West Virginia Division of Environmental Protection
Office of Water Resources

Water Quality Standards/Mixing Zones
Implementation Guidance

June 30, 1997

Introduction

This document contains guidance for WV/NPDES Permit writers to use in the development of water quality-based effluent limitations for toxic pollutants. It is intended to assist permit writers in the implementation of the Environmental Quality Board's Water Quality Standards and Mixing Zone rules (46 CSR 1). Recommended procedures herein replace those of the interim Toxics Strategy.

This guidance does not address technology-based effluent limitation development, or anti-degradation and anti-backsliding issues. It also does not pertain to dissolved oxygen modeling performed in the wasteload allocation process.

The guidance is intended for consideration of individual discharges. Where there are multiple discharges, closely situated in a receiving stream segment, the assimilative capacity of the stream at downstream discharge locations may be significantly reduced or eliminated if the guidance is applied to an upstream point source. The permit writer must consider the impacts to existing downstream dischargers, and coordination will have to occur within the agency to effectuate equitable allocations to the multiple dischargers.

The guidance recognizes sufficient information to assess mixing zones will not usually be available to the permit writer the first time the new rules are implemented at a facility. Often, complete information will not be able to be generated in the permit reissuance time frame. For those situations, the guidance recommends a procedure which includes a time period for data generation/submission by the permittee, a subsequent reevaluation of water quality-based effluent limitations, and where necessary, permit modification to incorporate revised effluent limitations. It also recognizes the potential for economic hardship to minor facilities and offers limited use of default mixing zones and dilutions if discharges from such facilities are not likely to cause significant toxic impacts. After initial implementation of the new rules (i.e. the next permit cycle), water quality-based effluent limitation and mixing zone reevaluations should be performed within the permit reissuance process.

The technical complexity associated with mixing zones and water quality-based effluent limitation development precludes establishment of universally applicable procedures. This document is guidance and should be used as such. Permit writers must base permit decisions on the EQB Rules as applied to the discharge being considered. Deviation from the guidance, when technically justified, is authorized and encouraged. All important decisions should be rationalized in the Fact Sheet for the permit action.

In the assessment of water quality-based effluent limitations and implementation of mixing zone rules, the permit writer must determine, on a permit-by-permit basis, the toxic pollutants that are present, or potentially present, in the effluent; effluent quality and variability; the need for, and appropriateness of granting mixing zones; the size and location of the zone(s); the dilution available at the zone boundaries; and the quality of the receiving water upstream of the discharge. A general discussion of each aspect of the water quality-based effluent limitation development procedure follows.

Determination of Toxic Pollutants of Concern

The permit writer must first determine the toxic pollutants potentially present in the discharge. The determination should be based upon information provided in the application, as well as the permit writer's judgement. For many existing industrial facilities, the pollutants of concern have been established in the work performed in the issuance of previous permits, but previous permitting of POTWs did not always include toxic pollutant evaluations. All POTW discharges contain ammonia and many contain chlorine. Additionally, POTW discharges can be expected to contain low levels of metals, cyanide and phenolics.

Quantification of Toxic Pollutants

If the concentration of a toxic pollutant in the discharge is not likely to exceed the value of the most stringent, applicable water quality standard, then there is no reason to develop a water quality-based effluent limit, or to consider mixing zones, for that pollutant. To make the determination, the permit writer should use the "Reasonable Potential" procedures of Chapter 3.3 of EPA's Technical Support Document For Water Quality-based Toxics Control (TSD).

Where adequate effluent data exists, the coefficient of variation (CV) for the pollutant in the effluent should be calculated. The coefficient of variation is defined as the ratio of the standard deviation to the mean for a particular data set. The number of samples and the CV should be used with Table 3-1 of the TSD to determine the Reasonable Potential (RP) Multiplying Factor. The RP factor should then be applied to the highest analytical result of the considered data set. If the subsequent result is less than the water quality standard, then there is no reasonable potential for the effluent concentration to exceed the standard.

The TSD advises at least ten analytical results are needed to calculate a specific CV for a discharge. Therefore, a minimum of ten results are recommended for this assessment. Difficulty in discharge-specific CV calculation can result if a large percentage of results are "not detected". If the permit writer must base a reasonable potential assessment on less than ten samples, or upon a data set containing numerous results less than the detection limit, then a CV default value of 0.6 may be used in Table 3-1.

If the permit writer determines toxic pollutants are expected present in the discharge, but has no effluent data to ascertain concentration, then such data must be requested from the permittee. In limited situations, effluent data may be generated quickly and provided as an addendum to the application. Otherwise, effluent characterization should be the first activity in the compliance schedule recommended by this guidance. This initial data collection may be very advantageous to the permittee because it could limit the scope of subsequent data collection efforts.

Determination of Facility Eligibility for Mixing Zones

If a discharge is found to contain, or have reasonable potential to contain, toxic pollutants at concentrations in excess of applicable water quality standards, then the agency must determine if the granting of a mixing zone is an appropriate mechanism for compliance with the standards. Keep in mind, mixing zones cannot substitute for technology-based treatment requirements.

There are two general scenarios where mixing zones should not be granted - where they are not needed and where they are disallowed by the rules.

As stated previously, mixing zones are not needed if the discharge concentration of a pollutant is not likely to exceed the most stringent, applicable water quality standard. Nor are they needed if the mixing of an effluent and its receiving stream can be assumed to be complete. If the Instream Waste Concentration (IWC) of a discharge is greater than or equal to 50%, the permit writer may assume the discharge mixes instantaneously and completely with the receiving stream.

Mixing Zones are prohibited by the rules in all situations where the IWC of the effluent is greater than 80%. As stated above, the permit writer should assume the effluent mixes completely and instantaneously with the receiving stream at IWCs of 50% or greater. The prohibition is assumed to mean that effluent limits must be based upon achieving water quality standards at end-of-pipe, if the IWC is greater than 80%.

Mixing zones for Human Health A Water Quality Standards are prohibited if the discharge location is within 1/2 mile of an intake for human water consumption. Mixing zones for Human Health A and C

Standards are prohibited if the receiving stream 7Q10 flow is less than 5 cfs.

It is also inappropriate to grant a mixing zone where upstream water quality is in violation of an applicable standard for a pollutant. Mixing zones cannot be granted for the pollutant(s) in violation. Exceedance of a standard for an individual parameter does not preclude the granting of a mixing zone for other pollutants. Assessment of upstream water quality should be performed in the immediate upstream vicinity of the discharge. If, at the discharge location, a receiving stream has recovered from an upstream water quality standard violation, then a mixing zone should not be disallowed based upon the upstream violation.

In situations where mixing zones are prohibited, or where upstream water quality prevents the granting of mixing zones, effluent limitations must be based upon achieving water quality standards at end-of-pipe. The discharge level for the various protections should be set equal to their corresponding water quality standard and the procedures for limitation development of the TSD, as discussed later in this guidance, should be followed. For discharges within 1/2 mile of a public water supply intake, the water quality standard for use designation "Human Health A" should be imposed as a maximum daily effluent limit, unless another applicable use designation dictates a more stringent limit.

Sizing / Locating Zones of Initial Dilution

The zone of initial dilution (ZID) is a regulatory mixing zone for acute aquatic life protection water quality standards. It is intended to provide permittees a small area of the receiving stream for initial mixing, while also preventing lethal impacts to passing aquatic organisms. The spatial limitation of the ZID must be determined by one of the four methods described in Section 4.3.3 of the TSD. Those methods are described below:

The first TSD method for determining ZID size is to impose acute standards at end-of-pipe. Use of this method is not recommended for discharges that are eligible to be granted a ZID. Imposition of acute standards at end-of-pipe should only be considered for situations where mixing zones are prohibited, or where upstream water quality exceeds standards. In cases where the permit writer determines no reasonable potential for the effluent concentration of a pollutant to exceed the acute standard, no further acute assessments need to be performed for that pollutant.

ZID sizing for most facilities should be determined by use of either the second or third TSD method. The second method applies when discharge velocity is greater than 10 fps. The spatial limitation of the ZID for high velocity discharges is 50 times the "discharge length scale". The discharge length scale is the square root of cross-sectional area of the discharge pipe. The third method applies when discharge velocity is less than 10 fps. The spatial limitation of the ZID for low velocity discharges is the smallest of: 50 times discharge length scale; 5 times receiving water depth at the outlet during low flow conditions; 10% of the distance from the outlet to the edge of the chronic mixing zone in any direction. The distance calculated by those methods applies in any direction from the outlet.

The fourth TSD method allows the permittee to demonstrate that a drifting organism would not be exposed to a one-hour average concentration exceeding the acute criteria, or would not receive harmful exposure when evaluated by other valid toxicological analyses. Data collection for such demonstrations must be performed during environmental conditions that approximate critical conditions. Although few permittees will pursue this alternative because of its expense and complex technical nature, the option should be available provided that evaluation, at or near critical conditions, can be performed in the time period authorized for data generation. The statement in Section 2.2.2 of the TSD, **"***In many situations, travel time through the acute mixing zone must be less than roughly fifteen minutes if a one-hour average exposure is not to exceed the acute criterion*", cannot be used to size ZIDs. Such a mechanism is inappropriate because it fails to consider the concentration of pollutant to which the organism would be

exposed. If the fourth TSD method is used to size a ZID, the permit writer should also consider the exposure received by slow moving or immobile aquatic organisms. Also, sensitive taxa may not take up long-term residence in the elevated concentration isopleths of a mixing zone. It is important to minimize the size of elevated concentration isopleths so the structure and function of the ecological community is not adversely affected.

In the next section, specific restrictions relative to locating mixing zones are described in detail. In the event that a ZID, projected by the mechanisms above, would violate one of the restrictions, then it must be reduced to a size that does not violate.

Sizing / Locating Mixing Zones for Chronic Aquatic Life and Human Health Standards

Title 46, Series I Section 5 places the following restrictions on the size and location of mixing zones:

* Mixing zones shall not interfere with fish spawning or nursery areas.
* Mixing zones shall not interfere with fish migration routes.
* Mixing zones shall not overlap public water supply intakes or bathing areas.
* Mixing zones shall not cause lethality to or prevent the free passage of aquatic life.
* Mixing zones shall not harm endangered species.
* Mixing zones shall not exceed 1/3 of receiving stream width or 1/2 cross-sectional area.
* Mixing zones shall not extend downstream a distance more than 5 times the width of the receiving stream.
* Mixing zones shall not overlap one another.

The permit writer should first determine if sensitive areas, endangered species, public water supply intakes, bathing areas, tributary mouths, or other point source discharges exist within 5 river widths downstream of the outfall. If they do, the initial downstream boundary estimation for the mixing zone should be at a distance preventing overlap. If not, the initial downstream boundary estimation should be at a distance of 5 river widths.

The permit writer should then determine the percentage of the receiving stream cross-sectional area that is encompassed at 1/3 width. If less than 50%, the initial mixing zone boundary estimation, parallel to the bank, should be at 1/3 width. If more, the initial boundary estimation, parallel to the bank, should be reduced to a distance that encompasses 50% of the cross-sectional area.

The initial boundary estimations would be the maximum that could be granted. If subsequent evaluations show compliance could be expected with effluent limitations based upon the dilution provided by smaller zones, then the zone boundaries should be reduced accordingly. The permit writer should follow a principle of granting mixing zones only as large as necessary. However, such minimization should not be so stringent as to place otherwise compliant dischargers into noncompliance.

It is assumed that the 1/3 width and 50% cross-sectional area limits for mixing zones will prevent creation of conditions that impede fish migration, or prevent the free passage of aquatic life, in the immediate receiving stream. However, a mixing zone that overlaps a tributary mouth may repel fish and impede migration/passage into or out of the tributary. Consideration should be given to preventing mixing zone overlap of tributary mouths, especially ZIDs. If migratory species are present in the watershed, the permit writer will have to assess the potential for mixing zones to repel them from the tributary mouth. Consultation with agency aquatic biologists, DNR fisheries biologists, or other recognized professionals may be warranted.

The presence of rare, threatened or endangered species in the vicinity of a discharge, and the potential impact of the discharge upon them, is best assessed by the U.S. Fish and Wildlife Service. If the

permit writer is aware of the presence of such species, contact should be made with Service during the application review. That agency should be provided notice of the draft permits authorizing mixing zones during the public notice/comment period.

It is recognized that the shallow water, near shore environment is often a location for fish spawning and for residence of immature aquatic life in larger rivers. However, universal requirements to extend discharge lines specific distances away from the bank, or to specific water depths, are not recommended. Such could be required in exceptionally sensitive areas, but the relatively small mixing zone sizes authorized by the Rules should provide adequate protection for fish spawning and nursing in the receiving water body as a whole.

The legality of mixing zone intrusion into the 0.5 mile zone above existing water supply intakes remains uncertain. Section 7.2.a.B of the Rules indicates the discharge of pollutants in excess of the concentrations established for Water Use Category A must be prohibited in that segment. "Discharge" could mean the effluent or elevated concentrations of pollutants in the intruding mixing zone. The EQB has been asked to clarify the intent of the Rule. If such clarification is provided, this document will be amended.

Minimizing Zone Delineations

Theoretically, mixing zones are to be derived on a pollutant-by-pollutant basis for various receiving stream uses. This creates the potential for numerous zone delineations for an individual discharge. Numerous delineations will increase instream compliance assessment activities, and create additional work for the permittee and the agency. Provided that compliance with the maximum boundaries of the EQB Rules are maintained, permit writers are advised to minimize the number of delineations. Ideally, a discharge should have two zones delineated - a ZID to allow the effluent and receiving stream to mix to acute aquatic life protection standards, and a total mixing zone to allow mixing to chronic aquatic life protection and human health protection standards. ZID sizing per methods two and three of the TSD are not pollutant-dependent. Delineation of an single total mixing zone may be accomplished if the zone for all pollutants is established as the largest needed for the most critical pollutant in the discharge. Such practice is acceptable, provided that the zone doesn't exceed the maximum boundaries authorized by the Rules.

Determination of Available Dilution

In complete mix situations, the dilution (D) available for acute aquatic life standards, chronic aquatic life standards, and human health standards is:

(Equation 1.1) D = 7Q10/Qeff, if source of discharge is receiving stream, or
(Equation 1.2) D = (7Q10 + Qeff)/Qeff, if not

In incomplete mix situations, CORMIX should be used to provide a characterization of the plume shape and to predict the dilution available at various distances from the pipe. The input data necessary to run the CORMIX model is described later in this guidance. The permit writer should determine the points of intersection of the plume with the regulatory boundaries of the mixing zones and the dilution available at the intersections. The percentage of cross-sectional area of the receiving stream established for the mixing zone should be assumed equal to the percentage of the 7Q10 of the receiving stream that is available for dilution under a complete mix assessment. The model output should be checked against that dilution to ensure an overly generous dilution factor is not predicted.

Evaluation of Upstream Water Quality

Determination of background concentrations of pollutants in the receiving stream, upstream of the discharge point, is necessary. An average of all available recent and qualified data should be used. Data

should be collected immediately upstream and outside the influence of the discharge, and proper sample collection techniques and analytical methods should be used. Data generated by sources other than the permittee or the Office, but meeting the above qualifications, may be used. Final qualification of data for consideration is left to the permit writer. “Recent” data is suggested as that collected over the past two years, but permit writers could consider older data such as that generated over the previous permit cycle.

The permit writer should strive to obtain ambient analytical results sensitive enough to ascertain compliance with water quality standards. If the applicable water quality standard is greater than the detection level of the analysis, "not detected" should be assumed as 1/2 the detection level of the analysis. If the applicable water quality standard is less than or equal to the detection level of the analysis, "not detected" should be assumed as 1/2 the water quality standard. Some professional judgement will be necessary in interpreting results of "not detected" at inappropriately high detection levels. Such results could be used or excluded in the averaging process, depending upon the circumstances.

Determining the Value of Water Quality Standards

For water quality standards that are dependent upon other environmental conditions, such as hardness, pH and temperature, the permit writer should strive to determine the environmental conditions that will be present at the location being assessed, at low flow conditions. Effluent hardness is recommended for determining the value of acute aquatic life protection water quality standards. Downstream hardness is recommended for all other standard determinations. Downstream hardness can be determined by mass balance of effluent flow and hardness and upstream flow and hardness. Consideration of the dilution available at the mixing zone boundary must be factored into that balance. Downstream hardness could also be obtained from a downstream water quality sampling station, if available. If ambient hardness data can be correlated to stream flow, calculation of an average low flow hardness would be appropriate. Similarly, upper range values for temperature and pH can be chosen for determination of ammonia standards at the mixing zone boundaries. The permit writer must use judgement in determining the design values for hardness, temperature, and pH and detail all decisions in the Fact Sheet for the permit action.

Obtaining Information to Assess Water Quality-Based Effluent Limitations (WQBELs)

If the permit writer determines additional information is necessary to perform a technically justifiable assessment, then such information must be requested from the permittee. If the time frame associated with permit issuance/reissuance process precludes the immediate generation of necessary information, then the permit writer should require the information as terms and conditions of the permit. Permitting procedures are described later in this document.

The information envisioned as necessary is described below. Not all situations will require all the information, nor should the list be considered all-inclusive of necessary information. The permit writer must determine necessary information on a case-by-case basis, and rationalize decisions in the Fact Sheet for the Draft Permit.

1) **Effluent concentration of pollutants of concern** - If metals are pollutants of concern, effluent hardness is needed. For all discharges, effluent temperature or density, during receiving stream low flow conditions will be needed. If ammonia is a pollutant of concern, effluent temperature and pH are needed, unless ambient temperature and pH data, representative of the effluent/ambient mix, is available.

   a) The sample type could be composite, grab or a series of grabs as appropriate for the parameter being monitored. It should be designed to generate an average value for the pollutant in the effluent over the monitoring date.

   b) Ten to twelve, recent, effluent monitoring results should be available to the permit writer. Monitoring

frequency for effluent characterization would be a case-by-case determination. Continuation of existing self-monitoring frequency, or establishment of a requirement to monitor concurrently with ambient monitoring, may be appropriate for existing facilities where some degree of pollutant characterization has occurred in the previous permit. If previous self-monitoring indicated no reasonable potential for a pollutant to exceed water quality standards at end-of-pipe, no additional self- monitoring would be necessary for that pollutant. Conversely, for facilities where toxic pollutants are expected present, but no quantitative effluent data exists, an initial, accelerated monitoring effort may be needed to define the scope of subsequent information generation requirements. In such instances, the accelerated effort is recommended, provided that significant seasonal variation of effluent characteristics is not expected.

c) Average effluent flow rate and total volume discharged on the monitoring date should be required to be reported.

2) **Upstream background concentrations of pollutants of concern** - If metals are pollutants of concern, receiving stream hardness may be necessary to calculate water quality standards. Surface and bottom temperature at low flow conditions will also be necessary to determine receiving stream density and stratification. If ammonia is a pollutant of concern, receiving stream pH is needed.

a) The sampling location should be upstream and outside the influence of the discharge. For small receiving streams, a grab sample at an individual location at mid-depth and 1/3 to 1/2 receiving stream width away from the bank, would be appropriate. For larger streams, additional sampling locations or depth-integrated and width-integrated composite sampling may be necessary to characterize average quality. The precise latitude and longitude of sampling locations should be required to be recorded.

b) Ten to twelve analytical results should be used to assess upstream quality. Because water quality-based effluent limitations are primarily designed to protect standards at low flow conditions, the permit writer may place more weight on analytical results obtained in the low flow season. New monitoring requirements may be designed to provide that weighting. A suggested monitoring frequency would be 2/month in July, August, September, and October, and 1/2 months January - June and November - December.

c) Monitoring should not be performed during high flow/muddy water conditions. Permittees may be advised to monitor when stream is at average to low flow for the month or season being considered. If a USGS gauge is operating on the receiving stream, the requirement could specify the flow above which monitoring should not be performed. Permittees may also be advised not to monitor during a specified period after a significant rainfall event.

d) Receiving stream flow on the day of monitoring should be evaluated/recorded. If a USGS station is operating on the receiving stream, the permittee should be directed to contact, obtain value and record. If not, establishment of a gauge at the discharge location could be required. The permit writer could also devise alternative strategies for qualitative assessment of stream flow on the monitoring date. A gauge on an adjacent stream in the basin, a downstream water, or on major upstream tributaries could be used as an indicator.

3) **Outlet and receiving stream physical characteristics**

a) The size/ dimensions of the effluent pipe or outlet channel.

b) The velocity of discharge at high, low, and average effluent flow.

c) If a submerged, single port diffuser is provided or proposed, the following information relating to discharge geometry/orientation is needed for input to the CORMIX model:

1. The location of the nearest bank (left or right to an observer looking downstream in the direction of the ambient flow.)
2. The distance to the nearest bank.
3. The port radius (or cross-sectional area for noncircular shaped ports.)
4. The height of the port center above the bottom.
5. The vertical angle of discharge between the port centerline and the horizontal plane.
6. The horizontal angle of discharge measured counterclockwise from the ambient flow direction to the plan projection of the port centerline.

d) If a multiport diffuser is provided or proposed, the following information relating to diffuser geometry/orientation is needed for input to the CORMIX model:

1. The location of the nearest bank (left or right to an observer looking downstream in the direction of the ambient flow.)
2. The average distance to the nearest bank.
3. The average diameter of the discharge ports or nozzles.
4. The contraction ratio of the ports or nozzles.
5. The average height of the port centers above the bottom.
6. The average vertical angle of discharge between the port centerlines and the horizontal plane.
7. The average horizontal angle of discharge measured counterclockwise from the ambient flow direction to the plan projection of the port centerlines (for unidirectional and staged diffusers, only.)
8. The approximate straight-line diffuser length between the first and last ports or risers.
9. The distance from the bank to the first and last ports or risers.
10. The number of ports or risers, and the number of ports per riser, if risers are present.
11. The average alignment angle measured counterclockwise from the ambient flow direction to the diffuser axis.
12. The relative orientation angle measured either clockwise or counterclockwise from the average plan projection of the port centerlines to the nearest diffuser axis (for unidirectional and staged diffusers, only.)

e) If the discharge in question is a buoyant (or neutral) surface discharge, the following information relating to discharge geometry/orientation is needed for input to the CORMIX model:

1. The location of the nearest bank (left or right to an observer looking downstream in the direction of the ambient flow.)
2. The discharge channel width, if rectangular.
3. The discharge channel depth.
4. The actual receiving water depth at the channel entry.
5. The outlet configuration (i.e flush with bank, protruding into receiving stream, or co-flowing along the bank.) For protruding configuration, the distance from the nearest bank.
6. The bottom slope in the receiving stream in the vicinity of the discharge channel.
7. The horizontal angle of discharge measured counterclockwise from the ambient flow direction to the plan projection of the port centerline.
8. For circular discharge pipes, the pipe diameter and the depth of the bottom invert below the water surface. (For pipes flowing partially full, the cross-sectional area needs to be represented schematically as a rectangular channel of equal area and similar channel depth.)

f) The following receiving stream information will be needed in most situations: (information should

pertain to 7Q10 conditions.)

1. The width of the receiving stream.
2. The average depth of the receiving stream.
3. A cross-sectional profile of receiving stream at the discharge location. Additional downstream profiles may be necessary for large mixing zones in receiving streams with irregular channels.
4. A description of downstream channel uniformity and substrate type.
5. The location of nearest upstream and downstream intake for human consumption of water.
6. The location of other point source discharges upstream and downstream for a distance of the larger of one mile or 5 river widths.
7. The name and locations of downstream tributary mouths for a distance of the larger of one mile or five river widths.
8. The average velocity of the receiving stream.

Default Mixing Zones

It is recognized that some smaller facilities will lack the in-house technical ability to generate information required by the procedures herein and the economic ability to contract the work. If the potential for toxic impacts from a discharge is judged to be small, and the economic burden great, the permit writer may desire to make conservative assumptions regarding mixing zone sizes and upstream water quality, and use conservative default dilutions to calculate permit limits. **The use of any default procedure should be limited to the initial mixing zone assessment for existing minor facilities where the IWC is small. Also, the permit writer should determine there are no known or suspected water quality standard violations in the receiving stream for the pollutants of concern in the discharge.** A ZID default dilution value of three is suggested for low velocity discharges. A default value of five is suggested for chronic aquatic life and human health mixing zones. The default values may only be granted if adequate dilution is available based upon the discharge flow and the 7Q10 of the receiving stream. If default dilutions are used, permit conditions for information generation may be imposed to refine any assumptions made, so that, at permit reissuance, a detailed assessment of WQBELs can be performed.

Calculating Water Quality-based Effluent Limitations

Calculation of water quality-based effluent limitations can be viewed as a three-step process. The first step involves consideration of various water quality standards, background concentrations and dilutions available to determine protective discharge levels of pollutant. The second step involves conversion of the discharge levels to average monthly and maximum daily effluent limitations
using the procedures of Chapter 5 of the TSD. The third step involves selection of the more stringent limitations as the appropriate water quality-based effluent limitations.

Discharge Level Determinations

After determining the background concentration of pollutant present in the receiving stream upstream of the discharge, the spatial limitation of the ZID, and the dilution available at the edge of the ZID, the following formula may be used to determine the discharge level of pollutant that will prevent **acute** aquatic life toxic impacts:

(Equation 2.1) **DLa = BKG + (WQSa - BKG)(D)** where,

DLa = discharge level to prevent acutely-toxic aquatic life impact
WQSa = acute aquatic life water quality standard
BKG = background concentration of pollutant upstream
D = dilution available at edge of ZID

For facilities that have no reasonable potential to exceed acute standards at end-of-pipe, but, are seeking a chronic or human health mixing zone, **do not establish DLa = WQSa**.

After determining the background concentration of pollutants, the spatial limitations of the mixing zone for chronic aquatic life standards and the dilution available at the critical intersection, the following formula may be used to determine the discharge level of pollutant that will prevent **chronic** aquatic life toxic impacts:

(Equation 2.2) **DLc = BKG + (WQSc - BKG)(D)** where,

DLc = discharge level to prevent chronically-toxic aquatic life impacts
WQSc = chronic aquatic life water quality standard
BKG = background concentration of pollutant upstream
D = dilution available at critical chronic mixing zone boundary

Calculation of the discharge level of pollutants to protect human health would be identical to those for chronic aquatic life protection. All streams and stream segments should be protected for Human Health Categories A and C, unless specifically excepted by the Legislative Rules. If a mixing zone is allowed, standards apply at the edge of the human health mixing zone. The sizing of the human health mixing zone should be identical to that for chronic aquatic life protection, unless a more restrictive zone is indicated to be necessary by the Health Department. The following formula may be used to determine the discharge level of pollutant that will prevent adverse **human health** impacts:

(Equation 2.3) **DLh = BKG + (WQSh - BKG)(D)** where,

DLh = discharge level to prevent human health impacts
WQSh = human health water quality standard (Category A or C)
BKG = background concentration of pollutant upstream
D = dilution available at critical human health mixing zone boundary

In complete mix situations, Equations 2.1 - 2.3 may be used to determine the respective discharge levels. The dilution available (D) would be calculated by Equation 1.1 or 1.2.

In situations where mixing zones are prohibited, or where upstream water quality exceeds the standard, Equations 2.1 - 2.3 should not be used. The discharge levels for the various protections should be set equal to the corresponding water quality standard.

When assessing discharge levels for Whole Effluent Toxicity, EPA recommends protecting 0.3 Toxic Units, acute at the edge of the ZID, and 1.0 Toxic Units, chronic at the edge of the chronic mixing zone. If the permit writer can assume background toxicity levels equal to zero, the following formulas can be used to determine discharge levels:

(Equation 2.4) **DLa = 0.3 (TUa) * D,** where

DLa = discharge level of acute whole effluent toxicity
D = the dilution available

(Equation 2.5) **DLc = 1.0 (TUc) * D,** where

DLc = discharge level of chronic whole effluent toxicity
D = the dilution available

The assessment of background toxicity is a difficult proposition. In the Case Examples of Chapter 7 of the TSD, upstream toxicity is assumed equal to zero. The use of upstream ambient water as a diluent for toxicity tests is prescribed as a means to validate the assumption of zero background toxicity. If such is required for compliance monitoring purposes, an additional control of 100% upstream water may be warranted. Without that control, the cause of any identified toxic impacts (i.e the effluent or the receiving stream) could not be surely determined. If ambient water is tested and a toxic impact identified, the cause could be toxic pollutants or environmental conditions (pH, temperature, hardness) that the test organisms are not acclimated to. Use of diluent water with properties objectionable to the test organisms may add uncertainty to test results. Additional uncertainty may exist relative to the additivity of the effluent and ambient toxicity. The TSD advises that acute toxicity from multiple sources should be considered additive, but not chronic toxicity. All of this uncertainty leads to the following suggested procedure.

If the permit writer judges toxicity from upstream point sources is not likely to be present, then background toxicity may be assumed equal to zero. Discharge levels may be calculated by Equations 2.4 and 2.5, and average monthly and maximum daily effluent limits may be calculated in accordance with the procedures detailed later in this document. In the self-monitoring requirements for WET limits, the standard procedures should be specified. Additionally, an upstream control (100% ambient water from receiving stream upstream and outside the influence of the discharge) should be required. If the upstream control exhibits no toxic impacts and the effluent is in compliance with limits, then limit development procedures will be validated. The exhibition of toxic impacts in the upstream control would be a flag for additional study and possible reassessment of WET limits. A permit condition that triggers such additional study should be included. If the permit writer judges that upstream toxicity may be present, then limit development and self-monitoring requirements should be coordinated with WAP biology personnel.

Conversion of Discharge Levels to Permit Limitations

This step has two subparts - one for aquatic life protection, and one for human health protection. For aquatic life protection, the procedure consists of back calculating long term average effluent values for acute and chronic protection from their respective discharge levels, selecting the more stringent, and calculating average monthly and maximum daily effluent limitations from the selected long term average value. For human health protection, the average monthly limit is set equal to the discharge level and the maximum daily limit is derived from the average monthly limit. The statistical procedures of Chapter 5 of the TSD, as briefly described below, should be used..

1) **For Whole Effluent Toxicity only,** convert DLa to chronic toxic units:

(Equation 3.1) **DLac (TUc) = DLa (TUa) * ACR,** where

DLac = discharge level for acute toxicity, in terms of chronic toxicity
ACR = acute to chronic ratio

The ACR should be assumed equal to 10 (See Section 1.3 on Page 18 of TSD.)

2) Calculate Long Term Average values to satisfy acute and chronic aquatic life protection discharge levels. Use Table 5-1 of the TSD, the calculated CV (coefficient of variation, defined as the ratio of the standard deviation to the mean) for the pollutant in the effluent (or default = 0.6), and the 99th percentile occurrence probability to determine the appropriate LTA multipliers.

Example: DLa = 25, DLc = 10, DLh = 10, CV = 0.6

LTAac = DLa * .321
LTAac = (25)(.321) = 8

LTAc = DLc * .527
LTAc = (10)(.527) = 5.3

3) Select the more limiting of the two LTAs for aquatic life protection:

For above example: LTA = 5.3

4) Convert LTA to average monthly and maximum daily permit limitations for aquatic life protection. Use Table 5-2 of the TSD, the calculated CV for the pollutant in the effluent (or default = 0.6), and the 99th percentile occurrence probability to determine the Maximum Daily Limit multiplier.

For above example: MDL = LTA * 3.11 = (5.3)(3.11) = 16.5

Use Table 5-2 of the TSD, the calculated CV for the pollutant in the effluent (or default = 0.6), the 95th percentile occurrence probability, and the planned self-monitoring frequency to determine the Average Monthly Limit multiplier. (n) should be set equal to 4 if self-monitoring frequency is 1/month or less frequent, per 5.5.3 of the TSD.

In above example, assume the planned self-monitoring frequency is 1/month. Then:

AML = LTA * 1.55 = (5.3)(1.55) = 8.2

5) Calculate average monthly and maximum daily limits for human health protection. The average monthly limit is set equal to the discharge level for human health protection.

For above example: AML = DLh = 10

Use Table 5-3 of the TSD, the calculated CV for the pollutant in the effluent (or default = 0.6), the 95th percentile exceedance probability for the AML, and n at the planned self-monitoring frequency to determine the Maximum Daily Limit multiplier. (n) should be set equal to 4 if self-monitoring frequency is 1/month or less frequent, per 5.5.3 of the TSD.

For above example: MDL = AML * 2.01 = (10)(2.01) = 20

Selection of Average Monthly and Maximum Daily Limits

In the final step, the permit writer would compare the AML for aquatic life protection to the AML for human health protection, and select the more stringent. The MDL for aquatic life protection would then be compared to the MDL for human health protection, and the more stringent selected. The selected AML and MDL would be the projected water quality-based effluent limitations.

The projected water quality-based limits would be compared with applicable technology-based limits (promulgated effluent guidelines or BPJ) and the more stringent incorporated in the permit. Also, the permit writer should assess the potential for violation of water quality standards at the boundaries of established mixing zones. If there is no reasonable potential for the discharge to exceed standards, after consideration of dilution available in the zones, then there is no need to impose water quality-based effluent limitations. The permit writer should again use the procedures of Chapter 3.3 of the TSD to perform the "reasonable potential" assessment.

Permitting Procedures

The water quality-based effluent limitation development procedures described herein may be

implemented as soon as the permit writer is in possession of information necessary to perform a sound technical analysis. Eventually, implementation of the procedures will be a routine component of permit reissuance. But now, permit writers will be faced with the responsibility to draft permits without the necessary information.

For existing facilities seeking mixing zones, where information is lacking and generation is not possible within the permitting time frame, the draft permit should include a compliance schedule that requires the submission of information by the permittee. The reissued permit should contain the toxic pollutant effluent limitations of the previous permit. If the previous permit did not limit toxic pollutants expected present, then the permit would contain appropriate effluent self-monitoring requirements. If the previous permit did not implement applicable technology-based requirements, such should be included in the reissuance. Permit conditions and the Fact Sheet should advise that the Office is deferring final decisions relative to water quality-based effluent limitations, until the permittee generates and submits information necessary for the Office to make that technical evaluation. The information being required should be specified in detail and rationalized in the Fact Sheet.

The permit should require the submission of a Modification Application after a reasonable time period for data generation (generally 6-18 months after the effective date of the permit.) Within the Modification Application, the permittee would request a mixing zone and provide the required information. The permit may also require earlier submission of information, when such information is a prerequisite for subsequent data collection activities.

A permit condition should also be included that authorizes the Office's reopening of the permit, for the purpose of imposing water quality-based effluent limitations, if the permittee fails to provide information as requested, or if the permittee submits frivolous information. If the Office exercises that option, effluent limitations may have to be based upon the imposition of water quality standards at end-of-pipe, because information indicating the feasibility of mixing zones may not be available.

For new facilities, an attempt should be made to have applicants generate information on receiving stream water quality and physical characteristics, early in the process. Such information, coupled with outlet design and wastewater characterization, may allow the development of water quality-based effluent limitations prior to the initiation of the new discharge. If early information generation is not possible, a deferred assessment similar to that proposed for existing facilities may have to occur. The permit writer will have to use judgement in establishing initial effluent limitations that are protective of water quality. To offset uncertainty in incomplete mix situations, new discharges that have reasonable potential to contain toxic pollutants should be required to extend the effluent line away from the bank, provide a high velocity discharge, install a high rate diffuser, or provide other means to optimize mixing. The rationale for such requirements could be the extension of the BPJ/BAT evaluation to include optimization of mixing of the effluent and the receiving stream.

Upon receipt of the permit modification application, the permit writer would perform an assessment of water quality-based effluent limitations. If the assessment indicates the need for more stringent limitations, the modified permit would contain such. It should also include a definition of the mixing zones granted, and upstream and downstream self-monitoring requirements. If a facility is unable to comply with the revised limits, then a reasonable compliance schedule may be included in the modification.

The following outcomes of the aforementioned procedure are envisioned, along with the recommended approach for corresponding permitting actions:

1) **The water quality-based assessment indicates the existing permit limits (existing facilities), or technology-based limits (new facilities) will ensure compliance with applicable water quality standards at the maximum boundaries of the mixing zones, and**

the permittee has demonstrated consistent compliance with existing limits (existing facilities); or has proposed appropriate treatment to comply with technology based limits (new facilities).

The existing or technology-based effluent limits should not be made more stringent. The Modification should specify the spatial limitation of the ZID as determined per the TSD procedures. The boundaries of the chronic mixing zone should be shortened from the regulatory maximums to be only as large as necessary to accommodate discharge at applicable limits. The modified permit should require ambient monitoring upstream of the discharge and at the edges of the ZID and the chronic mixing zone.

2) The permittee has demonstrated noncompliance with one or more of the existing limits, and the water quality-based assessment indicates limits could be relaxed while maintaining compliance with applicable water quality standards at the maximum boundaries of the mixing zones.

If the existing effluent limits were technology-based and the basis remains appropriate, then such limits could not be relaxed. If the existing limits were water quality-based (using old rules and procedures), less stringent limits could be granted. Such would not be considered backsliding. The Modification should specify the spatial limitation of the ZID as determined per the TSD procedures. The boundaries of the chronic mixing zone should be established only as large as necessary to accommodate discharge at the existing effluent quality. The modified permit should require ambient monitoring upstream of the discharge and at the edges of the ZID and the chronic mixing zone.

3) The water quality-based assessment indicates the receiving stream has assimilative capacity available for pollutants in the discharge, the mixing characteristics of the discharge require limits more stringent than existing, and the permittee has demonstrated the ability to comply with the more stringent limits.

The modified permit should include the more stringent limits, the spatial limitation of the ZID, and the definition of the chronic mixing zone boundary at the maximum distance available for the specific site. The modified permit should require ambient monitoring upstream of the discharge and at the edges of the ZID and the chronic mixing zone.

4) The water quality-based assessment indicates the receiving stream has assimilative capacity available for pollutants in the discharge, but the permittee will not be able to comply with one or more of the limits, due to insufficient mixing. (Existing or new facilities)

The permittee should be advised of the situation and presented with the following alternatives:

a) The permittee could perform more detailed study of the mixing zone (ex. dye study) and attempt to demonstrate that the dilution available from the existing outlet is greater than the dilution predicted by the agency.

b) The permittee could upgrade its outlet structure/configuration/orientation to improve mixing.

c) The permittee could install additional treatment to achieve compliance with the more stringent limits.

For existing facilities, this situation may be handled by an Administrative Order, with a compliance schedule, which expedites study and construction. Additional time for study should not be granted when the permit writer believes such study will not result in achievable limits. Conversely, the permittee should not be

prevented from performing a detailed study when the permit writer believes the model predictions are overly conservative. Specific conditions of the modification and/or permit will have to be decided case-by-case. New facilities should be required to achieve compliance prior to commencement of discharge.

5) The background monitoring provided by the permittee indicates that the receiving stream has no capacity to assimilate one or more pollutants present in the discharge.

This is a wasteload allocation problem and not a mixing problem. Effluent limits should be established based upon discharge levels of pollutants being equal to the most stringent, applicable, water quality standard. The receiving stream would be a TMDL candidate for the pollutant(s) that are in violation of standards. For facilities that are unable to provide treatment to comply with those stringent effluent limitations, the permit writer will have to assess possible compliance solutions, case-by-case.

Ambient Monitoring Requirements

In the aforementioned section, certain continuing ambient monitoring requirements are prescribed for permittees. The primary compliance assessment point should continue to be at the effluent, with the majority of permittee self-monitoring occurring at that location. There is a need to continue monitoring upstream water quality so that data is available for mixing zone/WQBEL assessment in the next permit reissuance. This should be a relatively infrequent activity (1/quarter is suggested) for toxic pollutants of concern. Additionally, the Legislative Rules require instream compliance assessment if mixing zones are granted. Again, this should be a relatively infrequent activity (1/year during low-flow season is suggested). Downstream monitoring could be further limited through the use of an indicator pollutant, if practical.