Agency's mixing zone program came after Noveon's most recently issued NPDES permit. Ag. Memo at 29. The Agency has stated that Noveon is providing BDT to all wastestreams for all parameters except ammonia. 1991 Tr. at 131. The Board further finds in this order that Noveon qualifies for an adjusted standard from the ammonia effluent limit because no other alternative investigated is both technologically feasible and economically reasonable. Thus, the Board finds that Noveon meets the threshold requirement for a mixing zone and ZID by providing BDT at the Henry Plant.

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[3] "In adopting adjusted standards the Board may impose such conditions as may be necessary to accomplish the purposes of the Act." 35 Ill. Adm. Code 104.428(a).

Though the Board does not include the mixing zone and ZID in Noveon's granted relief, the Board does require Noveon to install and maintain a high-rate, multi-port diffuser as a condition to the adjusted standard. The diffuser must be designed to achieve effluent dispersion necessary to meet the applicable ammonia nitrogen water quality standards at the edge of the mixing zone and ZID. The Agency will define both Noveon's mixing zone and ZID, in accordance with Board mixing zone regulations, through the NPDES permitting process.

Adjusted Standard Language

After hearing, Noveon withdrew the first two of the three proposed alternatives and submitted revised adjusted standard language to which the Agency maintained its objection. The revised wording incorporated a daily maximum limit for ammonia of 225 mg/L. The revised wording, like alternatives one through three, also reiterated that Noveon will install and operate a multi-port diffuser.

In granting this adjusted standard, the Board is adopting language based on the ammonia effluent limits suggested by Noveon in alternative three. The Board finds no historic data that shows Noveon cannot meet the limit of 155 mg/L ammonia year-round. The Board does not agree that simply because the Agency calculated a theoretical level that is higher than what Noveon actually discharges, Noveon should be permitted to discharge up to that amount. Accordingly, the Board limits Noveon's maximum ammonia concentration to 155 mg/L. The Board also includes the requirement that Noveon install and operate a high-rate multi-port diffuser and requires that the diffuser be designed to achieve a dispersion rate necessary to meet the applicable ammonia nitrogen water quality standards at the edge of the mixing zone and ZID as will be defined by the Agency.

The Board drafts this adjusted standard so that it terminates after seven years. This period of time will allow Noveon to complete the installation of the multi-port diffuser and perform water quality monitoring and reporting obligations required by this adjusted standard. The Board also notes that in seven years results of the water quality monitoring will be in and new, more economically reasonable technology may become available and revisiting the ammonia nitrogen issue at that time will be beneficial.

The Board uses the language Noveon proposed in Alternative 3, applies the proposed summer standard as a year-round limit, imposes a sunset provision, and adds monitoring and reporting requirements. Any non-substantive changes are intended to bring this order into conformity with the Board's usual drafting style in adjusted standards.

CONCLUSION

The Board grants Noveon relief from the ammonia effluent limit found at Section 304.122(b) of the Board's regulations at its facility in Henry, Marshall County. Noveon remains subject to the water quality limits found at Section 304.105 and conditions included in the Board's order. The relief is effective as of the date of this order.

This opinion constitutes the Board's findings of fact and conclusions of law.

ORDER

1. This adjusted standard will expire on November 4, 2011.

2. Noveon is hereby granted an adjusted standard from 35 Ill. Adm. Code 304.122(b). Pursuant to this adjusted standard, 35 Ill. Adm. Code 304.122 shall not apply to the discharge of effluent into the Illinois River from the Noveon plant located at 1550 County Road, 850 N., in Henry, Illinois as regards ammonia nitrogen. The granting of this adjusted standard is contingent upon the following conditions:

3. Noveon must not discharge calculated total ammonia nitrogen at concentrations greater than 155 mg/L from its Henry, Illinois plant into the Illinois River.

4. Discharge into the Illinois River shall occur through a high-rate, multi-port diffuser designed to achieve an effluent dispersion necessary to meet the applicable ammonia nitrogen water quality standards at the edge of the mixing zone and zone of initial dilution (ZID). Noveon must install the multi-port diffuser within one year of issuance of its revised NDPES permit.

5. Monitoring Requirements: Noveon must monitor ammonia nitrogen in the Illinois River on a quarterly basis to demonstrate compliance with the applicable ammonia water quality standards in accordance with 35 Ill. Adm. Code 302.212. The monitoring must commence within 30 days of the installation of the multi-port diffuser and continue until the termination of this adjusted standard. The monitoring results must be reported to the Agency in the annual report described in section (6)(c), below.

6. New Production Methods and Technologies

   a. Noveon must continue to investigate production methods and technologies that generate less ammonia in Noveon's discharge into the Illinois River. Where practicable, Noveon must substitute current methods or technologies with new ones so long as the substitution generates less ammonia in Noveon's discharge.

   b. Noveon must perform any reasonable test of new technologically or economically reasonable production methods or materials applicable to the specialty chemicals manufacturing process, which may reduce ammonia concentration in the discharge from Noveon's facility which the Illinois Environmental Protection Agency (Agency) specifically requests in writing that they do.

   c. Noveon must prepare and submit each year an annual report summarizing the activities and results of these investigatory efforts. The annual report must be submitted to the Agency, Bureau of Water, Compliance and Enforcement Section.

7. Noveon must operate in full compliance with the Clean Water Act, its National Pollutant Discharge Elimination System program, the Board's water pollution regulations, and any other applicable regulation.

IT IS SO ORDERED.

Section 41(a) of the Environmental Protection Act provides that final Board orders may be appealed directly to the Illinois Appellate Court within 35 days after the Board serves the order. 415 ILCS 5/41(a) (2002); *see also* 35 Ill. Adm. Code 101.300(d)(2), 101.906, 102.706. Illinois Supreme Court Rule 335 establishes filing requirements that apply when the Illinois Appellate Court, by statute, directly reviews administrative orders. 172 Ill. 2d R. 335. The Board's procedural rules provide that motions for the Board to reconsider or modify its final orders may be filed with the Board within 35 days after the order is received. 35 Ill. Adm. Code 101.520; *see also* 35 Ill. Adm. Code 101.902, 102.700, 102.702.

I, Dorothy M. Gunn, Clerk of the Illinois Pollution Control Board, certify that the Board adopted the above opinion and order on November 4, 2004, by a vote of 5-0.

Dorothy M. Gunn

Dorothy M. Gunn, Clerk
Illinois Pollution Control Board

Illinois Department of
Natural Resources
One Natural Resources Way • Springfield, Illinois 62702-1271
http://dnr.state.il.us

Rod R. Blagojevich, Governor
Joel Brunsvold, Director

July 14, 2005

SUBJECT: Permit No. DS2005058
Multiport Wastewater Outfall Diffuser System
Illinois River (Mile 198), Marshall County

Mr. Dave Giffin
Noveon, Inc.
1550 County Road 1450N
Henry, Illinois 61537-9706

Dear Mr. Giffin:

Enclosed is Illinois Department of Natural Resources, Office of Water Resources Permit No. DS2005058 authorizing the subject project. This permit does not supersede any other federal, state or local authorizations that may be required for the project.

If any changes in the plans or location of the work are found necessary, revised plans should be submitted promptly to this office so that they may receive approval before work thereon is begun. When the work is done, please provide written notification that the project has been completed in accordance with the approved plans and conditions of the permit.

Please feel free to contact me at 217/782-4426 if you have any questions concerning this authorization.

Sincerely,

Michael Diedrichsen

Michael L. Diedrichsen, P.E.
Acting Manager, Downstate Regulatory Programs

JB:GRC:MLD:crw
Enclosure
cc: AquAeTer, Inc. ✓
Massman Construction Co.
Horner & Shifrin, Inc.
City of Henry
Marshall County Highway Department
Illinois Environmental Protection Agency (James Allison)

AUG. 26TH 1818

PERMIT NO. DS2005058
DATE: July 14, 2005

State of Illinois

Department of Natural Resources, Office of Water Resources

Permission is hereby granted to:

NOVEON, INC.
1550 COUNTY ROAD 1450N
HENRY, ILLINOIS 61537-9706

to construct a multiport wastewater diffuser outfall on the western side of the Illinois River (Mile 198) in the Northeast ¼ of Section 10, Township 13 North, Range 10 East of the 4th Principal Meridian in Marshall County,

in accordance with an application dated January 28, 2005, Massman Construction Company's letter dated June 22, 2005 and the plans and specifications entitled:

NOVEON, INC; HENRY, ILLINOIS; MULTIPORT WASTEWATER OUTFALL DIFFUSION SYSTEM
(Plan Sheets 1 - 5 of 5 and Technical Specifications Booklet, Dated June 2005).

Examined and Recommended:

Michael Diedrichsen 7/14

Michael L. Diedrichsen, Acting Manager
Downstate Regulatory Programs

Approval Recommended:

Gary R. Clark

Gary R. Clark, Director
Office of Water Resources

Approved:

Joel Brunsvold mc

Joel Brunsvold, Director
Department of Natural Resources

This PERMIT is subject to the terms and special conditions contained herein.

PERMIT NO. DS2005058

THIS PERMIT IS SUBJECT TO THE FOLLOWING CONDITIONS:

1) This permit is granted in accordance with the Rivers, Lakes and Streams Act "615 ILCS 5."

2) This permit does not convey title to the permittee or recognize title of the permittee to any submerged or other lands, and furthermore, does not convey, lease or provide any right or rights of occupancy or use of the public or private property on which the activity or any part thereof will be located, or otherwise grant to the permittee any right or interest in or to the property, whether the property is owned or possessed by the State of Illinois or by any private or public party or parties.

3) This permit does not release the permittee from liability for damage to persons or property resulting from the work covered by this permit, and does not authorize any injury to private property or invasion of private rights.

4) This permit does not relieve the permittee of the responsibility to obtain other federal, state or local authorizations required for the construction of the permitted activity; and if the permittee is required by law to obtain approvals from any federal or other state agency to do the work, this permit is not effective until the federal and state approvals are obtained.

5) The permittee shall, at the permittee's own expense, remove all temporary piling, cofferdams, false work, and material incidental to the construction of the project. If the permittee fails to remove such structures or materials, the Department may have removal made at the expense of the permittee.

6) In public waters, if future need for public navigation or other public interest by the state or federal government necessitates changes in any part of the structure or structures, such changes shall be made by and at the expense of the permittee or the permittee's successors as required by the Department or other properly constituted agency, within sixty (60) days from receipt of written notice of the necessity from the Department or other agency, unless a longer period of time is specifically authorized.

7) The execution and details of the work authorized shall be subject to the review and approval of the Department. Department personnel shall have the right of access to accomplish this purpose.

8) Starting work on the activity authorized will be considered full acceptance by the permittee of the terms and conditions of the permit.

9) The Department in issuing this permit has relied upon the statements and representations made by the permittee; if any substantive statement or representation made by the permittee is found to be false, this permit will be revoked; and when revoked, all rights of the permittee under the permit are voided.

10) In public waters, the permittee and the permittee's successors shall make no claim whatsoever to any interest in any accretions caused by the activity.

11) In issuing this permit, the Department does not ensure the adequacy of the design or structural strength of the structure or improvement.

12) Noncompliance with the conditions of this permit will be considered grounds for revocation.

13) If the construction activity permitted is not completed on or before December 31, 2008, this permit shall cease and be null and void. When all work is constructed, the permittee shall notify the Department so that a final inspection can be completed.

04/14/07

Illinois Department of
Natural Resources
One Natural Resources Way • Springfield, Illinois 62702-1271
http://dnr.state.il.us

Rod R. Blagojevich, Governor
Joel Brunsvold, Director

March 15, 2005

PUBLIC NOTICE

Proposed Multiport Effluent Diffuser Outfall
on the Western Side of the Illinois River in Marshall County

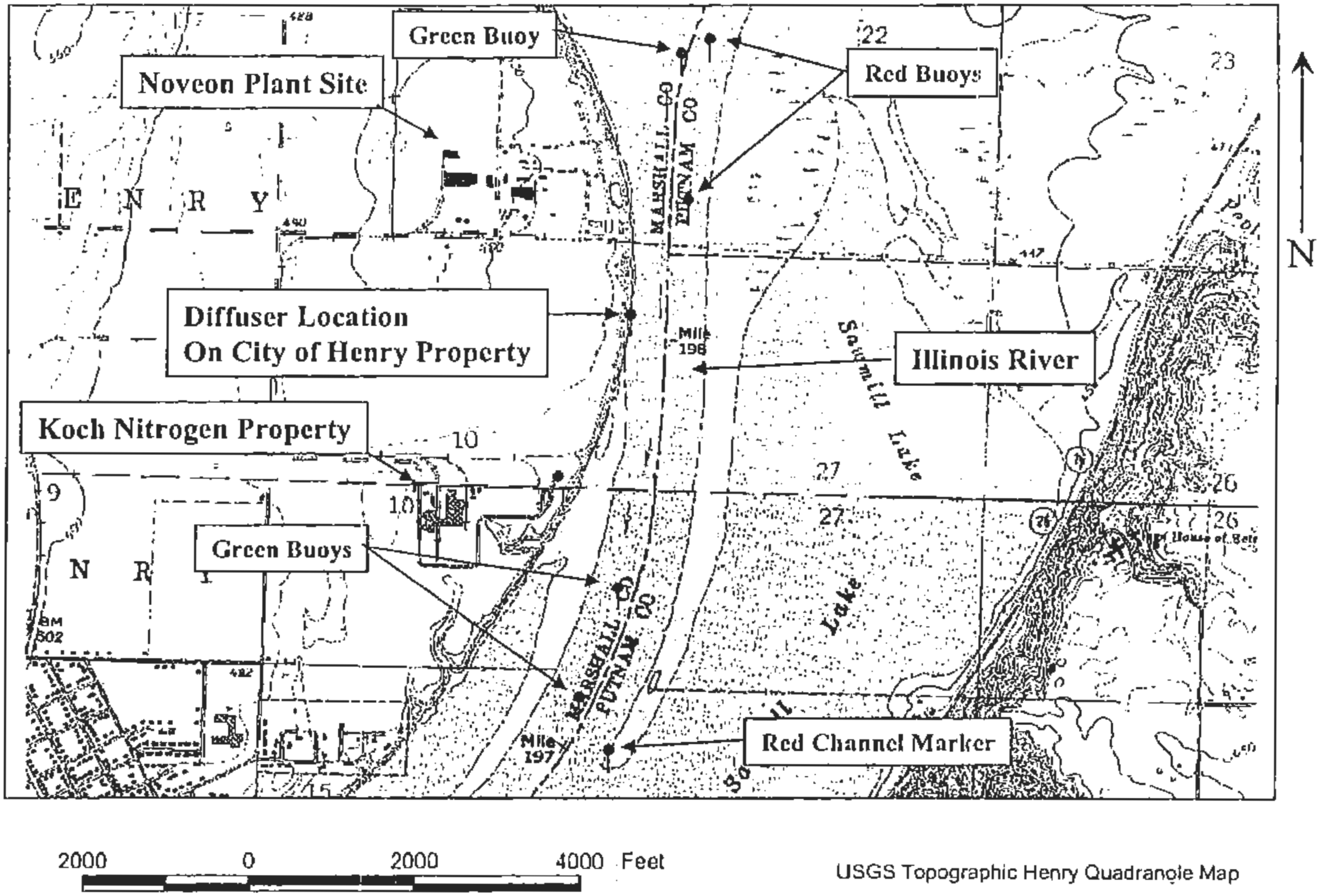
Notice is hereby given all interested parties that an application has been received from Noveon, Inc., 1550 County Road 1450N, Henry, Illinois 61537-9706 for a permit authorizing the construction of a multiport effluent diffuser outfall to supplement their existing single port diffuser. The outfalls will serve to diffuse treated effluent from Noveon's wastewater treatment facilities and the City of Henry's wastewater treatment facilities. The modification of the outfall is being required by the Illinois Pollution Control Board. As indicated on the map on the reverse side of this notice, the outfall is located two miles upstream from Henry on the western side of the Illinois River (River Mile 198) in the Northeast ¼ of Section 10, Township 13 North, Range 10 East of the 4th Principal Meridian in Marshall County.

The plans show that the proposed work consists of constructing a new manhole on the river bluff just northwest of the existing outfall manhole and installing a 10" diameter diffuser pipe extending approximately 15' into the river. The diffuser pipe is to be anchored on the riverbed with a pile bent support system. The pipe is to have four-3" diameter diffuser ports spaced 3' apart and angled 45° up from the riverbed.

No work is to be commenced or completed on this project unless and until the permit is issued. Local authorization may also be required for this project.

Inquiries may be directed to Mike Diedrichsen at 217/782-4426. All interested parties are invited to submit written statements regarding the proposed work to the above address by April 5, 2005.

IN THE VICINITY OF THE PROPOSED DIFFUSER ON ILLINOIS RIVER



USGS Topographic Henry Quadrangle Map

AquAeTer

CLIENT: Noveon, Henry
LOCATION: Illinois River at Henry, Illinois
PROJECT/FILE: 041401

optimizing environmental resources | water, air, earth

FIGURE 2 OF 7

AREA MAP

AquAeTer
optimizing environmental resources
water, air, earth

Project Number: ________ Sheet No. ____ of ____
Project Name: ________
Prepared by: ________ Date: ________
Checked by: ________ Date: ________
Title: Fluorometer Check

10:41 Running DI water.
Initial Reading 1,01 ppb
~~Run as~~ Adjust as blank - New Reading 0,015 ppb

Make solutions of 1 ppb, + 10 ppb, + 200 ppb

~~$(2 * 10^5 \text{ ppb})(x \text{ volume}) + (0 \text{ ppb})(16 \text{ L}) = (16 + x)(200 \text{ ppb})$~~

$(2 * 10^5 \text{ ppb})(x \text{ mL}) + 0\ (16{,}000 \text{ mL}) = 2*10^5 \text{ ppb} \times (16{,}000 + x)$

$x = 16 \text{ mL}$

change to just 1 L: $x = 1.00$ mL

For 1 ppb solution: Add 7 mL of $2*10^3$ ppb Rhodamine WT
to 14 L DI water
Let pump stir for ~5 min.

Fluorometer reads 4,37 ppb - very stable
Adjust - Reads ~~0,9~~ 1,00 ppb to 0,991 ppb

For 10 ppb soln: Add 0.63 mL of 2E5 ppb Rhodamine
to 1 ppb, 14,000 mL solution
Let pump stir for ~5 min

Fluorometer Reading 9,51 ppb

For 200 ppb soln: Add 1 mL of 2E5 ppb Rhodamine WT to
1 L of DI water
Reads 170 ppb

Flush System w/ DI water. 0,231 ppb
Flush w/ Fresh DI water 0.0 ppb
10-23-05 10:11 Reads 10 ppb soln as 10,2

AquAeTer

optimizing environmental resources
water, air, earth

Project Number: ____________ Sheet No. ____ of ______

Project Name: ____________

Prepared by: JMC Date: 10-27-05

Checked by: ____________ Date: ____________

Title: Fluorometer Check

0850 Initial DI water:
In-line -8.3 ppb
Sub. -9.1

0910 Fresh DI water -
In-line -9.2
sub -10

0915 10 ppb Soln.
In-line 9.44
sub. 6.47 ppb

AquAeTer
optimizing environmental resources
water, air, earth

Project Number: ______ Sheet No. ___ of ___
Project Name: ______
Prepared by: MLL Date: 102505
Checked by: ______ Date: ______
Title: dye injection calibration

@ Novem outfall 0519 Oct 25, 2005

turn on dye @ 0528 11 mL 60.3 sec
11 mL 65 sec poor
~ ~~10~~ 61.3 sec
MLC 12.5
0713

0709 start dye 2nd time
~ 0714 dye in pit

5600 cfs @ 0900

~10 mL 61.9 sec @ 1147
11 mL 61.2 sec @ 1150

1532 turn off

10-24-05 051415

Date 10-24-05
Aquatic Project 051415
Project Name Noveon, Henry Henry, ILL
Start Time : Leave Brentwood 0600
Arrive @ plant ~1400

End Time
Weather - ~50s cloudy
Personnel on-site JMC
~~PPE used~~ NSC
PPE used - PFDs
Project Notes :
Set up pump for Rhodamine
Pumped ~10 mL in one minute
Measured w/ graduated cylinder
At Boat Dock 1530
Put in to Mark Diffuser Location
815 - 866 - 0012 Dave cell
Diffuser marked
Pulled boat out ~1645
calibrated Quanta

Date 10-25-05
Aquatic Project 051415
Name Noveon
Start Time 0500
End Time
Weather : ~50s sunny
Personnel JMC, NSC, MRC
PPE used : PFD's
Project Notes :
Project Notes
GPS unit not responding initially
Able to communicate w/ it through computer
MRC restart dye 0714
Met JMC & NSC @ river control structure
upstream station
NSC taking velocity
MRC taking
0740 Blanked Fluorometer to Background
River Water
Initially reading ~7 ppb
Now reading ~0.39 to ~0.50
Move through Dye cloud
0815 Approximate Diffuser Location Marked

12

0917 Marked 1st downstream position (DS11?)
Surface Dye reading of 6,7 ppm
wait submersible pump placement

	Depth	6,4'	-6,67
		4,8	-6,75
		1,6'	-6,79
	DS11 B	3,2'	-6,79
		[illegible]	-6,78
		13,0	-6,80
0946	DS11 C	2,2'	-5,82
		6,7'	-6,1
		8,9'	-6,16
0955	DS11 D	2'	-6.1

Marked 0910
DS50A marked 0912

1,8'	-7,37
5,3'	-7,35
7,0	-7,33

1st long to
09:25 @ 1000' 0926

2nd Lateral long 1000 to -100
0929

Lateral Runs

not recorded
933 Run ending pump off logger
937 Started again
942
945 Run end
945

947 Started
948 Stop time
948 Start time
949 Stopped
950 Started
951 Stopped
951 Start time
952 Stopped
953 Started
954 Started
955 Stopped
957 Started
958 Stopped
958 Started
1000 Stopped
1000 Started
1002 Stopped
1003 Started longitude runs
1004 Stopped

Longitude Runs

1006 Started
1009 Stopped
1009 Started
1012 stopped
1012 Started
1016 Stopped
1016 Started
1020 Stopped
Returned to Boat dock

Time	Depth (ft)	Fluor (ppb)	
[illegible]:37	1'	11.97	
	2'	11.97	
	3'	11.98	
[illegible]:35	4'	11.93	Any boat swaying removes from plume (0 ppb)
	5'	11.94	
	6'	11.92	
	7'	11.92	
	8'	11.91	
[illegible]:43	9'		-7.99 to 7.00
	10'		-4.19 to 5.42
	11'		-7.90 to -0.74

10 28 09

Time	Depth (ft)	Fluor (ppb)
13.0.	1'	-7.74
	2'	-7.72
	3'	-7.70
	4'	-7.70
	5'	-7.69
	6'	-7.68
	7'	-7.66
	8'	-7.62
	9'	~~-7.62~~ JMC ~~-7.62~~ -7.54
	10'	-7.62
1307	11'	-7.61
Remarked 1313		
1319 marked		
	1'	12.00
	2'	12.03
	3'	~~12~~,11.99
	4'	11.98
	5'	11.97
	6'	-1.65-3.0 to 3.0
	7'	-5.35
	8'	-6.6 to -7.65
	9'	-7.64

1400 Marked

Time Depth Fluor
~~1400~~ 1400 1' -4,8 to 6,5
1403 1' ~~7,60~~ 3,3 to → 12 - assumed hi Fluorometer read over scale 11-2-05
4,95
2' 1,01 - 7,24
3' 5,25 - 7,96
4' 5,06 - 9,85
5' 5,70 - 6, 7,01
6' 4,93 - 10,95
7' 4,46 11,87
8' 6,54 9,04
9' ~~6,36~~ 5,12 ~~6,60~~ 8,41
10' ~~6,00~~ 2,72 8,00
11' 1,02 3,55

1440 marked remarked 1440 51 over pump
1' -5,2 -5,48
2' - -5,47 to -6,05
3' -4,67 -6,14
4' -5,46 -6,21
5 -4,9 -5,00
6 -3,99
7' -4,1 -4,31

Depth Fluor
8' -2,84 -3,74
9' -3,86 to 3,67
10' -3,44 -3,7

Background River sample collected at 1505

1519 Position marked
1ft -6.67
2ft -6.72
3ft -6.64, -6.81
4ft -7.27
5ft -6.19 to -7.25
6ft -6.8 to 6.92
7ft -6.92 to -6.97
8ft ~~-5.16 to~~ -4.90 to 6.96
9ft -7.1 to -6.54
10ft -6.24 to -5.39
11ft -5.08 to -5.98
12ft -6.29 to -5.91
13ft -6.24 to -6.67

1537	1ft	-4.5 to -07.08
	2ft	-6.97 to 6.77
	3ft	-6.53 to -6.32
	4ft	-6.36 to -6.14
	5ft	-6.27 to -5.22
	6ft	-4.59 to -4.97
	7ft	~~4.[illegible] to~~ -4.67 to -5.01
	8ft	-4.45 to -4.60
	9ft	-5.67 to -5.28
	10ft	-6.65 to -6.76
	11ft	-7.27 to -7.37
	12ft	-7.43
1549	1ft	-6.36
	2ft	-6.44 to -6.32
	3ft	-6.35
	4ft	-6.2 to -6.1
	5ft	-6.38 to -4.29
	6ft	-5.16 to -4.24
	7ft	-4.38 to -4.87
	8ft	-4.20
	9ft	-4.51 -3.93
	10ft	-4.34 to -4.89
	11ft	-4.22 to -5.54
	12ft	-5.05 to -4.90
	13ft	-6.96 to

VELOCITY/FLOW MEASUREMENT
FIELD DATA FORM

STATION: Various
RIVER MILE: Illinois River
CREW ID: JMC, NJC, MRC
BOAT ID: Landau
START FROM: REW LEW (circle one)

PAGE: 1 **OF** ____

CLIENT Noveon, Inc.
JOB NO. 051415/4

	DATE	SAMPLING TIME (military)	STATION	TOTAL DEPTH (ft)	READING DEPTH (ft)	TIME INTERVAL (secs)	REVS (n.o.)	INST. SETTING (mult.)
1	10/25/2005	7:51	Upstream	9.7	7.76	44.25	9	1
2	10/25/2005		Upstream	9.7	6.8	43.5	10	1
3	10/25/2005	7:56	Upstream	9.7	2.94	42.1	11	1
4	10/25/2005	8:20	DS11A	8.8	7.04	41.75	8	1
5	10/25/2005		DS11A	8.8	5.28	41.31	8	1
6	10/25/2005		DS11A	8.8	1.76	43.13	10	1
7	10/25/2005	8:35	DS11B	16.2	12.96	41.66	7	1
8	10/25/2005		DS11B	16.2	9.72	40.41	7	1
9	10/25/2005		DS11B	16.2	3.24	42.34	10	1
10	10/25/2005	8:47	DS11C	11.1	8.88	41.85	8	1
11	10/25/2005			11.1	6.66	43.78	7	1
12	10/25/2005	8:50	DS11D	11.1	2.22	42.75	11	1
13	10/25/2005	9:14	DS50A	8.8	7.04	42.47	16	1
14	10/25/2005		DS50A	8.8	5.28	42.31	11	1
15	10/25/2005		DS50A	8.8	1.76	42.78	11	1
16	10/25/2005	14:52	DS500	11.7	9.36	42.13	4	1
17	10/25/2005		DS500	11.7	7.02	44.09	7	1
18	10/25/2005		DS500	11.7	2.34	41.19	7	1
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								

COMMENTS AND OBSERVATIONS:

INST. TYPE
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA
Price AA

VELOCITY/FLOW MEASUREMENT
FIELD DATA FORM

STATION: ______
RIVER MILE: ______
CREW ID: ______
BOAT ID: ______
START FROM: REW LEW (circle one)

PAGE: ______ **OF** ______

CLIENT ______
JOB NO. ______

	DATE	SAMPLING TIME (military)	DIST. TO REW/LEW (ft)	TOTAL DEPTH (ft)	READING DEPTH (ft)	TIME INTERVAL (secs)	REVS (n.o.)	INST. SETTING (mult.)	INST. TYPE
1	10.25	7151	[illegible]	9.7	7.76+1	44.25	9	1	Price AA
2	10 25		GPS taken	9.7	6.8	43.50	10	1	P AA
3	10 25	7156		9.7	7.94	42.10	11	1	P AA
4									
5	10 25	0820	DS11A		7.04+1	41.75	8	1	
6					5.28+1	41.31	8		
7					1.76+1	43.13	10		
8	10/25	0835	DS11B	16.2	12.96+1	41.66	7		
9					9.72+1	40.41	7		
10					3.24+1	42.34	10		
11		0847	DS11C	11.1	8.88+1	41.85	8		
12					6.66+1	43.78	7		
13		0850	DS11D		2.22+1	42.75	11		
14		0914	DS5LA	8.8	7.04+1	42.47	16		
15					5.28+1	42.31	11		
16					1.76+1	42.78	11		
17		14.52	DS500	11.7	9.36+1	42.13	9		
18					7.02+1	44.09	7		
19					2.34+1	41.19	7		
20		18229							
21									
22									
23									
24									
25									
26									
27									
28									
29									

COMMENTS AND OBSERVATIONS: +1 signifies depth read on reel because bomb is at 0.0 ft and Price AA is 1' higher

WATER QUALITY MEASUREMENTS

CLIENT: Noveon, Inc. SHEET 1 OF 2

JOB NUMBER: 051415

DATE	TIME (military)	LOCATION	LOCATION IN CHANNEL (REW, MID, LEW, etc.)	DEPTH		TEMP.	COND.	pH	DO
				TOTAL (ft)	SAMPLE (ft)	(°C)	(mS/cm)	(S.U.)	(mg/L)
10/25/2005	8:05	Upstream	REW	9.7	7.76	13.40	0.779	8.88	8.87
10/25/2005	8:04			9.7	5.8	13.46	0.780	8.88	8.88
10/25/2005	8:04			9.7	1.94	13.50	0.780	8.88	8.86
10/25/2005	8:22	DS11A	REW	8.8	7	13.44	0.782	8.85	8.46
10/25/2005				8.8	4.8	13.42	0.781	8.85	8.61
10/25/2005				8.8	1.6	13.45	0.781	8.86	8.80
10/25/2005	8:37	DS11B	REW	16.2	13	13.42	0.782	8.85	8.42
10/25/2005				16.2	9.7	13.43	0.781	8.84	8.64
10/25/2005	8:39			16.2	3.2	13.42	0.782	8.85	8.76
10/25/2005	8:49	DS11C	REW	11.1	8.9	13.37	0.781	8.84	8.33
10/25/2005				11.1	6.7	13.38	0.781	8.84	8.67
10/25/2005				11.1	2.2	13.39	0.781	8.85	8.79
10/25/2005	9:15			8.8	7	13.37	0.783	8.84	9.02
10/25/2005				8.8	5.3	13.36	0.783	8.85	8.92
10/25/2005				8.8	1.8	13.38	0.783	8.86	9.00
10/25/2005	12:47				1	14.38	1.028	8.59	9.76
10/25/2005					3	14.29	0.975	8.65	9.60
10/25/2005					5	14.23	0.891	8.64	9.44
10/25/2005					7	14.17	0.946	8.63	9.41
10/25/2005					9	14.08	0.898	8.65	9.36
10/25/2005					11	13.20	0.786	8.65	9.23
10/25/2005	13:07				1	14.05	0.786	8.75	10.47
10/25/2005					3	13.98	0.786	8.74	9.82
10/25/2005					5	13.95	0.787	8.73	9.74
10/25/2005					7	13.86	0.787	8.72	9.65
10/25/2005					9	13.83	0.787	8.72	9.62
10/25/2005					11	13.35 - 13.7	0.786	8.72	9.43
10/25/2005	13:23				1	14.07	0.787	8.77	10.96
10/25/2005					3	14.05	0.786	8.77	10.07
10/25/2005					5	14.02	0.786 - 0.9	8.76	9.78
10/25/2005					7	13.83	0.786	8.75	9.69

WATER QUALITY MEASUREMENTS

CLIENT: Noveon, Inc.
JOB NUMBER: 051415

SHEET 2 OF 2

DATE	TIME (military)	LOCATION	LOCATION IN CHANNEL (REW, MID, LEW, etc.)	DEPTH		TEMP.	COND.	pH	DO
				TOTAL (ft)	SAMPLE (ft)	(°C)	(mS/cm)	(S.U.)	(mg/L)
10/25/2005					9	13.66	0.786	8.75	9.57
	14:11				1	14.22	0.971	8.74	10.66
	14:12				3	14.12	0.905	8.73	10.00
	14:12				5	14.03	0.871	8.72	9.86
	14:13				7	13.98	0.872	8.73	9.77
	14:13				9	13.80	0.875	8.73	9.64
	14:14				11	13.02	0.786	8.73	9.44
	14:46	500'			1	14.17	0.787	8.83	10.55
	14:47				3	14.07	0.789	8.80	10.19
	14:47				5	13.85	0.823	8.78	9.86
	14:48				7	13.69	0.824	8.77	9.75
	14:49				9	13.48	0.814	8.76	9.57
	15:30				1	14.13	0.797	8.82	10.14
					3	14.08	0.798	8.82	10.19
					5	13.77	0.796	8.79	9.81
					7	13.63	0.802	8.77	9.64
	15:32				9	13.42	0.791	8.76	9.64
					11	13.30	0.790	8.76	9.67
	15:33				13	13.24	0.788	8.75	9.65

WATER QUALITY MEASUREMENTS

CLIENT: Noveen
JOB NUMBER: 031415

SHEET 1 OF

DATE	TIME (military)	LOCATION	LOCATION IN CHANNEL (REW, MID, LEW, etc.)	DEPTH TOTAL/ SAMPLE (ft)	TEMP. (°__)	COND. (__/__)	pH (S.U.)	DO (mg/L)	~~TIDE~~ DO
10.25	~~0755~~ 805	upstream Husir	LB REW	9.7/7.76	13.40	0.774	8.58	~~8.76~~	8.87
10.25	0804	[illegible]	/	5.8	13.46	0.780	8.85	[illegible]	8.88
10.25	0804		/	1.94	13.50	0.780	8.85	[illegible]	8.86
10.25	0822	DS11A	REW11A	8.7	13.44	0.782	8.85	8.46	
				4.8	13.42	0.781	8.85	8.61	
				1.6	13.45	0.781	8.86	8.97	
	0831	DS11B		13	13.42	0.782	8.85	8.42	
				9.7	13.43	0.781	8.84	8.64	
	0839			3.2	13.42	0.782	8.85	8.86	
	0844	DS11C		8.9	13.37	0.781	8.84	8.33	
				6.7	13.38	0.781	8.84	8.67	
				2.2	13.39	0.781	8.85	8.79	
	0915			7	13.37	0.783	8.84	9.02	
				5.3	13.36	0.783	8.85	8.92	
				1.8	13.38	0.783	8.86	9.00	
	1247	Marked 1237 [illegible]		1	14.38	1.025	8.59	9.76	
				3'	14.29	0.975	8.65	9.60	
				5'	14.23	0.891	8.64	9.44	
				7'	14.17	0.946	8.63	9.41	
				9'	14.08	0.898	8.65	9.36	
				11'	13.20	0.786	8.65	9.22	
	1307	Marked 1301		1'	14.05	0.786	8.75	10.47	
				3'	13.98	0.786	8.74	9.82	
				5'	13.95	0.787	8.73	9.74	
				7'	13.86	0.787	8.72	9.65	
				9'	13.83	0.787	8.72	9.62	
				11'	13.35-13.37	0.786	8.72	9.43	
	1323	Marked 1319		1'	14.07	0.787	8.77	10.46	
				3'	14.05	0.786	8.77	10.07	
				5'	14.02	0.~~789~~ 786-87	8.76	9.78	
				7'	13.83	0.786	8.75	9.65	
				9'	13.66	0.786	8.75	9.57	

WATER QUALITY MEASUREMENTS

CLIENT: ____________ SHEET ______ OF ______
JOB NUMBER: ____________

DATE	TIME (military)	LOCATION	LOCATION IN CHANNEL (REW, MID, LEW, etc.)	DEPTH TOTAL/ SAMPLE (ft)	TEMP. (°__)	COND. (m/__)	pH (S.U.)	DO (mg/L)	TIDE
10-25-09	1411	marker 1400		1'	14,22	0 971	8,75	10 66	
	1412			3'	14,12	0 905	8,74	10,00	
	1412			5'	14,03	0,871	8,73	9,86	
	1413			7'	13,98	0,872	8,72	9,77	
	1413			9'	13,80	0,875	8,73	9,64	
	1414			11'	13,02	0,786	8.73	9,44	
	1446	marker 1400	.300	1	14,17	0 787	8.53	10.55	
	1447			3'	14,07	0,789	8.80	10 15	
	1447			5'	13,85	0.823	8.78	9,86	
	1448			7'	13,69	0,824	8.77	9.75	
	1449			9'	13,48	0.814	8,76	9,57	
	1530	marker 1514		1'	14,13	.797	8.82	10.14	
				3'	14,08	798	8.82	10.19	
				5'	13,77	796	8.79	9.81	
				7'	13.63	.802	8.77	9.64	
	1532			9'	13.42	.791	8.76	9.64	
				11'	13,30	.790	8.76	9.67	
	1533			13'	13.24	.788	8.75	9.65	

TABLE __. CALIBRATION LOG

			pH				CONDUCTIVITY				DO											
DATE	TIME	INSTRUMENT	pH_i	TEMP	pH_f	TEMP	$COND_i$	TEMP	$COND_f$	TEMP	$DO_{(\%sat)}$	TEMP	$DO_{100\%sat}$	TEMP	$DO_{i\,mg/L}$	TEMP	$DO_{f\,mg/L}$	TEMP	AUTO LOG OFF	BATT (v)	INITIALS	COMMENTS
10-24	7 55	Quanta	7,10	15,59	7,00	15,70	1,274	15,75	1,413	16,69					8,87	16,26	8,21	16,48				QD 0755
10-24	[illegible]	↓	10,06	15,82	10,00	15,89																
10-24	22:05	Quanta	7.14	16,69	7,00	16,11	~~2,59~~	~~16,33~~							8,99	18,41	7,83	18,38				QD 02205
			10,00	16,33	10,00	16,71	1,456	17,72	1,412	17,06					~~7.99~~	~~22.3~~						
10-26	10:50	Quanta	6.99	12.98	—	—	1.415	20.81	←					AKW	7.99	22.3					AKW	QD 02205
↓	↓	↓	10.06	~~11.67~~																	↓	↓
				11.99	AKW																	