Turbidity, Temperature, and Toxics for the Non-Scientist*

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Introduction

This paper addresses turbidity, temperature, and the reasonable potential analysis for toxic pollutants from the perspective of science rather than from that of statutes or regulations. Turbidity and temperature are physical characteristics of waterbodies, but the reasonable probability analysis is not such a characteristic. Regardless, for all three concerns it is important for those in the regulated community to understand what each is, how it is measured, and why it is part of the regulatory environment.

All ecosystems are dynamic, even the so-called "climax" forest. The rates at which they change range from minutes to decades or centuries. Flowing water systems (streams and rivers) are the most dynamic. The sand waves that form naturally in the lower Columbia River by sediment transport along the surface of the riverbed can move down river as much as 3 meters a day during the summer low water period. During spring rains and snowmelt runoff, streams and rivers undergo continuous change. These physical changes are natural events to which the aquatic biota have adapted. Anthropogenic changes are generally held to be unacceptable above established threshold levels, so activities are regulated to minimize or eliminate their impacts on system dynamics.

This paper explains the natural dynamics of turbidity and temperature in aquatic ecosystems so as to place the relevant laws and regulations in a scientific framework. Reasonable potential analysis for toxics, however, is an administrative process and not a scientific or technical standard.

Turbidity

Background

Turbidity is the physical property of reduced light transmission through water due to absorbence and scattering by solid particles in suspension. Very fine

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dissolved solids can also contribute to turbidity. Most of these suspended particles will settle on the bottom of the basin or channel when water velocity drops below the rate necessary to retain the particles in suspension. This is why sediment particle sizes are not distributed uniformly in space; the swifter the current, the larger the sediment particles on the bottom.

Streams and rivers are normally much more turbid than are still waters in lakes and reservoirs. Many famous rivers are always noticeably cloudy. Such rivers include most in tropical South America and central Africa; the White Nile is so named for its persistent turbidity. Glacier-fed streams and rivers (such as those that drain Mt. Hood) are consistently cloudy, and during snowmelt runoff in the spring local rivers such as the Tualatin, Clackamas, and Willamette are brown with muds and silts.

During low flow periods, however, most streams and rivers are quite clear—although never as clear as lakes—and they become turbid during storm events when large amounts of materials are transported in suspension within the water column. In general, there is a positive relationship between discharge (the volume of water flowing past a defined point in the channel) and turbidity.

Dams and natural lakes along the channel of a river allow large amounts of suspended solids to settle out of suspension, the result is clearer water downstream from the impoundment. In larger rivers, such as the Missouri, Mississippi, and Columbia, plankton[1] can increase turbidity when flows are very low and water temperatures are high.

As a result of all these factors, the percentage of light which penetrates to a given water depth in a stream or river is lower than that reaching the same depth in still water. The depth of penetration is also dependent upon the wavelength of the light; red is absorbed completely near the surface while green and blue penetrate deeper. The depth to which the longer, red-orange wavelengths can penetrate water is the lower depth of photosynthetic activity by phytoplankton and algae.

In still waters, the amount of light reflected from the surface increases with increasing angle of incidence, and therefore depends upon latitude and time of day. At large angles, however, this applies less to a ruffled surface than to a smooth one, and hence less to turbulently flowing than to still water. Thus the turbulence which disturbs the water surface allows more light to penetrate early and late in the day, and to a limited extent this offsets the effects of turbidity.

A further complication is introduced by riparian vegetation. The predominant natural vegetation of stream and river banks are trees in most climates. This is true along the Oregon coast, in the Willamette Valley and for many of the rivers in the semi-arid high desert of eastern Oregon. The shallow water near the banks is normally shaded for some of the time, and small streams in their natural condition, are completely covered with branches and leaves (during the growing season). The penetration of much light to the bottom of the channel in running water systems has been, until development by people, a

[1] Microscopic plants and animals that form the base of the aquatic food web.

rather rare event, particularly in the summertime.

The effects of turbidity on the ecological processes of streams and rivers varies with location within the river system and with geomorphic conditions. High in headwater reaches turbidity may occur from glacial melt water, snowmelt runoff, or large storms. However, these are transient events that have little effect on the physical system and the biota. The channel gradient is usually steep, the stream channel narrow (frequently deeply incised in a valley bottom), and water flows consistently high. The streambed consists of bedrock, boulders, or large cobbles. Finer sediments (small gravels, sands, silts, and clays) are flushed downstream. The interstitial spaces among the large streambed components holds clear flowing water usually highly saturated with dissolved oxygen. In these reaches the primary source of energy for aquatic organisms are leaves from overhanging trees and shrubs and terrestrial insects that fall into the water. Because energy is initially produced external to the aquatic system, the system has *allochthonous* energy sources.

At the other end of the river system, where it flows into a much larger river or the ocean, the gradient is almost flat, the valley is broad and open, and any riparian vegetation can shade only a small percentage of the water surface. The river bed is generally sands and small to medium size gravels, with fine particles (organic as well as mineral silts and clays) adjacent to the banks, in backwaters, and immediately downriver from stable obstructions such as piers, dolphins, downed trees, or other large objects. Sunlight supports an abundant plant community, from microscopic plankton to algae and emergent macrophytes. This internal photosynthetic plant growth is the source of energy for all aquatic animals, so the system has *autochthonous* energy production.

Because of the numerous factors that can influence both turbidity measurements and—more importantly—the effects of turbidity on the most sensitive beneficial uses, care must be taken in determining the appropriate sampling locations when assessing the potential effects of point or non-point sources of materials that could contribute to turbidity in the receiving waters.

Application

Based on the above, it is understandable how the former turbidity threshold and measurement standard were too high and needed to be adjusted. However, there is no overarching scientific insight about the effects of the new criteria because there are so many factors affecting turbidity and its effects on beneficial uses. Since site-specificity is of critical concern, where and how to collect water samples for turbidity measurements is of paramount importance.

The key is in the DEQ's *Draft Implementation Guidelines for Turbidity* in Oregon Administrative Regulations (OAR) 630-041:

> "For all sources that have a reasonable potential to cause or contribute to an exceedance of the turbidity criteria, effluent limits must be calculated to meet the applicable turbidity criteria at the edge of the permitted mixing zone. ... Effluent limits are calculated as an

> increase above background turbidity using stream background turbidity and dilution data."

To determine the baseline against which effluent discharges are measured, the *Guidelines* offer both a reasonable potential analysis based on best professional judgment and:

> "Background may be established using representative monitoring data or a default value. Background turbidity is the turbidity that would occur without the anthropogenic impact. Background turbidity is measured as the turbidity upstream of a turbidity-causing source or if multiple sources are contributing to overlapping plumes of turbidity, upstream of the cumulative plume from the sources. "

There is no general scientific basis for using an established ambient sampling location rather than a project specific location. However, the regulations want applicants to provide such data from a site visited by DEQ, the US Geological Survey (USGS), or other "established" sampling location. The regulations also want measurements immediately upstream from the outfall and not influenced by the effluent plume. The time series analysis of these latter data (especially if they are seasonally detrended) provide insight into turbidity dynamics immediately above the discharge. Depending upon the distance to the nearest upstream ambient monitoring location, the data from the two locations may be valuable.

The mechanics of calculating the requisite data are described in the *Guidelines*. The scientific considerations are sample and outfall locations, temporal variability, constituents of the added turbidity, and the designated most sensitive beneficial use that could be affected.

The temporal consideration involves the beneficial uses and the characteristics of the discharge. If ESA-listed fish species are the principal concern, but the fish are not present during periods of the year, that should affect regulatory decisions about discharge limits in the permit. Similarly, if human water contact (e.g. swimming) is a concern, then discharge limits during the winter or springtime high flows could justifiably be higher than during the summer.

Temperature

Background

The temperatures of streams and rivers vary much more rapidly than those of lakes or reservoirs, but frequently this variation is over a much narrower range than that of at least the shallower parts of still waters.

Water temperature data collected in many locations around the world, and over many decades, have identified diurnal[2] cycles that overlay the seasonal

[2] Daily

and annual cycles. During the summer, in small streams, the daily fluctuation has been measured as much as $6^oC(10.8^oF)$. Maxima usually occur in the mid-afternoon and minima during the latter half of the night. In small streams the deeper the water the less the daily variation, which is caused primarily by radiation into and out of the water; when a stream is spring-fed the daily variation declines towards the source. Shallow streams a few meters wide—such as many in the high desert east of the Cascade Mountains—are particularly subject to short-term variation in water temperature, especially when they are not shaded from the sun.

Water temperature also varies along the length of the valley. Large rivers, and streams at large distances from their sources, are usually at approximately the mean monthly air temperature at the point of measurement. In Oregon, the warmest summer water temperatures in larger streams and rivers are also in the eastern high desert. During the winter. ice and snow form an insulating layer over the water (even in extreme climatic areas) so the water temperature does not fall below 0^oC. The range of mean monthly temperatures of rivers (and of lakes) is often much less than that of the surrounding land surface.

Superimposed on the annual similarity between mean water and air temperatures are frequent exceptions. For example, in the spring snowmelt runoff may maintain water temperatures much lower than air temperatures—particularly at lower elevations—well into the summer. Also, sometimes sunshine after heavy rain results in high water temperatures, presumably because water from the warm soils continues to flow into the stream channel.

In Oregon, temperatures measured in many of the larger rivers (e.g., Columbia, Willamette, Deschutes) are altered from their natural annual and diurnal cycles by storage and release by dams[3]. Another important temperature influence is whether a stream is spring-fed. Spring-fed streams are cooler in summer and warmer in winter than are streams that are runoff fed. Biologically, winter-warm streams may be more important to fish than that the same stream is summer-cool.

Local conditions can invalidate all the generalizations above. For example, cool ground water input to the lower reaches of a river can lower its temperature below what would be expected by its gradient, exposure to sunlight, and lower water velocity. In landscapes that are not flat, the aspect (compass direction) of the stream or river also affects water temperature. A stream flowing down a north-facing slope in Oregon will be cooler than one flowing down a south-facing slope at the same altitude and latitude. Similarly, a west-facing slope will have warmer stream water than will an east-facing slope. These directional effects are amplified by steep, narrow valleys.

An interesting effect of temperature on water is to alter its viscosity, and this causes silt to sink twice as fast at 23^oC as it does at 0^oC. Therefore, warmer wa-

[3]Electricity demand met by hydroelectric dam operations also affect river water levels and discharge. For example, in the Columbia River the level at Fairview varies by 70–100 centimeters (2–3 feet) each week. Weekend electricity demands in the Portland area require more water to spin the generator turbines, and that water flows the 20 miles from Bonneville Dam to Fairview by Tuesday. Water levels then drop as the weekly electricity demands lower, and the cycle is repeated.

ter carries less silt than does colder water so turbidity caused by small silt particles is dependent upon temperature. Warmer water also flows a little faster than does colder water (0.5 percent for each 1^oC rise between 4 and 20^0C.) It also produces a thinner boundary layer on the bottom; this can affect macroinvertebrates such as aquatic insect nymphs and larvæ as well as snails and freshwater mussels.

Too much has been written on the effects of water temperature on aquatic organisms to summarize here. Algae, macroinvertebrates, and fish are all influenced in their distributions, life histories, and behaviors by temperature and temperature cycles. One of the specific drivers of temperature as a critical water quality component is the inverse relationship between water temperature and dissolved oxygen concentration; the colder the water, the more oxygen can be dissolved in it. Salmon eggs buried in gravels need sufficient dissolved oxygen to survive and produce alevin[4].

Human recreational use of water bodies is also influenced by water temperatures. Warm waters are known to allow pathogenic parasites to increase their population sizes enough that people become ill by contacting the dense parasite populations while swimming, diving, or participating in other water sports. Parasitic infections of fish also tend to increase as water temperatures rise. All of these situations contribute to water quality temperature standards by regulatory agencies, including DEQ.

Application

The most important technical considerations in the application of water temperature standards in a regulatory setting are where and when such measurements are made, and how data are analyzed into information and interpreted for permitting decisions and compliance assurance.

Where to measure water temperature is based on many considerations. At one level is deciding on the physical location within the stream or river, at another level is deciding where within the water column to take the measurement. If you want one measurement to characterize a site there is no cookbook solution that adequately addresses all the variables.

If the stream is narrow and wadeable, and uniformly shaped and shaded, a single measurement in the center of the channel, or in the *thalweg*[5] if there is a discernible difference in the water depth across the channel, could be adequate. When the river is broad and unwadable the decision is more difficult. Establishing a transect and taking temperature measurements at regular intervals along it allow both temperature contours and mean values to be calculated. Factors in the location decision include the complexity of the channel's physical structure, degree of incision below the surrounding land, amount and type of shading, and the purpose for measuring temperatures.

[4]The youngest juvenile, with the egg yolk sac still attached to its body. When the sac is absorbed and all fins developed the juvenile is called a fry.

[5]The deepest part of the channel. Around a bend, the thalweg is along the outside bank, in a straight reach it could be in the center or meander from bank to bank.

Where in the water column to measure temperature depends on the purpose for taking the measurements in the first place. If you want to check the temperature (and estimate the dissolved oxygen) available to trout and salmon eggs, then you want to measure just above the streambed or in the gravels, if they are sufficiently large, and not at the water surface. If, however, you need a comparatively coarse measurement to characterize each of a series of locations along the course of a river or stream, then you can either take the average of two measurements (one at 0.2 of the water depth, the other at 0.8 of the water depth) or a single measurement at 0.6 of the water depth. These depth values are accepted as guidelines by river ecologists as adequate compromises considering the very high variability in streams and rivers. The decision of where in the stream or river cross-section to take one or more measurements is highly dependent on the ultimate use of the resulting information.

DEQ has implemented numeric temperature criteria for various streams and rivers, based on their use by cold-water salmonids (OAR 340-041-0028). This is not the appropriate forum to discuss whether the temperature values are appropriate; however, it is appropriate to consider the designated anthropogenic increase limit above ambient temperature as $0.3^oC/0.5^oF$ based on either the discharge water mixing with 25 percent of the stream flow or the boundary of the temperature mixing zone [OAR 340-041-0028(12)(b)(A) or (B)].

For streams inhabited by bull trout the seven-day average of daily maximum temperatures is $12.0^oC/53.6^oF$; this maximum average temperature is $20^oC/68.0^oF$ for other species of salmon and trout. Looking at the temperature rise allowed by anthropogenic activities from the perspective of a fish, it is difficult to understand the potential effects that such a small temperature change can have—whether short-term or long-term in daily maxima—when diurnal temperatures can fluctuate over a much greater range (see page 5). Note, too, that a change of 0.3^oC represents 2.5 percent of the lower temperature and 1.5 percent of the higher temperature. Biologically, one would expect fish adapted to the coldest waters to be more sensitive to a change of a defined percentage than would fish adapted to warmer temperatures.

When demonstrating compliance with temperature criteria both sampling location and potential effects on designated sensitive cold water fish species become important considerations. Of course, this includes the constraint that fish in the protected life stage are present in the reach being evaluated.

When the temperature difference is less than 1^o (either Celsius or Fahrenheit) the techniques and location of measurement are very important. For example, if salmonids have spawned in the area of concern, and redds[6] have been built and, presumably, occupied by viable developing eggs then the temperature criterion should be applied at the surface of the stream or river bottom and not at the water's surface. If a thermometer is lowered to the streambed and raised for reading, the temperature read is not necessarily that of the water in the immediate vicinity of the eggs. There is also the need to use a measur-

[6] The nests that female salmon create in the substrate for their eggs.

ing device with sufficient resolution. One of the better data loggers[7] (a device that can be placed in the water for an extended period of time to record temperatures at defined time intervals) has an accuracy of $\pm 0.2^o C$ over the range of $0 - 50^0 C$, and a resolution of $0.02^o C$ at $25^o C$; this means that the accuracy of measurement is just about the temperature differential permitted under statute. This, of course, is for instantaneous measurements at a single location and time.

Setting and enforcing water temperature limits is contentious, sensitive, difficult, and stressful for both regulator and regulated community. The inherent variability in natural flowing water systems is so great that it is almost impossible to develop broad criteria that work for the intended purpose. DEQ is working on developing site-specific criteria. When they succeed in having the EPA sign off and accept these criteria the situation will be much better for everyone, including fish. A powerful benefit of such criteria is that the process is consistent and predictable, yet the application of that process yields highly specific results optimally tuned to each location, activity, and fish need.

Reasonable Potential Analysis for Toxic Pollutants

Reasonable potential analysis for toxic pollutants is an administrative process, not a technical standard or criterion such as those for turbidity and temperature. The process is also referenced in DEQ's *Draft Implementation Guidelines for Turbidity Standard* (OAR 340-041-0038). It is a preliminary screening stage to separate those effluent discharge permit applications that need more detailed and complex data and review from those that can be administratively processed more quickly and efficiently without violating statute, regulation, or water quality in the receiving water body.

How DEQ staff apply the analyses to a particular permitting decision usually are negotiated between the applicant and regulator. Knowledgeable technical insight and expertise by an external scientific consultant can contribute to decisions are are technically sound, relevant to the permitted discharge and receiving water body, and cost effective with a positive benefits-to-costs comparison.

There are five stages in the determination whether there is a reasonable potential for a discharged pollutant to exceed numeric concentration standards in the receiving water body. Each stage will be discussed from the scientific/technical perspective. The stages are:

1. Application completeness review.

2. Antidegradation review.

3. Site-specific receiving water characterization.

4. Effluent characterization.

[7] HOBO Water Temp Pro v2 by Onset Computing

5. Effluent limit calculations for pollutants with reasonable potential to exceed water quality standards.

Application Completeness Review

This first step uses a checklist appropriate for the type of source (publicly owned treatment works—POTW, existing industrial activity, new industrial activity). Within each checklist are a list of required data or information that will be used to make a decision on the reasonable potential for each pollutant to exceed standards. Therefore, it is in the applicant's best interests that these data be technically correct with regard to location and timing of collection, collection method and chain-of-custody from site to laboratory (when appropriate), analytical methods, and statistical analyses.

This is a good opportunity to assemble all data and documents that are pertinent to permit application and compliance monitoring to ensure that they are current and available. This is a good time to review all data and see if monitoring locations and frequencies are still appropriate for the receiving water body and discharge. If the river has changed structurally or hydraulically changing monitoring locations may be warranted.

Antidegradation Review

DEQ's antidegradation policy intends to protect existing water quality from needless lowering. It is described and defined in Oregon Administrative Rule (OAR) 340-041-0026(1)(a). The OAR spells out the level of protection offered to the existing water quality of a waterbody. There are three levels (tiers) of protection for all water bodies in the state[8]:

Tier 1 The basic protection afforded to all waterbodies regardless of current water quality; that is, existing uses will be maintained.

Tier 2 Applies protection to water quality that equals or is better than the water quality criteria.

Tier 3 Applies to waterbodies that constitute an outstanding national resource.

The antidegradation policy requires that all activities with the potential to lower existing water quality undergo review and comment prior to any decision to approve an NPDES permit or 401 certification. For NPDES permit applications, this includes requests for new or increased discharges, and for newly regulated

[8] EPA allows states and tribes to classify their waterbodies, or segments of waterbodies, into categories that differ from this tier classification as long as the degree of antidegradation protection is consistent with these tiers. For example, in Oregon, waters can be classified as Outstanding Resource Waters, High Quality Waters, or Water Quality Limited Waters. The OAR states that in each class of water, beneficial uses will be maintained, which is consistent with Tier 1 protection. The policies for High Quality Waters and Water Quality Limited Waters also have stipulations that are consistent with Tier 2 protection, and the policy for Outstanding Resource Waters is consistent with Tier 3

discharges (i.e., chemicals may have been present in historic discharges but were unregulated by the Department). After this systematic decision-making process degradation of existing water quality could be prohibited or allowed. Scientific and technical expertise can facilitate an appropriate decision by ensuring that the process is technically sound.

The specifics of the antidegradation review protocol are in the *Antidegradation Policy Implementation Internal Management Directive for NPDES Permits and Section 401 Water Quality Certifications* (`http://www.deq.state.or.us/wq/standards/AntidegPolicyDirect.pdf`) in March 2001. The antidegradation internal management directive provides step-by-step directions to guide staff through the antidegradation review process. The goal of the review is to determine if the proposed activity would likely result in any measurable change in water quality away from conditions unimpacted by anthropogenic sources (outside the mixing zone, if existing).

The basis for this review is the application of

> "best professional judgment in focusing on those pollutants that are in the pollution stream. A measurable change in water quality can be assessed by calculation of mass load or by modeling. Furthermore, a measurable change has been defined in the administrative rules for some pollutant parameters, but not for others. For these other parameters, determining whether a measurable change will occur must be made based on case-specific information."

Because the precise nature of conditions unimpacted by anthropogenic sources need not be known, but can be estimated by examining upstream conditions unaffected by similar sources of pollution or by comparing conditions in similar waterbodies that are unaffected by similar sources of pollution, the results will be greatly enhanced by third-party expertise. A DEQ permit writer may conclude that if a pollutant is in the effluent stream, then the applicant has the burden of proof to show that there is no consequent lowering of water quality. If an applicant claims that the activity will not result in a lowering of water quality, then DEQ can require the source to submit data to support this claim. These data should be collected by DEQ-approved methods in order to show that no statistically significant ($p < 0.05$) change will result in water quality due to the proposed activity. Note particularly that the Department staff can make a subjective decision that there will be degradation of the receiving water body, but the applicant must provide objective "proof" that this is not the case. If the process was balanced then technically sound, objective methods based on collected data and appropriate analyses would replace the subjective DEQ decision.

Receiving Water Characterization

A general characterization of the receiving water environment must be performed to evaluate an NPDES application for compliance with criteria in the

Oregon Toxics Rule. This characterization provides an environmental context from which to consider the impact of the point source discharge of pollutants into the receiving water. The permit writer must ensure that at least the following components are addressed in the receiving water characterization:

- Physical description of the receiving water and its relation to the point source discharge.
- Land use status, specifically the proximity to other potential sources of pollutants of concern
- Status of Table 20, 33A, and 33B pollutants in receiving water and subbasin; namely, is it water quality limited for toxic pollutants? If so, what is the TMDL status?

Because this characterization of ambient conditions in the receiving water body are so important to the ultimate decision, an aquatic ecologist and/or fluvial geomorphologist can assist the applicant in providing complete and relevant descriptions as part of the application process.

Beneficial use identification of the receiving waters include fish, wildlife, and human contact/health. There is no science involved in this decision, but there certainly can be science involved in determining whether the discharge affects those beneficial uses. However, the water quality criteria to be used in the receiving water characterization needs to consider all pertinent factors:

- Freshwater acute and chronic toxicity for aquatic biota.
- Marine acute and chronic toxicity for aquatic biota.
- Estuarine discharge germane to aquatic biota.
- Human health.
- Interpretation of narrative criteria.

A qualified third-party scientist can assist both the applicant and Department in evaluating these critical in a technically sound manner appropriate to the activity to be permitted.

Effluent Characterization

For all NPDES industrial dischargers, the type of effluent characterization depends on the industry category to which the discharger belongs. For the specific industrial category identified in Oregon Toxics Rule Tables 3 or 4, the discharger must characterize the effluent for those pollutant categories marked with an 'x'. If the discharger's industrial category does not require any specific monitoring, best professional judgment is used to determine whether to require effluent characterization. Factors such as whether organic or metal chemicals are applied in the treatment or presumed to be present in the influent or effluent may be used to justify monitoring data.

This effluent characterization is at the core of the reasonable potential analysis process. The DEQ staff guidance notes,

> "To paraphrase the Technical Support Document, effluent characterization is necessary to determine whether the point source has the *reasonable potential* to exceed or contribute to the exceedence of the most limiting numeric or narrative water quality criteria at the point of impact in the receiving water environment. This reasonable potential analysis . . . shall be performed on a pollutant by pollutant basis."

A third-party science consultant can provide valuable technical input in this evaluation. This expertise can both increase the quality of the decision and decrease the time required to make the decision.

For those discharge applications with identified pollutants of concern, the next step the Department takes is to evaluate whether any of those pollutants of concern have been addressed in a Wasteload Allocation (WLA) derived from a Total Maximum Daily Load (TMDL) for specific pollutants. If a WLA has been completed for any of the toxics listed as pollutants of concern, then an effluent limit will automatically be required. There is no need to perform the reasonable potential analysis for exceedence of a water quality criteria because reasonable potential for this specific pollutant has already been determined. The permit writer will proceed directly to the Effluent Limit Calculation for that chemical.

If a TMDL has not been completed, the permit writer proceeds with the effluent characterization process and determines if sufficient effluent data and receiving water data exist to conduct the reasonable potential analysis. If the facility meets the minimum data requirements, the permit writer performs an analysis on a pollutant-by-pollutant basis. If the facility does not meet the minimum data requirements, the permit writer must require the data to be submitted in a report no more than two years from the date of permit reissuance. A clause must be included in the permit that an RPA may be performed at any time during the permit cycle, and the permit potentially modified based on the results of the analysis. Beginning with permits that expire on January 1, 2007 (and thus with applications due by July 1, 2006), DEQ expects that results of all required minimum effluent and receiving water toxics sampling will need to be submitted along with the permit application. The permit writer maintains the discretion, however, to perform a reasonable potential analysis with fewer than the minimum effluent metals data requirements, provided that an adequate (that is, at least four) receiving water samples are available for pollutants of concern. If there is no reasonable potential to exceed criteria, the permit writer will allow the source the remainder of the permit cycle to collect the minimum effluent data samples to complete the robust data set. Here, too, third-party scientific expertise can facilitate the appropriate decision.

Limit Calculations

The EPA states that permit effluent limitations must be developed to control a point source discharge where it is determined that the point source will cause or contribute to an exceedence of specified pollutant water quality criteria. Detailed guidance for calculating a permit effluent limit is described in depth in their Technical Support Document Permit Requirements section.

When a TMDL has been completed for a pollutant in the applicant's receiving water, the resulting Waste Load Allocation for the point source needs to be converted into a limit that can easily be expressed in a permit, such as a Maximum Daily or Average Monthly Limit concentration limit. Typically this WLA will be in the form of a maximum daily load that the applicant is allocated to discharge. Once the permit-expressible limit has been established, the applicant will proceed to calculate a water quality-based effluent limit according to the protocol outlined in the TSD. This is to ensure that even though a WLA has been set for this parameter, the TSD-based limit is not more stringent, and thus should be applied as the limiting water quality-based effluent limit for this parameter. A technical consultant can help the applicant correctly calculate the limit based on EPA's protocol.

If a TMDL has not been completed for a specific pollutant in the receiving water, then the applicant similarly proceeds with the next step.

The Department has developed methods derived from EPA's 1991 Technical Support Document (TSD) to calculate water quality-based effluent limits (WQBELs) that are deemed protective of applicable water quality criteria in the receiving water. This method accounts for the allowable dilution, background concentration, effluent variability, and sampling frequency to calculate a WQBEL.

Once the permit-expressible limit has been established, it needs to be determined whether the discharger can immediately comply. If the applicant can comply, then the effluent limit will be placed into the permit. If the applicant cannot immediately comply, then the permittee will still need an applicable limit as some point during the life of the permit, but will need an interim compliance schedule to achieve compliance with the final limit. Compliance schedules must be as short as feasible, and less than 5 years (or less than 5 years, if the permit life is shorter than the traditional 5 years), with milestones for the applicant at yearly intervals, to come into compliance with the final effluent limit. Such milestones are improving the treatment process or gathering additional site-specific data to support granting a mixing zone. Interim effluent limits may be applied during the compliance schedule at the permit writer's discretion, and should be based on current performance of the plant. Since some treatment processes are limited to the Best Available Technology (BAT), specific technical assistance of a third-party expert can be especially beneficial to the proper determination reached in a timely manner.

About The Author

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