COMMONWEALTH OF VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY
Division of Water Permit Coordination

629 E. Main Street Richmond, VA 23240

M E M O R A N D U M

SUBJECT: Guidance Memo No. 00-2011; Guidance on Preparing VPDES Permit Limits

TO: Regional Directors

FROM: Larry G. Lawson

DATE: August 24, 2000

COPIES: David Paylor, Martin Ferguson, Alan Pollock Jean Gregory, Regional Office Permit Managers, Regional Office Water Permit Managers, Regional Office Compliance and Enforcement Managers, OWPP staff

The purpose of this guidance is to replace/update Guidance Memo No. 93 - 015 "Guidance on Preparing VPDES Permits Based on the Water Quality Standards for Toxics"

This guidance was last updated in 1993. Modifications to the water quality standards (WQS) make it necessary to update the guidance. This guidance replaces all previous guidance on the subjects covered herein. Specifically it updates or replaces the following guidance:

91-002	Use of WQS in the VPDES Permit Program
91-011	Selection of Sample Types for VPDES Monitoring
91-016	Use of Existing WQSA Criteria for Silver and Phenol
92-012	Guidance on Use of WQS for Toxics in VPDES Permits
92-012a	Modification of 92-012
930-15	Guidance on Preparing VPDES Permits Based on the Water Quality Standards for Toxics
93-021	Antidegradation Implementation Guidance
94-008	Metals Monitoring, Monitoring Special Condition TOMP Revisions, & Di-2-Ethylhexyl Phthalate
95-012	pH Limits in the VPDES Permits for Cooling Water Outfalls

Note to Users: This document is provided as guidance and, as such, sets forth standard operating procedures for the agency. However, It does not mandate any particular method nor does it prohibit any particular method for the analysis of data, establishment of a wasteload allocation, or establishment of a permit limit. If alternative proposals are made, such proposals should be reviewed and accepted or denied based on their technical adequacy and compliance with appropriate laws and regulations.

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MODIFICATIONS TO THE WATER QUALITY STANDARDS

Ammonia:

The previous ammonia chronic criterion was expressed as a 4 day average. The chronic criterion for ammonia is now expressed in terms of a 30 day average concentration that may not occur more frequently than once in a three year period on the average.

The acute criterion remains as a 1 hour average that may not occur more frequently than once in a three year period on the average.

The formula and tables for criteria values have changed slightly.

<u>Implications:</u>

The modifications will result in only slight changes relative to old guidance. The chronic averaging period is accounted for by new software distributed with this guidance.

Chlorine:

Formerly, chlorine had it own separate standard and implementation procedures. However, that standard was repealed and the old implementation procedures no longer apply.

Chlorine is currently listed in the table of toxic criteria along with other toxic materials and the criteria are given in terms of average concentrations that may not occur more frequently than once in three years.

<u>Implications:</u>

There is now no reason to include special permit language relative to chlorine toxicity as was the case with the old standard. Procedures to determine final effluent limitations for chlorine and their specification in a permit will now be consistent with those for other toxic materials.

However, there remains a need to ensure adequate disinfection. This will require a permit special condition that establishes certain monitoring requirements/limits at an internal location.

Antidegradation:

Formerly, it was necessary to perform an antidegradation review only when a new or increased discharge of pollutants was proposed. However, the phrase: “new or increased” has been removed from the antidegradation provisions.

<u>Implications:</u>

It will now be necessary to perform an antidegradation review for **<u>all</u> permit actions** undertaken by DEQ.

GENERAL PROTOCOL

The following protocol should be used for developing limits for VPDES permits:

- Perform an antidegradation review (Page 8)
  - Identify the appropriate tier
  - Establish baselines for tier 2 waters
- Determine what water quality standards apply and determine the appropriate criteria, including baselines if necessary
- Evaluate mixing zones (page 18)
- Calculate wasteload allocation/permit limits
  - Identify any applicable effluent guideline limits (EPA publications)
  - BOD/DO (Separate guidance)
  - Temperature
  - Toxic materials
    - Chlorine (Page 46)
    - Ammonia (Page 48)
    - Evaluate available effluent data for other toxic materials
  - Human health criteria (if applicable) (page 92)
  - Whole effluent toxicity (if applicable) (Separate guidance)
- Evaluate antibacksliding if less stringent limits are proposed. (page 38)
- Calculate limits for all materials having a reasonable potential to cause or contribute to a violation of standards (provided software, page 60, 76).
- Determine if reduced monitoring should be provided. (page 54)
- Determine if effluent monitoring is required for toxic materials.
- Prepare special conditions
  - Chlorine (page 45)
  - Appendix A Monitoring (page 80)

ANTIDEGRADATION

Background:

The antidegradation policy was slightly modified in 1997. The modification will not require changes to the existing implementation policies but will require slight changes in the way antidegradation is considered and applied.

The previous standard required that antidegradation be considered only when a proposal was made for a new or expanded discharge. The words, "new or expanded", in that context, have been removed from the standard. It results that antidegradation must now be evaluated and applied with any action that has a potential to affect water quality. **Specifically, this means that <u>every permit action</u> must include an appropriate application of the antidegradation policy**.

Note that for existing dischargers that are not expanding this may be limited to simply establishing the tier ranking and baselines for the receiving water.

The Standard:

9 VAC 25-260-30 establishes three categories of antidegradation protection for the surface waters of the state. These categories will be referred to as tier 1, 2 and 3.

Tier 1.

9 VAC 25-260-30.1 requires that the existing beneficial uses and the quality necessary to protect such existing uses be maintained.

Tier 2.

9 VAC 25-260-30.2 requires that the existing water quality be maintained for all waters wherein the existing quality exceeds the water quality standards.

Tier 3.

9 VAC 25-260-30.3 prohibits permanent new or increased discharges into waters designated by the Board as providing exceptional environmental setting, aquatic communities or recreational opportunities.

Note for tier 2 waters: There are certain waters that do not attain the standards due to natural causes. These waters fall into two primary categories:

1. Periodic, short term exceedance of generally one criteria, *e.g*. periodic summer exceedance of the temperature criteria in class VI waters.

2. Routine and long term exceedance of one or more criteria, *e.g.* swamps that practically never attain the 5 mg/l D.O. criteria during critical conditions.

The exceedance in the first category may not necessarily be considered a violation of the standards. This is particularly true if the uses are not adversely impacted. Waters, in first category may be assigned to tier 2 provided the periodic excursions above the criteria does not curtail the uses of the water body. This will depend on the specific case and the judgement of the person investigating the water in question.

When waters in the second category fail to meet the standards due to natural causes then it is apparent that the standard is in error and requires modification. In this case, it is not possible to assign a tier ranking because there is no valid standard to compare the quality to. Permits should contain limitations that are designed to allow no significant additional impact due to the discharge of pollutants.

Implementation:

<u>Any action undertaken by the Board, DEQ or its staff requires application of the antidegradation policy</u>. Its implementation is according to the following protocol:

- Establish the tier category of the waters concerned.
- Establish wasteload allocations consistent with the tier category.
- Document the findings for future reference.

Establishing the tier:

<u>Note:</u> the **fecal coliform** bacteria standard will **not be used** relative to antidegradation. Neither attainment nor non attainment of the fecal coliform bacteria criteria will be used to establish the tier category of a water unless there is clear and convincing evidence that the elevated bacteria numbers are due to inadequately disinfected human waste.

<u>Note</u>: periodic violation of the maximum temperature standard for class V waters during the summer period is not a necessarily a reason to find that these waters are tier 1. These streams are stocked to provide an artificial trout fishery and occasional exceedance of the temperature criteria can be expected. This does not normally impact the use of the stream since it is not expected to support a permanent trout fishery.

<u>Note</u>: The tier category of a stream is determined outside the boundaries of any mixing zones. New and existing mixing zones, with the proper restrictions (see mixing zone section), are allowable within tier 2 waters. However, **expanded mixing zones are not allowed in tier 2** waters unless the requirements of 9 VAC 25-260-30.A.2 are met. Neither permanent new nor expanded zones are allowed in tier 3 waters.

<u>Note:</u> The definition and implementation of tier 1 waters contains an overlap regarding application of the standard for waters that do not attain the standards and those that just barely do. This results in some confusion because the requirements for both type waters are the same but for basically different reasons. For waters that just barely manage to attain the standards (equal to but not greater than), antidegradation requires that no further lowering of quality be allowed. For waters that do not attain the requirements of the standards antidegradation simply requires that these waters be improved to the point where standards are attained. The result is

that the wasteload allocations and permit requirements for both type waters are the same and they are both grouped under tier 1 for implementation.

Tier 1 waters are defined as those waters wherein one or more standards are not being attained or wherein the existing quality, under critical conditions, is equal to but does not exceed one or more applicable criteria. Information that may be used to establish this tier includes:

- Data collected from the segment of stream being considered that demonstrate that one or more standards are violated or are just barely being met (note exceptions above for fecal coliform and temperature). This demonstration must be outside any mixing zones.

- Data collected for an existing effluent that indicates the need for a more stringent limit than currently exists indicates that the standard is not currently being attained by the effluent under consideration. Thus the water would be tier 1.

- Default assumptions for ammonia that indicate the need for a more stringent limit than currently exists indicates that the ammonia standard is not currently being attained by the effluent under consideration; thus, the water is tier 1.

- An existing water quality based permit limit that was obtained through mathematical modeling may indicate that the effluent under consideration allows the standard to be just barely met in the receiving waters for the parameter modeled, *e.g.* a predicted D.O. of 5.0.

  Note: this does not apply to fecal coliform or to effluent limits adopted as special standards (*e.g.* Potomac Embayment Standards).

- Biological data that demonstrate in stream toxicity.

- Judgement based on the presence of definitely identified sources of pollutants or demonstrated use impairment. Such judgement must be justified and documented. An example might be a water supply reservoir where it is known that algicides are routinely applied.

Tier 2 waters are defined as those waters wherein the existing quality is better than the standards for all parameters that the Board has adopted criteria for (except fecal coliform and temperature for class V waters, see notes above).

<u>If data or information is not available to make a determination, the stream is assumed to be tier 2.</u> Public water supplies and trout streams are assumed to be tier 2 unless information is available to indicate otherwise.

Tier 3 waters are those waters so designated by the Board. These waters are listed in 9 VAC 25-260-30.3.c. If waters are not listed in 9 VAC 25-260-30.3.c, then they are not tier 3.

Once the appropriate tier is assigned, the finding should be documented for future reference. The method for doing this is not recommended since it will vary from region to region. The only guidance is that they should be readily available to future permit writers.

Establishing the wasteload allocation and permit limits:

Tier 1 waters:

Permit limits for discharges into tier 1 waters are established by determining wasteload allocations that will result in attaining and/or maintaining all water standards that apply to such waters, including narrative criteria. Such WLAs will provide for the protection and maintenance of all existing uses.

Note: For a single discharge, the wasteload allocation may be essentially equal to the permit limit. In multiple discharger situations the allocation will have to be divided between the competing interests.

Tier 2 waters:

Since the quality of tier 2 waters is better than required by the standards, no significant degradation of the existing quality will be allowed.

A consensus of agency opinion is that there will be no significant lowering of water quality if the permit limits is based on the following restrictions:

- The dissolved oxygen is not lowered more than 0.2 mg/l from the existing levels.
- pH is maintained within the range 6.0 to 9.0
- The temperature criteria are complied with (this standard has its own effective antidegradation criteria, *e.g.*, rise above natural and rate of rise restrictions).
- No more than 25% of the unused assimilative capacity is allocated for toxic criteria for the protection of aquatic life.
- No more than 10% of the unused assimilative capacity is allocated for criteria for the protection of the human health.

In order to comply with the above restrictions, it is necessary to establish antidegradation baselines at the time the water is assigned to the tier 2 category. This baseline includes the insignificant allocation and identifies the quality that must be maintained by the current proposal as well as all future proposals.

Note: the calculation of baselines for tier 1 and tier 3 is not necessary since they are established by the criteria and Board action respectively. As a result baselines are only required for tier 2 waters.

The unused assimilative capacity is defined as the difference between the existing water quality and the lower quality allowed by the standards. For example:

> If the criteria for a water body is 10 mg/l and the existing quality is found to be 2 mg/l then the unused capacity is: 10 – 2 = 8 mg/l.

25% (10% for human health criteria) of this unused capacity may be allocated. The baseline is then simply the sum of the existing quality and the allowed allocation. In the example above, the baseline would be the existing quality plus 25% of the unused capacity, e.g.,

> Baseline = 2 + (0.25)(8.0) = 4 mg/l

In this case, a permit may be written that results in an in stream concentration of 4 mg/l. However, as indicated above, neither the current proposal nor any future proposal may be allowed to result in a stream concentration greater than 4 mg/l..
Note: if data do not exist and the stream is assumed to be tier 2 then the existing background concentration of pollutants should be assumed to be zero. This will result in a baseline that is equal to 25% (or 10%) of the criteria.

The baseline establishes the level above which neither the current proposal nor any future proposal may exceed. A baseline needs to be established for all criteria that apply to the stream in question. Obviously, these baselines become the *de facto* criteria and this requires that they must be recorded for future reference. The method for doing so is not recommended here because each region may have different procedures.

Tier 3 waters:

If the water body is classified as tier 3, no permanent new, additional or increased discharge of sewage, industrial wastes or other pollution shall be allowed in these waters. Existing mixing zones from upstream or tributary discharges existing in these waters cannot be expanded and no new mixing zones will be allowed to be created in or extend into these waters. Only temporary, short - term impacts shall be allowed on a case by case basis.

Note: Permits for existing sources may be reissued but may not allow expansions of flow, mixing zones or pollutants (neither mass loading nor concentration may be raised).

Note: Antidegradation does not apply within the confines of a mixing zone. However, all of the antidegradation requirements apply at the boundary of such zones. In the case where the mixing zone boundaries are known, the baselines must be attained at the boundary of the mixing zone. In the case where a complete mix assumption is applied the actual boundaries of the mixing zone is unknown, however, the baseline is used to establish the wasteload allocations by application of the complete mix assumption. In critical situations, it may be necessary to establish the actual boundaries of the mixing zone by field studies or application of an appropriate model. Note that MIX.EXE cannot be used for this purpose.

Exceptions:

There are no exceptions to the above regarding tier 1 and tier 3 waters and no exceptions, at the staff level, for tier 2 waters.

However, the Board may allow degradation of tier 2 waters beyond the baselines but only after full satisfaction of intergovernmental coordination and public participation and providing that such degradation has been demonstrated to be necessary to accommodate important economic or social development (see 9 VAC 25-260-30.A.2).

Note: a use attainability study, water effect ratio, variance request, etc. may result in modifications to the criteria. In such cases, the modified criteria would be used in accordance with the above protocols to apply antidegradation.

Note: in multiple discharge situations, the total available capacity must be allocated among all sources of the pollutant. The aggregate lowering of water quality must be within the bounds set forth above.

Note: provided the baselines are not exceeded the activity can be considered to result in an insignificant lowering of water quality and it can be allowed. Insignificant in this context means within the baselines established according to the discussion above.

Note: The baselines should remain fixed unless water quality improves. If water quality improves, then the baseline should be adjusted accordingly. Both the current and all subsequent proposed activities are then evaluated against the baseline rather than the standard. This procedure ensures that multiple small water quality changes will not inadvertently add up to significant water quality degradation without adequate water quality and economic impact analyses.

Guidelines for required actions when a significant lowering of water quality is to be allowed in tier 2 waters:

If the proposed regulated activity would significantly lower water quality, a letter must be sent to the director of the Division of Soil and Water of the Department of Conservation and Recreation notifying them of this designation and requesting that they undertake the appropriate non point source control activities to maintain water quality. The Division of Soil and Water will be asked to provide comments back to the DEQ by the close of the public notice comment permit for the proposed VPDES permit. This action will be made part of the file and considered in the final permit process.

Any entity seeking to significantly lower water quality through a new or increased discharge of pollutants must first, as required by VR 680-21-01.3.B submit an antidegradation socioeconomic demonstration for consideration by the regional office. Any discharger seeking such an action should first submit a proposed study work plan to the regional office for review, comment and/or approval before undertaking such a demonstration. (The same rationale for application or collection of data provided in the guidance for antidegradation category determination applies for this demonstration).

The antidegradation demonstration shall identify the important social or economic developments to the area in which the waters are located that will not occur if the significant lowering of water quality is not allowed. Developments considered, should, as a minimum, fall into one or more of the following categories:

(i) increase in the number of jobs;
(ii) increase in personal income or wages;
(iii) reduction in the unemployment rate or other social service expenses;
(iv) increase in tax revenues;
(v) provision of necessary social services.

Prior approval from DEQ staff shall be required for use of any alternative economic indicators.

In conducting the analysis of social or economic development, the applicant should follow Section 5.5 of the EPA Water Quality Standards Handbook and the EPA draft Economic Guidance Workbook for Water Quality Standards. The EPA workbook provides worksheets to assist applicants in their evaluation of socioeconomic impacts but the applicants should feel free to use anecdotal information to describe any current community characteristics or anticipated impacts that are not listed in the worksheets. The workbook provides few useful economic ratios and tests for evaluating socioeconomic impacts, so the applicant's demonstration will primarily consist of a narrative evaluation of the relative magnitude of indicators such as increases in unemployment, losses to the local economy, decreases in tax revenues, and indirect effects on other businesses. Bureau of Economic Analysis multipliers can also be used by the applicant to estimate the effect of reduced economic activity on output (sales), earnings, and employment.

Since EPA does not have standardized tests and benchmarks with which to measure these socioeconomic impacts, the regional office may exercise case specific flexibility in their requirements for a discharger socioeconomic antidegradation review.

Decision

Upon receipt and review of the applicant antidegradation socioeconomic demonstration, the regional office may determine that a significant lowering of water quality is not necessary to provide important economic or social development. In this case, the staff would simply recommend that the Board deny the application.

Alternatively, the regional office may fine that the request is proper. In this case, proper public participation should be obtained. This will be accomplished by public notice that provides the public with an opportunity to comment and the opportunity to request a public hearing. Activities that may affect several water bodies in a basin or sub-basin may be considered in the same public notice or hearing. In addition, antidegradation issues may be combined with appropriate hearings on environmental impact statements, water management plans, or permits. However, if this is done, the public must be clearly informed that changes to the water quality are being considered along with the other activities.

The following is a summary of the elements that must be made available to the public in order to meet the public notification requirements of the antidegradation provisions of the water quality standards. The following items need not be included in detail in the public notice. However, the public must be made aware of their existence, given sufficient information to determine their applicability and informed of how they may be obtained.

(1) A statement that the action will result in a significant lowering of water quality but that it will comply with the States' antidegradation policy.

(2) A determination that existing uses will be maintained and protected. This determination will be attached to the fact sheet along with a description of which parameters are included in the proposed degradation.

(3) A summary of other known actions, if any, that have lowered water quality since November 28, 1975.

(4) The estimate of the impact, if any, that the action will have on the physical, chemical, and biological integrity of the water body.

(5) A determination that the lower water quality is necessary to accommodate important economic or social development. (The socioeconomic antidegradation review provided by the applicant must be included as part of the fact sheet for public comment.)

(6) A description how the intergovernmental coordination process has occurred.

(7) A determination that the highest statutory and regulatory requirements for all new and existing point sources have been achieved.

(8) Notification letter to Department of Conservation and Recreation and their response regarding their undertaking non point source control activities to maintain water quality.

Examples

Situation: The reissuance of an existing permit containing BOD limits that were predicted to result in a D.O. of 5.0 mg/l.
antidegradation Review: Based on the D.O. standard being met, but not exceeded, the receiving waters are classed as Tier 1. No baselines need to be established. The permit is written to attain/maintain all applicable criteria.

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Situation: A new discharge is proposed into a water that is currently ranked as tier 1.

Antidegradation Review: Since the waters are tier 1 it can be assumed that the standards are being violated or just barely being met for one or more parameters. It results that there is no additional capacity for those parameters. Since there is no additional capacity available for these parameters the permit limits for the new discharge must be established to equal the standards in the effluent prior to discharge (*e.g.* end of pipe limits equal to the standards). For those parameters where there is additional capacity (i.e. those not the cause of the tier 1 ranking), the permit limits for the new facility are established to attain the standards.

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Situation: A new discharge is proposed into tier 3 waters.

Antidegradation Review: The segment is listed in the water quality standards as a tier 3 water. The permit is denied and the applicant is sent a copy of the standards regulation and the listing.

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Situation: A new discharge is proposed into waters where the tier is unknown.

Antidegradation review: Data are gathered and analyzed and it is found that the quality is better than the standards for all parameters that the Board has adopted standards for. This justifies a tier 2 finding.

Baselines are calculated for all materials for which there are standards. The baselines are calculated according to the following:

- Data exists: The existing quality is determined by the data. The unused capacity is determined by subtracting the existing quality from the standards criteria. The baselines are determined by multiplying the unused capacity by 0.25 and adding it to the existing quality. The permit limits are determined such that they will provide attainment of the baselines.

- Data does not exists: The existing quality is determined by assuming the concentrations are zero. The unused capacity is equal to the criteria. The baselines are determined by multiplying the standards criteria by 0.25. The permit limits are determined such that they will provide attainment of the baselines.

Note: Mixing zones may be allowed in tier 2 waters providing the antidegradation requirements for such waters are met. Thus, in the example above the baselines should be met at the edge of the mixing zone.

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Situation: An existing discharger into tier 2 waters wishes to expand his discharge.

Antidegradation review: Since the waters are tier 2 outside the existing mixing zone, it results that any allowable allocations have already been made and they apply at the edge of the existing mixing zone. In this case, the baselines are equal to the quality at the edge of the existing mixing zone. Further degradation cannot be allowed. The permit limits are established to maintain the size of the current mixing zone and the current water quality at its edge.

Note: Since the mixing zone standard prohibits the expansion of mixing zones in tier 2 waters, neither the flow nor the concentration of pollutants can be increased unless:

- Enhanced mixing devices are installed that would result in the higher flow and pollutants having the same mixing zone size and concentrations at its edge as the existing one.

- The necessary governmental coordination, public participation and socio-economic need are demonstrated according to 9 VAC 25-260-30-A.2.

MIXING ZONES

Changes from previous guidance:

Recommendations for the staff consider **decay within the mixing zone has been removed**. It is now recommended that if a discharger wishes to consider decay then they should provide a more rigorous model than provided here. Such models should be calibrated and verified for the mixing zone and the decay should be demonstrated by field data.

Definitions:

To avoid confusion and to provide for consistent implementation, the following definitions for key terms to be used in this section are provided:

Completely Mixed - The condition where there is no more than a specified difference in the concentration of a material across the width and/or depth of a flowing stream. Note that, when referring to a lake or estuary, complete mix may need to be defined to include the length of the water body as well as the width and depth. However, this consideration is not addressed herein.

Physical Mixing Area (PMA) - The actual physical space required for an effluent to become completely mixed with its receiving stream. Note that, by definition, a PMA must extend from the discharge point to the complete mix point and must eventually occupy the entire width and depth of the receiving water. The size of a PMA and the distribution of materials within it are functions of the design of the outfall structure, the relative volumes and velocities of the mixing streams and the physical conditions in the stream. Changes in any of these parameters will usually result in a different PMA. However, the discharge of an effluent always results in a PMA and always requires a finite time and space regardless of the characteristics of the mixing streams.

In this regard, please note that physical mixing always takes place. When a mixing zone is "not allowed" what it really means that the parameter of interest must be equal to the ambient or background concentration prior to discharge (*e.g.* “end of pipe” limits equal to the existing quality of the stream).

Regulatory mixing zone (RMZ) - An area or volume in a stream, the boundaries of which must be specified in a VPDES permit or other legal document adopted or approved by the Board or its designee, wherein a specific amount of mixing is allowed to take place. The maximum size of a RMZ is specified in the water quality standards at 9 VAC 25-260-20.B.

Mixing Zone: An area or volume in a stream wherein mixing is allowed. All criteria may be exceeded within this zone but must be met at its boundaries.

Allocated Impact Zone - A sub area within a mixing zone. The concentrations within this zone may be higher than the concentrations specified by the acute standards but the exposure time must be sufficiently short to avoid lethality.

Lethality, (includes "acute lethality") - In reference to a specific chemical, lethality means the exposure of an organism to concentrations higher than the acute criteria listed in 9 VAC 260-25-140.B for a period of one hour or longer.

Passing organism - A free swimming aquatic organism that has a mean velocity, in any direction, at least equal to the mean velocity of the current through a PMA or RMZ.

Drifting organism – means a planktonic aquatic organism depending solely on the stream current for bulk movement. A drifting organism is unable to move against the current. A drifting organism has a mean velocity at least equal to the mean velocity of the current through a PMA or RMZ.

Resident organism - means any organism that has a mean velocity less than the mean velocity of the current through a PMA or RMZ.

Established by the Board - means a regulation, requirement or limitation contained in a VPDES permit, a consent special order or other legal document adopted or approved by the Virginia State Water Control Board or its designee. Specifically, a RMZ must be established by the board. Note that a PMA is the natural result of physical mixing processes and is not established by the Board or regulation.

Mixing zone concepts - The concentration of pollutants and the exposure times for various classes of non-resident organisms are estimated for locations near an effluent outfall. These are compared to the requirements of the mixing zone standard to ascertain if the expected PMA results in conditions sufficient to justify a complete mix assumption or if a RMZ must be specified in the VPDES permit for that outfall.

Basic Physical Mixing Processes:

The mixing of an effluent with its receiving stream usually takes place in two distinct phases. The first phase occurs very close to the discharge structure and is driven mostly by the characteristics of the effluent and the design of the discharge structure. The second phase occurs away from the outfall structure and is driven by the ambient turbulence and flow characteristics of the receiving water body.

The effluent will usually have a different velocity and direction than the stream and may be of a different density. The result is that a jet or plume may be formed in the stream. As the jet moves into the stream, it entrains ambient water causing relatively rapid mixing. The jet slows and changes direction as it extends further from the outfall until it gradually loses its identity as a separate hydraulic feature. The mixing within the hydraulically distinct plume, driven mostly by the momentum of the effluent, will be referred to as initial mixing.

Once the plume loses its identity as a separate hydraulic feature, it simply flows along with the stream but it may have significantly different concentrations of materials than the bulk of the stream. Further mixing does occur and is caused by the ambient turbulence and concentration gradients of the receiving stream. This phase of mixing is usually much slower than initial mixing and continues until the effluent is completely mixed with the stream. The mixing that takes place after the completion of initial mixing and prior to complete mix will be referred to as ambient mixing.

Discussion of the Mixing Zone Standard:

At 9 VAC 25-260-20.B the WQS contain three distinct requirements. One requirement is general in nature and the others are quite specific:

1. It contains a general requirement for the Board to "use mixing zone concepts in evaluating permit limits" for the acute and chronic water quality standards.

2. It contains specific requirements, including spatial restrictions, for mixing zones that are "established by the Board".

In addition, the standard **specifically allows waiving of the spatial requirements in cases where a complete mix assumption is shown to be appropriate**.

Note: The key elements are "use mixing zone concepts" and "established by the Board". These have very distinct meanings and lead to very different implementation procedures. Application of one of these requirements does not necessarily lead to application of the other.

The standard basically means that the PMA must be evaluated to ascertain if there is a reasonable potential for any of the chemicals, listed under the acute or chronic heading, to cause lethality to passing and drifting organisms. If it is suitably demonstrated that no reasonable potential exists for lethality within the PMA, then routine complete mixing equations are appropriate to evaluate permit limits.

If a reasonable potential is shown for the PMA associated with an effluent to result in lethality to passing or drifting organisms or the PMA is otherwise unacceptable (to be discussed later) and an acceptable PMA cannot be attained, then a Regulatory Mixing Zone (RMZ) must be established that will comply with the specific requirements of the standard.

Recognizing that the requirement to "use mixing zone concepts" to evaluate permit limits is non-specific and recognizing that “acute lethality” is not defined in the standards or elsewhere, it is important to specify exactly what conditions will be deemed acceptable within a PMA.

The recommendations herein are based on the following assumptions:

For chronic toxicity:

> **IF** the physical configuration of the stream and effluent and the concentrations in each are such that complete mixing, during 7Q10 drought conditions, results in concentrations equal to or lower than the criteria in the chronic standards,
>
> **AND** these concentrations are reached in a time that is equal to or less than the exposure times allowed by the standards,
>
> **THEN** it is assumed that no chronic toxicity or blockage of passage, attributable to the discharge, will occur for passing or drifting organisms regardless of the initial concentration.

For acute toxicity:

> **IF** the physical configuration of the stream and effluent and the concentrations in each are such that complete mixing, during 1Q10 drought conditions, results in concentrations equal to or lower than the criteria in the acute standards,
>
> **AND** these concentrations are reached in a time that is equal to or less than the exposure times allowed by the standards,

THEN it is assumed that no acute lethality, attributable to the discharge, will be experienced by passing or drifting organisms regardless of the initial concentration.

It should be clearly understood that a mixing zone is an area wherein the standards are not met. The mixing zone standard only provides that acute lethality and/or blockage of passage for passing and drifting organisms will not occur. The mixing zone standard does not require protection for organisms permanently resident within a mixing zone. As a result, both chronic and acute effects (including lethality) may be experienced by such organisms whenever a mixing zone is allowed regardless of its size. However, all organisms will be fully protected from all toxic effects at and beyond the edges of such zones.

Exclusions:

Due to the fact that protection is not provided for species that are resident within a mixing zone, this guidance should not be applied to a stream or stream segment that contains important resident species that are deemed to require special protection from toxic effects. This is a decision that the permit writer will have to make based on a site inspection, their detailed knowledge of specific situations, public comments and/or comments from other agencies. This exclusion acknowledges that there are some waters having critical beneficial uses or sensitive resident species where a RMZ, with the appropriate spatial restrictions, should be specified as a matter of course.

If the receiving water has a rare and endangered species within reasonable proximity of the proposed mixing zone then this guidance should not be used unless data exists that demonstrate that the parameters for which a mixing zone is being allowed will not result in adverse impacts on that species.

The model used in this guidance is very conservative and is used to estimate the largest probable PMA under worst case conditions. **It does not make an attempt to accurately model a mixing zone and can be considered to be a screening tool.** It is very unlikely that any real mixing zone will reach the dimensions estimated by the model. The basic concept is that if the largest probable PMA is acceptable then there should be little or no concern with applying a complete mix assumption. **The model is only intended to judge the applicability of the complete mix assumption as provided for in 9 VAC 25-260-20.B.4.a. It has no other application!** In critical situations, a more realistic model should be used to assess the PMA or mixing zone and judge its acceptability.

This guidance should not be applied to a stream if the resulting PMA would significantly impact the ecology of the stream taken as a whole. For example, it may not be desirable to accept a PMA (and therefore a complete mix assumption) that occupies a significant area of a section of natural trout stream. This will require judgement on the part of the permit writer and the regional management. We cannot attempt to recommend specific guidelines for all the situations that may be encountered. **This exclusion is mainly an admonition to the permit writer not to apply this guidance blindly to all situations without a site inspection and without considering what critical beneficial uses may occur within the predicted PMA.**

The standard specifically requires the application of the mixing zone concepts to acute and chronic standards. However, it does not limit the Board’s ability to apply those concepts to other parameters where doing so is reasonable. It must be kept in mind, however, that this guidance is based on exposure times and cannot be applied where exposure times are not a concern.

This guidance assumes a constant discharge and therefore does not apply to storm water or other intermittent discharges.

Implementation Concepts - Free Flowing Streams:

It is recommended that the magnitude, duration and frequency aspects of the toxic standards be implemented according to the following:

If a simple complete mixing equation (see equation 1) is used, with the flows identified in 9 VAC 25-260-140.- footnote 10, to calculate the instream concentration of toxic materials, it is assumed that the resultant concentration will comply with the magnitude, duration and frequency requirements of the standards. An independent statistical confirmation of those requirements is not required.

If a simple complete mixing equation, with the flows identified in VR680-21-01.4.A.1 and 2, **is not used** to estimate the instream concentration of toxic materials, a complete statistical confirmation of the concentration, duration and frequency requirements of the standards will be required.

The following general protocol is recommended for implementation of the mixing zone standard for chemical specific limits in free flowing streams:

1. Identify the largest probable PMA by application of available mathematical models using reasonable parameter values taken from the literature. Additional model inputs should be derived from the design parameters in the final plans and specifications for the outfall structure as well as the physical configuration of the stream.

2. Estimate the longest probable exposure time within the PMA for drifting and passing organisms as a function of the current velocity and rate of mixing under 7Q10 (chronic) and 1Q10 (acute) conditions.

3. Compare these exposure times to those identified later in this section.

4. The PMA is acceptable if the exposure time to concentrations greater than the standard is less than the exposure time allowed. In this case, neither a chronic nor an acute event can occur within the PMA for passing or drifting organisms and steady state complete mixing assumptions with the appropriate stream flows may be used for waste load allocations. The standards will be met, for all organisms, once mixing is complete (at the edges of the PMA).

5. The PMA is unacceptable if the exposure time to concentrations greater than the standard exceeds the exposure times allowed. If an acceptable PMA cannot be obtained by discussions with the discharger (design changes or pollutant reductions) then a RMZ should be specified in the permit that considers all of the specific requirements of the mixing zone standard, particularly the spatial restrictions.

6. No modifications to any stream, effluent or outfall structure should be allowed if such modifications would enlarge, relocate or extend a PMA or RMZ contained within or extending into tier 3 waters.

7. No modifications to any stream, effluent or outfall structure should be allowed if such modifications would enlarge a PMA or RMZ contained within tier 2 waters.

8. Waters supporting sensitive uses or waters containing permanently resident species that require special protection should not be within the boundaries of any mixing zone if the parameters for which mixing is allowed would adversely impact that species.

Application of Mixing Concepts and Assumptions:

The actual processes that result in the mixing of an effluent with its receiving stream are complex. This renders it difficult to estimate the concentration at particular locations or average concentrations over some area without extensive field data. In order to obtain reasonable estimation of the exposure time to varying concentrations for an average organism moving with the current through a mixing plume, simplifying assumptions and reasonable approximations must be made.

However, given the definitions, interpretations of the standards and the concepts discussed above, a methodology that is protective of water quality can be developed that is amenable to routine use by permit writers within the time constraints for permit development.

The methodology to be developed in this section applies only to effluents entering at the side of a free flowing stream via a pipe, channel or ditch. The central office should be contacted for case by case assistance for other effluent configurations.

Since the actual physical dimensions of a stream usually change rapidly and since it is not possible, practical or necessary to specify them in complete detail, **it will be assumed that streams have a rectangular channel of constant cross section and are much wider than they are deep (at least 10 times)**. If this assumption is seriously violated (e.g. a narrow deep channel) the central office should be contacted for case by case assistance.

The transport of materials by longitudinal (upstream and downstream) diffusive mixing is usually very small compared to transport by advection. The result is that the longitudinal concentration gradient is primarily a result of advective transport and diffusive mixing in this direction can usually be neglected without significant error. **It will be assumed that longitudinal mixing is insignificant** and it will be neglected.

Effluents entering at the side of a stream usually have a downward direction compared to the stream and/or initially occupy a significant portion of the depth (due to jet entrainment). Even in the absence of such effects, vertical mixing (top to bottom) is so rapid compared with lateral mixing that the vertical mixing processes can be neglected in a wide, relatively shallow stream, without significant error. **It will be assumed that complete vertical mixing occurs instantaneously at the discharge point.**

During critical flow conditions the temperature and density of a typical effluent are not usually very different from the receiving stream. **It will be assumed that the effluent is neutrally buoyant.** If this assumption is seriously violated (e.g. winter tier for a heated discharge or the discharge of cooling water) the central office should be contacted for case by case assistance.

Mixing processes result in an effluent plume that is not completely mixed across its width. The concentrations across a plume after initial mixing is complete are distributed according to a normal distribution with the maximum concentration at the center of the plume. The distribution of concentrations within a plume attached to the bank looks about like 1/2 of a normal distribution with the maximum at the bank.

Mixing and dilution widens a plume and flattens the lateral concentration distribution downstream from the outfall. Theoretically, the normal distribution will never flatten out entirely and so complete mix must be arbitrarily defined in terms of some percent variation of a material across the width and/or depth of the stream. Less than 5% variation across the width and/or depth is perhaps the most common definition of complete mix.

However, the materials for which this protocol is developed (toxic materials) may have concentrations near the quantification level (QL) and may be near or below the method detection limit (MDL) at the edge of the plume. Analytical variability could easily result in greater than 5% variation among such samples. Since this protocol may tend to establish a definition for complete mix and since dischargers may wish to demonstrate complete mix for their effluent, a definition is needed that has a reasonable chance of being demonstrated in the field. A variation in concentration of 20% or less is recommended as the definition of complete mix for toxic materials.

Note: for materials which can be measured with much more precision or for concentrations much larger than the QL a smaller variation may be used.

The average dilution with distance downstream is roughly linear and ranges from near zero at the discharge point to the maximum possible amount at the complete mix point.

Drifting organisms will spend the maximum time in the PMA, therefore, if they are protected then all organisms to which the standard applies will be protected. Calculating exposure times for a drifting organism depends upon the assumptions made regarding the trajectory of the plume and concentration distributions within it in conjunction with the trajectory of organism relative to the plume. This rapidly becomes too complex for routine analysis and some simplifying assumptions must be made.

A typical assumption is that all organisms move along the path of maximum concentration from the discharge point to the point of complete mix. This assumption is much too conservative, particularly, with regard to chronic toxicity.

If drifting organisms are assumed to generally be moved about by the same eddy currents that are responsible for most of the ambient lateral mixing, then it can be reasonably assumed that, on the average, they will not remain in the center of the plume for the entire distance required for mixing.

It is reasonable to assume that, as they are swept downstream by the current, drifting organisms will also be moved about laterally at about the same rate and by the same processes that result in mixing. The result is that the **average organism** in a plume will be exposed to roughly the **average concentration** across the plume as the organism moves downstream. About the same result is obtained if it is assumed that there are no concentration gradients within the plume (complete mix within the plume at any point) and that organisms follow a simple straight path through the entire PMA. The latter is much easier to implement and should be utilized.

The following assumptions will therefore be made for this development:

- **Lateral mixing will be assumed to be a linear function of distance downstream.**

- **Complete mix will be defined as that point where the variation in concentration across the depth and/or width of the stream is 20% or less.**

- **It will be assumed that there are no lateral or vertical concentration gradients within the plume.**

- **Passing and drifting organisms will be assumed to remain within the plume from the discharge to the complete mix point.**

The usual discharge configuration into free flowing streams is simply a pipe or channel entering at the side of a stream and in many cases the effluent runs down the bank or across rip-rap. The velocity of the average effluent, as it actually enters the stream, is usually not significantly greater than the velocity of the stream. Under these conditions the initial mixing phase can be expected to be completed very rapidly, to result in limited initial mixing and to produce a plume that is coflowing with the stream and attached to the bank. Almost all mixing is due to far field ambient mixing in such cases. Therefore, initial mixing processes will be neglected. However, if the effluent actually enters the stream at a velocity that is significantly greater than the stream velocity, the central office should be contacted for assistance. Significant, as used here, is difficult to define but generally initial mixing may be significant if:

- The effluent velocity, as it enters the stream, is at about 1 to 2 ft/sec greater than the stream velocity.

- An initial plume can be visually observed (color, or turbulence) extending more than about 10% of the distance across the stream.

Design Stream Flows and Exposure Times:

Chronic toxicity:

The analysis of the PMA will be carried out using the 7Q10 stream flow. The exposure time for drifting organisms within the PMA will be estimated.

The theoretical models that will be applied can be expected to be in error by as much as plus or minus 50%. This makes it necessary to introduce some conservative considerations into the analysis. Considering the complexity of the standards and the mixing process, the most direct way to accomplish this is to simply modify the exposure time. In order to adjust for the largest expected error, **the exposure times within the PMA will be compared to two days** for judging its acceptability (50% of the exposure allowed by the chronic standards).

Acute toxicity:

The analysis of the PMA will be carried out using the 1Q10 stream flow. The exposure time for drifting organisms within the PMA will be estimated.

The acute toxic criteria have already had a 50% reduction applied. Due to recommendations by EPA, the acute concentrations in the standards are only 50% of the final acute value (FAV) obtained by biological toxicity testing. The Criteria Maximum Concentration, CMC, (adopted as the standard criteria) is defined as one half of the final acute value for a specific toxic pollutant. The FAV is defined, by EPA, as "an estimate of the concentration of the toxicant corresponding to a cumulative probability of 0.05 in the acute toxicity values for all genera for which acceptable acute tests have been conducted with the toxicant". This simply means that the FAV prevents acute toxicity 95% of the time for the genera tested and the standard is 1/2 of this value. Introducing further conservative assumptions seems unwarranted. The exposure times within the PMA will therefore be compared to the full 1 hour exposure allowed by the standards for judging the acceptability of the PMA.

Models:

Mixing models and typical parameter values are described in various literature sources e.g. *Mixing in Inland and Coastal Waters*, Fischer, et al, 1979, *Modeling of rivers*, Chapters 15 and 16, H.W. Shen, 1979, *Technical Support Document for Water Quality-based Toxics Control*, USEPA, 1991 (TSD), the CORMIX expert systems produced by Cornel University. These models range from simple to extremely complex and are available for point, line and distributed sources. Considering that extensive field data and specific technical expertise are necessary to create and calibrate such models and considering that this guidance is intended to be applied as a general evaluation tool by permit writers, the simplest reasonable modeling approach will be used.

The model that will be used here is described by equations 2.68, 5.1, 5.6, 5.8, 5.9 as found in *Mixing in Inland and Coastal Waters*, Fischer, et al, 1979. This same model forms the basis for certain recommendations in the TSD. The model assumes a rectangular channel and one dimensional steady state mixing.

Equation 5.1 defines the shear velocity as: $u^* = (gdS)^{0.5}$, where g = acceleration of gravity, d= stream depth and S = stream bed slope.

Equation 5.6 defines the transverse mixing rate as E = 0.6du*.

Note: Equation 5.6 describes more or less normal streams that have moderate sidewall irregularities and are slowly meandering. Curves in the channel and bank irregularities will enhance mixing but not enough is known to mathematically describe the processes. This development will apply arbitrary correction factors for streams that are more irregular than those for which the model was developed. E will simply be multiplied by the factor. The correction factors are:

Slowly meandering streams having moderate sidewall irregularities (Most larger rivers and streams): factor = 1.0

Rapidly meandering streams with significant sidewall irregularities (smaller streams with shorter curves and significantly different widths over short distances): factor = 1.5

Extremely irregular channels (smaller mountain streams with very rocky bottoms and sidewalls): factor = 2.0

Equation 2.68 defines the general solution:

$$C_{(x,y)} = \frac{M}{u[(4pE\frac{x}{u})^{0.5}]} e^{(\frac{y^2 u}{4Ex})}$$

where:
C = concentration of material

M = mass of source per unit time
u = average stream velocity
x and y are distances in the down stream and lateral directions respectively.

Equation 5.8 defines the dimensionless quantities:

Co = M/udW, x' = xE/uW^2, y' = y/W, where W = channel width

Equation 5.9 defines the concentration distribution from a source at y'_o as:

$$\frac{C}{C_0} = \frac{1}{(4\pi x')^{0.5}} \sum_{-\infty}^{\infty} \{e^{(\frac{-(y'-2_n-y_0)^2}{4x'})} + e^{(\frac{-(y'-2_n+y_0)^2}{4x'})}\}$$

For a source located at the center of the stream (y'_o = 0.5), the concentration is within 20% of the mean everywhere on the cross section when x' is greater than about 0.06. The length of stream required for complete mixing with a center discharge is then:

$$L = \frac{0.06uW^2}{E}$$

A source located at the edge of the stream (y'_o = 0.0) requires 4 times the distance to mix as one at the center so the length of stream required for mixing with a discharge at the bank of the stream is:

$$L = \frac{0.24uW^2}{E}$$

$$L = \frac{0.06uW^2}{E}$$

The time required is simply L/u in both cases.

Note on source assumptions: The model above assumes a constant line source at the bank of a stream. For most applications, the error introduced by this assumption will not be significant.

When the effluent is large relative to the stream it may form an initial plume that could more adequately be modeled as an initial distributed source over some fraction of the stream width. The error would be maximum when the distributed source occupies half the stream width. A distributed source model may estimate a mixing length of about 75% of that estimated by the simpler model. Neglecting initial mixing, therefore, does not add unacceptable error to this simple screening tool that should remain somewhat conservative. Even these minor differences disappear rapidly as the fraction of stream occupied by the distributed source becomes smaller or larger than 50%.

The added complexity of including initial mixing for a simple screening tool is not worth the presumed increased accuracy considering the complexities of such mixing, the difficulties associated with ease of staff support, ease of application and the ability of the permit writer to explain the protocol.

However, in borderline cases, consideration should be given to requesting assistance from the central office for a more complex or realistic model. For example, if a discharge is 52% of the stream flow and the estimated mixing time is 1.1 hours (where 1 is acceptable) then a closer look with a more sophisticated model is indicated).

If the time required for mixing, at 1Q10, to reduce the concentration to the standard is less than 1 hour then the PMA is acceptable relative to acute toxicity. Acceptable means that passage through PMA cannot cause lethality at the design conditions.

Likewise, if the time required for mixing, at 7Q10, to reduce the concentration to the standard is less than 2 days then the PMA is acceptable relative to chronic toxicity. Acceptable means that passage through the PMA cannot cause chronic effects at the design conditions.

An acceptable PMA indicates that the actual process of mixing can be neglected and that complete mix assumptions using the appropriate design stream flow may be utilized to calculate the wasteload allocation. This provides the determination for each case as required in the WQS at 9 VAC 25-260-20.B.4.a.

If the PMA resulting from the proposed effluent is unacceptable three alternatives are available:

1. The physical configuration of the discharge structure or the location of the structure may be modified to achieve an acceptable PMA. This may involve installation of a diffuser, outfall relocation, etc. and should be described in the permit application. Note that the mixing length can be reduced by a factor of 4 simply by moving the discharge to the center of the stream! Of course, this would involve the installation of a proper outfall pipe and perhaps a diffuser and is not addressed herein.

2. Wasteload allocations may be identified that will result in a reduction in effluent concentrations.

3. A regulatory mixing zone may be specified in the permit. This alternative should identify the boundaries of the RMZ and concentrations that must be maintained at the boundaries in accordance with the standard. A monitoring requirement, at the RMZ boundary, should be included in the permit to ensure compliance with the standard.

The first alternative is a matter of design and must be proposed by the discharger, emphasis will be placed on the second alternative as a means to achieve an acceptable PMA in cases where mixing is somewhat slow. **However, the discharger should be made aware that other alternatives may exist and should be requested to consider proposing design modifications to the outfall structure before more stringent limitations are imposed.**

The second alternative simply consists of identifying a lower effluent concentration than currently exists (or is proposed). The basis for identifying the proper effluent concentration is simply: exposure times to concentrations above the standard is kept below 2 days (chronic) and 1 hour (acute). Since the mixing is assumed to be a linear function of distance the degree of mixing can be calculated for any distance downstream. The amount of mixing that occurs over the allowed exposure time and the proportion of stream flow that has mixed with the effluent during that time is calculated. This proportion of stream flow is used to calculate a reduced WLA (using a complete mix assumption) that will comply with the standards.

Exclusions: This model assumes a single source located at the side of the stream that becomes completely mixed with the receiving stream. If another source of waste or a major tributary enters the PMA or RMZ, a request for central office assistance should be considered.

WLA Calculations:

The 7Q10 and 1Q10, or some percentage of those flows (the percentage to be used is identified by the program, MIX.EXE), will be used in a simple mixing calculation to determine the WLA for both acute and chronic toxicity, e.g.:

$$WLA = \frac{[Std(Qs(f) + Qd] - (Qs(f)Cs)}{Qd}$$

where: WLA = wasteload allocation
Std = the stream standard
Qs = stream flow
Qd = effluent flow
Cs = background concentration in the stream
f = decimal fraction of low flow to use

f is given by MIX.EXE as a percentage and must be converted to a decimal fraction
i.e.: 75% = 0.75

Software:

A computer program is included with this guidance to solve the model equations. It is very simple and only very basic physical data are required. Due to the simplicity, the data are not saved. A hard copy of the results, suitable for the fact sheet, can be printed if desired.

The program is MIX.EXE and it must be properly installed before execution.

Example:

The input data needed for the program are:

- Name of discharger
- 7Q10 stream flow
- 1Q10 stream flow
- Effluent flow
- Stream slope
- Stream width
- A number representing the roughness of the stream bed
- A number representing the degree of meandering

The first 3 items are readily available to the permit writer and will not be discussed.

The effluent flow is the same design flow that is being used for all other permit actions so should not present a problem.

The stream slope can be obtained from topographic maps and the procedure is the same as is used in the Regional Stream Modeling System. The distance over which the slope should be estimated is difficult to determine without some knowledge of the mixing length. It is suggested that using the slope for the first 1/2 to 1 mile below the discharge is a reasonable approximation.

Some general rules of thumb can be found in canoeing handbooks that may be of general assistance:

0 – 2 ft/mile (0.00038 ft/ft) – flat water with minor riffles
3 – 6 ft/mile (0.00057 – 0.001 ft/ft) – moderate rapids or pool and riffle
> 6 ft/mile – heavy rapids or pool and riffle.

The average stream width is estimated during a field inspection. Again use the same procedure as those required for the Regional Stream Model. Note that the width needed is that associated with a drought flow. It will require some experience and imagination to look at a stream under high flow conditions and see in your mind's eye what it would look like during an extreme drought. Rough field estimates of the flow at the time of the inspection and knowledge of the 7Q10 and 1Q10 will greatly assist you in this assessment. Knowledge of general flow characteristics of streams will also greatly assist in making this estimate. Many streams should be observed and their flows measured or estimated so that one gets a feel for what a stream that carries a particular flow looks like. Keep in mind that flow, in cfs, is simply the width times the depth times the velocity. Flow, in MGD, is about 0.6 times the flow in cfs. Quick field estimates based on these approximate relationships can be very helpful.

The number representing the bottom roughness is simply on a scale of 1 to 5:

1 represents a sand or silt bottom that is very smooth and even.
5 represents a very rough bottom consisting of large rocks and boulders.
2 through 4 simply grade between these two extremes with 3 representing the "average" stream.

The number representing the degree of meandering or bank irregularities is simply on a scale of 1 to 3:

1 represents a moderately meandering channel of moderate uniformity.
2 represents a smaller stream with more significant meandering and less uniform channel.
3 represents a severely meandering and very non-uniform channel.

There will be cases where the entire stream flow cannot be used. In these cases the program will identify some percentage of the stream flow to use. For example, if the program indicates that only 50% of the 1Q10 can be used for the acute WLA then the 1Q10 would be multiplied by 0.5 and the result used with a complete mix assumption to determine the WLAa, i.e. "f" = 0.5 in the complete mix equation previously presented.

Implementation Concepts - Tidal Waters:

Background:

Generalized concepts can be successfully applied to free flowing streams because of several considerations:

- mixing across the width is usually the most important consideration,
- vertical mixing can usually be neglected due its rapidity compared to lateral mixing,
- longitudinal mixing can usually be neglected due to its insignificance,
- things move only in one general direction; downstream.

None of these are generally true for tidal waters.

Discharges into tidal waters fall naturally into several categories. The most common distinctions among these categories are:

- Location in the estuary - locations near the fall line may have characteristics similar to free flowing streams while locations near the ocean have distinctly different mixing processes.

- Design of outfall structure - a discharge to the surface of an estuary and a discharge to the bottom of an estuary have very different mixing characteristics. For example, a single pipe to the surface and a submerged multiport diffuser result in vastly different mixing rates.

- Relative density - an effluent whose density is different from the receiving water has very different mixing characteristics than if the densities are about equal. This aspect of mixing becomes most critical in saline waters receiving fresh water effluents.

These categories grade into one another without any clear and definite boundaries so that it is difficult to classify estuarine mixing processes but there are some generalities:

1. All domestic and most industrial process water effluents discharged to estuaries consist of fresh or almost fresh water. The density of the effluent may be about equal to the stream in the tidal, fresh water portions of the estuary but the effluent density is generally less than the stream in saline waters. The density differences in saline waters may speed mixing for bottom discharges but may significantly inhibit mixing for surface discharges.

2. Mixing in estuaries is generally such that all three dimensions (depth, width and length) must be analyzed.

3. Many large effluents to estuaries are discharged through subsurface diffusers of some type (designs vary widely). This results in a rising plume(s) that may or may not reach the surface. Ambient mixing is complex and difficult to analyze. The complete mix locations are almost impossible to determine and from a theoretical standpoint do not exist. **This means that the complete mix assumption is practically never appropriate for tidal waters**.

4. Most small effluents to estuaries are discharged via a simple pipe to the surface of the stream or to its bank. In saline waters, density differences oppose mixing and initial stratification of the effluent is common. Both initial and ambient mixing processes are complex and difficult to analyze.

In addition to the three dimensional characteristics of mixing in tidal waters, are the difficulties associated with estimating the residence time, and thus exposure times, of organisms at or near a particular location. The definitions for passing and drifting organisms are not much help in this situation because net advective velocities may be very, very small. Drifting organisms in particular may spend very long times near or in an effluent plume because both the plume and drifting organisms tend to move along with tidal currents.

While apparently applicable to all waters, it seems clear that the mixing zone standard was intended primarily for application to free flowing streams. It would be extremely difficult to analyze a PMA or to determine compliance with the standard for drifting organisms in tidal waters (either theoretically or with field data). The concepts associated with tidal mixing are not amenable to the simplifying assumptions that can be applied to free flowing streams.

Formidable difficulties may also be encountered in an attempt to establish a RMZ in estuaries. In many locations, the requirement in the standard regarding the length and width of a RMZ is simply inappropriate or cannot be adequately defined, *e.g.* discharges to the open ocean or the Chesapeake Bay.

Recommendations cannot be made for a general protocol that could be applied to the majority of dischargers to tidal waters. Only some general recommendations for specific situations can be made.

Recommendations for Tidal Waters:

In those cases where a subsurface diffuser is used and where a well developed plume exists, analysis of the initial mixing plume with the requirement that the all standards be met at the edge of the plume is recommended. No standard needs be met within the confines of the plume.

It is recommended that we not attempt to routinely implement the present mixing zone standard for other discharge configurations in tidal waters and continue to use the default values of 50:1 for chronic and 2:1 for acute toxicity.

As for flowing streams, if the receiving water has resident organisms that require special protection or rare and endangered species within reasonable proximity of the proposed mixing zone then this guidance should not be used unless data exists that demonstrate that the parameters for which a mixing zone is being allowed will not result in adverse impacts on that species.

Swamps/Marshes:

In a swamp environment, mixing is very limited. Due to the generally wide expanse of shallow, standing water, the effluent simply tends to displace ambient water so that initial mixing processes occur in an area where no significant dilution is available. There is very little turbulence and ambient mixing is mostly due to concentration gradients. Thus, it takes place very, very slowly.

Tidal marshes are periodically flooded at high tide but usually do not have standing water during the entire tidal cycle. Mixing in this situation is intermittent and complicated and is not amenable to analysis.

It is recommended that no mixing zones be allowed in these situations unless the discharger provides actual physical/chemical data to demonstrate acceptable conditions. This means that the effluent itself should meet all applicable criteria prior to discharge.

Lakes:

Mixing in lakes is complex and depends mostly on initial jet effects near the discharge point and extremely slow ambient mixing. There is normally very little turbulent mixing below the surface in lakes and what turbulence that exists near the surface is usually caused by the wind. If the lake is thermally stratified, pollutants may be trapped in either the epilimnion or hypolimnion for extended periods of time (6 months or more). Exposure times in such circumstances can easily violate the WQS for all organisms.

It is recommended that no mixing zones be allowed in lakes unless the discharger provides actual physical/chemical data to demonstrate acceptable conditions both within the mixing and the lake as a whole. This means that the effluent itself should meet all applicable criteria prior to discharge.

In order to consider decay the actual boundaries of the mixing zone and the residence time within it for passing or drifting organisms must be known. The model included with this guidance is not suitable for this application because it was not formulated to accurately model a mixing zone. **If a discharger wishes to account for decay within a mixing zone then it is recommended that he be required to submit a study that defines the boundaries of the actual mixing zone and associated hydraulic considerations.**

NOTES ON THE RELATIONSHIP BETWEEN ANTIDEGRADATION AND MIXING ZONES

The mixing zone standard at 9 VAC 25-260-20.B.6.b prohibits new or expanded mixing zones in tier 2 waters unless the antidegradation requirements for tier 2 waters are satisfied.

Note: expansion, in this context, means to enlarge the area where the criteria are exceeded. It results that any increase in flow or concentration would have to be accompanied by a reduction in pollutant concentration or modified discharge configuration in order to maintain the same concentration at specified points in the stream.

The antidegradation implementation requirements for tier 2 waters is that, if not more than 25% (10% for the human health standards) of the unused assimilative capacity is allocated, then the resulting change in water quality is insignificant and can be allowed without implementation of the intergovernmental coordination, public participation and showing of socio-economic need requirements in 9 VAC 26-260-30-A.2.

New discharges:

It results that new mixing zones may be allowed in tier 2 waters providing that the appropriate baselines are established and the resulting water quality at the edge of the mixing zone is equal to or below the baselines. This satisfies the requirements of 9 VAC 26-260-30-A.2.

Note: for future reissuances this mixing zone cannot be expanded without full implementation of the requirements of 9 VAC 26-260-30-A.2.

Existing discharges:

There are many discharges that have been in place for many years where the effluent limits derived according to older protocols have resulted in mixing zones. These zones may not have been officially derived, sized or condoned (see the discussion relative to physical mixing zones). However, that they exist and may be in tier 2 waters is a fact that must be considered. This is particularly true for large tidal bodies of water where a small mixing zone that has historically existed does not impact the overall body of water. Small discharges into large rivers may also have resulted in mixing zones that exist in tier 2 waters.

Antidegradation considerations would seem to indicate that the maximum available lowering of water quality has already been granted to such dischargers. In this case the, baseline would be represented by the existing quality at the edge of the existing mixing zone. Expansion of such a zone is prohibited unless the requirements of 9 VAC 26-260-30-A.2 are satisfied.

ANTIBACKSLIDING

Background:

Backsliding is defined as issuing or modifying a VPDES permit to have less stringent limits for a pollutant than the existing (previous) permit. Such backsliding is prohibited in many instances and the body of regulations that specify when and to what extent backsliding can occur are collectively called antibacksliding.

During permit actions that involve removing or lessening the stringency of a permit limit, antibacksliding becomes the primary concern. Past guidance at both the state and federal level is not complete and is often contradictory. The purpose of this section is to provide a discussion of antibacksliding regulations, their requirements and limitations and to recommend implementation procedures.

Some of the guidance according to which limits are developed for our VPDES permits has undergone and continues to undergo significant changes over short time periods. This is because the original guidance was excessively conservative due to the many unknowns that had to be dealt with. Rapidly changing and/or developing technology, better quality data and more accurate guidance results in the frequent need to adjust a permit limit. Due to the extremely conservative nature of the initial guidance, many of these needed adjustments are to some less stringent level. In addition, there is often the need to have the flexibility to include a limit in a permit with the understanding that upon the completion of certain requirements or demonstrations the limit will be removed if it is proven to be unnecessary. Dischargers, to date, have been extremely reluctant to accept this latter approach because of the uncertainties associated with the antibacksliding requirements.

Virginia's VPDES regulation (9 VAC 25-31-10 et seq.) and the antibacksliding provisions it contains (9 VAC 25-31-220.L) are identical to the requirements of the Clean Water Act (Act) as amended by congress in 1987. It is assumed that there are no other valid constraints regarding backsliding (in particular, it is assumed that the Act will take precedence if it differs from the old EPA regulations that predate the 1987 amendments by about a decade).

Brief references to the Clean Water Act:

The antibacksliding provisions are set forth in section 402(o) of the act [United States Code, title 33 chapter 24, section 1342(o)] and the Virginia VPDES permit regulation at 9 VAC 25-31-220,L. Both of these reference several other sections of the Act. For reference, those sections of the Act are:

301(b)(1)(C), [USC 33 § 26 §§ 1311(b)(1)(C)] - requires that any needed permit limits that are more stringent than the technology based minimum effluent limits must be in place by 1977.

303(d), [USC 33 § 26 §§ 1313(d)] - addresses priority water bodies for which the technology based minimum effluent limits are not sufficiently stringent and requires the identification of total maximum daily loads (TMDL).

303(d)(4), [USC 33 § 26 §§ 1313(d)(4)] - This section contains additional/alternative considerations when modifying permit limits. There are two parts:

1. Waters where the standard is not attained - limits can be revised only if the new TMDL (or other limitation derived under section 303) will result in attainment **or** if the designated use that is not being attained is removed.

2. Waters where the standard is attained - limits can be revised if the new limits were derived under section 303, will attain the standard and are subject to and comply with antidegradation.

303(e), [USC 33 § 26 §§ 1313(e)] - requires a continuing planning process. This process, among other things, must identify effluent limits.

304(b), [USC 33 § 26 §§ 1314(b)] - requires EPA to develop and promulgate technology based minimum effluent limits for publicly owned treatment works and certain categories of industry.

402(a)(1)(B), [USC 33 § 26 §§ 1342(a)(1)(B)] - provides the authority for permit limits based on judgement and/or opinion (the, so called, Best Professional Judgement (BPJ) limits).

Types of Permit Limits:

Commonly, there are three types of permit limits that we refer to and distinguish by the requirements that make them necessary:

1. Minimum effluent guideline limits, applicable to all dischargers in a specified class as minimum legal requirements. These are promulgated by EPA according to § 304(b) and § 301(b) of the Act and are based on the capabilities of existing and/or available technology. There is no consideration of water quality standards or other in-stream requirements as the basis for these limits; **They are based solely on considerations of waste treatment technology and are promulgated as federal regulations**. Included in this category are the secondary treatment requirements for POTWs and industrial BAT, BCT, BPT, etc.

   Also included in this category are effluent limits promulgated as regulations by the state. **These limits are regulations and no alternatives can be accepted**. Examples include: Potomac Embayment standards, Chickahominy Standards, Dulles Watershed Policy, the Occoquan Policy, Nutrient Sensitive Waters Policy, etc.).

   These limits will be referred to as **technology limits** herein.

2. Limits based on best professional judgement. These limits generally result when:

   a. There is a pollutant of concern but minimum effluent guidelines have not been promulgated for the category.

   b. A pollutant of concern must be controlled to attain a narrative water quality standard that cannot be quantified.

   c. There exists a numerical standard where a limit to ensure compliance cannot be reasonably quantified.

   The basis for such limits generally fall into one of two categories:

   1. Agency guidance - The judgement is contained in guidance that reflects a consensus of the agency's opinion. **Such guidance is not regulation and reasonable, valid alternatives are acceptable**. Such guidance provides adequate justification for permit limits that are normally included for specific parameters in certain types of permits.

2. Case by case decisions - The difference between this and "a" above is that these are case by case considerations made by specific permit writers for specific permits and are not contained in formal agency guidance.

The basis for BPJ limits may be either water quality or technology considerations. The distinction for these limits is that they are ultimately based on judgement.

These limits will be referred to as **BPJ limits** herein.

3. Water quality based limits. These limits result:

   a. When the minimum effluent guideline limits are not sufficiently stringent to maintain compliance with a water quality standard and a more stringent limit is required.

   b. When a numerical standard exists and where the permit limit needed to attain compliance can be reasonably quantified, *e.g.* based on modeling studies.

   c. As a result of a TMDL or waste load allocation resulting from the continuing planning process.

Permit limits that are neither technology or BPJ based will be referred to as **water quality limits** herein.

Note: It is sometimes difficult to distinguish between BPJ limits and water quality limits because the predictive technology available involves a large measure of judgement and opinion. The key consideration that we would recommend to distinguish between the two is the means used to identify the limit. If a model or other predictive tool is used to quantify the conditions that are expected to result from a particular limit and those conditions are compared to a numerical standard then that limit should be considered a water quality limit.

The Antibacksliding regulations:

Section 402(o) of the Act and the Virginia VPDES permit regulation at 9 VAC-25-31-220.L are general prohibitions against the issuance of a permit that contains BPJ or water quality limits (technology limits are not addressed) that are less stringent than comparable limits in the previous permit. The prohibition has two parts that address BPJ and water quality limits separately. Briefly, they are:

1. BPJ limits [based on section 402(a)(1)(B) of the Act] that have become effective may not be made less stringent <u>if the basis for the change is newer, minimum effluent guidelines</u> promulgated subsequent to permit issuance.

   Note: This restriction addresses only BPJ limits, and the only restriction on changing these limits is that the basis cannot be newer effluent guidelines (technology limits) promulgated according to section 304(b) of the Act. No other restrictions would seem to apply.

2. Water quality limits [based on sections 301(b)(1)(C), 303(d) and 303(e)] may not be made less stringent unless the change complies with section 303(d)(4).

Note 1: If the modified limit in #1 or #2 above complies with section 303(d)(4) of the Act then the antibacksliding prohibitions do not apply.

Note 2: Antibacksliding does not address and therefore does not prohibit modification of limits based on minimum effluent guidelines promulgated according to section 304(b). However, the requirements in section 303(d)(4) may restrict such modifications.

There are six exceptions to the above prohibitions:

1. Limits may be made less stringent if material and substantial alterations or additions have been made to the facility that would justify less stringent limits.

   Note: For a POTW, facility means the collection system, industrial contributors, and the waste treatment plant from the headwork to and including the outfall structure. For an industry, facility means all buildings and appurtenances associated with the industrial activity including the treatment facility.

2. New information (other than revised regulations, guidance or test methods) is available which would have justified a less stringent limit but was not available when the old permit was issued.

   Note 1: The water quality standards are regulations, therefore, exclusion #2 does not allow a modified limit if a new, less stringent standard is adopted.

   Note 3: New information does not include any information that was available at the time the permit was issued.

3. Technical mistakes or mistaken interpretations of law were made in issuing a permit containing BPJ limits.

   Note: This exclusion applies solely to BPJ limits (determined under section 402(a)(1)(B) of the act. It results that this exclusion does not apply to water quality limits even if it can be documented that a mistake was made.

4. Less stringent limits are necessary because of events over which the permittee has no control and there is no reasonably available remedy.

5. The permittee has received a permit modification under one of several sections of the act that specifically allow modifications of permit limits (including technology limits). Briefly, these sections and subject matter are:

   301(c) - maximum use of technology,
   301(g) - certain non-conventional pollutants,
   301(h) - discharges to marine waters,
   301(i) - compliance schedules to meet certain limits,
   301(k) - innovative technology,

301(n) - fundamentally different factors,
316(a) - thermal discharges.

6. Treatment **facilities have been installed** to meet the existing limit and have been properly operated and maintained but compliance has not been achieved. The limit may be reduced to the actual degree of pollutant control achieved but may not be less stringent then existing effluent guidelines.

   Note 1: Data must be available to demonstrate not only that compliance cannot be achieved but to demonstrate what has been achieved to date.

   Note 2: **Proper facilities** must have been **built** and **operated**. Non-compliance for any other reason is not acceptable under this exclusion.

   Note 3: The treatment actually attained and the resulting less stringent limit must result in attainment of all applicable water quality standards.

The final requirements of antibacksliding establish limitations on the extent to which a limit may be made less stringent:

1. No permit limit may be made less stringent than the technology limits in effect at the time of permit issuance.

2. No permit limit may be made less stringent than what is required to attain a water quality standard (including antidegradation considerations).

Application of Antibacksliding:

<u>General:</u>

Permit limits that are contained in a VPDES permit but <u>have not become effective are not subject to antibacksliding</u> and may be modified for any reason providing that such modification is made prior to the date on which the limits become effective and providing that all water quality standards will be attained.

<u>Technology Limits:</u>

The basis for these limits is minimum effluent guidelines promulgated according to § 304(b) or § 301 of the Act or regulations promulgated by the Virginia State Water Control Board. **Antibacksliding does not address and therefore does not apply to this category of limits**. If newer less stringent guidelines are promulgated by EPA or the state, then permit limits may be based on these newer guidelines even if they are less stringent than in the previous permit. However, the limit cannot be relaxed to the extent where any water quality standard (including antidegradation) would not be attained (Note: state regulations cannot be less stringent than the federal technology limits). In addition, no permit may be issued that contains limits less stringent than the current technology limits.

<u>BPJ Limits:</u>

The basis for these limits is best professional judgement. The only restriction on backsliding from BPJ limits is that they cannot be made less stringent **if the reason for the change is newer less**

stringent effluent guidelines promulgated according to section 304(b) of the Act. It would appear that BPJ limits can be made less stringent for any other reason, including the exceptions listed above. However, such modifications should be thoroughly considered prior to implementation and should be fully documented in the fact sheet for any permit where the judgement leading to a specific limit is being modified. In addition, the permit writer should be prepared to defend the revised judgement in all appropriate forums.

Water Quality limits:

The basis for these limits is generally the requirements of a specific water quality standard. In these cases there is either no technology limit in existence for that parameter or an analysis demonstrates that an existing technology limit is not sufficiently stringent to attain the standard.

These limits cannot be made less stringent unless one of the 6 exceptions listed above applies or the change complies with § 303(d)(4) of the Act.

Section 303(d)(4) of the Act:

Antibacksliding does not apply to a water quality limit that is made less stringent if the change complies with § 303(d)(4), e.g. any water quality limit may be made less stringent:

1. if the new limit is at least as stringent as any effluent guidelines in effect at the time of permit issuance, **and**

2a. if the standard is not being attained:

   i. the revised TMDL will result in attainment or,
   ii. the beneficial use that was not being attained has been removed,

or,

2b. if the standard is being attained then the revised limit is subject to and complies with antidegradation.

Note that in order to be in compliance with § 303(d)(4) the new limitations must be based on a TMDL or other wasteload allocation established under section 303 (river basin plan, etc).

Examples:

Examples involving Technology Limits:

An industry has a TSS limit of 20 mg/l based on the minimum effluent guidelines. EPA promulgates new minimum effluent guidelines that establishes TSS limits of 30 mg/l for that industry. May the limit be relaxed.

Yes - Antibacksliding does not prohibit the modification of technology based limits providing all applicable water quality standards (including antidegradation) will be attained.

An industry has a BOD limit of 40 mg/l based on a water quality model. EPA subsequently promulgates minimum effluent guidelines that establishes BOD limits for the facility at 50 mg/l. May the limit be relaxed?

No - Technology limits can be applied only if they result in attainment of the water quality standards. According to the model the new effluent limits would not maintain water quality.

An industry has a BOD limit of 40 mg/l based on minimum effluent guidelines and a model shows that this limit is not necessary to maintain the standard. A new modeling study indicates that the discharge of 100 mg/l would allow the standard to be maintained. May the limit be relaxed?

No - no permit limit may be less stringent than existing effluent guidelines.

An industry has a limit based on minimum effluent guidelines and after permit issuance it was discovered that the guidelines were applied in error and that correct application would lead to a less stringent limit. May the limit be relaxed?

Yes – an exception to backsliding allows this relaxation.

A permit writer placed BPJ limits in a permit based solely on the minimum effluent guidelines for a similar industry. May the limits be relaxed?

Yes - this is a case where a mistaken interpretation of law lead to the BPJ limits and an exception allows the limit to be modified.

Note: It is not an error or mistake in law to utilize the guidelines promulgated for a similar industry or process to assist in formulating a BPJ limit. However, the development of and justification for the limit requires more than just simply applying the guidelines for a similar industry. A discussion, in the fact sheet, of how and why the judgement was formulated for the particular limit and exactly how the guidelines for a similar industry influenced the decision should suffice to avoid a misapplication of the guidelines.

The State Water Control Board, based on new studies, revises the effluent BOD requirement in the Potomac Embayment Standards from 3 mg/l to 10 mg/l. Existing permits have a BOD limit of 3 based on these regulations. May the limit be relaxed.

Yes - These limits are considered to be minimum effluent limits. Antibacksliding does not prohibit the relaxation of such limits providing the regulations are modified prior the action.

Examples involving BPJ Limits:

A permit has a TSS limit of 20 mg/l. The basis for the limit was BPJ. After the permit was issued EPA promulgated effluent guidelines that require TSS limits of 30 mg/l. There is no water quality standard for TSS and no designated use will be the threatened if the limit is reduced. May the limit be relaxed?

No - the regulations expressly prohibits a relaxation of BPJ limits where the basis is newer effluent guidelines.

A permit has a O&G limit of 20 mg/l. The basis for the limit was a professional judgement estimation of the efficiency of an oil and water separator. A new permit writer having much more expertise in the design and operation of this equipment believes that the limit should have been 25 mg/l. May the limit be relaxed?

Yes - Since the modification was not based on new effluent guidelines antibacksliding would not prevent the modification. **However, complete justification for the revised judgement, including a discussion of the relative expertise of the two permit writers, should be provided in the fact sheet and backed up with whatever literature is available.**

A permit has a BOD of 10 mg/l based on agency guidance that established BPJ as a consensus of agency opinion. The permit writer reviewed the guidance and found that it was applicable to a particular case and included the limit. Subsequently, the State Water Control Board adopted regulations that established the BOD limit for facilities in this category at 20 mg/l. The permit writer wishes to use the regulation as a basis for relaxing the limit. May the limit be relaxed?

No - The regulations prohibit backsliding from BPJ limits where the basis is new minimum effluent limits. Recall that such state regulations are considered to be minimum effluent guidelines.

Examples involving Water Quality Limits:

A POTW permit has a limit of 2.0 mg/l for ammonia that was derived by a mathematical model to attain the dissolved oxygen standard. Data for the past 5 years indicate that the effluent contains insignificant ammonia concentrations (max = 0.5 mg/l). May the limit be removed or relaxed?

No – Although this is new information, with no limit a POTW can be expected to discharge ammonia at levels much higher than 2.0 mg/l. The limit must be maintained to ensure that proper removal of ammonia continues. However, the monitoring frequency associated with the limit could be significantly reduced.

A POTW has BOD limits of 20 mg/l. The state's antidegradation criteria is currently a maximum D.O. sag of 0.2 mg/l. The predicted dissolved oxygen sag was 0.16 mg/l. Subsequent application of the

D.O. model and development of a TMDL shows that the limit could have been raised to 25 mg/l and the predicted sag would be 0.19 mg/l. May the limit be relaxed?

Yes - It is as stringent as existing effluent guidelines, the D.O. standard is being and will continue to be attained, antidegradation applies and is complied with and the new limits was the result of a TMDL. This modification complies with section 303(d)(4) of the Act and therefore antibacksliding does not apply.

A permit has a TKN limit of 2.0 based on an uncalibrated dissolved oxygen model. The owner has installed and properly operated a STP designed to be capable of attaining the limit. However, the demonstrated treatment attained has been 2.8 mg/l. May the limit be relaxed?

Yes - However, the limit may not be relaxed beyond the demonstrated removal efficiency e.g. 2.8 mg/l and only then providing that the revised limit will result in attainment of all applicable water quality standards. It will be necessary to obtain a better model to verify that the standard will be complied with.

A non-contact, once through cooling water discharge has a pH limit of 6 to 9. The intake is from and discharge is to the same stream. The basis for the limit was the accepted standard operating practice of putting pH limits, equal to the standard, in all permits. Both the intake and effluent simultaneously show occasional pH values as high as 10. May the limit be relaxed?

Yes – an exclusion applies since the permittee has no control over the pH of the intake water and no reasonable remedy if the intake water is above his limit.

A permit has an ammonia limit of 3.0 mg/l based on the water quality standards in effect when it was issued. Three years after its issuance a new ammonia standard was adopted that was less stringent. A new analysis indicates that the limit could be raised to 5.0 and would comply with the new standard. May the limit be made less stringent?
No - The exceptions expressly say that new regulations are not a acceptable reason to backslide.

A theoretical (desktop) model was applied and a permit was written to contain a BOD limit of 20 mg/l. Thereafter, two field surveys were conducted and used to calibrate and verify a more reliable model. The new model indicates that the limit can be raised to 30 mg/l. May the limit be relaxed?

Yes - The recent data and new model is information that would have resulted in a less stringent limit if it had been available at the time the permit was issued.

A facility has a limit that is not yet effective but nevertheless the facility is capable of currently meeting the limit. May the limit be relaxed?

Yes - A limit that has not become effective is not subject to antibacksliding.

However, please note that this situation should not arise. A permit should not be written to allow a compliance schedule for meeting a limit if the facility is capable of meeting the limit upon issuance of the permit. This may violate other requirements of the VPDES regulation.

A limit is provided in the permit for a new facility and the permit is due for reissuance but the facility has not yet been built and a discharge has not commenced. May the limit be relaxed?

No - The limits are effective and the antibacksliding requirements are applicable solely to a permit and not to a facility. The physical existence of the facility is not addressed in the regulations that prevent a limit from being made less stringent than in the previous permit.

ALTERNATE IMPLEMENTATION FOR CERTAIN STANDARDS

Chlorine and Chlorine Produced Oxidants (CPO)

Chlorine and CPO limitations are determined in much the same manner as for any other toxic substance *e.g.* use of MIX.EXE, WLA.EXE, default assumptions, etc. There are differences based on the fact that chlorine/CPO is a toxicant that is purposefully introduced into the effluent and is known to be present in the effluent. Therefore, if an owner chlorinates his effluent, **<u>effluent data are not necessary</u>** to determine that a reasonable potential exists for the facility to cause or contribute to a violation of the standards. **Therefore, all chlorinated effluents must have a chlorine and/or CPO limit.**

The application of WLA.EXE, in this case, simply requires the user to input a fictitious datum that is sufficiently large to force the program to calculate a limit.

The recommended minimum monitoring frequency for total residual chlorine in the final effluent is 1/day for all domestic facilities that have a design flow greater than 1000 gpd. This frequency is sufficient for assuring protection of the receiving stream. This is similar to the monitoring for other toxic materials. Increasing the frequency of monitoring on a case-by-case basis may be appropriate. However, in most instances, the permit limits for disinfection or operation and maintenance requirements may require more frequent internal monitoring to insure adequate disinfection. As there are various types of discharges from an industrial source which may contain chlorine, the monitoring frequency for these can be set as per existing guidance. However, 1/day should be considered.

An upper, technology based, limit is recommended where the chlorine limit, based solely on dilution, would be excessive. 4.0 mg/l is recommended as the maximum limit. If a WLAa of 4.0 is input into WLA.EXE then the program will calculate appropriate limits since the program will use 4.0 as the 97th percentile of the distribution that must be attained. The result will be that, if the limits are met then 97% of the daily values will be below 4.0. This is true even if the actual limits are written in terms of weekly and monthly averages. The following protocol is recommended:

- Calculate the WLAa and WLAc

- If the WLAa is greater than 4.0 mg/l, run WLA.EXE with the following inputs:
  WLAa = 4.0
  WLAc = 4.0
  One datum of 20.0 is input to force the program to calculate a limit.

- If the WLAa is less than 4.0 mg/l, run WLA.EXE with the following inputs:
  WLAa = calculated values
  WLAc = calculated values
  One datum of 20.0 is input to force the program to calculate a limit.

It is recommended that we maintain the current quantification level of 0.1 mg/l for chlorine. However, the <u>limits are included in the permit as actual numbers even if they are less than the QL</u> (see compliance reporting special condition on page 112).

The limits are placed onto the Part I.A page and are expressed as:

Domestic effluents: monthly average and weekly average.
Industrial effluent: monthly average and daily maximum.

Examples are:

- MIX.EXE and the mixing equation yields a WLAa of 11 mg/l and a WLAc of 8 mg/l.
- WLA.Exe is run with inputs of: WLAa = 4.0, WLAc = 4.0, one datum of 20.0,one sample/day
- The resulting limits are a Daily maximum = 4.0 mg/l, monthly average of 2.0 mg/l and a weekly average of 2.4 mg/l. The frequency of final effluent sampling would be 1/day.

If this were a domestic facility the monthly average and weekly average limits would be used.
If this were an industrial facility the monthly average and daily maximum limits would be used.

- MIX.EXE and the mixing equation yields a WLAa of 2 mg/l and a WLAc of 1 mg/l.
- WLA.EXE is run with inputs of: WLAa = 2.0, WLAc = 1, one datum of 20.0
- The resulting limits are a daily maximum = 2.0, monthly average of 1.0 mg/l and a weekly average of 1.2 mg/l. The frequency of final effluent sampling would be 1/day. The fact sheet should list the basis for the limits as water quality.

If this were a domestic facility the monthly average and weekly average limits would be used.
If this were an industrial facility the monthly average and daily maximum limits would be used.

Note that the limits are included in the permit as calculated by WLA.EXE if they are below the QL.

Additional TRC Limitations and Monitoring Requirements (permit special condition)

In order to ensure proper disinfection the following special condition should be included in the permit:

a. The permittee shall monitor the TRC at the outlet of the chlorine contact tank once per ________ by grab sample.

b. No more than _____[10% OF TOTAL NO. OF MONTHLY SAMPLES]_____ of all samples taken at the outlet of the chlorine contact tank shall be less than X.X mg/l for any one calendar month.

   Note: for X.X in the above, use 1.5 mg/l for waters designated as public water supplies or shellfish waters and 1.0 mg/l for other waters.

c. No TRC sample collected at the outlet of the chlorine contact tank shall be less than 0.6 mg/l.

d. If dechlorination facilities exist the samples above shall be collected prior to dechlorination.

If chlorine disinfection is not used, fecal coliform shall be limited and monitored by the permittee as specified below:

	Discharge Limitations Monthly Average	Monitoring Requirements Frequency	Sample Type
Fecal Coliform	200* #/100 ml	1/day* *	Grab

* Geometric Mean
* * Sample is to be obtained between 10 AM & 4 PM

The above requirements, if applicable, shall substitute for the TRC requirements delineated in Parts I.A and I.D.1 above.

Ammonia:

Domestic Facilities:

Ammonia toxicity limitations are determined in much the same manner as for any other toxic substance *e.g.* use of MIX.EXE, WLA.EXE, default assumptions, etc. There are some minor differences based on the fact that ammonia known to be present in domestic effluents. **Therefore, effluent data are not necessary** to determine that a reasonable potential may exist for a domestic facility to cause or contribute to a violation of the standards.

There is a large body of data relative to the concentration of ammonia in domestic effluents. Analysis of those data indicate that the expected value is about 9.0 mg/l and the maximum is about 22 mg/l. This makes is easy to determine if a limit is required. The protocol is:

- Determine the acute and chronic wasteload allocations.
- Run WLA.EXE with the calculated WLAs and input one datum of 9.0 mg/l.
- The program will indicate if a limit is required and its value.

Note: actual effluent data is not analyzed to make the determination if a limit is required.

Note: There may be circumstances where a facility was required to nitrify the effluent for reasons other than ammonia toxicity, *e.g.* to control nitrogenous BOD. Frequently those limits are in terms of TKN rather than ammonia. The agency has defined nitrogenous BOD as TKN - 3 mg/l and assumes that all the nitrogenous BOD will be hydrolyzed to ammonia in the stream. In these cases, the limit derived according to the above protocol for ammonia should be compared to the existing TKN limit – 3.0 mg/l. The more stringent of the two should be placed in the permit.

If the TKN limit is retained, the fact sheet should state that the TKN limit will also result in maintenance of the ammonia toxicity water quality criteria.

Industrial Facilities

Industrial facilities may or may not have significant ammonia (or TKN) in the effluent. Effluent data will be necessary to determine if a limit is required. Such data should be available for the majority of facilities. If so it is analyzed the same as any other toxicant.

However, if the facility already has an ammonia or TKN limit then effluent data that was obtained to demonstrate compliance cannot be used to determine if a reasonable potential to cause or contribute to a violation of the standards exists. In these cases, WLA.EXE can be used with a high fictitious datum to force the program to calculate a limit. The resulting limit can be compared to the existing limit to determine if it is sufficiently stringent.

In no case may a limit be removed or made less stringent based on effluent data where active treatment is provided to comply with a existing limit for that parameter.

Mercury

The chronic standard for mercury is expressed as methyl mercury, however, the permit limit should be expressed as total recoverable mercury. Please note that if the permit limit is based on chronic toxicity, the permittee may be allowed to perform a fish tissue study to demonstrate that bioaccumulation of methyl mercury is not occurring. Such a study, if approved by the staff, can provide sufficient grounds for removing the total recoverable mercury limit from the permit or expressing the limit as methyl mercury. For a reissuance the permittee may utilize the 4 year compliance period to perform the study and request permit modification. If the permit is not modified the limit will become effective according to the compliance schedule. If a permit is being issued for a proposed discharge or for an increased discharge, and the permit writer determines that a mercury limit is required, the permittee should be advised up front about the basis of the permit limit and the option to perform the study. The study must, however, be performed and conclusions reached prior to The issuance of the permit since permits for proposed facilities or expansions are not allowed any time to come into compliance with the permit limits once the permit is issued.

Note further, that this provision of the standards applies only to chronic toxicity. It does not apply to the acute standards or the human health standards. Therefore if a permit limit is based on acute toxicity or human health, the fish tissue study allowance is not applicable.

Note that methyl mercury is not likely to occur in the effluent since it is generally the result of biological activity in the stream. It should be assumed that all mercury discharged from a facility will be methylated in the stream. It is recommended that effluent total mercury be analyzed relative to the need for limits.

ESTABLISHING WQS

Once data for a pollutant has been determined to be suitable for analysis, the applicable WQS for the pollutant must be established. NOTE: if antidegradation applies and the receiving waters are tier 2, the applicable water quality standard(s) is not used directly but the antidegradation baseline becomes the target criterion for allowable in stream concentration.

Most of the WQS may be applied directly as given in the standards. However, there are certain parameters for which the appropriate WQS must be calculated. These are discussed below.

Metals:

Most metals listed in the WQS are expressed as a hardness based equation for acute and chronic freshwater aquatic life values. The appropriate hardness to use in the equations is discussed below.

The establishment of water quality standards for ammonia is based on the tables presented in the Water Quality Standards Regulation (see 9 VAC 25-260-140.B). In order to derive an appropriate WQS for ammonia, the permit writer must first pick the appropriate table or equation in regard to discharges into freshwater or saltwater, or the mean salinity in saltwater. Once the proper table is selected, a pH and temperature parameter must be derived in order to determine the appropriate standard from the table.

The appropriate pH and temperature values are discussed below.

Pentachlorophenol:

The freshwater acute and chronic standards for Pentachlorophenol are pH based. The percentile determination presented below should be used for establishing the pH values to be used in the standards equation, however since the relationship in this case is inverse **the 10th percentile should be used** rather than the 90th percentile. The 10^{th} percentile is the mean – 2.65 standard deviations.

Hardness:

In order to determine the hardness value to be used in the applicable equation, use the following:

- If downstream hardness is available that represents a mix of the stream and effluent, use that hardness to calculate the criteria.
- The hardness value derived from a mix of the mean of the effluent hardness and the mean of the upstream hardness may be used to set the WQS value for the critical conditions. The standard mass balance equation may be used to determine this mix value:
- If no effluent hardness data are available use mean downstream hardness.
- If no effluent or receiving stream hardness data are available use:

  mean upstream hardness or
  the hardness of a nearby similar stream or,
  default value of 50 mg/l east of the Blue Ridge and 100 mg/l west of the Blue Ridge.

- If no receiving stream hardness data are available but effluent hardness is available, then the default value for the stream hardness may be used and the steady state complete mix performed using the appropriate low flow.

- If the 7Q10 or the 1Q10 of the receiving stream is determined to be zero, then the hardness of the effluent may be used to establish the applicable in stream criteria.

Regardless of the mix value or ambient data, the minimum hardness value used to set the WQS cannot be less than 25 mg/l, and the maximum value used to set the WQS cannot be greater than 400 mg/l. This is because hardness values outside these values are off the scale used to establish the WQS hardness equation.

Temperature and pH

In setting design conditions for the determination of water quality standards, wasteload allocations and subsequent permit limits, the permit writer must attempt to determine the parameters of the receiving stream at (critical) design conditions and the impacts of any effluent on the receiving stream at these design conditions. The design condition for a receiving water body is generally found during periods of warm weather, long sunny days and low stream flows. These conditions result in high aquatic plant productivity which in turn produces a higher pH. Also rainfall is generally lower so there is reduced opportunity for dilution or a reduced pH due to acid rain impacts. Consequently when viewing a pH record for a stream the 90th percentile value comes closest to generally representing the critical design conditions for the stream because the 90th percentile represents higher values which are generally found during design conditions.

Temperature is similar. Design conditions are generally during warm weather so the temperature of the receiving water is higher. When using a stream record for setting temperature, one would pick a higher (i.e. 90th) percentile value for representation of temperature during design conditions.

It is recommended that the 90^{th} percentile temperature and pH be used to calculate the criteria for specific sites.

Generally these percentiles can be based on an analysis of STORET data from an appropriate monitoring station or data from a USGS water quality station. In general the best station would be on the same stream as the discharge and just outside the mixing zone so that it represent the condition that will exist.

There are two acceptable methods for establishing the 90^{th} percentile:

Statistical: The 90^{th} percentile is the mean + 1.65 standard deviations.

> Note: if the distribution is log-normal then the equations described in the section <u>Permit Limits Based on Effluent Variability</u> should be used to calculate the mean and standard deviation.

Simple counting: find the value that 90% of the data are below. For example, if one has 20 observations and they are ranked from highest to lowest. A reasonable estimate of the 90^{th} percentile is a value that falls just below the 18^{th} observation (*e.g.* 90% of the observations are below the 18^{th} observation).

REDUCED MONITORING

Background:

This section contains recommendations for implementation of reduced monitoring frequencies for certain facilities. This guidance (particularly the amount of monitoring reduction) is based on EPA initiatives and guidance.

Introduction:

Minimum frequencies for monitoring effluent quality and quantity for the purpose of determining compliance with VPDES permits are recommended in the Permit Manual. Reductions in those frequencies have usually been made only when requested by a permittee and when there was overwhelming evidence that effluent quality could not be manipulated by a permittee.

EPA published *Interim Guidance For Performance-Based Reduction Of NPDES Permit Monitoring Frequencies* (EPA 833-B-96-001) in April 1996. This initiative is an effort to reduce the cost of environmental compliance and to provide incentives to facilities that demonstrate outstanding performance and consistent compliance with their permits. DEQ supports this initiative and this guidance contains our recommendations, based on the EPA document, for routine application during preparation of all VPDES permits.

We recommend a three step protocol:

1. Upon receipt of an application for permit reissuance, determine if the facility qualifies for reduced monitoring.

2. Determine the degree of monitoring reduction that should be allowed.

3. Make provisions in the permit to require increased monitoring if the facility does not continue to maintain its past compliance record.

There may be cases where reduced monitoring may be appropriate but the circumstances do not fit this guidance (e.g., a limit may not be needed, but antibacksliding prevents its removal). Some minimal monitoring frequency may be appropriate, but would not be based on this guidance. In such cases, the permit writer should provide complete documentation regarding his/her decision in the fact sheet.

This guidance should be applied for all permit reissuance applications received.

Qualification Criteria:

Only permittees having exemplary operations that consistently meet permit requirements should be considered for reduced monitoring. No facilities are specifically excluded from the evaluation; however, to ensure protection of aquatic life and human health, disinfection and dechlorination parameters should not be considered eligible for reduced monitoring. Procedures already established, such as the Beneficial Use Attainability Analysis that requires Virginia Department of Health review and concurrence, should be used for this purpose.

To qualify for consideration of reduced monitoring requirements, the facility should not have been issued any letter of noncompliance (LON), notice of violation (NOV), or unsatisfactory laboratory determinations, or be under any Consent Orders, Consent Decrees, Executive Compliance Agreements, or related enforcement documents during the past three years.

It is suggested that some discretion be utilized when evaluating the unsatisfactory laboratory determinations. Some of these may be minor infractions that may not affect the data.

Monitoring Reductions:

For each eligible parameter, calculate the three-year composite average of representative data at each outfall. (Note: D.O., pH, and temperature should be evaluated differently, as described at the end of this section.) This composite average is divided by the permit limit to determine the ratio of actual performance to the permit limit. Table 1, contains the recommended reductions in monitoring frequency based on that ratio.

Table 1. **Recommended monitoring reductions**

Baseline	Actual performance/permit limit			
Monitoring	75-66%	65-50%	49-25%	<25%
7/wk	5/wk	4/wk	3/wk	1/wk
6/wk	4/wk	3/wk	2/wk	1/wk
5/wk	4/wk	3/wk	2/wk	1/wk
4/wk	3/wk	2/wk	1/wk	1/wk
3/wk	3/wk	2/wk	1/wk	1/wk
2/wk	2/wk	1/wk	2/mo	1/mo
1/wk	1/wk	1/wk	2/mo	1/2mos
2/month	2/mo	2/mo	2/mo	1/quarter
1/month	1/mo	1/mo	1/quarter	1/6mos

- The baseline monitoring frequencies in Table 1 of this guidance will normally be considered the level of monitoring in the existing effective VPDES permit. It is important to recognize that permittees which receive monitoring frequency reductions in accordance with Table 1 are still expected to take all appropriate measures to control both the average level of pollutants of concern in their discharge (mean) as well as the variability of such parameters in the discharge (variance), regardless of any reductions in monitoring frequencies granted from the baseline levels.

- New permittees and upgraded treatment facilities should generate three years of data before being eligible for consideration for reduced monitoring.

- Facilities which satisfy the entry criteria but are not experiencing discharges of 75% or less of their permitted levels of water quality-based parameters should not be eligible for reductions in monitoring/reporting frequencies.

- Dissolved Oxygen: Where the post-aeration system is passive (i.e., cascade steps), reduction of monitoring frequency can be considered on a case-by-case basis. We recommend that reduced monitoring not be allowed during months when minimum or average D.O. fall within 0.5 mg/l or 1.0 mg/l, respectively, of the permit limit.

- pH: Where pH is not directly adjusted by chemical addition, reduction of monitoring frequency can be considered on a case-by-case basis. We recommend that reduced monitoring not be allowed where minimum or maximum pHs fall within 0.5 units of the permit limits.

- Temperature: Reduction of monitoring frequency can be considered on a case-by-case basis.

<u>Requiring Higher Monitoring:</u>

Permittees are expected to maintain the performance levels that were used as the basis for granting monitoring reductions. To remain eligible for these reductions, the permittee should not have any violations which result in the issuance of an LON, NOV, or unsatisfactory laboratory determinations, or should not be subject to any new formal enforcement action. For facilities that do not maintain performance levels, we recommend requiring the baseline frequencies in the manual (i.e., all or nothing).

<u>Permit recommendations</u>:

1. List only the reduced monitoring requirements in the Part I.A page of the permit, adding a footnote reference number following the "Frequency" column heading.

2. Add the following footnote to the Part I.A page: "See Part I._._* for additional instructions regarding effluent monitoring frequencies."

3. Add the following permit special condition at Part I._._*:

Effluent Monitoring Frequencies: Should the facility permitted herein be issued a Letter of Noncompliance, a Notice of Violation, or unsatisfactory laboratory determination, or be the subject of an active enforcement action, the following effluent monitoring frequencies shall become effective and remain in effect until the expiration date of the permit:

(for example:)

pH	1/Day**
BOD_5	1/Week**
TSS	1/Week**
Dissolved Oxygen	1/Day**

No other effluent limitations or monitoring requirements are affected by this special condition.

* = Use the appropriate permit special condition reference
** = List the appropriate parameters and use the monitoring frequencies that would routinely be assigned for this parameter, as prescribed by the VPDES Permit Manual, BPJ, etc.

Special Considerations:

Discontinuous data: Monitoring cannot be reduced using the methodology described above if effluent data have not been continuously reported over the period of time being considered. Effluent averages from interrupted or discontinuous data sets may not be representative of long-term performance. Monitoring frequencies for discharges that are intermittent or short-term, such as seasonal discharges, and highly variable batch processes cannot be assessed or reduced using the methods described in this guidance.

Monitoring Frequency "Floor": Current federal NPDES regulations do not establish a monitoring frequency "floor" but do establish a reporting frequency floor of once/year. Thus, **no monitoring frequency may be less than once per year**. The monitoring frequency from which reductions could be made in this guidance is considered to be the level of the monitoring in the existing effective VPDES permit. It is important to recognize that the EPA guidance from which Table 1 was taken asserts that there is no loss of statistical confidence in determining whether a permit limit is being violated at reduced monitoring frequencies. Also, the EPA guidance does not advocate any reductions for parameters that are currently monitored only once/quarter.

However, other factors may be considered specific to the facility. If a facility has already been given monitoring reductions due to superior performance, the baseline may be a previous permit. In this case it is not recommended that further reductions be granted.

Exceptions: It may be appropriate to maintain higher monitoring levels in individual situations where there may be a particular interest in human health, endangered species, or a sensitive aquatic environment. An example would be a water body that has water quality problems and it has been determined which point and nonpoint sources are particularly critical from the standpoint of protection of aquatic resources (e.g., endangered species) or human health (e.g., drinking water source). The permit writer may well decide not to reduce monitoring of critical point sources in these instances, while continuing to monitor the overall situation.

Limits below Levels of Detection: We do not recommend reductions in monitoring frequencies in cases where stringent water-quality based limits (WQBELs) are below levels of quantification (the level at which a constituent present in a wastewater sample can be reliably detected and quantified). Permittees with these types of limits will normally be deemed to be in compliance when test results are below the level of quantification; however, by definition, it is not scientifically possible (until analytical methods improve) to certify that the WQBELs are actually being achieved. Thus, we feel it would be inappropriate to develop guidance recommending reductions from established monitoring frequencies for these types of limits.

Use of Daily Maximum Values: This guidance does not provide a specific methodology for considering daily maximum permit values when considering monitoring/reporting reductions. Consider such situations on a case-by-case basis. There may be concerns in instances where, for example, there are acutely toxic conditions in the receiving water due to violations of daily maximum permit limitations. In such cases, higher monitoring frequencies may be required. In addition, it is important to recognize that dischargers who frequently violate daily maximum permit limitations will likely be unable to achieve high levels of performance in monthly average limits and effectively would not be eligible to participate in this program on that basis. In addition, such facilities may also trigger enforcement criteria.

Examples:

Q1 Can a period of record other than 3 years be used for developing a long term average?

Yes, permit writers should use best professional judgement when determining what data is representative of a discharge. For a POTW that has just added large significant industrial users or new developments, data before the new connections may no longer be representative of the facility. In this case, three years of data after the user connects would need to be assessed before reduced monitoring could be considered. In the same manner, a significant user may have closed 2 years ago and only the last 2 years of data are representative. Permit writers should avoid using long periods of record to reduce or increase the value of the past 3 years of effluent data.

Q2 A facility was upgraded three years ago as the result of a CSO. The CSO was canceled 2 years ago. There was an NOV issued the month of the startup due to startup problems. Data since startup shows no violations of the permit's FELs.

If it is apparent that the facility was substantially in compliance when the month after the upgrade was completed and the delay in canceling the CSO was due to staff/Board processing time, then the permit writer may evaluate the facility for reduced monitoring and document in the fact sheet the reasons the guidance applies. The permit writer may be able to wait for submission of another month of data to be able to evaluate a full 3 years of data. Alternately, the data from the set that was in violation should be evaluated to see if it was representative. If not, it should not be used in step 2 of the evaluation protocol.

Q3 The guidance does not reduce testing that was initially conducted 1/3 months, but does reduce monthly monitoring to 1/6 months in one case. Why is this?

Data collection at quarterly intervals was not considered by EPA in their analysis. DEQ has adopted EPA's statistical analysis and the assumptions that come with it. EPA apparently did not believe that a quarterly frequency was often enough to develop valid reduced monitoring statistics.

Q4 Some flocculation operations, such as color, phosphorus and metals removal, are controlled by polymer addition. A twist of a valve can increase pollutant concentrations almost instantaneously, similar to chlorination or dechlorination. Does the permit writer have flexibility in deciding whether to reduce monitoring on these types of pollutants?

Yes, while we would like to reward owners that have conscientiously operated their treatment facilities for three continuous years without violations or enforcement actions, the permit writer should always apply Best Professional Judgement in setting monitoring frequencies. Fact sheets and statements of basis should provide a rationale for monitoring frequencies and reasons why they have or have not been reduced as recommended by Agency guidance.

Q5 A facility has been having 95% flow problems and has reported bypasses and overflows as a result, but has not been issued an NOV or LON. Can monitoring at this facility be reduced?

Speak to your regional compliance personnel to see if an LON should be issued. It is recommended that only facilities subject to the referenced enforcement actions be disqualified from the reduced monitoring proposed in this guidance.

Q6 County owned pump station overflows have resulted in an LON to the county. Wastewater is treated in a regional STP owned by a PSA. If these overflows were within the 3 year window, is the STP disqualified from receiving reduced monitoring under this guidance?

It seems contrary to the goals of the program to allow reduced monitoring for a system that has significant overflows. Remember the goal of the program is to reward operations with exemplary operations that consistently meet permit requirements.

However, if the upstream owner's overflows are being addressed in a separate permit or compliance document, this could be justification for applying reduced monitoring to the STP outfall.

Q7 A facility has multiple and independent outfalls. If one outfall has received enforcement actions in the past 3 years, are the rest of the outfalls eligible for reduced monitoring?

This guidance recommends that the entire facility not receive reduced monitoring if the facility is cited with any of the referenced enforcement actions. As always, with appropriate rationale and documentation, a permit writer may deviate from the guidance on a case-by-case basis.

PERMIT LIMITS BASED ON EFFLUENT VARIABILITY

Background:

The Technical Support Document (TSD), published by EPA, recommends the use of a statistical approach to analyze effluent variability when establishing setting permit limits for toxic materials. Further, the TSD recommends that the effluent data be assumed to be log-normally distributed, with a coefficient of variation of 0.6, if insufficient data exist to properly define the actual distribution and its parameters. This section contains recommendations for implementation of such statistically based permit limits. Except for the definitions for reasonable potential (used when there are insufficient data with which to calculate actual distribution parameters), these procedures generally follow the recommendations in the TSD. There are minor differences, mostly concerned with clarification and/or the correction of errors in the TSD.

If sufficient data exist to allow accurate definition of the distribution type, then the data should be fitted to the appropriate distribution and the methods specific to that distribution should be used to calculate the distribution parameters and permit limits. This may require hundreds of observations. It will be found that the log-normal distribution will fit most data sets from effluent monitoring sufficiently well to allow decisions to be made without excessive error. When the data are relatively scarce the techniques described here are recommended.

Historically, permit limits have been specified in terms of "never to be exceeded" numbers at some defined stream flow. This approach is suitable when the parameter is relatively easy to remove from the effluent, limits are sufficiently large that they can be easily measured and treatment technology to allow reliable compliance is economically and technically feasible. Variability of the effluent concentrations has not historically been a significant consideration because it is has been relatively easy to operate a treatment plant to maintain compliance with the limits. However, with the advent of standards for toxic materials the situation is considerably more complex. There are several reasons for this, the most important of which are:

> Toxic materials can cause adverse effects at extremely low concentrations, consequently the standards themselves and the permit limits based on them are frequently near or below the limits of detection available with routine laboratory technology.
>
> The permit limits for toxic materials are frequently near or below the concentrations that can be attained with available and/or economically feasible treatment technology.
>
> The standards for toxic standards are not written in terms of "not to be exceeded numbers at 7Q10". They are written on a statistical basis and the probability of seeing high concentrations becomes the key issue in deciding if the effluent has a reasonable potential to cause a violation of the standards. Thus, the variability of the effluent becomes a very important measure of the need for limits. Limits, when established, must also consider and allow for such variability in order to obtain compliance with the standards while avoiding undue penalties upon dischargers for occasional excursions that can be expected and that do not violate the standards.

This presents somewhat of a dilemma for permit writers. One must be reasonably certain that the permit limits will result in acceptable water quality while at the same time one must be reasonably certain that they are, in fact, necessary and can be technically defended.

The purpose of the material presented here is to provide methods to demonstrate, with an acceptable degree of confidence, when a permit limit is needed and, if so, to establish a limit that can be determined to be in compliance with permit requirements.

Note regarding data requirements:

In order to apply the procedures in this section, at least one observation must be available and it must be above the quantification level (QL). In addition, the data must represent the exact material as identified in the water quality standards. For example, the water quality criteria for metals are in terms of the dissolved fraction, therefore, dissolved metals data must be available.

If suitable data is not available then a special permit condition is recommended to obtain the required data.

Introduction:

Data sets available to permit writers frequently have a small number of observations on which a decision must be based. It is also common for toxic data to be censored is some way, e.g. values may be reported as not detected, as less than a quantification level or simply less than some number. The censored data do contain information that needs to be used in the decision process but relatively simple and easy to explain methods to incorporate such information from small data sets are very limited.

Small data sets or data sets that have a large proportion of censored data are difficult to analyze unless there are sufficient data above the censoring point on which to base estimates of the distribution parameters. For data sets that contain fewer than about 10 observations, calculations of the distribution parameters may not be significantly more accurate than if they are based on reasonable assumptions extrapolated from larger data sets and similar effluents.

Since there are rarely sufficient data to accurately define the actual distribution of data, reasonable assumptions almost always have to be made regarding the distribution type. Unless shown otherwise, it is reasonable to assume that most environmental and effluent data are lognormally distributed and to calculate the parameters accordingly. There are non-parametric and maximum likelihood methods available for the analysis of censored data but they are considerably more difficult to apply and adequately explain than the more common parametric approaches. It is recommended that parametric methods be used for the routine analysis of censored data even if in certain circumstances assumptions are necessary regarding parameter values. However, alternate procedures would be acceptable providing they are properly documented and implemented.

There are six basic types of data that will require somewhat different analytical approaches:

Type 1. Censored data sets that do not have sufficient data above the censoring point to allow reasonable estimates of the parameter values to be calculated. Such data sets are defined as those which contain fewer than 10 observations above the censoring point.

These data will be assumed to be lognormally distributed and standard lognormal statistics will be applied using assumed distribution parameters. The assumptions are:

a. The censoring point is equal to the quantification level.

b. The censoring point represents a percentile of the distribution that is equal to the proportion of censored data, e.g. if QL is the censoring point and 25% of the data are < QL then QL = the 25th percentile of the distribution.

c. The coefficient of variation is equal to 0.6.

Type 2. Uncensored data sets that contain fewer observations than necessary for the calculation of the distribution parameters. Such data sets are defined as those which contain fewer than 10 observations.

These data will be assumed to be lognormally distributed and standard lognormal statistics will be applied using assumed distribution parameters. The assumptions are:

a. The censoring point is equal to the quantification level.

b. The arithmetic mean of the observed data is equal to the expected value of the distribution.

c. The coefficient of variation is equal to 0.6.

Type 3. Uncensored data sets that have sufficient data to allow the parameter values to be estimated with reasonable confidence. Such data sets are defined as those which contain more than 10 observations but have insufficient data to allow the distribution type to be ascertained.

These data will be assumed to be lognormally distributed and standard lognormal statistics will be applied to such data sets to estimate the distribution parameters from the available sample data (expected value, variance, coefficient of variation and percentiles).

Type 4. Censored data sets that have sufficient data above the censoring point to allow reasonable estimates of the parameter values to be calculated. Such data sets are defined as those which contain more than 10 observations above the censoring point. The censoring point is the QL.

These data will be assumed to be lognormally distributed and delta lognormal statistics, as recommended by EPA in the TSD, will be applied to estimate the distribution parameters from the available sample data.

Type 5. Data sets that have sufficient data to allow both the nature of the distribution and its parameters to be specified.

Specific guidance will not be given for such data sets because the methods are many and varied and may be dictated or limited by the data itself.

Type 6. Data sets in which all data are below the censoring point. Such data sets provide no information on which to base an analysis and none will be attempted. Although such data may be used to demonstrate that a limit is **not** necessary, permit limits cannot be based on such data. The censoring point is the QL.

For the purposes of setting permit limits, it is recommended that the maximum value of a distribution be defined as the 97th percentile. The selection of some high percentile is arbitrary and can be considered the statistical equivalent of "not to be expected". The reason for the recommendation to use the 97th percentile is simplistic: One excursion, with appropriate temporal restrictions, above the standards is allowable once in a three year period for the acute and chronic standards. There are 36 Discharge Monitoring Reports (DMR) submitted in any three year period. If only one DMR, in this three year period, contains results that are above the limits, the standards can be assumed to have been maintained. In this case the percentage of compliance is 100(1 - 1/36) or about 97%. The 97th percentile is recommended for all statistical permitting procedures discussed herein.

Note: it is important to keep in mind that limits established according to these protocols are fully expected to be exceeded once in a three year period. One such exceedance should not be considered a violation of the permit limit.

<u>Symbols and definitions:</u>

Exp( )	=	e raised to the power in the parenthesis
u	=	mean of a normal distribution
s^{2}	=	Variance of a normal distribution
s	=	standard deviation of a normal distribution
V	=	variance of a non-normal distribution
$\mathbf{E_x}$	=	expected value (mean) of a non-normal distribution
CV	=	coefficient of variation = σ\u
n	=	generally refers to the number of observations. May be restricted to the number of observations above a censoring point.
X	=	generally refers to values from a distribution of single observations.
Y	=	generally refers to the natural log of X
a	=	generally refers to the arithmetic averages of samples drawn from some parent distribution.
b	=	generally refers to the distribution of ln(α)
t	=	generally refers to the number of observations that are averaged to obtain the α distribution.
Z	=	standard Z score = areas expected under the normal curve
p	=	refers to a probability
QL	**=**	Quantification level
D	=	The censoring point in a distribution. Data exist below this point but the actual value cannot be determined. It is usually defined as the quantification level.
r	=	generally refers to the number of observations that are < D

d = the proportion of a data set are < D (may be expressed as a percentage or as a decimal number)
f = variability factor = 97^{th} percentile / E_x

Note: any or all of the above may be subscripted to refer to a particular distribution.

WLAa = Waste load allocation for acute toxicity.
WLAc = Waste load allocation for chronic toxicity.
Log-normal distribution = Data whose logarithms are normally distributed.
Delta lognormal distribution = a lognormal distribution censored at some non-zero level. The number of occurrences that fall below this level are known but their actual values are not.
Expected value = The central tendency of a skewed distribution. It is analogous to the mean of the normal distribution.
97^{th} percentile = the value in a distribution that is greater in magnitude than 97 % of all values.
LTA = Long Term Average.

Note: Long term average and expected value as, used in the TSD, are synonymous. E_x and LA are both used by EPA and the usage is apparently an attempt to distinguish between actual and predicted distributions. E_x is used exclusively herein.

Type 1 data:

Given $X_1, X_2, .. ,X_n$, for 1> n <10; X > D, and $X_1, X_2, .. ,X_r$ for X < D:

where D = censoring point and is equal to QL,

<u>Estimating maximum values:</u>

Assume a log-normal distribution of X.

1. let $\delta = 100(r/r+n)$ = percent of values < D

It is not reasonable to arbitrarily assign discrete values to those data < D. It is also not reasonable to ignore the observations < D since they do provide valid information regarding the effluent data. There are few or no methods for a reasonable estimation of distribution parameters when the data set is very small. Analysis of such data sets must depend on reasonable assumptions:

Assume that the coefficient of variation is equal to 0.6.

Since δ% of the data are below D it is reasonable to assume that the δ^t percentile of the distribution is equal to D.

For a lognormal distribution:

2. $CV_x = [\exp(\sigma_y^2) - 1]^{1/2}$, where σ_y^2 is the variance of the log transformed data.

Solution of 2 for σ_y^2, given that CV = 0.6, yields:

3. $\sigma_y^2 = 0.30748$ and $\sigma_y = 0.55451$

Percentiles of the distribution of X are estimated using the log transformed data. Let $Y_i = \ln(X_i)$, so that the percentiles (p) of X are defined by:

4. $X_p = \exp(u_y + Z_p\sigma_y)$

Since the δt percentile of X has been assumed equal to D:

5. $D = \exp(u_y + Z_\delta\sigma_y)$

Solution of 5 for u_y yields the mean of the transformed data:

6. $u_y = \ln(D) - Z_\delta\sigma_y$

Substituting the assumed values for D, and σ_y into 6 yields:

7. $u_y = \ln(D) - (.55451)Z_\delta$

For a log normal distribution the expected value is defined by:

8. $E_x = \exp(u_y + .5\sigma_y^2)$

Substituting 7 and the known $.5\sigma_y^2$into 8 yields

9. $E_x = \exp(\ln(D) - .z_\delta + .15374)$

All the information needed to estimate a percentile is now available. Using 4, with appropriate substitutions, gives:

10. $X_p = \exp[\ln(D) + .55451(Z_p - Z_\delta]$

X_p is then a reasonable approximation of the p^{th} percentile of the distribution from which the small data set was drawn.

The recommendations in the TSD for establishing permit limits requires that the parameters be rescaled to define a distribution with a different expected value. If it is assumed that the ratio of the maximum (97^{th} percentile) and the expected value will be constant for all distributions of the material being analyzed in a particular effluent, a factor, f, can be defined such that:

11. $f = X_{.97} / E_x$

This factor allows the parameters of the original distribution to be used to specify a different distribution that will comply with specified restrictions. If the future distribution must meet a specified maximum, the factor f can be used to estimate the expected value of that future distribution, etc.

Estimating the distribution of averages:

Let $\alpha_1, \alpha_2, \ldots \alpha_n$ be the averages of t observations taken from a type 1 distribution of X.
The distribution of the averages of observations taken from X will be calculated according to the discussion below for estimating distribution parameters of averages for type 3 data.

Type 2 data:

Given X_1, X_2, ... X_n for n<10, assume a log-normal distribution of X.

<u>Estimating maximum values:</u>

Again the coefficient of variation will be assumed = 0.6.

The data are not censored (all are > QL) but are not sufficient in number to allow meaningful calculation of the distribution parameters. If an observation is made at random, it has a higher probability of being near the mean of the distribution than near the extremes. It is, therefore, reasonable to assume that the arithmetic mean of a small data set approximates the expected value of the distribution from which it was drawn. It will be so assumed, *i.e.*:

12. $E_x = \sum X_i/n$

For a lognormal distribution:

13. $CV_x = [\exp(\sigma_y^2) - 1]^{1/2}$

Solution of 13 for σ_y^2, given that CV = 0.6, yields:

14. $\sigma_y^2 = 0.30748$ and $\sigma_y = 0.55451$

For a log normal distribution the expected value is:

15. $E_x = \exp(u_y + .5\sigma_y^2)$

Substituting 12 and the known $.5\sigma_y^2$ into 15 yields

16. $u_y = \ln(E_x) - .15374)$

Since $X_p = \exp(u_y + Z_p\sigma_y)$, all the information needed to estimate percentiles is now available:

17. $X_p = \exp[\ln(E_x) - .15374 + .55451\ Z_P]$

X_p is then a reasonable approximation of the p^{th} percentile of the distribution from which the very small data set was drawn.

As before a scaling factor is defined by:

18. $f = X_{.97} / E_x$

Estimating the distribution of averages:

Let α_1, α_2, ... α_n be the averages of t observations taken from a type 2 distribution of X.

The distribution of the averages of numbers taken from X will be calculated according to the protocol discussed below for estimating distribution parameters of averages for type 3 data.

Type 3 data:

Given X_1, X_2,… X_n for n >10, assume a lognormal distribution of X.

19. let $Y_i = \ln(X_i)$, then

20. $u_y = \sum Y_i/n$,

21. $\sigma_y^2 = \sum [(Y_i - u_y)^2]/(n-1)$

The parameters for the distribution of X are:

22. $E_x = \exp(u_y + 0.5\sigma_y^2)$

23. $V_x = \exp(u_y + \sigma_y^2)\,[\exp(\sigma_y^2) - 1]$

24. $CV_x = [\exp(\sigma_y^2) - 1]^{1/2}$

Estimating maximum values:

The percentiles of X are:

25. $X_p = \exp(u_y + Z_p\sigma_y)$

where: Z_p is the Z score associated with percentage p.

Again a scaling factor is given by:

26. $f = X_p / E_x$

Estimating the distribution of averages:

Let α_1, α_2, .. ,α_n, to be the averages, of t observations, taken at random from the distribution of X.

Case 1: t > 10:

According to the central limit theorem, the distribution of α will be normal and has parameters:

27. $u_\alpha = E_x$

28. $\sigma_\alpha = V_x/t$

The percentiles of α are estimated by:

29. $\alpha_p = u_\alpha + Z_p\sigma_\alpha$

The scaling factor is:

30. $f = \alpha_p / u_\alpha$

Case 2: t < 10:

According to the TSD the distribution of α will be log-normal.

Let $\beta_i = \ln(\alpha_i)$, then:

31. $u_\beta = \ln(E_x) - .5\sigma_\beta^2$

32. $$\sigma_\beta^2 = \ln\left(\frac{V_x}{tE_x^2} + 1\right)$$

33. $E_\alpha = \exp(u_\beta + 0.5\sigma_\beta^2)$

34. $V_\alpha = \exp(u_\beta + \sigma_\beta^2)\,[\exp(\sigma_\beta^2) - 1]$

Substitution and simplification yields:

35. $E_\alpha = E_x$

36. $V_\alpha = V_x / t$

The percentiles of α are:

37. $\alpha_p = \exp(u_{ps} + Z_p\sigma_\beta)$

Again, the scaling factor is:

38. $f = \alpha_p / \alpha_x$,

Type 4 data:

The TSD recommends the use of a delta lognormal distribution when values exist that indicate that the value of the datum is not zero but its exact value cannot be quantified. A similar distribution is described in Aitchison and Brown for application when some observations are zero and they provide an excellent theoretical discussion of censored data sets. However, that distribution is not suitable for application to a censored data set when the censoring point is greater than zero. EPA has modified it so that it can be so applied to such data sets. The modification is described sketchily in the TSD and more fully in the development document for the OCPSF regulation.

Define D = as the censoring point such that;

$X_1, X_2, \ldots X_n$ for $n > 10$, $X > D$ and $X_1, \ldots X_r$ for $X < D$:

Assume that the X's are log normally distributed and define:

39. δ = the sample proportion of observations < D = r/r+n

Given that:

40. The probability that $(X < 0) = 0$

41. The probability that $(X < D) = \delta$

then:

42. The probability that $(X \# x) = \delta D+(1-\delta)g(x)$; for $x > 0$

where:

43. $$g(x) = \frac{1}{x\sigma(2\pi)^{-1/2}} \exp\left[\frac{-(\ln(x) - u)^2}{2\sigma^2}\right] \text{ for } x > D$$

EPA's modification is given by equations 41 and 42. It is seen that the modification simply shifts the distribution by a fraction (δ) from its usual position.

Note, that g(x) is the usual two parameter log-normal distribution. Note also that, if $\delta = 0$, the distribution reduces to an unmodified lognormal distribution.

The parameters u and σ are estimated from the sample log mean and log variance of the data > D (e.g. equations 19, 20 and 21 but using only data > D). The expected value and variance of the distribution of X are given by:

44. $E_x = \delta D + (1-\delta) \exp(u_y + \sigma_y^2/2)$

45. $V_x =(1-\delta)\exp(2u_y+\sigma_y^2)[\exp(\sigma_y^2)-(1-\delta)]+\delta(1-\delta)D[D-2\exp(u_y+\sigma_y^2/2)]$

Estimating maximum values:

The percentiles of x are estimated by:

46. $$X_p = \begin{cases} D & \text{for } \delta \ \$ \ p \\ \text{maximum of: } D \text{ or } \exp(u_y + Z_{\text{Å}}\sigma_y) & \text{for } \delta < p \end{cases}$$

where:

47. $\text{Å} = [(p-\delta)/(1-\delta)]$; p is the probability sought (0.97).

Again a scaling factor is required and is:

48. $f = X_p / E_x$,

Estimating the distribution of averages:

Consider $\alpha_1, \alpha_2, \ldots, \alpha_n$, as the averages, of t observations, taken at random, from the delta lognormal distribution of X.

Case 1: $t > 10$:

According to the central limit theorem, the distribution of α will be normal and has parameters:

49. $E_\alpha = E_x$

50. $V_\alpha = V_x/t$

51. $\sigma_\alpha = (V_\alpha)^{1/2}$

Percentiles of α are estimated by:

52. $\alpha_p = u_\alpha + Z_p\sigma_\alpha$

The scaling factor, f is given by:

53. $f = \alpha_p / E_\alpha$

Case 2: $t < 10$:

According to the TSD, the distribution of α will be approximately log-normal:

Let $\beta_i = \ln(\alpha_i)$, then:

54. $\sigma^2_\beta = \ln[(1 - \delta^t)(1 + A - B + C)]$

where:

55. $$A = \frac{V_x}{t(E_x - \delta^t D)^2}$$

56. $$B = \frac{\delta^t D^2(1 - \delta^t)}{(E_x - \delta^t D)^2}$$

57. $$C = \frac{2\delta^t D}{E_x - \delta^t D}$$

58. $$u_\beta = \ln\left[\frac{(E_x - \delta^t D)}{(1-\delta^t)}\right] - 0.5V_\beta$$

The parameters of α are then:

59. $E_\alpha = \delta D+(1-\delta)\exp(u_\beta + \sigma^2_\beta/2)$

60. $V_x = (1-\delta)\exp(2u_\beta+\sigma_\beta^2)[\exp(\sigma_\beta^2)-(1-\delta)]\}$

$$+ \{\delta(1-\delta)D[D-2\exp(u_{\beta}+\sigma_{\beta}^{2}/2)]\}$$

As before appropriate substitutions and simplification will show that:

61. $E_{\alpha} = E_{x}$

62. $V_{\alpha} = V_{x}/t$

The percentiles of α are:

63. $$\alpha_{p} = \begin{cases} D & \text{for } \delta \ \$ \ p \\ \text{max of: } D \text{ or } \exp(E_{\beta} + Z_{\text{Å}}\sigma_{\beta}) & \text{for } \delta < p \end{cases}$$

where:

64. $\text{Å} = [(p - \delta)/(1-\delta)]$; p is the probability sought(.97).

As usual the scaling factor is:

65. $f= \alpha_{p} / E_{\alpha}$

Parameters required:

In order to perform all the necessary calculations for establishing permit limits the expected value, 97th percentile, and the scaling factor "f" will be required for the following:

- distribution of daily effluent data
- distribution of 4 day averages
- distribution of 30 day averages
- distribution of n day averages where n is the number of samples that will be required to be obtained for reporting averages on the DMR. Note that if both weekly and monthly averages are limited in the permit then an n day average based on the number of samples per week and an n day average based on the number of samples per month with be required.

Permit Limits:

The need for permit limits can be evaluated once the 97th percentile of the various distributions of the effluent data and the waste load allocations (WLA) for acute, chronic and human health toxicity have been calculated. The protocol for establishing limits is:

Calculate the WLAa and WLAc:

Using an appropriate water quality model (complete mix, regulatory mixing zone, etc), the WLAs are calculated such that the water quality standards will be maintained.

Calculate the statistics for the available data:

Using the appropriate protocol for the available data, calculate the parameters associated with the daily values and the parameters associated with the distribution of averages of values drawn from the daily values. Using these parameters, calculate the 97th percentile of daily values, 4 day averages, 30 day averages and n day averages (where n = the number of samples that will be required each month and/or week by the permit) for each distribution and determine the scaling factor "f" for each distribution.

Determine if a limit is needed:

> If the WLAa is greater than the 97th percentile of the daily values then no acute limit is needed, otherwise a limit is needed.
>
> If the WLAc is greater than the 97th percentile of the 4 day averages (30 day average for ammonia) then no chronic limit is needed, otherwise a limit is needed.

Compare the WLAs if a limit is needed:

The WLAs all have different units and interpretations, *e.g.* the acute WLA is compared to the maximum of the daily distribution, the chronic WLA is compared to the maximum of the 4 day average distribution, etc. The WLAs and associated distributions must be reduced to some kind of common ground so that they can be compared to find the most restrictive WLA. The scaling factor "f" that has been calculated for each distribution is used for this purpose.

If a limit is needed in the permit, a distribution must be identified such that it will result in compliance with all of the WLAs. That distribution can then be used to identify the numerical values for the limits. The scaling factors "f" are used to identify the expected value of this future distribution.

- For acute toxicity, the maximum (97th percentile) of the required but unknown distribution of daily values must be equal to the WLAa.
- For chronic toxicity, the maximum of the required but unknown distribution of 4 day (30 day for ammonia) averages must be equal to the WLAc.

The maximum (equal to the appropriate WLA) of each of these required distributions is divided by the appropriate "f" to obtain the expected value of each unknown distribution, e.g.:

- The E_x of the distribution that will have a 97th percentile equal to the WLAa is obtained by dividing the WLAa by the "f" obtained from distribution of daily values.
- The E_x of the distribution that will have a 97th percentile equal to the WLAc is obtained by dividing the WLAc by the "f" obtained from the distribution of 4 day averages (30 day for ammonia).

The values so obtained are compared and the lowest one specifies the expected value of the one distribution that will comply with all of the WLAs.

Calculate limits:

As indicated above, establishing the need for a limit is straight forward, *e.g.* the average and maximum values (97^{th} percentile) are calculated from the existing data. If the maxima are less than the respective WLAs then no permit limit is needed, otherwise, a limit must be in the permit. Determining what the limit should be is not so straight forward. The problem is that one must predict what the distribution of effluent data will look like after treatment is provided and write limits accordingly.

This is impossible to do without extensive treatability studies on the specific waste stream and pollutant involved because the data, after treatment is increased, may not have the same distribution type or relative variability as before. If the control strategy is passive (source reduction etc.) the data may continue to have the same general distribution type. However, if the control consists of removal by treatment the variability of effluent concentrations may be greatly reduced and the nature of the distribution may change.

Since data cannot be obtained until after the treatment implemented, EPA recommends a simple approach:

> Assume that the ratio of the 97^{th} percentile / Ex (e.g. the "f" scaling factors) obtained from existing data will be constant across all treatment technologies including no treatment.

This provides an easy means to re-scale the distribution by the application of the "f" obtained from the original data. As discussed above, the distribution of daily values that the effluent must comply with in the future is specified by its expected value. The 97^{th} percentile of this distribution becomes the maximum daily limit.

The calculation of this maximum is simply an inverse application of the factor "f". The lowest expected value (as described above) is multiplied by the "f" obtained from the distribution of daily values to obtain the maximum daily limit.

The average limits are obtained by multiplying the selected Ex by the "f" from the distribution of averages based on the number of samples (n day averages) that will be taken to calculate that particular average. Note that weekly, monthly or both averages may be required.

Notes on limits:

The existing regulations require the inclusion of weekly average and monthly average limits in discharge permits for POTWs and daily maximum and monthly average limits or industrial treatment plants. This approach may be reasonable when applied to limits based on technology studies or when the maximum limit is not a defined function of the average but is some arbitrary number.

However, when the limits are based on a statistical description of the effluent variability, as described herein, these multiple limits are unnecessary. This is because both average and maximum limits are based on parameters calculated from the same distribution. In this case, all limits that can be derived from that distribution specify exactly the same distribution of effluent concentrations and consequently specify exactly the same effluent quality.

EPA has been made aware of these difficulties that have been simply carried over from the specification of permit limits for conventional pollutants and are not really applicable to the limits as derived herein. However, they have insisted (via objections to our permits) that the regulations be complied with as written.

It is therefore recommended that:

> Permits for facilities treating domestic waste should have weekly average and monthly average permit limits.
>
> Permits for facilities treating industrial waste should have daily maximum and monthly average permit limits.

References:

Technical Support Document for Water Quality Based Toxics Control, 1991 EPA/505/2-90-001

Aitchison and Brown, *The Lognormal Distribution*, Cambridge University Press, 1973

Yevjevich, Vukica, *Probability and Statistics in Hydrology*, Water Resources Publications, 1972

ESTABLISHING BPJ PERMIT LIMITS

Background:

Section 402(a)(1)(B) of the Clean Water Act (the Act) authorizes "such conditions as the Administrator determines are necessary to carry out the provisions of this Act." This authorization is also set forth in 9 VAC 25-31-210.A which states in part "in all permits, the Board shall establish conditions, as required on a case-by-case basis, to provide for and assure compliance with all applicable requirements of the Law"

These regulations provide the basis for the so called Best Professional Judgement (BPJ) limits. Neither the Act nor the Virginia regulations have any requirements whatsoever as to what basis needs to be considered when a BPJ limit is formulated. It could be based on water quality considerations in a particular case or, just as well, could be based on the capability of a particular installed (or proposed) treatment technology.

The agency has, for years, used inconsistent terminology to describe BPJ limits. Such terms as Best Engineering Judgement (BEJ) and Best Professional Opinion (BPO) seem to be the most common. The reasons for the inconsistent terminology generally include one or a combination of the following:

1. The desire to simply apply existing effluent guidelines to a facility that is not in the category but has similar processes and to do so without any further consideration, discussion or documentation.

2. The desire to apply uniform permit limitations to a category of dischargers without adopting the limitations as minimum effluent guidelines as provided for in section 304(b) of the Act or adopting them as regulations according to the Virginia Administrative Process Act (APA).

It was apparently believed that by calling the limits something like BEJ or BPO avoided having them interpreted as *de facto* regulations that are implemented without due process.

Several of these historical approaches used by the agency have significant problems in that:

1. The federal minimum effluent guidelines positively identify the facilities to which they apply. It is a misapplication of federal regulations to apply them to any facility that is not in the category.

2. Applying mandatory criteria to a group or category of facilities without following the procedures of the (APA) to adopt the criterion as a Virginia regulation is a would not appear to follow state law and regulation.

Neither the federal nor state regulations prohibit the application on a case by case basis of any permit limit whatsoever that is needed establish a BPJ or to protect the quality and beneficial uses of a specific receiving stream.

As used herein, **BPJ limitations are defined as those that are developed based on either a technology or water quality basis that are developed for a category of discharges or for individual dischargers based on knowledge of treatment processes, analytical data, empirical evidence from similar facilities, site conditions, *etc*.**

As indicated by the above definition, BPJ limits fall into two categories: those that are adopted as regulation in accordance with 40 CFR § 125 and the Virginia APA and those that are established on a case by case basis for an individual discharge.

This guidance will not address further those BPJ limits that are adopted as regulations since the proper application is generally specified in the regulation.

This guidance focuses on the BPJ limit that is developed for a specific facility. In this regard, a BPJ limit as authorized by section 402(a)(1)(B), is simply one that is based on judgement where that judgement is considered and applied on a case by case basis. The judgement may consider available or installed technology, the required water quality or any combination of these considerations. The key elements of a BPJ limit are:

1. It is based on the judgement of the permit writer (or collective judgement of the issuing agency and confirmed by the permit writer).

2. It does not apply to an entire class or category of facilities (in the case of guidance, it must be considered and confirmed to be applicable on a case-by-case basis and valid alternatives are acceptable).

3. It is determined on a case by case basis for a particular facility.

Determining the value for a BPJ based limit:

There are several approaches to forming these judgements:

1. The agency often issues guidance documents that are intended to assist with determining BPJ limits. In many cases, these documents address a category of discharger and contain recommendations regarding a consensus of agency opinion and judgement regarding the substances that should be limited and suggests numerical values. Such documents are guidance only and are not regulatory nor are they mandatory. The key elements to be aware of when using such guidance is that:

    a. It should be evaluated for its application on a case by case basis considering the specific facility in question before it is applied and the fact sheet should contain an evaluation statement.

    b. It is not mandatory and reasonable alternatives are acceptable.

2. The federal minimum effluent guidelines may be consulted to assist a permit writer in formulating his or her judgement regarding both the types of pollutants that a certain process may be expected to produce and the capabilities of treatment technology to remove them. The key elements to be aware of when using these guidelines are:

    a. They cannot be simply applied to a facility that is not in the category.

b. It should be clearly stated in the fact sheet that the guidelines were consulted only to help in formulating a BPJ limit.

c. The judgement that leads to a limit must be considered on a case by case basis and formulated for the specific facility in question.

3. The permit writer may consider each pollutant that can reasonably expected to be present in a discharge, how each would impact a water quality standard and formulate a judgement regarding what limits would prevent objectionable conditions. A limit is perfectly acceptable based on the judgement of the individual permit writer and/or his supervisors providing the basis is properly documented in the fact sheet or permit file.

Recommendations:

1. All fact sheets for permits that contain a limit based on agency guidance should contain a statement to the effect that the permit writer has reviewed and evaluated the guidance to confirm its applicability to the case being considered before it was applied to a particular discharge.

2. The basis for the judgement leading to individual BPJ limits should be clearly set forth in the fact sheet for a permit.

3. Reasonable alternatives to draft BPJ limitations should be evaluated on their merit and accepted if appropriate.

EFFLUENT MONITORING FOR TOXIC MATERIALS

When a water quality standard is adopted the agency must implement one of only two alternatives:

- A limit for the material may be included in all permits and compliance monitoring required.
- The discharger may be allowed to demonstrate if the effluent poses a reasonable potential to cause or contribute to a violation of a standard prior to a limit being placed in the permit.

The agency has chosen to implement the second alternative (often referred to as attachment A monitoring). The implementation protocol is straight forward and consists of:

- The analysis of available effluent data for all materials for which the agency has adopted water quality standards.
- The inclusion of a special condition to obtain data if it does not exist.
- An evaluation of the data according to the methods discussed herein.
- Placing limits in the permit only if the analysis of the data indicates they are necessary.
- The monitoring should be repeated when any significant change occurs to the facility or a significant industrial discharger is added.

The effluent monitoring special condition is to be used for domestic dischargers with flows greater than 0.04 MGD and for industrial facilities with a toxics management program (TMP). At some point in time, the data gathered for the larger domestic facilities will be reviewed with the results applied as necessary to the smaller facilities.

The required frequency for sampling and analysis is once per five years (to be initiated after the start of the third year from the permit's effective date) with the data being submitted with the next permit reissuance application (due at least 180 days prior to the expiration date the permit).

The condition will still be a requirement contained in Part I of the permit; however, there is an attachment (Attachment A) to the permit which may serve as the reporting form.

There is no reason to include the full condition in a reissued permit which previously carried the requirement unless there has been (or is expected to be) a significant change in the wastewater characteristics. If it is included a second time, the rationale for requiring it should be included in the fact sheet.

The following are some reasons where a partial listing of parameters should be included in the reissued permit.

a. **If the permittee used higher QLs than specified in the permit for the analyses of any previous parameters.** This situation is to be referred to the compliance/enforcement staff as a permit violation. However, evaluate the data that were submitted using WLA.EXE. If the evaluation shows that a lower QL is necessary, the monitoring for the given parameter(s) should be reinstated in the reissued permit. If the WLA.EXE evaluation shows that no limit would be necessary, even at the higher QLs, then no further monitoring would be required. This information should also be provided to the compliance/enforcement staff as it may affect the actions taken.

b. **If the permittee failed to collect/report certain data from the previously required condition.** This is to be referred to the compliance/enforcement staff as a permit violation and the monitoring for the given parameter(s) should be reinstated in the permit reissuance.

c. **If the expected value of the reported data is greater than 25 percent of the most conservative waste load allocation, even though WLA.EXE determines that no limit is necessary.** In these instances, the potential for a pollutant's presence in higher amounts becomes a concern and the requirement to monitor those should be reinstated. If the expected value is less than 25 percent of the most conservative waste load allocation or less than the required QL, whichever is greater, then no further monitoring is required.

d. **If there are parameters listed in Attachment A which were not included in the previous permit or where the monitoring was deemed unnecessary without substantial justification.** These parameters should be included in the reissuance. For those parameters that were previously evaluated with a decision that no further monitoring was necessary, then there is no need to reevaluate them at each reissuance.

For items a. and b. above, an accelerated schedule for obtaining the data should be considered.

Ethylhexyl Phthalate:

This substance appears to be a component of the plastic/rubber apparatus used in collecting and/or preparing samples for analysis. The result is contamination of the sample to a minor extent. The analytical results for this material may be disregarded unless the reported concentrations exceed 30 µg/l or unless there is an identifiable source of this material tributary to the effluent in question.

Attachment A has notations to the permit writer showing a few parameters which are specific to either public water supplies (PWS), fresh water (FW) only or salt water (SW) only. Monitoring for those parameters should be required only in those instances.

Dioxin monitoring will only be required for pulp and paper mills and oil refineries.

QLs for metals will equal the lesser of 0.4 WLAa or 0.6 WLAc, but not less than the following:

Silver	0.2 µg/l
Aluminum	2.0 µg/l
Arsenic	1.0 µg/l
Cadmium	0.3 µg/l
Chromium	0.5 µg/l
Copper	0.5 µg/l
Iron	1.0 µg/l
Mercury	1.0 µg/l
Manganese	0.2 µg/l
Nickel	0.5 µg/l
Lead	0.5 µg/l
Antimony	0.2 µg/l
Selenium	2.0 µg/l
Zinc	2.0 µg/l

All other QLs are included in the example Attachment below.

The regional office may elect to allow the permittee to analyze for total recoverable metals. However, the regional office and the permittee must be aware that dissolved and/or clean metals analyses may be necessary prior to the next permit issuance.

For discharges where salt water standards would apply, hardness monitoring is unnecessary.

Following are representative special condition language for the fact sheet, the permit condition language and an example Attachment A.

Fact Sheet Special Condition Rationale

Water Quality Monitoring **(INDUSTRIALS WITH TMPs AND MUNICIPALS WITH >0.04 MGD FLOW)**

Rationale: The State Water Control Law, Section 62.1-44.21, authorizes the Board to request information needed to determine the discharge's impact on State waters. States are required to review data on discharges to identify actual or potential toxicity problems, or the attainment of water quality goals, according to 40 CFR Part 131, Water Quality Standards, subpart 131.11. To ensure that water quality criteria are maintained, the permittee is required to analyze the facility's effluent for the substances noted in Attachment A of this VPDES permit.

Permit Special Condition:

SPECIAL EFFLUENT MONITORING

The permittee shall **monitor the effluent at outfall(s) ___________ for the substances noted in Attachment A** of the permit according to the indicated analysis number, quantification level, sample type and frequency. Monitoring shall be initiated after the start of the third year from the permit's effective date. Using Attachment A as the reporting form, **the data shall be submitted with the next permit reissuance application which is due at least 180 days prior to the expiration date of this permit.** Monitoring and analysis shall be conducted in accordance with 40 CFR Part 136 or alternative EPA approved methods. It is the responsibility of the permittee to ensure that proper QA/QC protocols are followed during the sample gathering and analytical procedures. The DEQ will use these data for making specific permit decisions in the future. This permit may be modified or, alternatively, revoked and reissued to incorporate limits for any of the substances listed in Attachment A.

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY MONITORING
ATTACHMENT A

FACILITY NAME:
ADDRESS:

PERMIT NO.: VA00 OUTFALL NO.: 001

DEQ PARA #	EPA PARA #	CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL(1)	REPORTING RESULTS	SAMPLE TYPE(2)	SAMPLE FREQUENCY(3)	SPECIFIC TARGET VALUE(4)
		METALS						
		Antimony (Dis.)	(5)	(5)		G	1/5 YR	
438	01000	Arsenic (Dis.)	(5)	(5)		G	1/5 YR (PWS)	
		Arsenic III (Dis.)	(5)	(5)		G	1/5 YR	
439	01005	Barium (Dis.)	(5)	(5)		G	1/5 YR (PWS)	
440	01025	Cadmium (Dis.)	(5)	(5)		G	1/5 YR	
232	01033	Chromium III*	(5)	(5)		G	1/5 YR (FW)	
023	01032	Chromium VI	(5)	(5)		G	1/5 YR	
442	01040	Copper (Dis.)	(5)	(5)		G	1/5 YR	
308	01046	Iron (Dis.)	(5)	(5)		G	1/5 YR (PWS)	
405	01049	Lead (Dis.)	(5)	(5)		G	1/5 YR	

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY MONITORING
ATTACHMENT A

FACILITY NAME:
ADDRESS:

PERMIT NO.: VA00 OUTFALL NO.: 001

DEQ PARA #	EPA PARA #	CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[(1)]	REPORTING RESULTS	SAMPLE TYPE[(2)]	SAMPLE FREQUENCY[(3)]	SPECIFIC TARGET VALUE[(4)]
443	01056	Manganese (Dis.)	(5)	(5)		G	1/5 YR (PWS)	
444	71890	Mercury (Dis.)	(5)	(5)		G	1/5 YR	
445	01065	Nickel (Dis.)	(5)	(5)		G	1/5 YR	
446	01145	Selenium (Dis.)	(5)	(5)		G	1/5 YR	
447	01075	Silver (Dis.)	(5)	(5)		G	1/5 YR	
448	01092	Zinc (Dis.)	(5)	(5)		G	1/5 YR	
PESTICIDES/PCB'S								
332	39330	Aldrin	608	0.05		G or C	1/5 YR	NA
333	39350	Chlordane	608	0.2		G or C	1/5 YR	NA
334	77969	Chlorpyrifos (Dursban)	622	(7)		G or C	1/5 YR	NA
		DDD	608	0.1		G or C	1/5 YR	NA
		DDE	608	0.1		G or C	1/5 YR	NA
335	39370	DDT	608	0.1		G or C	1/5 YR	NA
336	39560	Demeton	(6)	(7)		G or C	1/5 YR	NA
523	39730	2,4-dichlorophenoxy acetic acid (2,4-D)	(6)	(7)		G or C	1/5 YR (PWS)	NA
337	39380	Dieldrin	608	0.1		G or C	1/5 YR	NA
		Endosulfan	608	0.1		G or C	1/5 YR	NA
339	39390	Endrin	608	0.1		G or C	1/5 YR	NA
340	39580	Guthion	622	(7)		G or C	1/5 YR	NA
341	39410	Heptachlor	608	0.05		G or C	1/5 YR	NA
342	77835	Hexachlorocyclo hexane (Lindane)	608	0.05		G or C	1/5 YR	NA
		Kepone	(6)	(7)		G or C	1/5 YR	NA
343	39530	Malathion	(6)	(7)		G or C	1/5 YR	NA
344	39480	Methoxychlor	(6)	(7)		G or C	1/5 YR	NA
345	39755	Mirex	(6)	(7)		G or C	1/5 YR	NA

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY MONITORING
ATTACHMENT A

FACILITY NAME:
ADDRESS:

PERMIT NO.: VA00 OUTFALL NO.: 001

DEQ PARA #	EPA PARA #	CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL(1)	REPORTING RESULTS	SAMPLE TYPE(2)	SAMPLE FREQUENCY(3)	SPECIFIC TARGET VALUE(4)
346	39540	Parathion	(6)	(7)		G or C	1/5 YR (FW)	NA
641		PCB-1242	608	1.0		G or C	1/5 YR	NA
642		PCB-1254	608	1.0		G or C	1/5 YR	NA
643		PCB-1221	608	1.0		G or C	1/5 YR	NA
644		PCB-1232	608	1.0		G or C	1/5 YR	NA
645		PCB-1248	608	1.0		G or C	1/5 YR	NA
618	39508	PCB-1260	608	1.0		G or C	1/5 YR	NA
646		PCB-1016	608	1.0		G or C	1/5 YR	NA
349	39400	Toxaphene	608	5.0		G or C	1/5 YR	NA
647		2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	(6)	(7)		G or C	1/5 YR (PWS)	NA
BASE NEUTRAL EXTRACTABLES								
		Acenaphthene	625	10.0		G or C	1/5 YR	NA
275	34222	Anthracene	625	10.0		G or C	1/5 YR	NA
276	34526	Benzo(a) anthracene	625	10.0		G or C	1/5 YR	NA
648		Benzo(b) fluoranthene	625	10.0		G or C	1/5 YR	NA
278	34242	Benzo(k) fluoranthene	625	10.0		G or C	1/5 YR	NA
277	34247	Benzo(a)pyrene	625	10.0		G or C	1/5 YR	NA
		Butyl benzyl phthalate	625	10.0		G or C	1/5 YR	NA
282	34320	Chrysene	625	10.0		G or C	1/5 YR	NA
654		Dibenz(a,h) anthracene	625	20.0		G or C	1/5 YR	NA
		Dibutyl phthalate	625	10.0		G or C	1/5 YR	NA
259	34536	1,2-Dichlorobenz	625	10.0		G or C	1/5 YR	NA

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY MONITORING
ATTACHMENT A

FACILITY NAME:
ADDRESS:

PERMIT NO.: VA00 OUTFALL NO.: 001

DEQ PARA #	EPA PARA #	CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL(1)	REPORTING RESULTS	SAMPLE TYPE(2)	SAMPLE FREQUENCY(3)	SPECIFIC TARGET VALUE(4)
		ene						
264	34566	1,3-Dichlorobenzene	625	10.0		G or C	1/5 YR	NA
266	34571	1,4-Dichlorobenzene	625	10.0		G or C	1/5 YR	NA
		Diethyl phthalate	625	10.0		G or C	1/5 YR	NA
170		Di-2-Ethylhexyl Phthalate	625	10.0		G or C	1/5 YR	NA
239	34611	2,4-Dinitrotoluene	625	10.0		G or C	1/5 YR	NA
287	34376	Fluoranthene	625	10.0		G or C	1/5 YR	NA
288	34381	Fluorene	625	10.0		G or C	1/5 YR	NA
651		Indeno(1,2,3-cd) pyrene	625	20.0		G or C	1/5 YR	NA
650		Isophorone	625	10.0		G or C	1/5 YR	NA
293	34696	Naphthalene	625	10.0		G or C	1/5 YR	NA
		Nitrobenzene	625	10.0		G or C	1/5 YR	NA
296	34469	Pyrene	625	10.0		G or C	1/5 YR	NA
		1,2,4 Trichlorobenzene	625	10.0		G or C	1/5 YR	NA
VOLATILES								
216	34030	Benzene	624	10.0		G	1/5 YR	NA
484	32104	Bromoform	624	10.0		G	1/5 YR	NA
236	32102	Carbon Tetrachloride	624	10.0		G	1/5 YR	NA
652		Chlorodibromo methane	624	10.0		G	1/5 YR	NA
223	32106	Chloroform	624	10.0		G	1/5 YR	NA
649		Dichloromethane	624	20.0		G	1/5 YR	NA
244	79603	Dichlorobrom	624	20.0		G	1/5 YR	NA

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY MONITORING
ATTACHMENT A

FACILITY NAME:
ADDRESS:

PERMIT NO.: VA00 OUTFALL NO.: 001

DEQ PARA #	EPA PARA #	CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[(1)]	REPORTING RESULTS	SAMPLE TYPE[(2)]	SAMPLE FREQUENCY[(3)]	SPECIFIC TARGET VALUE[(4)]
		o methane						
260	34531	1,2-Dichloroethane	624	10.0		G	1/5 YR	NA
		1,1-Dichloroethylene	624	10.0		G	1/5 YR	NA
172	34371	Ethylbenzene	624	10.0		G	1/5 YR	NA
653		Monochlorobenzene	624	50.0		G	1/5 YR	NA
220	34475	Tetrachloroethylene	624	10.0		G	1/5 YR	NA
222	34010	Toluene	624	10.0		G	1/5 YR	NA
155	39180	Trichloroethylene	624	10.0		G	1/5 YR	NA
173	39175	Vinyl Chloride	624	10.0		G	1/5 YR	NA
ACIDS EXTRACTABLES								
		2-Chlorophenol	625	10.0		G or C	1/5 YR	NA
		2,4 Dichlorophenol	625	10.0		G or C	1/5 YR	NA
		2,4 Dimethylphenol	625	10.0		G or C	1/5 YR	NA
210	39032	Pentachlorophenol	625	50.0		G or C	1/5 YR	NA
175	46000	Phenol[(8)]	625	10.0		G or C	1/5 YR	NA
602	34621	2,4,6-Trichlorophenol	625	10.0		G or C	1/5 YR	NA
MISCELLANEOUS								
039	00610	Ammonia as NH3-N	350.1	200		C	1/5 YR	NA
		Chlorides (mg/l)	(6)	(7)		C	1/5 YR (FW & PWS)	NA
005	50060	Chlorine, Total	(6)	100		G	1/5 YR	NA

DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY MONITORING
ATTACHMENT A

FACILITY NAME:
ADDRESS:

PERMIT NO.: VA00 OUTFALL NO.: 001

DEQ PARA #	EPA PARA #	CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[(1)]	REPORTING RESULTS	SAMPLE TYPE[(2)]	SAMPLE FREQUENCY[(3)]	SPECIFIC TARGET VALUE[(4)]
		Residual						
018	00720	Cyanide	335.2	10.0		G	1/5 YR	NA
306	03556	Dioxin	1613	0.00001		C	1/5 YR	NA
		Fecal Coliform N/CML)	(6)	(7)		G	1/5 YR	NA
		Foaming Agents (as MBAS)	(6)	(7)		G	1/5 YR (PWS)	NA
137	00900	Hardness (as mg/l $CaCO_3$)	(6)	(7)		C	1/5 YR	NA
		Hydrogen Sulfide	(6)	(7)		G	1/5 YR	NA
		Nitrate (as mg/l N)	(6)	(7)		C	1/5 YR	NA
009	00945	Sulfate (mg/l)	(6)	(7)		C	1/5 YR (PWS)	NA
		Total Dissolved Solids (mg/l)	(6)	(7)		C	1/5 YR (PWS)	NA
350	30340	Tributyltin[(9)]	NBSR 85-3295	(7)		C	1/5 YR	NA
252	81551	Xylenes (total)	SW 846 Method 8021B	(7)		G	1/5 YR	NA

____
Name of Principal Exec. Officer or Authorized Agent / Title

____
Signature of Principal Officer or Authorized Agent / Date

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations. See 18 U.S.C. '1001 and 33 U.S.C. '1319. (Penalties under these statutes may include fines up to $10,000 and or maximum imprisonment of between 6 months and 5 years.)

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

Units for the quantification level and the specific target value are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than fifteen (15) minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported.

C = Composite = A 24-hour composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. For composite metals samples, the individual sample aliquots shall be filtered and preserved immediately upon collection and prior to compositing.

(3) Frequency

1/5 YR = once after the start of the third year from the permit's effective date
X = no monitoring required

(4) Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The specific target values are subject to change based on additional information such as hardness data, receiving stream flow and design flows.

(5) A specific analytical method is not specified. An appropriate method shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136) which will achieve a quantification level that is less than the indicated specific target value for each metal. If the test result is less than the specified specific target value, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

Metal	Analytical Methods
Antimony	204.1; 200.7; 204.2; 1639; 1638; 200.8
Arsenic	200.7; 200.9; 200.8; 1632
Barium	208.1; 200.7; 208.2; 200.8
Cadmium	213.1; 200.7; 213.2; 200.9; 200.8; 1638; 1639; 1637; 1640
Chromium*	218.1; 200.7; 218.2; 218.3; 200.9; 1639; 200.8
Chromium VI	218.4; 1636
Copper	220.1; 200.7; 220.2; 200.9; 1638; 1640; 200.8
Iron	236.1; 200.7; 236.2
Lead	239.1; 200.7; 239.2; 200.9; 200.8; 1638; 1637; 1640
Manganese	243.1; 200.7; 200.9; 243.2; 200.8
Mercury	200.7; 245.1; 200.8; 1631
Nickel	249.1; 200.7; 249.2; 1639; 200.9; 1638; 200.8; 1640
Selenium	200.7; 270.2; 200.8; 1638; 1639; 200.9
Silver	272.1; 200.7; 200.9; 272.2; 1638; 200.8
Zinc	289.1; 200.7; 1638; 1639; 200.8; 289.2

* Chromium III is measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the QL (or specific target value), the result for chromium III can be reported as less than QL.

(6) Any approved method presented in 40 CFR part 136.

(7) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(8) Requires continuous extraction.

(9) DEQ's approved analysis for TBT may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science dated November 1996.

HUMAN HEALTH STANDARDS

Background:

In previous guidance the standards for protection of human health were implemented using the same statistical procedures and concepts as were applied to the acute and chronic aquatic life criteria. Review of the standards and discussions with the standards group resulted in that being considered an error. This guidance modifies the application of the human health standards according to the concepts that led to the adoption of the criteria.

Carcinogens:

The basis for the human health criteria for carcinogens and the associated default stream flow (harmonic mean) used to determine wasteload allocations is a concept originated by EPA. The concept is based on limiting the average lifetime (assumed to be 70 years) exposure to these materials to the criterion concentration.

Note that in all of the following equations "n" represents a period of 70 years (e.g. 365.25 x 70 = 25567.5 days). Any other period introduces error into the development. The magnitude of the error will depend on how well the calculated harmonic means estimates the 70 year harmonic mean. This cannot be predicted. Also, be aware that for extremely long periods of record you may obtain different results depending on which particular 70 year period you analyze.

The rationale for using the harmonic mean flow is as follows:

1. Define W as a constant allowable instream pollutant load.
2. Define Q_i as the streamflow on any day, i.
3. Define C_i cas the concentration on day, i
4. The load on day i is = W/Qi
5. n = 25567 days

The average concentration over n days is given by:

1. $$C_{ave} = \frac{\sum_{i=1}^{n} C_i}{n}$$

When the concentration is defined in terms of loading:

2. $$C_{ave} = \frac{\sum_{i=1}^{n} \frac{W}{Q_i}}{n}$$

Since the load is assumed to be constant, it can be taken outside the summation:

3. $$C_{ave} = \frac{W \sum_{i=1}^{n} \frac{1}{Q_i}}{n}$$

Solving for the load (W) yields:

4. $$W = C_{ave} \frac{n}{\sum_{i=1}^{n} \frac{1}{Q_i}}$$

Notice that the second term on the right side of equation 4 is simply the definition of a harmonic mean. Thus, the allowable loading can be expressed as simply:

5. $$W = C_{ave} Q_{HM}$$

When C_{ave} is set equal to the water quality criteria W represents the allowable wasteload allocation.

6. $$W = C_{std} Q_{HM}$$

W is a loading and if a concentration is desired W would be set equal to the flow of the effluent multiplied by its concentration. The equivalent equation for concentration is:

7. $$\mathrm{Cd} = \frac{C_{std} Q_{HM}}{Qd}$$

Note that the harmonic mean is calculated for the total stream flow downstream from the discharge and includes the effluent flow.

Note also that this development assumes that the upstream concentration is zero.

Normally the harmonic mean that is available to DEQ is estimated based on stream flow records and does not include the effluent flow. We use that different harmonic mean ($Q'_{H.M.}$) in a complete mix equation to calculate the allowable wasteload allocation. Our standard procedures use:

8. $$Cd = \frac{C_{ave}(Qd + Q'_{HM}) - CsQ'_{HM}}{Qd}$$

If the upstream concentration is zero then:

9. $$Cd = \frac{C_{ave}(Qd + Q'_{HM})}{Qd}$$

It can be seen that equation 9 differs from equation 7 so our routine approach is not completely consistent with the development of the criteria. The difference is a maximum when the effluent flow is about equal to the correct harmonic mean and amounts to about 15%. As Qd becomes greater than or less than the correct harmonic mean the difference becomes less. It disappears when the effluent flow becomes 0 and becomes insignificant when the effluent flow is small compared to the stream flow.

Since direct stream flow measurements generally have a error of about ± 10% and estimates extrapolated from other sources may have even greater errors it does not appear that the methods we currently use will introduce unacceptable additional error into the estimations of the available wasteload allocations.

It is recommended that, for implementation of the human health criteria for carcinogens, we continue to use a mass balance calculation with the effluent flow and the harmonic mean flow as calculated from stream flow records (e.g. equation 9 where Cd is the wasteload allocation).

Implementation:

Implementation is relatively simple and permit limits should be calculated according to the following protocol:

Obtain the harmonic mean stream flow:
Obtain the design flow for the effluent
Apply a mass balance equation to calculate the allowable effluent concentration:

$$WLA = \frac{Cr(Qd+Q_{hm})}{Qd}$$

Where: LA = wasteload allocation (concentration)
Qd = effluent flow
Q_{hm} = stream flow (Harmonic mean)
Cr = Human health criteria from the standards

Note that in a single discharge situation the WLA will be equal to the permit limit. However, where multiple discharges impact the same stream section the total allowable load must be divided among the discharges.

Note: if the stream background concentration is not equal to zero the central office should be contacted for assistance with the proper calculations.

Note: the statistical program WLA.EXE will no longer be used to estimate a reasonable potential for the human health criteria.

Non-Carcinogens

The human health standards for non-carcinogens are based on a shorter exposure time than that for the carcinogens. There is no specified exposure time in the standards but a consensus of agency opinion is that 30 days is the appropriate period over which to consider these criteria. There is also no recurrence interval mentioned but again an agency consensus indicates that 5 years is appropriate.

What this basically says is that if the highest 30 day average concentration that a person is exposed to is equal to the criteria and they are only exposed once every 5 years then no toxic effects to humans should result.

Implementation:

Implementation is relatively simple and permit limits should be calculated according to the following protocol:

Obtain the 30Q5 stream flow:
Obtain the design flow for the effluent
Apply a mass balance equation to calculate the allowable effluent concentration:

$$WLA = \frac{Cr(Qd+Qs)-QsCs}{Qd}$$

Where:

Where:	WLA	=	wasteload allocation (concentration)
	Qd	=	effluent flow
	Qs	=	stream flow (30Q5)
	Cs	=	stream concentration (background)
	Cr	=	Human health criteria from the standards

Note that in a single discharge situation the WLA will be equal to the permit limit. However, where multiple discharges impact the same stream section the total allowable load must be divided among the discharges.

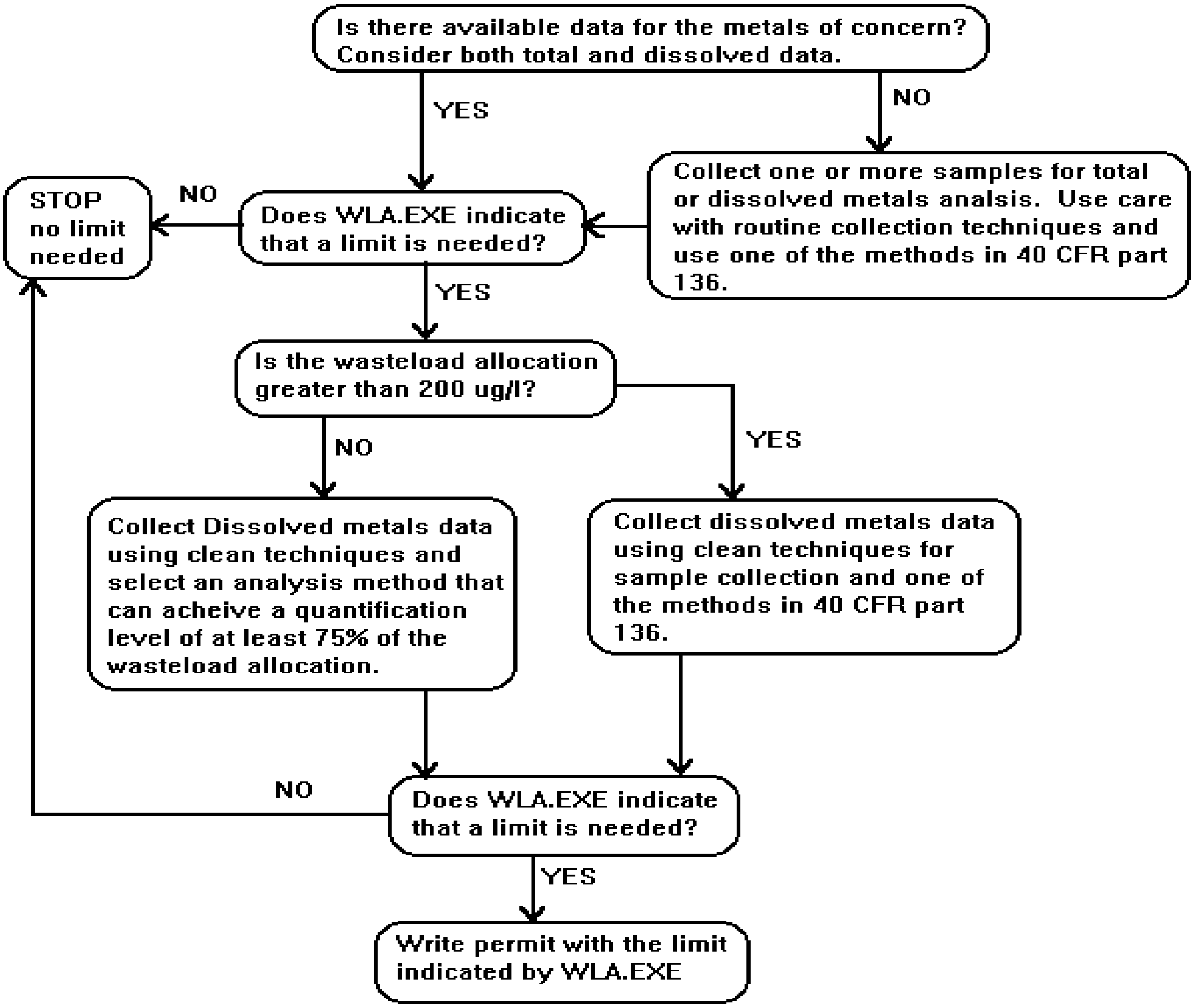
Note: the statistical protocol in WLA.EXE will no longer be used to estimate a reasonable potential for the human health criteria.

OBTAINING DISSOLVED METALS DATA

DEQ staff, along with staff from the Department of Consolidated Laboratory Services (DCLS) have developed procedures for collecting and analyzing metals samples that are not contaminated and that provide reliable results. At the same time we have been keeping abreast of what is happening at the local and national levels to address this issue and are aware that, although not common, the technology for obtaining reliable dissolved metals data now exists and is available to permittees.

Appendices II through V to this guidance summarize the efforts of DEQ to develop acceptable sampling and analytical procedures to obtain the required data. Also included are conclusions and recommendations regarding the availability and applicability of sampling/analytical procedures for obtaining metals data.

We believe that, based on the results of our efforts and those of other parties, acceptable procedures now available to allow permittees to collect and submit metals data that will reliably determine if a permit limit is required.



Notes:

Contamination is not generally a concern when the concentrations that need to be evaluated exceed about 200 ug/l. If the wasteload allocation is close to that level then more care is indicated and perhaps clean techniques.

We believe that significant funds may be saved by the step wise approach to determine if clean techniques are necessary for a particular effluent.

Generally the quantification level should be significantly lower than the target concentrations to be analyzed. Clean techniques and DEQ methods should produce quantification levels that are less than the standards. This is sufficient for almost all effluents.

Methods available for the analysis of dissolved metals:

For each metal the applicable analyses and their minimum detection levels (µg/l) are listed as: analysis #(MDL)

Antimony	-	204.1(200), 204.2(3), 200.7(32), 200.8(.008), 1638(.0097), 1639(1.9)
Arsenic	-	206.2(1), 206.3(2), 200.7(53), 200.8(.02), 200.9(.5), 1600(.002)
Cadmium	-	213.1(5), 213.2(.1), 200.7(3.4), 200.8(.02), 200.9(.05), 1600(.0074), 1638(.025), 1639(.023), 1640(.0024)
Chromium	-	218.1(50), 218.2(1), 218.3(1), 200.7(6.1), 200.8(.04), 200.9(.1), 1639(.1)
Chromium IV	-	218.4(10), 1600(.23)
Copper	-	220.1(20), 220.2(1), 200.7(5.4), 200.8(.004), 200.9(.7), 1638(.087), 1640(.024)
Iron	-	236.1(30), 236.2(1), 200.7(6.2)
Manganese	-	243.1(10), 243.2(.2), 200.7(1.4), 200.8(.007), 200.9(.3)
Mercury	-	245.1(.2), 200.7(2.5), 200.8(.2), 1631(.00005)
Nickel	-	249.1(40), 249.2(1), 200.7(15), 200.8(.07), 200.9(.6), 1638(.33), 1639(.65), 1640(.029)
Selenium	-	270.2(2), 200.7(75), 200.8(1.3), 200.9(.6), 1638(1.2), 1639(.83)
Silver	-	272.1(10), 272.2(.2), 200.7(7), 200.8(.004), 200.9(.5), 1638(.029)
Zinc	-	289.1(5), 289.2(.05), 200.7(1.8), 200.8(.07), 1638(.14), 1639(.14)

This information can be used to select an appropriate analysis for the metals of concern in a particular effluent and all should perform well providing contamination during sampling and sample preparation is avoided.

DEQ Methodology for Dissolved Metals sampling and Analysis at Quantification Levels Less than the Water Quality Standards.

Product notice:

The use of name brands, logos or trademarks in this document does not constitute any endorsement by DEQ for those products nor is it to be construed as a recommendation for those specific products. They are used herein for illustrative purposes only to accurately describe the materials actually used by DEQ and its contract laboratory in one specific study.

Laboratory Procedures:

Analytical methods:

The following methods are recommended:

200.8 - Inductively coupled plasma mass spectroscopy developed by EPA's EMSLC. We recommend that the mass spectrometer be equipped with an ultrasonic nebulizer. This method is applicable to all the metals except iron.

200.7 - Inductively coupled plasma atomic emission spectroscopy. This method is applicable to iron.

Both methods are described in EPA publication EPA/600/4-91/010, June 1991.

Most of the controversy concerning dissolved metals is associated with either filtration artifacts or contamination, therefore, we believe that there should be alternative analytical methods that might be suitable provided contamination is avoided during sample collection and preparation. These methods include:

200.9	-	EPA/600/4-91/010, June 1991	-	all metals
1631	-	EPA 821-R-95-027 April 1995, Draft	-	mercury
1632	-	EPA 821-R-95-028 April 1995, Draft	-	arsenic
1636	-	EPA 821-R-95-029 April 1995	-	hexavalent chromium
1637	-	EPA 821-R-95-030 April 1995	-	all metals
1638	-	EPA 821-R-95-031 April 1995	-	all metals
1639	-	EPA 821-R-95-032 April 1995	-	all metals
1640	-	EPA 821-R-95-033 April 1995	-	all metals

Prior to use, these analytical methods should be tested to ascertain if they are sufficient to reach the needed quantification level.

Laboratory water Specifications:

Deionized and filtered, ASTM type III water (DI water)

Particulate matter	none larger than 0.2 µm
Conductivity	# 0.25 µmhos/cm @ 25°C
Resistivity	# 4.0 mohms @ 25°C
Total organic carbon	# 200 µg/l
Sodium	# 10 µg/l
Chloride	# 10 µg/l
Total silica	# 500 µg/l
Heterotropic bacteria count	# 10/100 ml
Endotoxin	# 0.25 EU

Ultra Pure Water, ASTM type I water (UP water)

Barnstead type D4700 NANOPURE deionization system, or its equivalent, producing ASTM type I water.

The specifications for UP water are operational. This water should be routinely tested to demonstrate that no ion counts above general background noise are produced for target analytes and selected target metals.

Laboratory Air Specification:

All equipment cleaning and analytical procedures where a sample or equipment is open to ambient air should be conducted in a class 100 clean bench or clean room. When conducting limited studies with few samples it may be suitable to use a glove box provided it can be routinely demonstrated that the apparatus does not contribute contamination to the samples.

Equipment:

The equipment we used to obtain samples is suitable for both stream and effluent sampling. The critical concerns are clean sampling bottles, tubing, a proper sampling wand and a peristaltic pump. During our testing of the protocols we arranged the pump and battery into a small backpack that makes for easy transportation and use at stream sites but can also be easily used to sample an effluent.

Note: The design of the pump must be such that the central part of the tubing can be loaded into it without passing its open end through slots or holes.

General:

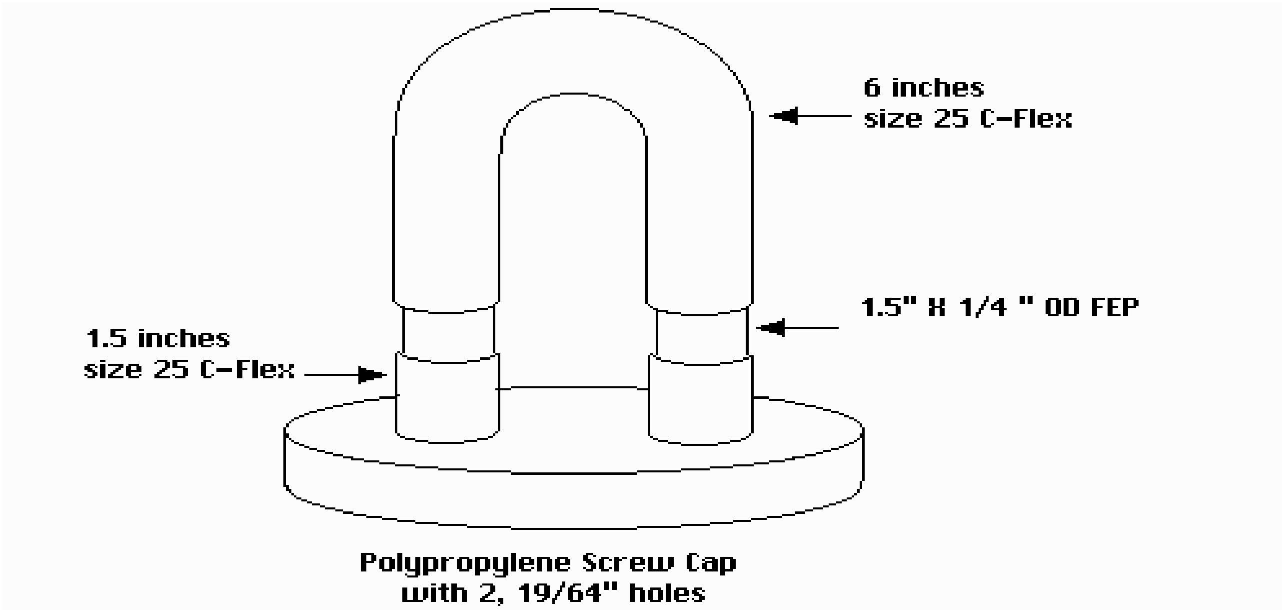
- 12 volt peristaltic pump set to deliver about 500 ml/min.
- 12 volt battery.
- Sampling wand with a snap in attachment point for sample collection tubing.
- Powder free vinyl gloves.
- Plastic bottle carrier with neck strap (optional).

Note: The pumping rate should remain constant throughout all applications once the protocol is set up.

Grab sample equipment (packed in lab and identified as clean):

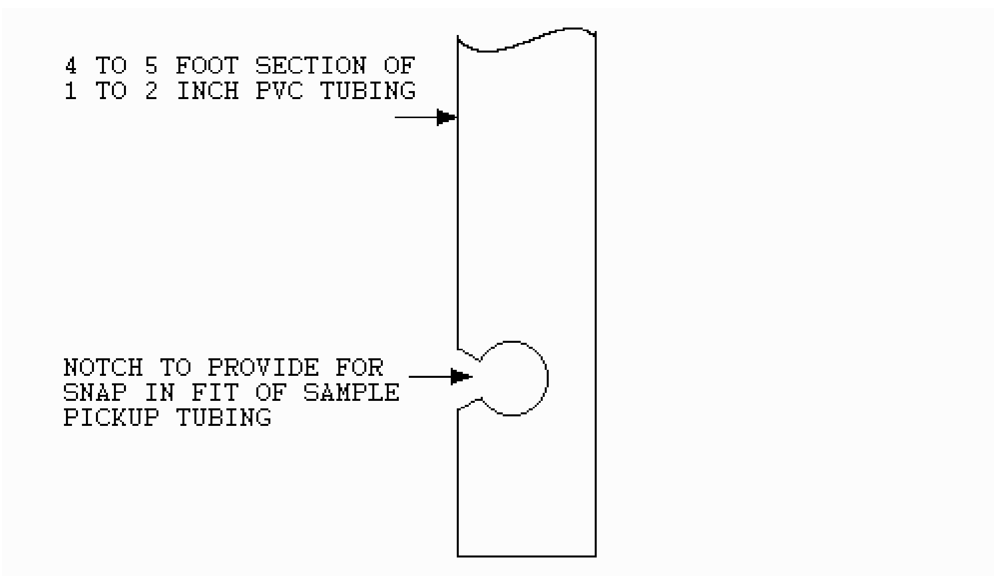
- 5 foot section of 1/4 inch Teflon tubing
- 4 foot section of flexible peristaltic pump tubing (CFLEX 25)
- 0.45 µm torturous path capsule filter (Gelman #12175, #12176 or equivalent) Our experience is that this filter is sufficiently clean as it comes from the manufacturer and it does not need further cleaning. Other filters should be tested in the laboratory prior by to use to ascertain if a conditioning or cleaning procedure will have to be used to yield acceptable blanks.
- 2, 1 liter, polyethylene bottles
- 2, 2 port bottle caps with closure tube (see fig. 1)

Figure 1. Detail of bottle Cap with sealing tube.



Note: the attachments are formed by first pushing the flex tubing through the hole and the pushing the piece of semi-rigid tubing through the flex. If the hole is the correct diameter (19/64 inches) a very tight seal is formed by compression of the flex tubing.

Figure 2. Detail of sampling wand



Equipment Cleaning:

Sample containers:

- Fill sample bottles with 5% HNO_3, cap and soak overnight in a water bath at 50° C.
- Remove the bottles from the water bath and rinse with DI water.
- Refill the bottles with 0.5% HNO_3, cap, and soak for 24 hours in a water bath at 50° C.

- Remove the bottles from the water bath and rinse three times with DI water.

- Fill the clean bottles with UP water, cap and place in a ziplock bag.

- After 24 hours, analyze the water from a minimum of 1% of the containers from each batch for target analytes plus the indicator metals sodium, potassium, calcium and magnesium.

- If no metals are detected in the above tests the batch of containers may be marked as clean and stored for distribution.

Sample tubing and connectors:

- Place sample tubing, prepared bottle caps and any other appropriate equipment (small items with can fit inside a wide mouth container) a plastic container filled with 5% HNO_3. Cap container and soaked overnight in a water bath at 50° C.

- Remove the container from the water bath and rinse the contents with DI water.

- Refill the container with 0.5% HNO_3, cap and soak for 24 hours in a water bath at 50° C.

- Remove the container and rinse the contents three times with DI water.

- Allow the equipment to air dry in a class 100 clean air environment.

- Fill a minimum of 1% of the assembled equipment from each batch with UP water and allow to stand overnight. Collect and analyze the water for target analytes plus the indicator metals sodium, potassium, calcium and magnesium.

- If no metals are detected in the above tests the batch of containers may be marked as clean and ready for use.

Packaging:

A grab sample kit is assembled in the laboratory and consists of:

- 2, 1 liter sample bottles filled with UP water and capped with a two port cap (see fig. 1), each sealed individually in a ziplock bag.

- A 5 foot section of 1/4 inch TFE tubing is connected to a 4 foot section of CFLEX 25 tubing. The CFLEX is then connected to a 0.45 :m torturous path capsule filter (Gelman #12175, #12176 or equivalent). This assembly is then sealed in a ziplock bag.

- Finally the bags containing the 2, one liter bottles and the tubing/filter assembly are sealed into a larger ziplock bag to complete one grab sampling kit.

  Note: all equipment is packed in double ziplock bags. Each bottle and the tubing/filter assembly may be double bagged separately if it is more convenient.

- The double bagged kits are packed in a suitable container (we used large coolers) for transport to the sampling location.

Equipment reuse:

The equipment, dated and marked as clean, is prepackaged in the laboratory so that all materials needed to collect one sample are packaged together in double ziplock bags. One package of clean equipment is used to collect one and only one sample.

Generally the clean equipment is disposable and should be discarded after use. However, it may be possible to reuse equipment providing it is properly cleaned, tested, dated and marked. New equipment and used equipment should not be mixed during the cleaning process e.g. batches of new and used equipment should be cleaned and tested separately. We would suggest testing 5% of each batch of used equipment before it is dated and marked as clean.

Note: the filter is not reusable and must be discarded after use.

Sample Analysis:

All sample handling, opening, preparation, digestion, dilution, standards preparation, etc. is performed by an analyst wearing two pairs of clean vinyl gloves in a class 100 clean air environment (e.g. a clean air bench or clean room) using UP water and apparatus verified as clean by proper QA/QC procedures.

The analytical methods we recommend are EPA 200.8, 200.7 and 1638 (EMSLC). The mass spectrometer that we used is equipped with an ultrasonic nebulizer and we strongly recommend its use. We found that it is not necessary to install the mass spectrometer or nebulizer in a clean air environment providing care is used during introduction of the samples for analysis.

Sample Collection Procedures:

The collection of a sample requires at least two persons. One is designated as clean hands and the other as dirty hands.

Field Blank:

We recommend collecting a field blank with every sample. The procedure for a field blank is:

- Clean hands dons a plastic bottle carrier equipped with a neck strap. This is optional but we found that this provides a convenient way to hold and handle the clean bottles during sample collection as it can hold the bottles without completely removing them from their individual bags and minimizes the handling and possible exposure of the equipment to the ambient environment.

- Dirty hands and clean hands each don two pairs of powder free vinyl gloves.

- Dirty hands opens the grab kit's outer plastic bag, clean hands removes the sample bottles and the tubing assembly, still in their bags, and places them in the carrier.

- Clean hands opens one bottle's bag and disconnects one side of the tubing loop that seals the 1 liter bottle

- Clean hands opens the bag containing the tubing and filter assembly and connects the 4' section of Teflon inlet tubing to the bottle using the open end of the sealing loop. There is no reason to remove the bottle from its bag. Note: the bottle is filled with UP water.

- Dirty hands installs the peristaltic tubing into the pump, and starts the pump. The filter is held with the open end up so that any air bubbles will be expelled. The contents of the bottle are pumped to waste (minimum of 1 liter). Note: Clean hands will have to invert the bottle during this step. This step serves two purposes: it provides a clean empty sample bottle and it conditions/cleans the filter.

- Clean hands removes the TFE tubing from the empty bottle and connects the bottle's still loose sealing loop to the capsule filter.

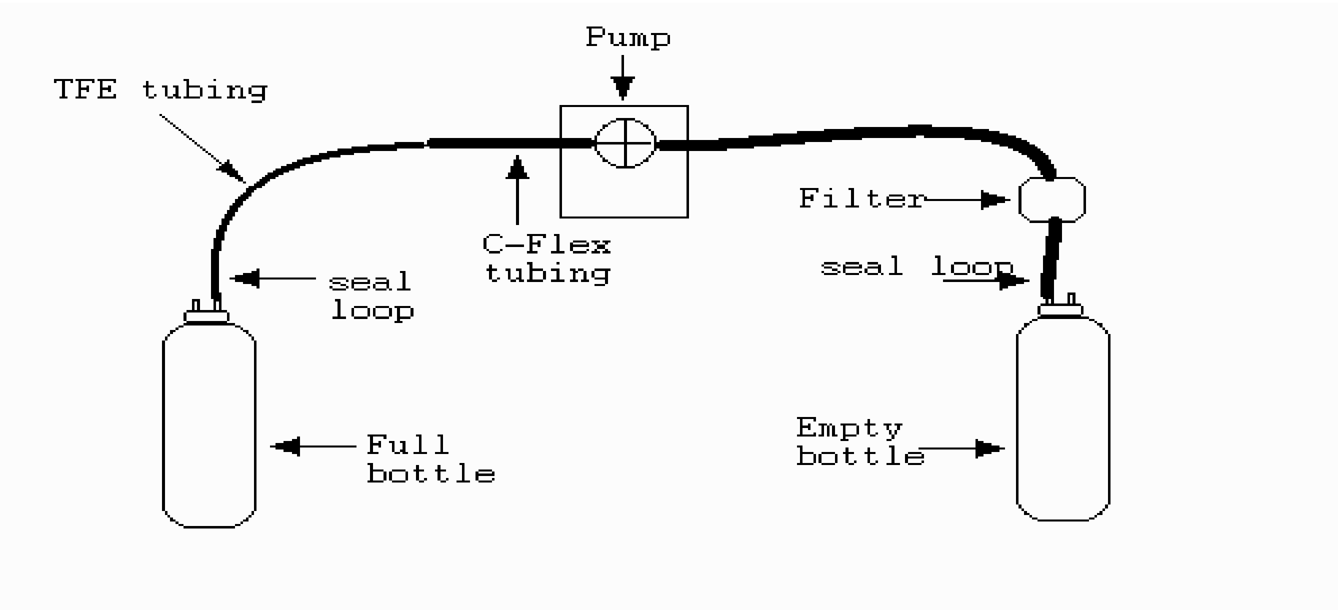
- Clean hands opens the bag containing the second bottle and disconnects one side of the sealing loop, then, connects the bottle to the TFE tubing as before. Note: a clean empty bottle is now connected to the outlet end of the filter and a full bottle of UP water is connected to the inlet.

- Collect a 1 liter field blank by pumping the full bottle into the empty bottle (dirty hands mans the pump). Again the full container will have to be inverted so that it can be pumped empty. Note: this step simply transfers the contents of one bottle to another.

- Clean hands disconnects the sealing tube of the now full bottle from the filter, immediately seals the bottle using the sealing tubing, seals the bottle's ziplock bag and places it back inside the outer bag.

- Dirty hands identifies the blank sample with appropriate tags, labels, etc.

Figure 3. Apparatus assembled to collect a field blank



This is a comprehensive field blank because it is collected in the field with the same equipment, under the same conditions and at the same time as the sample and it is processed just like the sample through all steps of the protocol. This is an extremely important check for contamination or failure of the sampling protocol.

Collecting the grab sample:

- Clean hands immediately (immediately means less than one minute) after collection of the blank disconnects the TFE tubing from the empty bottle.

- Clean hands presents the Teflon tubing to dirty hands who holds it several inches from the exposed end and snaps the tubing into the sample wand (see fig. 2) and, using the wand, places the sample pick up tube in the sample collection zone (stream or effluent) as quickly as possible.

  Note: Dirty hands should take care to not contact clean hand's gloves.

  Note: Dirty hands must take extreme care to prevent the exposed end of the sample pickup tubing from coming into contact with himself or other surfaces and any sources of contamination.

- Clean hands pours any entrained blank water out of the capsule filter.

- Dirty hands starts the pump and about 100 ml of sample is pumped through the tubing and filter, as waste. This provides a sample rinse of the equipment and serves to remove any residual blank water entrained in the tubing or filter. Again, the filter should be held with the open end up to discharge any air bubbles.

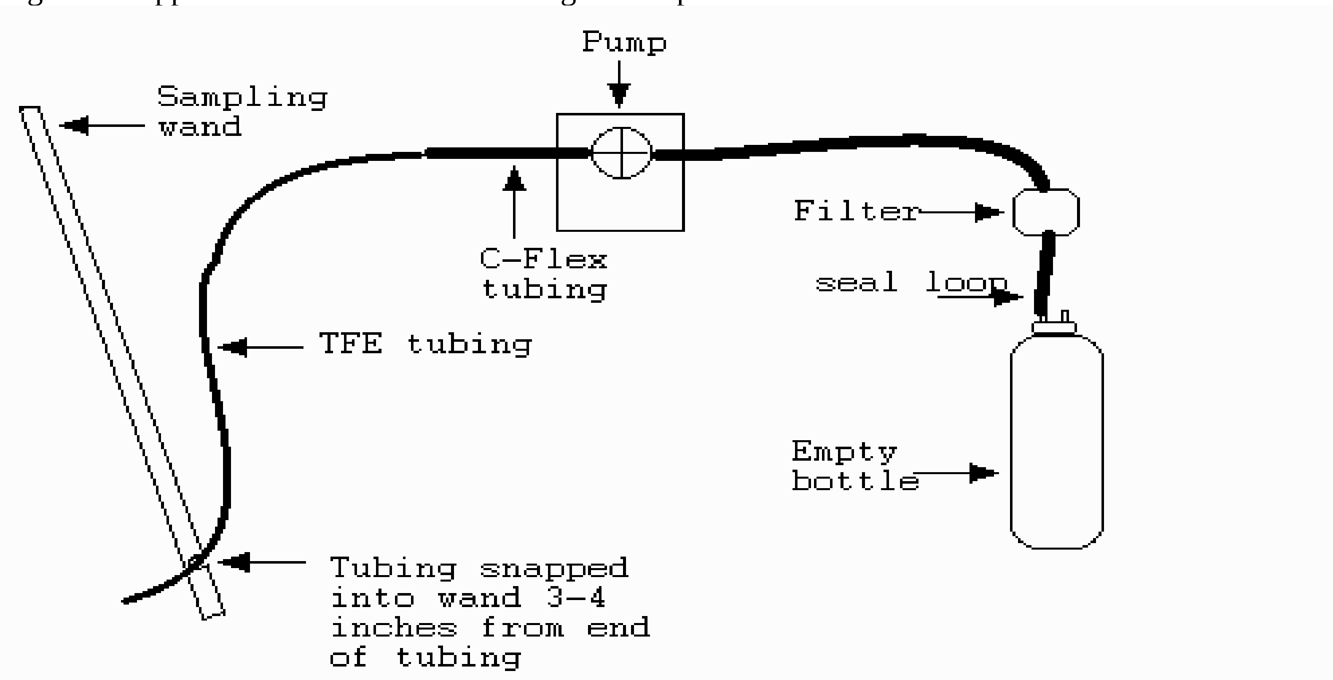
- Clean hands then connects the capsule filter to the sample bottle (the bottle just emptied during collection of the blank) and collects one liter of sample. It is not necessary to stop the pump when connecting the free end of the filter to the sample bottle via the sealing loop. Note: The maximum amount of sample passed through the filter should be consistent from sample to sample and should not exceed about 1.1 liters.

- Clean hands disconnects the sealing tubing from the filter and immediately plugs the container using the sealing tubing. Clean hands then seals the bottle's ziplock bag and places it inside the outer bag.

- Dirty hands identifies the sample, seals the outer bag and places the package on ice in a sample cooler for transportation to the laboratory.

- The Filter must be discarded. We recommend that the tubing be discarded but it may be possible to reuse it (see equipment cleaning above).

Figure 4. Apparatus assembled to collect a grab sample



Quality Control and Assurance:

We will not provide detailed QA/QC requirements but will discuss this subject in general. We followed very extensive QA/QC procedures during our demonstration project and tested almost every aspect of the protocol including, the sampling equipment, sampling protocol, field environment, laboratory equipment, and laboratory environment and analytical methods. Not all of this needs to be repeated for each application but most of it should be considered when a laboratory or sampling crew is initially setting up the protocols.

One of the most significant factors to consider during the collection and analysis of samples for analyte concentrations in the single digit µg/l range is avoidance of contamination. We believe that the most valuable QA/QC consideration in this regard is the large number of comprehensive field blanks we have described.

Other significant factors to consider when designing a QA/QC program for specific applications include:

- Routine analysis of the laboratory UP water to ensure that it remains contaminant free.

- Testing a reasonable percentage of each batch of the cleaned equipment to ensure that the cleaning procedures are and remain effective.

- Routine analysis of prepared standards of known concentrations to ensure that the analytical procedures are in control. NIST standard river water samples are available and very helpful.

- An effective QA/QC program should include a requirement to demonstrate the effectiveness and cleanliness of all procedures and equipment (both field and laboratory) used. Any changes in procedure or equipment should be accompanied by a repeat of these QA/QC procedures to demonstrate that the results remain consistent and reliable.

- Proper training including hands on experience for all field and laboratory personnel involved should be a top priority as seemingly minor departures from the prescribed protocols can result in significant contamination of the samples.

Detection Levels:

The protocols and equipment described earlier in this document have been used by DEQ for the past year to collect and analyze stream samples from the Pigg River and effluent samples from the Rocky Mount STP. The following summary data tables illustrate the typical results that can be obtained by application of these laboratory methods and sampling protocols.

Method detection levels (MDL) for the analytical methods used were calculated in accordance with 40 CFR part 136, appendix B. They were:

Table 1. Method Detection Levels

material	method	MDL µg/l
silver	200.8	.080
aluminum	200.8	.040
aluminum	200.7	.370
arsenic	200.8	.033
cadmium	200.8	.030
chromium	200.8	.019
copper	200.8	.012
iron	200.7	2.399
mercury	200.8	.121
manganese	200.8	.007
nickel	200.8	.024
lead	200.8	.053
antimony	200.8	.051
selenium	200.8	.128
zinc	200.8	2.286

Blanks:

During the Pigg River study many comprehensive field blanks were collected and analyzed. The results demonstrate that the protocols resulted little or no contamination. The overall blank results were:

Table 2. Blanks.

material	number samples	mean Conc.	standard deviation
silver	19	.0279	.0572
aluminum	17	-.5588	2.0048
arsenic	22	-.005	.0470
cadmium	21	-.007	.0186
chromium	20	-.002	.0263
copper	23	-.0981	.3380
iron	17	-.5294	1.1946
mercury	16	-.0494	.1006
manganese	25	-.0633	.1946
nickel	21	.0258	.0906
lead	21	.0169	.0253
antimony	20	.0033	.0128
selenium	22	.0782	.6592
zinc	28	-.1207	.7520

Prepared standards

Prepared standards were analyzed at varying concentrations. These consisted of laboratory standards and NIST standard river water samples. The combined results of all these analyses are summarized in table 3.

Table 3. Prepared Standards

	concentration µg/l								
	0.1	0.2	0.3	0.5	1	2	3	5	50	100
Ag										
n	7	7	7	7	28	7	7	7		
mean	0.083	0.204	0.295	0.498	0.999	2.01	2.96	4.88		
S.D.	0.002	0.006	0.004	0.008	0.029	0.037	0.079	0.086		
Al										
n	7	7	7	7	18	7	7	7	12	
mean	0.104	0.161	0.239	0.614	1.05	1.999	3.067	5.019	50.07	
S.D.	0.006	0.007	0.010	0.026	0.116	0.013	0.084	0.055	2.446	
As										
n	7	7	7	7	40	7	7	7		
mean	0.098	0.215	0.306	0.498	1.003	1.99	3.018	5.068		
S.D.	0.007	0.008	0.010	0.011	0.035	0.039	0.040	0.082		
Cd										
n	7	7	7	7	43	7	7	7		
mean	0.09	0.207	0.306	0.505	0.993	2.038	2.983	5.05		
S.D.	0.003	0.006	0.007	0.009	0.060	0.034	0.053	0.072		
Cr										
n	7	7	7	7	43	7	7	7		
mean	0.096	0.198	0.287	0.486	1.019	1.96	2.921	4.868		
S.D.	0.004	0.004	0.010	0.011	0.046	0.032	0.069	0.090		
Cu										
n	7	7	7	7	44	7	7	7		
mean	0.104	0.178	0.253	0.48	1	1.931	2.922	5.025		
S.D.	0.015	0.010	0.014	0.009	0.056	0.039	0.030	0.044		
Fe										
n					4				14	3
mean					0.995				48.76	101.1
S.D.					0.017				0.919	0.854
Hg										
n				7	21	7				
mean				0.516	0.99	2.048				
S.D.				0.037	0.06	0.080				
Mn										
n	7	7	7	7	42	7	7	7		
mean	0.099	0.208	0.296	0.488	1.01	1.97	2.935	4.926		
S.D.	0.002	0.005	0.006	0.012	0.030	0.040	0.047	0.045		

Ni										
n	7	7	7	7	43	7	7	7		
mean	0.091	0.206	0.299	0.507	1.012	2	2.962	5.055		
S.D.	0.002	0.007	0.012	0.010	0.034	0.051	0.018	0.050		
Pb										
n	7	7	7	7	41	7	7	7		
mean	0.092	0.195	0.299	0.484	1.02	1.989	2.986	5.035		
S.D.	0.004	0.008	0.008	0.004	0.086	0.039	0.029	0.055		
Sb										
n	7	7	7	7	44	7	7	7		
mean	0.099	0.208	0.304	0.503	1.018	1.967	2.934	4.789		
S.D.	0.002	0.004	0.004	0.006	0.004	0.012	0.080	0.089		
Se										
n	7	7	7	7	34	7	7	7		
mean	0.16	0.126	0.228	0.468	0.996	1.875	2.926	5.223		
S.D.	0.055	0.056	0.059	0.064	0.091	0.042	0.068	0.083		
Zn										
n	7	7	7	7	36	7	7	7	11	
mean	0.147	0.126	0.098	0.054	1.001	2.01	2.827	4.957	52.37	
S.D.	0.006	0.056	0.013	0.012	0.152	0.027	0.114	0.057	2.868	

Table 4. 1995 Stream Samples - station 1:

date	al	sb	as	Cd	cr	Cu	fe
6/13	31	< .05	0.08	< .06	2.11	< .02	
7/29	52	< .05	0.3	< .06	2.07	1.09	179
9/26	13	< .05	0.09	< .06	1.09	0.61	110
10/24	41	< .05	0.06	< .06	0.46	0.32	257
11/30	114	< .05	0.11	< .06	1.65	0.91	288
n	5	N/A	5	N/A	5	4	4
mean	50.2	N/A	0.128	N/A	1.476	0.7325	208.5
S.D.	38.4408	N/A	0.09782	N/A	0.70112	0.33885	80.093
	mn	hg	ni	Se	ag	Zn	
6/13	37	< .12	0.21	<.77	< .19		
7/29	17.8	< .12	0.36	<.77	< .19	< .26	
9/26	23	< .12	0.92		< .19	0.29	
10/24	23	< .12	0.15	0.03	< .19	0.54	
11/30	20	< .12	0.53	0.1	< .19	0.56	
n	5	N/A	5	2	N/A	3	
mean	24.16	N/A	0.434	0.065	N/A	0.46333	
S.D.	7.50519	N/A	0.30891	0.04949	N/A	0.15044	

Table 5. 1995 Stream samples - station 2:

date	al	sb	as	cd	Cr	Cu	fe	pb
6/13	24	0.05	0.2	< .06	0.44			< .17
7/29	32.2	0.05	0.43	< .06	0.56	0.79	188	
9/26	12	< .02	0.09	< .06	0.3	0.59	120	< .17
10/24	29	< .02	0.08	< .06	0.18	0.48	315	< .17
11/30	100	< .02	0.15	< .06	0.85	1.33	262	< .17
n	5	2	5	0	5	4	4	0
mean	39.44	0.05	0.19	N/A	0.466	0.7975	221.25	N/A
S.D.	34.714	0	0.1426	N/A	0.2580	0.3774	85.257	N/A
	mn	hg	ni	se	Ag	Zn		
6/13	34.7	< .12	0.28	< .77	< .19	< 2.18		
7/29	25.8	< .12	0.31	< .77	< .19	< .26		
9/26	28	< .12	0.26		< .19	< .26		
10/24	36	< .12	0.25	0.05	< .19	3.62		
11/30	36	< .12	0.73	0.13	< .19	0.95		
n	5	N/A	5	2	N/A	2		
mean	32.1	N/A	0.366	0.09	N/A	2.285		
S.D.	4.8394	N/A	0.2047	0.0565	N/A	1.8879		

Table 6. 1995 Effluent Samples (3 grab samples @ 8 hour intervals on each sampling day):

No analysis of these data is made here and they are included only to demonstrate that the protocols described will yield results that are suitable for analysis.

date	al	sb	as	cd	Cr	Cu	fe	pb
6/13	11.9	0.34	0.58	0.14	0.8	5.09	31	0.95
6/13	20.4	0.34	0.2	0.17	0.8	5.86	30	1.32
6/13	9.7	0.37	0.77	0.16	1.62	5.26	38	1.19
7/25	21.55	0.36	0.56	0.21	1.42	6.38	29	0.98
7/25	24.5	0.35	0.61	0.21	1	6.12	28	1
7/25	18	0.31	0.56	0.18	1.64	5.47	26	0.83
9/26	11.2	0.23	0.32	0.14	0.47	6.02	40	0.71
9/26	14.7	0.29	0.42	0.17	0.3	7.77	50	0.79
9/26	12.9	0.28	0.45	0.18	0.69	7.45	40	0.76
10/24	14	0.21	0.29	0.24	0.62	6.48	44	0.37
10/24	15	0.22	0.3	0.22	0.57	7.11	47	0.38
10/24	14	0.21	0.31	0.23	0.81	6.76	52	0.38
11/30	29	0.2	0.35	0.33	0.89	6.2	66	0.35
11/30	28	0.2	0.42	0.34	0.93	6.05	61	0.34
11/30	29	0.2	0.38	0.38	0.62	5.59	57	0.3
n	15	15	15	15	15	15	15	15
mean	18.256	0.274	0.4346	0.22	0.8786	6.2406	42.6	0.71
S.D.	6.7181	0.0666	0.1533	0.0743	0.3985	0.7770	12.704	0.3389

Table 6. cont.

date	mn	hg	ni	se	ag	Zn
6/13	4.06	< .12	1.07	< .77	< .19	100
6/13	3.7	< .12	1.13	< .77	0.54	95
6/13	3	< .12	1.18	< .77	< .19	102
7/25	3.28	< .12	1.41	1.2	0.17	104
7/25	3.5	< .12	1.39	0.87	0.13	108
7/25	3.3	< .12	1.16	1	0.12	86
9/26	1.47	< .12	1.21	0.38	0.07	54
9/26	1.46	< .12	1.18	0.83	0.08	59
9/26	2.29	< .12	2.51	0.73	0.07	57
10/24	2.14	< .12	1.25	< .77	< .19	79
10/24	1.54	< .12	1.43	< .77	< .19	78
10/24	0.93	< .12	1.35	< .77	< .19	77
11/30	1.12	< .12	1.26	0.31	0.55	60
11/30	0.71	< .12	1.26	0.26	0.53	56
11/30	0.81	< .12	1.15	0.28	0.39	56
n	15	15	15	15	15	15
mean	2.22066	N/A	1.32933	N/A	N/A	78.0666
S.D.	1.16093	N/A	0.34406	N/A	N/A	20.1085

Quantification:

There are many statistical models that may be used to specify a quantification level. The differences between them may be slight or major depending on the specific nuances one considers in building the statistical model. All methods have in common that they seek to establish a method by which one may judge if data are sufficiently accurate to allow them to be used as the basis for a rational and defensible decision.

Even if there were available a model that everyone agreed with (there is currently no such model) it would not eliminate the difficulties associated with establishing a quantification level. The real difficulty with specifying a quantification level is that it is basically not a statistical or technical issue rather it is one of public policy. Once someone decides how much risk can be tolerated for the decision being in error then many methods can be applied to determine if a particular data set is sufficiently accurate to provide the basis for a particular decision.

The express purpose of the data that is to be collected according to the protocols in this guidance is to ascertain if there exists a **reasonable potential for the materials in an effluent to cause or contribute to a violation of the water quality standards** that have been established for the streams in Virginia. Note the key concepts in this statement of purpose are *reasonable potential* and *cause or contribute.*

There is continuing controversy regarding the appropriate specification of a quantification level for use by DEQ. We will not attempt to solve this issue here. Rather, we will simply use the available data and our best judgment to try to get a handle on this issue.

The following table shows the tolerance intervals for the data resulting from the analysis of standards and prepared materials. Note that the concentrations in these samples are known and the tolerance interval accurately describes the overall results that can be obtained from reagent water prepared standards and NIST standard river water samples.

The table gives the lower and upper bounds of an interval such that based on the sample mean and standard deviation, there is 95% confidence that 99% of the population observations will be within the interval. The interval is defined as: sample mean ± K(standard deviation). K is taken from: W.H.Beyer, *CRC Handbook of Tables for Probability and Statistics*, 2nd. ed., 1983, pages 135-138.

Table 7. Tolerance Intervals based on the analysis of standards

	concentration							
	0.1	0.2	0.3	0.5	1.0	2.0	3.0	5.0
ag	.07/.09	.17/.24	.27/.32	.46/.54	.9/1.1	1.8/2.2	2.5/3.4	4.4/5.3
al	.07/.14	.12/.20	.18/.30	.47/.75	.6/1.5	1.9/2.2	2.6/3.5	4.7/5.3
as	.06/.14	.17/.26	.25/.36	.43/.56	.9/1.1	1.8/2.2	2.8/3.2	4.6/5.5
cd	.07/.11	.17/.24	.26/.35	.45/.55	.8/1.2	1.8/2.2	2.7/3.3	4.7/5.4
cr	.07/.12	.17/.22	.23/.34	.43/.54	.9/1.2	1.8/2.1	2.5/2.2	4.4/5.3
cu	.02/.18	.12/.23	.17/.33	.43/.53	.8/1.2	1.7/2.1	2.8/3.1	4.4/5.3
fe					.9/1.1			
hg			.31/.71		.8/1.2	1.6/2.5		
mn	.09/.11	.18/.24	.26/.33	.42/.55	.9/1.1	1.8/2.2	2.7/3.2	4.7/5.2
ni	.08/.10	.16/.25	.23/.37	.45/.56	.9/1.1	1.7/2.3	2.9/3.1	4.8/5.3
pb	.07/.11	.14/.23	.26/.34	.46/.51	.7/1.3	1.8/2.2	2.8/3.1	4.7/5.3
sb	.09/.11	.18/.23	.28/.33	.47/.54	1.0/1.0	1.9/2.0	2.5/3.4	4.3/5.3
se	.14/.45	.17/.42	.1/.54	.12/.81	.7/1.3	1.6/2.1	2.6/3.3	4.8/5.7
zn	.11/.18	.17/.42	.02/.17	.01/.12	.5/1.5	1.9/2.2	2.2/3.4	4.6/5.3

The above table demonstrates that the methods recommended herein can yield acceptable results at very low concentrations for most of the metals tested in prepared standards and standard river water.

Based on consistent accuracy and stability at low levels and an interval that contains the population mean to within about ± 10% to 20%, we believe that the data in table 7 adequately demonstrates that the protocols and methods we recommend can provide acceptable quantification of metals at the following concentrations:

Silver	0.2 µg/l
Aluminum	2.0 µg/l
Arsenic	1.0 µg/l
Cadmium	0.3 µg/l
Chromium	0.5 µg/l
Copper	0.5 µg/l
Iron	1.0 µg/l
Mercury	1.0 µg/l
Manganese	0.2 µg/l
Nickel	0.5 µg/l
Lead	0.5 µg/l
Antimony	0.2 µg/l
Selenium	2.0 µg/l
Zinc	2.0 µg/l

With the exception of silver, lead and cadmium the above numbers are much lower than the water quality standards and even for silver, lead and cadmium concentrations near or at the standards can be acceptably quantified.

It is our belief that the protocols and analytical methods described herein will yield data that will allow DEQ and/or a permittee to determine, with a high degree of confidence, if a reasonable potential exists for the dissolved metals in an effluent to cause a contravention of the water quality standards.

Summary of Quality Control Recommendations for Clean Protocols

QUALITY CONTROL RECOMMENDATIONS FOR TRACE METALS SAMPLE COLLECTION

SAMPLING REQUIREMENTS	CRITERIA	FREQUENCY
Type of method	Performances based by demonstration of no detectable contamination of target analytes or interference in samples or blanks. Method 1669 and the sampling apparatus and techniques used by the DEQ are recommended for sample collection.	Demonstration contamination free samples and blanks every time a variation is made to the method
Media Type	Freshwater and treated final effluent wastewater for dissolved and total recoverable metals.	NA

QUALITY CONTROL RECOMMENDATIONS FOR TRACE METALS SAMPLE COLLECTION (Continued)

SAMPLING REQUIREMENTS	CRITERIA	FREQUENCY
Training	Sample collection by only thoroughly trained personnel. Personnel must demonstrate proficiency in collecting contaminant free blanks and samples.	Train a minimum of one time prior any sample collection. Stop and provide additional training if field QC demonstrates problems until the criteria is achieved.
Filtration	0.45 um Capsule filter with nominal surface area of 600 cm2. Maximum sample volume 1000 ml through single use filter.	On site at time of collection or within one hour for composite samples after the sample sequence is complete.
Sample containers	no detectable target analytes above MDL.	minimum of 1% of containers checked by the laboratory per batch after initial demonstration of acceptable blank QC.
Sampling equipment	no detectable target analytes above MDL.	minimum of 1% of equipment checked by the laboratory per batch after initial demonstration of acceptable blank QC.
Comprehensive grab field blank	blanks must be < 10% sample concentration or if sample is < MDL field blank contamination Os OK.	Process one every sample collected. When duplicate samples are collected only one blank is necessary. Process field blank every time equipment is field cleaned to be reused between sites or sample events.
Comprehensive composite field blank	Blanks must be < 10% sample concentration or is sample is < MDL field blank contamination is OK.	Process one per site for every ten samples. When 10% frequency rule is applied blanks are to be collected with the first sample. Process field blank every time equipment is field cleaned to be reused between sites or sample events.
Field duplicate	Statistically equivalent to the RPD of the matrix spike and matrix spike duplicates for quantifiable concentrations	Process one per site for every ten samples.

QUALITY CONTROL RECOMMENDATIONS FOR TRACE METALS SAMPLE COLLECTION (Continued)

SAMPLING REQUIREMENTS	CRITERIA	FREQUENCY
Preservation	Samples must be iced in the field. Composite samples must be iced during collection. pH < 2 within 72 hours of collection and samples must remain in original containers for a minimum of 18 hours prior to digestion or analysis.	All samples must be acid preserved in the filed or laboratory with ultra pure HNO3 to pH < 2. Samples should be iced in field immediately after collecting.
Documentation	Sampling activities must be documented on paper or by computerized sample tracking.	Documentation must be done per sample per site.

Additional Methods and Procedures

Quality Assurance Project Plan for Clean Metals, Virginia Department of Environmental Quality, June 1996. This document is available on the world wide web at: http://www.deq.state.va.us

Copies can be obtained from:
R.E. Stewart
Va. DEQ
629 E. Main St.
Richmond VA 23219

U.S. Geological Survey Protocol for the Collection and Processing of Surface-Water Samples for the Subsequent Determination of Inorganic Constituents in Filtered Water, Open-File Report 94-539

Copies can be obtained from:
U.S. Geological Survey
Earth Science and Information Center
Open File Report Section
Box 25286, MS517
Denver Federal Center
Denver, Colorado 80225

Guidance on Establishing Trace Metal Clean Rooms in Existing Facilities, EPA 821-B-96-???, January 1996. DRAFT.

Copies can be obtained from:
Water Resource Center
Mail Code RC-4100
401 M street, SW
Washington, D.C. 20460

Guidance on the Documentation and Evaluation of Trace Metals Data Collected for Clean Water Act Compliance Monitoring, EPA 821-B-95-???, January 1996, DRAFT

Copies can be obtained from:
US EPA NCEPI
11029 Kenwood Road
Cincinnati, OH 45242

Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels, EPA, 821-R-5-034, April, 1995

Copies can be obtained from:
US EPA NCEPI
11029 Kenwood Road
Cincinnati, OH 45242

SPECIAL CONDITION FOR COMPLIANCE REPORTING

A special condition should be included in all permits that include limits for materials that have identified quantification levels. An example follows:

Compliance Reporting Under Part I.A.

1. The quantification levels (QL) shall be as follows:

Effluent Characteristic	Quantification Level
Chlorine	0.1 mg/l
Ammonia-N	0.2 mg/l
Total Recoverable Cadmium	0.8 : g/l
Total Recoverable Copper	7.2 : g/l
Total Recoverable Nickel	13 : g/l
Total Recoverable Zinc	52 : g/l

2. Reporting

   a. **Monthly Average** -- Compliance with the monthly average limitations and/or reporting requirements for the parameters listed in Part I.B.1 shall be determined as follows: All data below the QL listed above shall be treated as zero. All data equal to or above the QL listed in 1. above shall be treated as it is reported. An arithmetic average shall be calculated using all reported data, including the defined zeros. This arithmetic average shall be reported on the DMR. If all data are less than the QL, then < XX shall be reported on the DMR where XX is the QL listed in 1. above.

EITHER

   b. **Weekly Average** (for municipal effluents) -- Compliance with the weekly average limitations and/or reporting requirements for the parameters listed in Part I.B.1 shall be determined as follows: All data below the QL listed in 1. above shall be treated as zero. All data equal to or above the QL shall be treated as reported. An arithmetic average shall be calculated using all reported data, including the defined zeros, collected within each complete calendar week and entirely contained within the reporting month. The maximum value of the weekly averages thus determined shall be reported on the DMR. If all data for each weekly average are less than the QL, then < XX shall be reported on the DMR where XX is the QL listed in 1. above.

OR

   b. **Daily maximum** (for industrial effluents) -- Compliance with the daily maximum limitations and/or reporting requirements for the parameters listed in Part I.B.1 shall be determined as follows: All data below the QL listed in 1. above shall be treated as zero. All data equal to or above the QL shall be treated as reported. An arithmetic average shall be calculated using all reported data, including the defined zeros, collected within each day during the reporting month. The maximum value of these daily averages thus determined shall be reported on the DMR as the Daily Maximum. If all data for each daily maximum are less than the QL, then < XX shall be reported on the DMR where XX is the QL listed in 1. above.

USE OF WATER QUALITY STANDARDS IN VPDES PERMITS

Questions often arise relative to such things as the definition of state waters, where do the standards apply, what are surface waters, what are intermittent streams, etc. The purpose of this section is to provide guidance on the use of the water quality standards in the VPDES permit program.

The State Water Control Law includes the following definition:

> "State Waters" means all water, on the surface and under the ground, wholly or partially within or bordering the Commonwealth or within its jurisdiction.

The Permit Regulation includes the following definitions:

> "Point Source" means any discernible, defined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, landfill leachate collection system, vessel or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture land.
>
> "Surface Water" means

(i) all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
(ii) all interstate waters, including interstate wetlands;
(iii) all other waters such as inter/intrastate lakes, rivers, streams)including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
  (1) which are or could be used by interstate of foreign travelers for recreational or other purposes;
  (2) from which fish or shell fish are or could be taken and sold in interstate or foreign commerce; or
  (3) which are used or could be used for industrial purposes by industries in interstate commerce;
(iv) all impoundments of waters otherwise defined as surface waters under this definition;
(v) tributaries of waters identified in paragraphs (i) to (vi) of this definition
(vi) the territorial sea; and
(vii) wetlands adjacent to waters other than waters that are themselves wetlands, identified in paragraphs (I) to (vi) of this definition

The permit regulation also includes the following provisions:

Section 1.5 prohibitions and requirements for permits

A. Except in compliance with a VPDES or VPA permit issued by the Board, it shall be unlawful for any person to:
   1. Discharge into state waters sewage, industrial wastes or any noxious or deleterious substances; or
   2. Otherwise alter the physical, chemical or biological properties of such state waters

and make them detrimental to the public health, or to animal or aquatic life, or the uses of such waters for domestic or industrial consumption, or for recreation, or for other uses.

B. Point source discharges of pollutants to surface waters may be authorized by a VPDES permit. The management of pollutants that are not point source discharges to surface water may be authorized by a VPA permit.

Section 2.5, establishing limitation, standards, and other permit conditions includes:

F. Water quality standards and state requirements
   1. The permit shall include limitations to prevent violations of water quality standards, narrative and numeric, and to comply with any requirement of the Act or the law. These limitations shall control all pollutants or pollutant parameters (either conventional, non conventional, or toxic pollutants) which the Board determines are or may be discharged at a level which will cause, have the reasonable potential to cause or contribute to n excursion above any applicable water quality standard.

As indicated by the above section of the permit regulation a VPDES permit my be issued authorizing the point source discharge of pollutants to surface waters. Thus, for a VPDES permit to the applicable there must be:

1. A point source discharge.
2. The point source discharge must contain pollutants.
3. The discharge must be to surface waters.

If any one of these three conditions does not exist then a VPDES permit is not applicable.

As indicated above the VPDES permit shall include limitations to prevent violations of the water quality standards. Therefore, in the issuance of a VPDES permit we must ensure that the limitations therein will result in the water quality standards being met outside any allowed mixing zones.

One of the decisions that the staff must make in the permitting process is to determine what are surface waters and what are state waters. The definitions are very broad but there are still some areas in the state where there may be a question as to where the water quality standards should apply. Probably the major area of question involves ephemeral or intermittent streams.

This guidance will use the following definitions:

Permanent Stream: a waterway that contains water at all times and that has, or could have, a well established aquatic community.

Intermittent Stream: a waterway that contains water for extended periods during a year, but do not contain water at all times. These streams are likely to have an active aquatic community for at least part of the average year.

Ephemeral Stream: a waterway such as a drainage way, ditch, hollow or swale that contain water only during or immediately following periods of rainfall.

Note: that the discharge of an effluent to an intermittent or ephemeral stream will probably result in the creation of a permanent stream.

Note: a spring fed stream should be considered to be a permanent stream unless flow data is available to demonstrate that the sprint ceases flow for extended times during the average year.

Discharges into permanent streams:

For permanent streams, the water quality standards apply at the point where the discharge enters the stream or at the edge of the mixing zone in cases where a mixing zone is allowed.

Discharges into intermittent streams:

For intermittent streams, that begin on a permittee's property then the water quality standards apply in the stream at the point where the stream leaves the permittee's property boundary.

For intermittent streams, that begin off the permittee's property but crosses the permittee's property then the water quality standards apply at the point where the discharge enters the stream.

Discharges into ephemeral streams:

For ephemeral streams, the water quality standards apply in the stream at the point where the stream leaves the permittee's property.

This guidance recognizes that there exist facilities that use a man made open ditch as a conveyance to deliver a treated effluent to its receiving stream. We do not believe that it is reasonable to treat the effluent in such a conveyance as state waters nor to apply the standards to it. It further recognizes that there is little or no difference in theory or fact between such a ditch and a naturally occurring ditch or channel that may be used for the same purpose. However, it is not the intent of this guidance to suggest or recommend that owners may avoid the proper application of the water quality standards by purchasing the entire watershed of an intermittent stream.

SELECTION OF SAMPLE TYPES FOR VPDES MONITORING

It is important that samples obtained for VPDES monitoring accurately reflect the effluent or waste stream being monitored. Selection of the proper sample type is important in collecting valid VPDES samples. Composite samples are desirable to sample effluent streams which are variable in composition and volume. Certain parameters, however, aren't amenable to composite sampling. These samples must be collected as grab samples. A grab sample is defined as an individual sample collected over a period of time not to exceed 15 minutes. Samples which should be collected as grab samples are:

- pH
- Dissolved oxygen
- Temperature
- Bacteria
- Oil and grease
- Sulfides
- Purgeable organics
- Cyanide
- Phenol
- Sulfites
- Hexavalent chromium

Where it is suspected that a particular discharge may have variable concentrations of the parameters listed above it may be desirable to collect multiple grab samples.

Note: the guidance contained herein relative to collecting samples for toxic metals recommend grab samples. This was because the method we developed was based on grab sample data. However, composite samples are acceptable for these metals providing proper collection and laboratory techniques are used and adequate quality control samples are obtained to demonstrate the validity of the data.

pH LIMITS FOR COOLING WATER OUTFALLS:

The agency has historically included pH limits in the VPDES permits for most cooling water outfalls. The main reason for this appears to be that the agency wanted to ensure that the limits addressed all parameters for which we had adopted water quality standards. Ostensively, the rationale for many of these limits was that they were BPJ effluent guidelines, however, we did not perform the analyses to justify them nor did we adopt their use as BPJ limits according to federal guidelines.

The result is that there are a significant number of permits that have pH limits on cooling water outfalls where no potential exists to impact the instream pH. Permittees must therefore monitor and report cooling water pH on a routine basis and we must spend time tracking and evaluating it. This situation wastes the resources of both the dischargers and our staff because we know, in many cases, that no pH related problem can reasonably be expected to occur even in the event of equipment breakdown.

A recent EPA initiative is to reduce monitoring and reporting requirements in permits where it can be show that such reduction can be made without an unacceptable risk of environmental harm.

In view of this, we believe that the pH limits on many of the once through, non-contact cooling water discharges could and should be removed.

The pH of the effluent will be equal to the pH of the intake and the permittee has no control over that fact. Antibacksliding provides an exception for events over which the permittee has no control so it would not prohibit removal of these limits.

Recommendations:

Evaluate the reasonable potential for the routine operation of the process or a major equipment failure to change the pH of the cooling water.

If no reasonable potential exists for changing the pH:

Do not include a pH limit in new permits.
Remove pH limits during a modification or reissuance of existing permits.

Include the following statement in the fact sheet for modification or reissuance of a permit where pH limits are being removed:

The pH limit in the previous permit for once through, non-contact cooling water has been removed because the process for which cooling is needed has been evaluated and it has been found that no reasonable potential exists for the pH of the cooling water or the receiving stream to be changed even in the event of equipment failure. In addition, the permittee has no control over the pH of the intake water and no reasonable remedy in available to the permittee if the intake water fails to meet the applicable water quality standard. The antibacksliding restrictions do not apply to the limit being removed in this situation.

Exclusions:

These recommendations are intended for application to once through, non-contact cooling water.

They are to be applied only to cooling waters are withdrawn from and discharged to the same source.

They do not apply to any cooling process where chemical additives, routine operation, equipment failure or leakage could change the pH of the cooling water.

SOFTWARE:

Mix.exe

The purpose of MIX.EXE is to assist the permit writer in determining when a complete mix assumption is appropriate for a particular case. The program requires simple, easy to acquire data. It then calculates the time of travel through the longest probable mixing zone associated with that particular effluent. If this time of travel is sufficiently short then the program will find that a complete mix assumption is appropriate. It does not perform the complete mix calculations since its sole purpose is to determine the appropriateness of an assumption being applied on a case by case basis.

Please note that this program cannot be used to estimate the actual size of an expected mixing zone.

STAT.EXE (formerly WLA.EXE)

The purpose of STAT.EXE is to estimate the variability associated with materials in an effluent and to determine appropriate permit limits that take the variability into account. The function of the application and the equations it solves are described in the section “Permit limits based on effluent variability”. However, as discussed in the human health section it no longer calculates permit limits based on the human health criteria.

Distribution:

This guidance will be placed in **k:\agency\water guidance** and can be accessed or downloaded from there. The software can also be installed on your computer from that directory.

This guidance, including the software, will also be posted on the DEQ web site as a self extracting ZIP file.

Individual hard copies will not be routinely distributed.

Installation:

<u>Agency</u>

Run **K:\AGENCY\WATER GUIDANCE\WLA\SETUP.EXE** to install the statistics software on your machine.

Run **K:\AGENCY\WATER GUIDANCE\MIX\SETUP.EXE** to install the mixing zone software on your machine.

Note: some of the files on agency machines are older versions. If the installation program prompts you to update these files, click yes. The machine will update the files and reboot. Then run the appropriate setup.exe program again.

A copy of the guidance is also on K:\AGENCY\WATER GUIDANCE\

Outside the agency

The guidance package is posted on our website as a self extracting zip file. Download the file to a folder and unzip it. **Make sure the recreate subdirectories check box is checked before you click on finish.**

The guidance is in MS WORD format. The software installation setup files will be in separate sub folders (WLA and MIX). If they are not, you didn't have the checkbox marked. In this case, delete the extracted files and do it again being sure that the check box is checked.

Go to the WLA folder and run the setup program.
Go to the MIX folder and run the setup program.