Medora Corporation

False High BOD Tests in Wastewater Lagoon Systems

Background: In municipal wastewater lagoon systems in the US, living algae comprises virtually all of the biochemical oxygen demand (BOD) material and total suspended solids (TSS) which is tested for regularly to ensure compliance with the city's National Pollution Discharge Elimination System (NPDES) permit.

Since both the BOD and TSS test are basically measuring the same thing, algae, the relationship between BOD and TSS for lagoon systems is well known in the industry and can be expressed mathematically as:BOD = (TSS x 0.5) +7.

This relationship is the reason that the typical NPDES permit for municipal lagoon systems throughout the US has a TSS limit of 45 mg/l and a BOD limit of 30 mg/l. The formula holds true for those limits: BOD = (45 mg/l of TSS x 0.5) + 7 = 30 mg/l.

The trouble with the BOD test when used on lagoon water: The standard BOD 5-day test is meant to be a test of carbon-based oxygen demand. And for activated sludge systems, the standard works well.

However, it was discovered in the 1980's that the BOD 5-day test does not work well for lagoon systems, because quite often nitrifying bacteria will be present in the sample and, during the test, will exert a nitrogen-based (ammonia reduction) oxygen demand.

So to label the entire oxygen demand that occurred during the 5-day test as "BOD", implying carbon-based demand, when in actuality some of it was nitrogen-based demand, results in a "false high BOD" result.

The first step: check the mathematical formula against the BOD and TSS test results. The mathematical relationship between BOD and TSS mentioned above can be used to check whether the BOD 5-day test is giving a "false high BOD".

The same formula can also be worked in reverse to determine if high TSS is being caused by detritus (dead) algae, or silt, as shown in Example 4.

<u>Example 1:</u> Water test shows TSS is 50 mg/l, BOD is 34 mg/l.

To check these results, apply the formula above; the expected BOD = (TSS x 0.5) + 7 = (50 x 0.5) + 7 = 32 mg/l. In this case the test result BOD was 34 mg/l. This is close enough to 32 mg/l, so the BOD test appears valid and accurate, and all the TSS was comprised of living algae.

<u>Example 2:</u> Water test shows TSS is 20 mg/l, BOD is 43 mg/l.

Applying the formula from above, the expected BOD = (TSS x 0.5) + 7 = (20 x 0.5) + 7 = 17 mg/l. But the water test showed BOD of 43 mg/l. The water test result higher than the formula predicted indicates that nitrification occurred in the test, and used up the DO during the test and gave a false high BOD reading, and that the actual carbon based BOD was only 17 mg/l.

The city should consider switching to a CBOD test and a discharge limit of 25 mg/l instead of 30 mg/l as mentioned below.

<u>Example 3:</u> Water test shows TSS is 16 mg/l, BOD is 13 mg/l.

Applying the formula from above. The expected BOD = (TSS x 0.5) + 7 = (16 x 0.5) + 7 = 15 mg/l. This is close enough, the BOD test appears valid and accurate enough, and all BOD was living algae.

<u>Example 4:</u> Water test shows TSS is 76, BOD is 20

Applying the formula from above, the expected BOD = (TSS x 0.5) + 7 = (76 x 0.5) + 7 = 45 mg/l.

When the tested BOD, 20 mg/l, is far lower than what the formula predicted, as here, 45 mg/l, this indicates that the TSS, which is always an accurate test number, was comprised of some non-oxygen-consuming suspended solids. The suspended solids were not all living algae because if they had been, the BOD test would have come in where the formula predicted. Most likely the "extra" TSS was detritus, most likely dead algae, or silt other solids stirred up from the bottom of the pond by high winds or regular lagoon turnovers.

To find out how much of the TSS was detritus or silt, you can reverse the formula. Making the assumption that the BOD test number is accurate, and working the formula backwards, the formula shows that TSS associated with the living algae = TSSL = (BOD - 7) / 0.5 = (20 - 7) / 0.5 = 26 mg/l.

So, of the 76 mg/l TSS, about 26 mg/l was associated with living algae, so the other 50 mg/l was detritus or silt. To address this problem of excess TSS, the city should be sure that it is discharging from mid-depth in the pond, or at least 2 feet or more off the bottom, and, if possible, try to avoid discharging during high wind events or at turnovers.

The next step: do parallel CBOD testing, verify the problem, move toward a CBOD permit instead of BOD permit. The "false high" issue for BOD testing of lagoon water shows up in many ways. One larger water sample, when split into three smaller subsamples, for instance, may show BODs of 10, 50 and 100 mg/l for what was basically the same water, because the results depend on exactly how many nitrifying bacteria each subsample had in it. And, the same water sample, when tested in two different labs, can result in two significantly different BOD numbers. In short, BOD data from lagoons cannot be dependably compared from day to day, month to month, year to year, or from one lab results to the next, making BOD testing a very poor indicator of the system performance or changes in performance.

Consequently, in order get true and dependable results for carbon-based BOD, the US EPA allows, and most states either require or allow, a city with a lagoon system to switch from BOD testing to CBOD testing, with a limit that is 5 mg/l less than what the BOD limit was. With CBOD testing, the nitrifying bacteria are killed before the test is started, so the 5-day test will give a true carbon-based BOD result, referred to as CBOD.

A good way to move toward a CBOD limit is to (a) inform the state permitting agency of the results of analyzing the BOD and TSS as mentioned above, and (b) ask for permission to conduct regular CBOD testing for one year, in parallel with the required BOD testing so that the results can be compared; usually the cost is only $30 per month more, and then (c) if the parallel testing proves that the BOD testing is inaccurate, request that the NPDES permit to be changed to CBOD testing with a limit of 5 mg/l less than the former BOD limit.

Summary and further reading: Wastewater lagoon systems can produce very high quality effluent, but standard BOD testing will often show false high readings. Consequently, all wastewater lagoon discharge permits should be based on CBOD testing instead of BOD testing. Finally, analyzing the relationship between BOD/CBOD and TSS, using the above formula and examples, can help understand the cause of high TSS problems due to detritus and silt.

For further reading on this subject, please see the USEPA NPDES Permit Writer's Manual, Chapter 5, section 5.2.1 and section 5.2.2, where it gives the federal statutory reference for issuing a lower NPDES CBOD limit to replace a BOD limit. For convenience, that chapter is linked next in this document.

Chapter 5

Technology-Based Effluent Limits

When developing effluent limits for a NPDES permit, a permit writer must consider limits based on both the technology available to treat the pollutants (i.e., technology-based effluent limits), and limits that are protective of the designated uses of the receiving water (water quality-based effluent limits). This chapter discusses considerations for deriving technology-based effluent limitations for both non-municipal (i.e., industrial) and municipal discharges.

There are two general approaches for developing technology-based effluent limits for industrial facilities: (1) using national effluent limitations guidelines (ELGs) and (2) using Best Professional Judgment (BPJ) on a case-by-case basis (in the absence of ELGs). Technology-based effluent limits for municipal facilities (POTWs) are derived from secondary treatment standards. The intent of a technology-based effluent limitation is to require a minimum level of treatment for industrial/municipal point sources based on currently available treatment technologies while allowing the discharger to use any available control technique to meet the limitations.

For industrial sources, the national ELGs are developed based on the demonstrated performance of a reasonable level of treatment that is within the economic means of specific categories of industrial facilities. Where national ELGs have not been developed, the same performance-based approach is applied to a specific industrial facility based on the permit writer's BPJ. In some cases, effluent limits based on ELGs and BPJ (as well as water quality considerations) may be included in a single permit.

5.1 Application of Technology-Based Effluent Limitations for Non-Municipal Dischargers

When developing technology-based effluent limitations for non-municipal dischargers, the permit writer must consider all applicable standards and requirements for all pollutants discharged. As indicated above, applicable technology-based requirements may include national standards and requirements applicable to all facilities in specified industrial categories, or facility-specific technology-based requirements based on the permit writer's BPJ. It is important, therefore, that permit writers understand the basis of the national standards and the differences between the various required levels of treatment performance. This section describes the statutory and regulatory foundation of the performance-based standards, and discusses considerations in the application of these standards for non-municipal dischargers.

5.1.1 Statutory and Regulatory Foundation

Originally, the Federal Water Pollution Control Act amendments of 1972 directed EPA to develop standards of performance (effluent limitation guidelines) for industrial categories. Specifically, for "existing" industrial dischargers, the Act directed the achievement:

> "...by July 1, 1977, of effluent limitations which will require application of the best practicable control technology currently available [BPT], and by July 1, 1983, of effluent limitations which will require application of the best available technology economically achievable [BAT]."

EPA defined BPT performance as the "average of the best existing performance by well operated plants within each industrial category or subcategory." The BAT level of performance was defined as the "very best control and treatment measures that have been or are capable of being achieved." The 1972 amendments, however, made no distinction regarding the application of BPT or BAT to different types of pollutants (i.e., BPT and BAT applied to all pollutants). The CWA did provide additional guidance for determining the economic achievability of BPT and BAT. The BPT standards required that effluent limits be justified in terms of the "total cost of [industry wide] application of the technology in relation to the effluent reduction benefits to be achieved." Thus, BPT required EPA to consider a cost-benefit test that considered a broad range of engineering factors relating to a category's ability to achieve the limits. For BAT, the Agency must still consider the cost of attainability, however, it is not required to balance cost against the effluent reduction benefit.

In addition to BPT and BAT requirements, Section 306 of the 1972 amendments established more restrictive requirements for "new sources." EPA has defined "new source" as any facility that commenced construction following the publication of the proposed standards of performance. The intent of this special set of guidelines is to set limitations that represent state-of-the-art treatment technology for new sources because these dischargers have the opportunity to install the latest in treatment technology at the time of start-up. These standards, identified as new source performance standards (NSPS), are described as the best available demonstrated control technology, processes, operating methods, or other alternatives including, where practicable, standards permitting no discharge of pollutants. NSPSs are effective on the date of the commencement of a new facility's operation and the facility must demonstrate compliance within 90 days [see 40 CFR §122.29(d)]. A major difference between NSPS and either BPT or BAT, is the absence of the kind of requirements for a detailed consideration of costs and benefits when establishing the technology requirements.

As noted above, the 1972 amendments tasked EPA with developing ELGs representing application of BPT, BAT, and NSPS; however, EPA was unable to complete development of all effluent guidelines within the statutory deadlines. In addition, EPA did not fully address toxic discharges in the guidelines it did promulgate. As a result, EPA was sued by several environmental groups for failing to accomplish the promulgation of effluent guidelines as directed by the 1972 amendments. As a consequence of the suit, EPA and the environmental groups entered into a settlement agreement that required EPA to develop a program and adhere to a schedule for promulgating BAT effluent guidelines, pretreatment standards, and NSPSs (NRDC v. Train, 1976). The standards focused on 65 toxic "priority pollutants" (including classes of pollutants) for 21 major categories of industries (known as “primary” industries). This settlement was incorporated in the 1977 amendments to the Act. This settlement was further amended to include a total of 34 major categories of industries and 129 priority pollutants (NRDC v. Costle, March 1979). [Note: The list of priority pollutants was subsequently revised to include 126 specific parameters which are listed in Appendix A of 40 CFR §423.]

In light of the settlement agreement, the 1977 amendments to the Federal Water Pollution Control Act (renamed the Clean Water Act [CWA]) revised the scope and application of BAT requirements to focus solely on toxic and nonconventional pollutants. The amendments also required the application of the best conventional pollutant control technology (BCT) for conventional pollutants. Both the BAT and BCT standards were defined to represent the best control and treatment measures that have been developed or that are capable of being developed within the industrial category or subcategory. With respect to the cost reasonableness, the 1977 CWA left the BAT definition relatively unchanged. For BCT, EPA was to consider the reasonableness of the relationship between the cost of attaining a reduction in effluent discharge and the benefits that would result. The cost of meeting BCT limits was expected by Congress to be comparable to the costs of achieving secondary treatment [see discussion in Section 5.2] for POTWs.

As noted in the discussion of the statutory evolution of the technology-based standards, deadlines for development of the various standards were established by the CWA and amendments. Due to technical and administrative difficulties, most of the initial deadlines were postponed. A summary of final statutory deadlines for the different required levels of treatment technologies is provided in **Exhibit 5-1**.

When applying applicable ELGs in permits, permit writers need to be aware that they do not have the authority to extend statutory deadlines in a NPDES permit; thus, all applicable technology-based requirements (i.e., ELGs and BPJ) must be applied in NPDES permits without the benefit of a compliance schedule.

EXHIBIT 5-1
Statutory Deadlines for BPT, BAT, and BCT

Pollutant	Level of Treatment	Statutory Deadlines
Conventional	BPT	July 1, 1977
Conventional	BCT	March 31, 1989
Nonconventional	BPT	July 1, 1977
Nonconventional	BAT	March 31, 1989
Toxic	BPT	July 1, 1977
Toxic	BAT	March 31, 1989

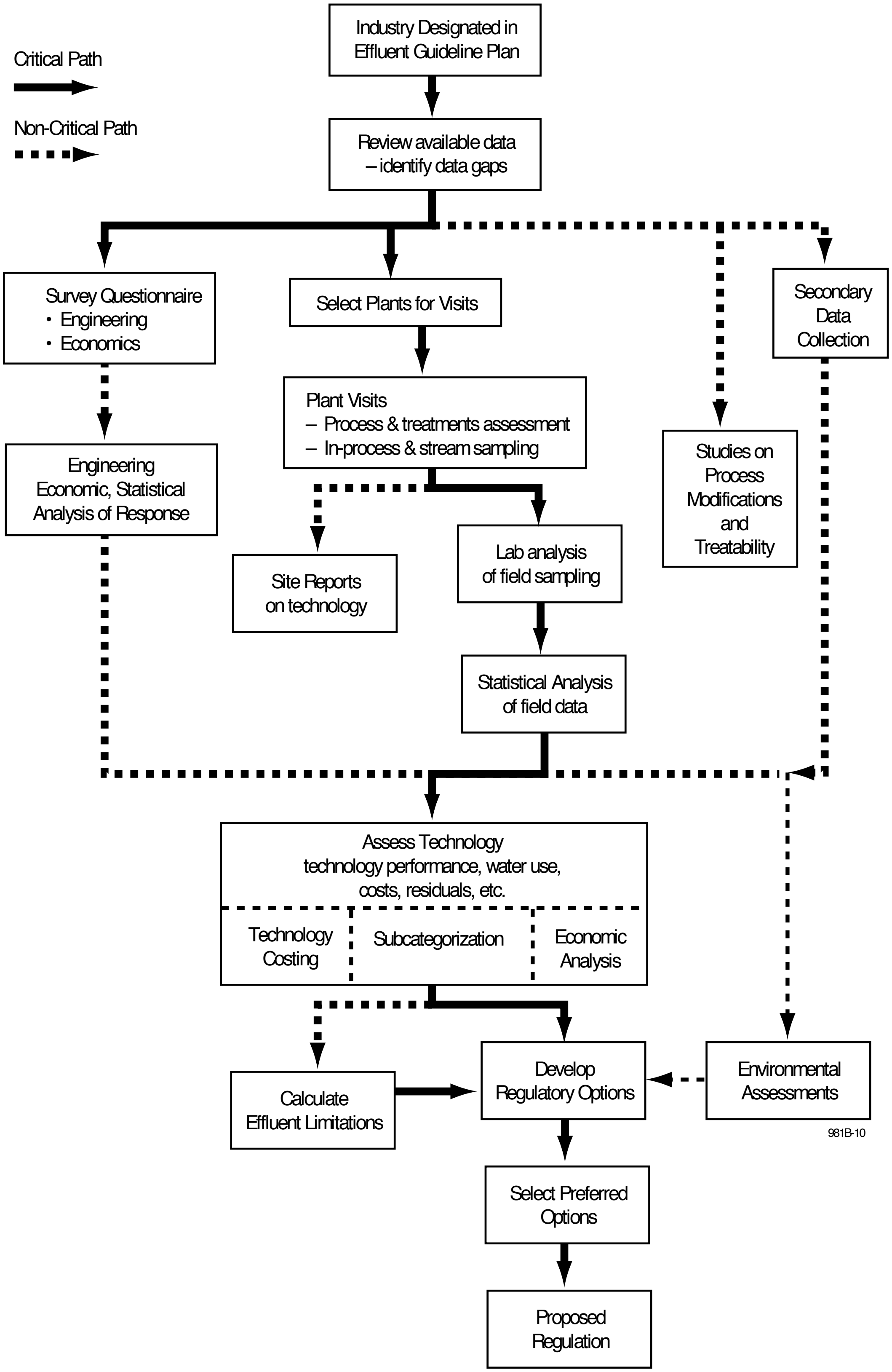
5.1.2 Development of National Effluent Limitations Guidelines and Performance Standards

Effluent limitations guidelines and performance standards are established by EPA for different industrial categories since the best control technology for one industry is not necessarily the best for another. These guidelines are developed based on the degree of pollutant reduction attainable by an industrial category through the application of control technologies, irrespective of the facility location. Using these factors, similar facilities are regulated in the same manner. In theory, for example, a pulp and paper mill on the west coast of the United States would be required to meet the same technology-based limitations as an identical plant located on the east coast (unless there were special site-specific concerns that had to be addressed).

To date, EPA has established guidelines and standards for more than 50 different industrial categories (e.g., metal finishing facilities, steam electric power plants, iron and steel manufacturing facilities). These guidelines appear in 40 CFR Parts 405-499, a list of which is provided in **Appendix B**. Additionally, Section 304(m) of the 1987 Water Quality Act (WQA) requires EPA to publish a biennial plan for developing new ELGs and a schedule for the annual review and revision of existing promulgated guidelines. As such, EPA is constantly developing new guidelines, and revising or updating existing guidelines.

Developing ELGs is a complicated and time-consuming effort. A schematic showing the general guidelines development process is presented in **Exhibit 5-2**. The regulations are based on complex engineering and economic studies that determine a subcategorization scheme for each industrial category and the wastewater

EXHIBIT 5-2
Effluent Guidelines Flowchart



characteristics and treatment capabilities of each industrial category and/or subcategory. The CWA requires EPA to assess certain factors when establishing ELGs, including the following:

- Age of the equipment and facilities involved
- Manufacturing processes used
- Engineering aspects of the application of recommended control technologies, including process changes and in-plant controls
- Non-water quality impacts, including energy requirements
- Cost
- Other factors, as deemed appropriate.

Where necessary, EPA sets multiple ELGs for facilities within a given category, where data indicates varying conditions warranting different requirements. These subdivisions, known as subcategories, provide EPA with a second level of regulatory control to improve consistency of the guidelines within an industrial category.

EPA develops both daily maximum and long-term average limitations for all ELGs, both of which must be included in the permit by the permit writer. The daily maximum limitations are based on the assumption that daily pollutant measurements are lognormally distributed. Long-term average limitations are based on the distribution of averages of measurements drawn from the distribution of daily measurements. When designing a treatment system, EPA recommends that the permittee target the design of its treatment system to meet the long-term average rather than the daily maximum. The daily maximum is intended to account for variation in effluent concentration above the long-term average.

It should be noted that ELGs are not always established for every pollutant present in a point source discharge. In many instances, ELGs are established only for those pollutants that are necessary to ensure that industrial facilities comply with the technology-based requirements of the CWA (i.e., BPT, BCT, BAT, NSPS). These are often referred to as “indicator” pollutants. For example, EPA may choose to regulate only one of several metal pollutants that are present in the effluent from an industrial category; however, compliance with the ELG (i.e., implementation of technology-based controls) will ensure that all metals present in the discharge are adequately treated.

EPA produces a number of documents that will prove useful to permit writers responsible for applying ELGs in permits. Most notable are the "Development Documents," prepared by EPA for every industrial category with ELGs. Development Documents are produced by EPA as part of the development of ELGs and provide a detailed overview of the limitations development process, including decisions made on applicability of the regulations to various process operations.

5.1.3 General Considerations Concerning the Use of Effluent Limitation Guidelines

Derivation of effluent limits based on ELGs requires that the permit writer have a general understanding of the ELGs for all industrial categories, and detailed knowledge of the ELGs applicable to the permittee. In order to properly apply effluent guidelines, there are several considerations that a permit writer must take into account:

- **Categorization—**Determination of the proper category and subcategory of the facility and proper use of the guidelines applicable to the category or subcategory under consideration
- **Multiple Products or Multiple Categories—**Classification of plants that fall under more than one subcategory and/or have multiple products with multiple measures of production
- **Production/Flow-based Limitations—**Determination of the appropriate measure of production or flow
- **Tiered Permit Limits—**Use of alternate limits for varying production and flow scenarios
- **Mass Versus Concentration Limits—**Considerations in the application of mass versus concentration limits.

Each of these considerations is discussed further below.

Once the appropriate ELGs have been identified, application of the limitations is relatively straightforward since it involves the application of a guideline that has already been technically derived (and sometimes litigated). Implementation of ELGs does require familiarity with several sources of information, particularly the CFR and the *Federal Register* (*FR*). As an example, two pages of the ELGs for the Iron and Steel Manufacturing industrial category are presented as **Exhibit 5-3**.

EXHIBIT 5-3
ELGs for Iron and Steel Manufacturing

EXHIBIT 5-3
ELGs for Iron and Steel Manufacturing (continued)

Categorization

To properly use and apply ELGs, the permit writer must first determine which industrial category(s) applies to the facility being permitted. In determining the appropriate category(s) into which a facility falls, the Standard Industrial Classification (SIC) code is often very helpful. SIC codes were developed and are maintained by the Federal government as a way to classify establishments by type of activity for comparing economic and other types of facility-specific data. A listing of SIC codes corresponding with ELG categories is provided in **Appendix C** and is useful for determining applicable industrial categories.

Item V-II of NPDES Application Form I requires that the applicant provide the SIC code for the activity covered by the permit application. In some instances, the SIC code will identify both the industrial category and the subcategory of a particular facility. Often, the SIC code will identify the appropriate industrial category, but may not necessarily identify the subcategory.

Example:

A primary smelter of copper, SIC code 3331, falls under the Nonferrous Metals Manufacturing category listed in 40 CFR Part 421. In this particular case, SIC code 3331 also clearly identifies the facility in the Copper Smelting Subcategory.

Example:

A facility that manufactures acrylic acids and acrylic acid esters (SIC code 2869) can easily be classified as subject to the Organic Chemicals, Plastics, and Synthetic Fibers (OCPSF) category based on its SIC code; however, determination of the applicable subcategory requires additional effort. In this example, the permit writer can determine from a review of the industrial categorization discussion in the Development Document for the OCPSF industry that facilities performing these manufacturing operations are subject to Subpart G (bulk organic chemicals).

Although SIC codes provide a helpful starting point for categorizing a facility, the permit writer should be cautious of relying exclusively on SIC codes for determining the appropriate industrial category. SIC codes were not developed based on EPA's industrial classification scheme, or vice versa, and, therefore, may not always correspond exactly with the categorization process. It is also important to note that more than one SIC code may apply to a facility. EPA's Development Documents, provide detailed information on the applicability of the regulations to specific types of facilities and are useful sources of information when categorizing a facility. Similarly, *FR* notices of the promulgated ELGs provide additional insight into applicability of the guideline to various types of facilities.

When determining applicable ELGs, it is best to identify the categories first, and then, through a careful analysis of plant operations, determine the subcategories. The determination of applicable categories can be accomplished by quickly classifying the categories as "not applicable" or "potentially applicable."

Example:

If a brewery is under consideration, the Iron and Steel Manufacturing category would obviously not be applicable but Organic Chemicals might be, depending on the extent of recovery and processing of byproducts. A careful analysis of the production of the plant and comparison to the subcategories under Organic Chemicals would establish which, if any, of the subcategories are applicable.

In many cases, industrial facilities may not clearly fall into a category or a subcategory, thus requiring some research on the part of the permit writer to identify the applicable category and subcategory.

Example:

An integrated washing machine producer (SIC code 3633) would be categorized in the Household Laundry Equipment category (as specified under the SIC code system). However, depending on the activities occurring at the facility, it may also fall under the Porcelain Enameling, Metal Finishing, or Plastic Molding and Forming categories for purposes of regulation under effluent guidelines.

After determination of potential categories, the permit writer can conduct a more detailed evaluation to narrow the list to only the applicable categories and subcategories using more detailed facility information.

Multiple Products or Multiple Categories

There are instances when one facility produces multiple products, or whose production process is covered by multiple categories and subcategories. In these cases, the permit writer must examine the applicable guidelines closely to ensure that (1) one guideline does not supersede another, and (2) the guidelines are properly applied. For example, as presented in **Exhibit 5-4**, the preamble to the final rule for the OCPSF ELGs (52 *FR* 42523) identified numerous circumstances where the OCPSF regulations are superseded by existing ELGs for other industrial categories.

When a facility is subject to multiple effluent guidelines, the permit writer must apply each of the effluent guidelines in deriving the technology-based effluent limits for the particular facility. If all wastewaters regulated by effluent guidelines are combined prior to treatment and discharge to navigable waters, then the permit writer could simply combine the allowable pollutant loadings from each effluent guideline to arrive at a single technology-based effluent limit for the facility (i.e., a “building block” approach).

Circumstances will also arise when an effluent guideline for one subcategory regulates a different set of pollutants than the effluent guidelines applicable to another subcategory. If all regulated wastestreams are combined, there are two approaches to ensure proper application of the effluent guidelines:

- If one wastestream containing a pollutant that is not covered by an effluent guideline is combined with another wastestream that has applicable effluent guidelines for the same pollutant, then the permit writers must use BPJ to establish a technology-based effluent limit for the non-regulated wastewater (see Section 5.1.4).
- If one wastestream that does not contain a pollutant is combined with another wastestream that has applicable effluent guidelines for the pollutant, the permit writer must ensure that the non-regulated wastestream does not dilute the regulated wastestream to the point where the pollutant is not analytically detectable. If this circumstance occurs, then the permit writer will most likely need to establish internal outfalls, as allowed under 40 CFR §122.45(h).

Effluent guidelines may also specify inconsistent limit expressions that will have to be adjusted. For example, effluent guidelines for one category (e.g., porcelain enameling) may contain limits with a daily maximum limit, while effluent guidelines for another category (e.g., electroplating) sets a 4-day average limit for the same pollutant. In this case, both ELGs must be applied in the permit. If this situation arises, a permit writer has several alternatives such as:

EXHIBIT 5-4
OCPSF Effluent Limitations Guidelines

- Place both limits in the permit (i.e., both the daily maximum and 4-day average)
- Apply the applicable effluent guidelines at internal outfalls [as allowed under 40 CFR §122.45(h)].

Example 1:

A facility with a newly constructed metal plating production line is added to a facility with an existing metal plating production line. Wastewater from both of these lines is commingled prior to treatment, treated, and then discharged. In this situation, the combination of the NSPS (for the new line) and BAT/BCT standards (for the older line) would be used to derive a limitation.

Example 2:

An integrated lamp maker conducts copper forming, aluminum forming, metal finishing, and porcelain enameling processes with wastewater combined prior to treatment and discharge. In this situation, the appropriate effluent guidelines for these categories must be applied to each waste stream and combined when developing limitations.

Production/Flow-Based Limitations

Most ELGs are expressed in terms of allowable pollutant discharge per unit of production (or some other measure of production) or are based on wastewater flow rates. In general, production/flow-based standards are developed for industries that incorporate flow reduction practices, and EPA considers this in the ELG development process. This methodology forces permittees to implement comparable measures to comply with the limitations. To determine permit limits, and in accordance with the requirements at 40 CFR §122.45(b), these standards are multiplied by a reasonable measure of the facility's actual production/flow rate (i.e., not the design production or flow rate). Thus, it is necessary for the permit writer to determine the facility's actual production or flow, based on information supplied by the facility in the permit application.

The ideal situation for the application of ELGs is where production or flow is constant from day-to-day and month-to-month. Production or flow for the purposes of calculating the limitations would then be the average rate. In actuality, production or flow rates are not as constant as this ideal situation. They vary based on factors such as the market demand, maintenance, product changes, down times, breakdowns, and facility modifications. As such, the production or flow rate of a facility will vary with time.

To apply production/flow-based ELGs to a facility with varying production or flow rates, the permit writer should determine a single estimate of the long-term average rate that is expected to exist during the term of the permit being prepared. It is recommended that the permit writer establish this average from the past 5 years of facility data. This single value is then multiplied by the ELGs to obtain permit limits. In certain instances, the permit writer may find that fewer than 5 years of data may better represent conditions that are anticipated for the next 5 years. This would be the case for a facility that has undergone major renovations that would impact production or flow; making use of data prior to this construction inappropriate to model future process options.

The objective in determining a production or flow estimate for a facility is to develop a single estimate of the long-term average production rate (in terms of mass of product per day or volume of process wastewater per day), which can reasonably be expected to prevail during the next term of the permit. The following example illustrates the proper application of production-based guidelines:

Example:

Company A has produced 331,000 tons, 301,500 tons, 361,500 tons, 332,000 tons, and 331,500 tons per year for the previous 5 years operating 255 days per year. What would be a reasonable measure of production for permitting purposes? Assuming that pollutant X has an effluent limitation guideline of 0.1 lbs/1,000 lbs for the monthly average and 0.15 lbs/1,000 lbs for the daily maximum, what would be the resulting effluent limitations?

Discussion:

The use of the long-term average production (i.e., average production over past 5 years = 331,500 tons per year) would be an appropriate and reasonable measure of production, if this figure represents the actual production expected to occur over the next term of the permit. Also, in evaluating these gross production figures, the number of production days must be considered. If the number of production days per year is not comparable, the numbers must be converted to production per day before they may be compared. To convert from the annual production rate to average daily rate, the annual production rate is divided by the number of production days per year. To determine the number of production days, the total number of normally scheduled nonproduction days are subtracted from the total days in a year.

If Company A normally has 255 production days per year, the annual production rate of 331,500 tons per year would yield an average daily rate of 1,300 tons per day.

Monthly average limit:
1,300 tons/day x 2,000 lbs/ton x 0.10 lbs/1,000 lbs = 260 lbs/day

Daily maximum limit:
1,300 tons/day x 2,000 lbs/ton x 0.15 lbs/1,000 lbs = 390 lbs/day

In the example above, the average production rate during the last 5 years was used as the estimate of production. This average rate is appropriate when production is not expected to change significantly during the permit term. However, if historical trends, market forces, or company plans indicate that a different level of production will prevail during the permit term, a different basis for estimating production should be used.

Tiered Permit Limits

If production rates are expected to change significantly during the life of the permit, the permit writer can include alternate or tiered limits. These tiered limits would become effective when production exceeds a threshold value, such as during seasonal production variations. As a general rule of thumb, up to a 20 percent fluctuation in production is within the range of normal variability, while changes in production higher than 20 percent could warrant consideration of alternate limits. The major characteristics of tiered limits are best described by illustration and example.

Example:

Plant B produced approximately 40 tons per day of product during spring and summer months (i.e., March through August) and 280 tons per day during fall and winter months during the previous 5 years. Production during the fall and winter months are significantly higher than during the off-season and the permittee has made a plausible argument that production is expected to continue at that level. The guideline for pollutant X is 0.08 lbs/1,000 lbs for the monthly average and 0.14 lbs/1,000 lbs for the daily maximum. What are the tiered effluent limitations?

Discussion:

The first tier or lower limits would be based on a production rate of 40 tons per day. These limits would apply between March and August.

Monthly average limit:
40 tons/day x 2,000 lbs/ton x 0.08 lbs/1,000 lbs = 6.4 lbs/day

Daily maximum limit:
40 tons/day x 2,000 lbs/ton x 0.14 lbs/1,000 lbs = 11.2 lbs/day

The second tier or higher limits would be based on a production rate of 280 tons per day. These limits would apply between September and February.

Monthly average limit:
280 tons/day x 2,000 lbs/ton x 0.08 lbs/1,000 lbs = 44.8 lbs/day

Daily maximum limit:
280 tons/day x 2,000 lbs/ton x 0.14 lbs/1,000 lbs = 78.4 lbs/day

Tiered permits with alternate limits should be used only after careful consideration of production data and only when a substantial increase or decrease in production is likely to occur. In the example above, the lower limits would be in effect when production was at "low" levels. During periods of significantly higher production, the higher limits would be in effect. In addition, alternate limits may also be appropriate in the case of special processes or product lines. The thresholds, measures of production, and special reporting requirements must be detailed in the permit. Special reporting requirements include provisions such as:

- The permittee notifying the permitting authority at least two business days prior to the month they expect to be operating at a higher level of production and the duration this level of production is expected to continue
- The permittee reporting, in the discharge monitoring report, the level of production and the limitation and standards applicable to that level.

Mass Versus Concentration Limits

The regulations at 40 CFR §122.45(f)(1) require that all permit limits, standards, or prohibitions be expressed in terms of mass units (e.g., pounds, kilograms, grams) except under the following conditions:

1) For pH, temperature, radiation, or other pollutants that cannot appropriately be addressed by mass limits;
2) When applicable standards and limitations are expressed in terms of other units of measurement; or
3) If in establishing technology-based permit limitations on a case-by-case basis limitations based on mass are infeasible because the mass or pollutant cannot be related to a measure of production. The limitations, however, must ensure that dilution will not be used as a substitute for treatment.

While the regulations require that limitations be expressed in terms of mass, a provision is included at 40 CFR §122.45(f)(2) that allows that permit writer, at his or her discretion, to express limits in additional units (e.g., concentration units). Where limits are expressed in more than one unit, the permittee must comply with both.

As provided by the regulations, the permit writer may determine that expressing limits in more than one unit is appropriate under certain circumstances. For example, expressing limitations in terms of concentration as well as mass encourages the proper operation of a treatment facility at all times. In the absence of concentration limits, a permittee would be able to increase its effluent concentration (i.e., reduce its level of treatment) during low flow periods and still meet its mass-based effluent limits. Concentration limits discourage the reduction in treatment efficiency during low flow periods, and require proper operation of treatment units at all times.

The derivation of concentration limits should be based on evaluating historical monitoring data and using engineering judgment to be sure they are reasonable. In certain situations, the use of concentration limits may not be appropriate since they may discourage the use of innovative techniques, such as water conservation by the permittee. For example, if a facility had a history of providing efficient treatment of its wastewater and also wished to practice water conservation, inclusion of concentration limits would not be appropriate (i.e., concentration limits would prohibit decreases in flow that would concurrently result in an increase in pollutant concentration). To summarize, the applicability of concentration limits should be a case-by-case determination based upon the professional judgment of the permit writer.

It should be noted that the long-term average flow should be used to calculate both the monthly average and daily maximum concentrations. The use of the long-term average flow is most appropriate for the calculation of concentration limits because it will reflect the range of concentrations that could be expected in a well operated plant. The use of the maximum daily flow is not appropriate to determine concentration limits from the mass limitations because it will reduce the concentration below the value which could be expected in a well operated plant. Alternatively, use of the lowest flow value will increase the concentration limit to levels above what would be expected in a well operated plant.

Example 1:

An industrial facility (leather tanner) is subject to effluent limitations guidelines based on its rate of production. The permit writer calculates the applicable mass-based limits based on the long-term production rate at the facility and incorporates the mass limits in accordance with 40 CFR §122.45(f)(1).

In reviewing the past inspection records for the facility, the permit writer notes that while the facility is generally in compliance with its mass limits, the effluent flow and concentration vary widely. To ensure that the treatment unit is operated properly at all times, the permit writer determines that concentration-based limits are also appropriate. The permit writer consults the EPA Development Document for the leather tanning effluent limitations guidelines and bases the concentration-based limits on the demonstrated performance of the treatment technology upon which the effluent guidelines were based. The concentration-based limits are then incorporated in the permit in accordance with 40 CFR §122.45(f)(2).

Example 2:

For Company A, the mass limits for pollutant X have been set at 260 lbs/day and 390 lbs/day monthly average and daily maximum, respectively. What are the monthly average concentration limitations in milligrams per liter (mg/l) using both an average flow of 0.9 mgd and the low flow of 0.6 mgd? Note: 8.34 is a conversion factor with the units (lbs/day)/(mgd)(mg/l).

Discussion:

Monthly average limit (based on average flow):
260 lbs/day/(8.34 x 0.9 mgd) = 35 mg/l

Monthly average limit (based on low flow):
260 lbs/day/(8.34 x 0.6 mgd) = 52 mg/l

This is almost 150 percent more than the concentration during average flow!

In determining applicable effluent concentration limitations, the monthly average and daily maximum mass limits divided by the average flow will provide appropriate concentrations.

Monthly average limit:
260 lbs/day/(8.34 x 0.9 mgd) = 35 mg/l

Daily maximum limit:
390 lbs/day/(8.34 x 0.9 mgd) = 52 mg/l

5.1.4 Best Professional Judgment Permit Limits

Best Professional Judgment (BPJ)-based limits are technology-based limits derived on a case-by-case basis for non-municipal (industrial) facilities. BPJ limits are established in cases where ELGs are not available for, or do not regulate, a particular pollutant of concern. BPJ is defined as the highest quality technical opinion developed by a permit writer after consideration of all reasonably available and pertinent data or information that forms the basis for the terms and conditions of a NPDES permit.

The authority for BPJ is contained in Section 402(a)(1) of the CWA, which authorizes the EPA Administrator to issue a permit containing "such conditions as the Administrator determines are necessary to carry out the provisions of this Act" prior to taking the necessary implementing actions, such as the establishment of ELGs. During the first round of NPDES permits in the early-to-mid-1970s, a majority of permits were based on the authority of Section 402(a)(1) of the CWA. These first round so-called best engineering judgment permits were drafted because effluent guidelines were not available for many industries. As effluent guidelines began to be promulgated, permit writers had to rely less on their best engineering judgment and could apply the ELGs in permits. As the implementation of the age of toxic pollutant control continues, the use of BPJ conditions in permits has again become more common. However, the statutory deadline for compliance with technology-based effluent limits (including BPJ-based pollutant limits) was March 31, 1989. Therefore, compliance schedules cannot be placed in permits to allow for extensions in meeting BPJ pollutant limits.

BPJ has proven to be a valuable tool for NPDES permit writers over the years. Because it is so broad in scope, BPJ allows the permit writer considerable flexibility in establishing permit terms and conditions. Inherent in this flexibility, however, is the burden on the permit writer to show that the BPJ is reasonable and based on sound engineering analysis. If this evaluation of reasonableness does not exist, the BPJ condition is vulnerable to a challenge by the permittee. Therefore, the need for and derivation of the permit condition, and the basis for its establishment, should be clearly defined and documented. References used to determine the BPJ condition should be identified. In short, the rationale for a BPJ permit must be carefully drafted to withstand the scrutiny of not only the permittee, but also the public and, ultimately, an administrative law judge.

Establishment of BPJ Permit Limits

The NPDES regulations in 40 CFR §125.3 state that permits developed on a case-by-case basis under Section 402(a)(1) of the CWA must consider (1) the appropriate technology for the category class of point sources of which the applicant is a member, based on all available information, and (2) any unique factors relating to the applicant. To set BPJ limits, a permit writer must first determine a need for additional controls beyond existing ELGs. The need for additional controls may be the result of the facility not falling under any of the categories for which ELGs exist (e.g., barrel reclaimers, transportation equipment cleaning facilities, or industrial laundries) or discharging pollutants of concern that are not directly or indirectly addressed by the development of the ELGs (e.g., a pharmaceutical manufacturer or a petroleum refiner may discharge elevated levels of organic solvents for which category-specific guidelines do not exist). It should be noted that prior to establishing BPJ-based limits for a pollutant not regulated in an effluent guideline, the permit writer should ensure that the pollutant was not considered by EPA while developing the ELGs (i.e., BPJ-based effluent limits are not required for pollutants that were considered by EPA for regulation under the effluent guidelines, but for which EPA determined that no ELG was necessary). Information contained in the appropriate "Development Document" should assist permit writers in making this determination.

In setting BPJ limitations, the permit writer must consider several specific factors as they appear in 40 CFR §125.3(d). These factors, which are enumerated below, are the same factors required to be considered by EPA in the development of ELGs and, therefore, are often referred to as the Section 304(b) factors:

- For BPT requirements:
  - The total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application
  - The age of equipment and facilities involved*
  - The process employed*
  - The engineering aspects of the application of various types of control techniques*
  - Process changes*
  - Non-water quality environmental impact including energy requirements*
- For BCT requirements:
  - All items in the BPT requirements indicated by an asterisk (*) above
  - The reasonableness of the relationship between the costs of attaining a reduction in effluent and the effluent reduction benefits derived
  - The comparison of the cost and level of reduction of such pollutants from the discharge of POTWs to the cost and level of reduction of such pollutants from a class or category of industrial sources
- For BAT requirements:
  - All items in the BPT requirements indicated by an asterisk (*) above
  - The cost of achieving such effluent reduction.

A permit writer must consider each of these factors in establishing BPJ-based conditions in permits. Since BPJ contains an element of judgment or educated opinion, a permit writer with the proper tools should be able to establish BPJ conditions in permits that are both technically sound and reasonable.

A technically sound and reasonable permit is not likely to be successfully challenged by the permittee or a third party. In this context, "technically sound permit conditions" means that the conditions are achievable with existing technology.

"Reasonable" means that the conditions are achievable at a cost that the facility can afford. Historically, some of the other factors, such as age, process employed and non-water quality impacts have assumed lesser importance than the technical and economic feasibility evaluations.

BPJ Permitting Tools and References

Permit writers can develop BPJ limits using one of two different methods. A permit writer can either transfer numerical limitations from an existing source such as from a similar NPDES permit or an existing ELG, or derive new numerical limitations. Numerous tools and references for BPJ permit writing exist. As one gains experience drafting BPJ permits, it is common practice to rely on some references more than others. **Exhibit 5-5** lists references and provides some examples for selected BPJ data sources that have proven useful to permit writers over the years.

Most of the tools and references listed in Exhibit 5-5 can be used to derive new BPJ-based permit limits. They provide information related to the expected performance of wastewater treatment systems. For example, the *Treatability Manual*[4] and associated data base provides treatability information for over 1,400 pollutants. Information collected for use in developing effluent guidelines and standards can also provide treatability data for a significant number of pollutants and for a variety of types of industrial wastewaters. The *Technical Support Document for Water Quality-Based Toxics Control*[5] provides extensive information and guidance related to the statistical considerations when establishing effluent limits.

Since best management practices (BMPs) can also be used by permit writers as the basis for effluent limits, the *Guidance Manual for Developing Best Management Practices*[6] can be used by permit writers to identify potentially applicable BMPs that could be used for the facility to be permitted. In addition, *Storm Water Management*

---

[4]USEPA (1980). *Treatability Manual, Volumes I - V*. EPA-600/8-80-042a-e. Office of Research and Development.

[5]USEPA (1991). *Technical Support Document for Water Quality-Based Toxics Control*. EPA-505/2-90-001. Office of Water Enforcement and Permits.

[6]USEPA (1993). *Guidance Manual for Developing Best Management Practices*. (BMPs). EPA-833-B-93-004. Office of Water.

EXHIBIT 5-5
BPJ Permitting Tools

- Abstracts of Industrial NPDES Permits
- Treatability Manual and Data Base
- NPDES Best Management Practices Guidance Document
- Guidance Manual for Developing Best Management Practices (BMPs). EPA 833-B-93-004. (USEPA, 1993) Office of Water and Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. EPA 832-R-92-006. (USEPA, 1992) Office of Water.
- Technical Support Document for the Development of Water Quality-based Permit Toxic Control
- Workbook for Determining Economic Achievability for NPDES Permits
- National Environmental Investigation Center reports on specific facilities
- Toxicity reduction evaluations for selected industries
- Industry experts within EPA Headquarters, Regions, and States
- Effluent guidelines development information
  - CWA Section 308 questionnaires
  - Screening and verification data
  - Development documents
  - Contractor's reports
  - Proposed regulations
  - Project Officers
- Permit Compliance System data
- Permit/compliance file information
  - Previous NPDES application forms
  - Discharge Monitoring Reports
  - Compliance Inspection reports
- Other media permit files (e.g., Resource Conservation and Recovery Act (RCRA) permit applications and Spill Prevention Countermeasure and Control (SPCC) plans)
- Literature (e.g., technical journals and books).

for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices[7] can be used by permit writers responsible for establishing BPJ permit limits for storm water discharges.

[7]USEPA (1992). *Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices*. EPA 832-R-92-006. Office of Water.

To assist permit writers in identifying other NPDES permits from which technology-based effluent limits can be transferred, EPA has developed the *NPDES Industrial Permit Abstracts*[8]. The abstracts are a compilation of NPDES permits issued by authorized State agencies and EPA Regional offices to a variety of non-municipal dischargers. The abstracts assist permit writers by providing rapid access to permit information in a standardized, cross-referenced and easy-to-read format.

As previously discussed, permit writers must consider the costs to comply when establishing BPJ permit limits for toxic and nonconventional pollutants. To assist permit writers in determining whether the estimated costs are reasonable for the facility to be permitted, a draft document, *Workbook for Determining Economic Achievability for National Pollutant Discharge Elimination System Permits*[9], has been developed. This guidance document provides a step-by-step procedure for permit writers to determine the economic achievability of BPJ effluent limits.

BPJ Statistical Considerations

The quality of the effluent from a treatment facility will normally vary over time. If BOD_5 data for a typical treatment plant are plotted against time, the day-to-day variations of effluent concentrations can be seen. Some of this behavior can be described by constructing a frequency-concentration plot. From this plot, one can see that for most of the time, BOD_5 concentrations are near some average value. Any treatment system can be described using the mean concentration of the parameter of interest (i.e., the long-term average) and the variance (or coefficient of variation) and by assuming a particular statistical distribution (usually lognormal).

Permit limits are generally set at the upper bounds of acceptable performance. As required at 40 CFR §122.45(d), two expressions of permit limits are required—an average monthly limit and a maximum daily limit. The use of average and maximum limits can vary depending on the effluent guidelines and water quality criteria that are consulted. Instantaneous maximums, daily averages and daily maximums, weekly averages, and monthly averages are all commonly used limitation expressions.

---

[8]USEPA (1993). *NPDES Industrial Permit Abstracts 1993*. EPA-833/B-93-005. Office of Water.

[9]USEPA (1982). *Workbook for Determining Economic Achievability for National Pollutant Discharge Elimination System Permits* (DRAFT). Permits Division Prepared by Putnam, Wayes & Bartlett, Inc.

Generally, the definitions are consistent with those set forth in the Glossary of this manual.

If permit limits are set too lenient relative to the long-term average, a discharger not complying with expected performance will not exceed the limits. If permit limits are set too stringently, a discharger that is complying with expected performance may frequently exceed the limits. It is important to note that statistical variability is already built in with respect to the ELGs, and the permit writer may not perform a separate evaluation in those cases where a permit limitation is derived from a guideline.

When developing a BPJ limit, permit writers can use an approach consistent with EPA's ELG statistical approach. Specifically, the daily maximum limitation can be calculated by multiplying the long-term average by a daily variability factor. The monthly maximum limitation can be calculated similarly except that the variability factor corresponds to the distribution of monthly averages instead of daily concentration measurements.

The daily variability factor is a statistical entity defined as the ratio of the estimated 99th percentile of a distribution of daily values divided by the mean of the distribution. Similarly, the monthly variability factor is typically defined as the estimated 95th percentile of the distribution of 4-day averages divided by the mean of the monthly averages.

A modified delta-lognormal distribution can be fit to concentration data. Variability factors can then be computed for a facility distribution. The modified delta-lognormal distribution models the data as a mixture of non-detect observations and measured values. This distribution is often selected because the data for most analytes consists of a mixture of measured values and non-detects. The modified delta-lognormal distribution assumes that all non-detects have a value equal to the detection limit and that the detected values follow a lognormal distribution.

For more details on EPA's use of statistical methods for developing ELGs, refer to *Development Document for Effluent Limitations Guidelines and Standards for the*

Organic Chemicals, Plastics and Synthetic Fibers Point Source Category[10] or *Technical Support Document for Water Quality-Based Toxics Control*[11].

5.2 Application of Technology-Based Effluent Limitations for Municipal Dischargers

The largest category of dischargers requiring individual NPDES permits is municipal POTWs. Similar to its approach for controlling the discharges from industrial sources, the 1972 CWA required POTWs to meet performance-based requirements based on available wastewater treatment technology. Section 301 of the CWA established a required performance level, referred to as "secondary treatment," that all POTWs were required to meet by July 1, 1977.

More specifically, Section 301(b)(1)(B) of the CWA requires that EPA develop secondary treatment standards for POTWs as defined in Section 304(d)(1) of the Act. Based on this statutory requirement, EPA developed secondary treatment regulations which are specified in 40 CFR Part 133. These technology-based regulations apply to all municipal wastewater treatment plants and identify the minimum level of effluent quality attainable by secondary treatment in terms of BOD_5, TSS, and pH. The regulations provide for special considerations regarding combined sewers, industrial wastes, waste stabilization ponds, and less concentrated influent wastewater for combined and separate sewers. Pursuant to Section 304(d)(4) of the CWA, the regulations also define "treatment equivalent to secondary treatment" and the alternative standards that apply to facilities meeting this definition.

5.2.1 Secondary Treatment

An important aspect of municipal wastewater is that it is amenable to biological treatment. The biological treatment component of a municipal treatment plant is termed secondary treatment and is usually preceded by simple settling (primary treatment). In response to the CWA requirements, EPA evaluated performance data

[10]USEPA (1987). *Development Document for Effluent Limitations Guidelines and Standards for the Organic Chemicals, Plastics, and Synthetic Fibers Point Source Category*. Vol I and Vol II. EPA 440/1-87/009. Office of Water, Industrial Technology Division.

[11]USEPA (1991). *Technical Support Document for Water Quality-Based Toxics Control*. EPA-505/2-90-001. Office of Water Enforcement and Permits.

for POTWs practicing secondary treatment and established performance standards based on its evaluation. Secondary treatment standards, therefore, are defined by the limitations provided in **Exhibit 5-6**.

EXHIBIT 5-6
Secondary Treatment Standards

Parameter	30-Day Average	7-Day Average
5-Day BOD	30 mg/l	45 mg/l
TSS	30 mg/l	45 mg/l
pH	6 - 9 s.u. (instantaneous)	–
Removal	85% BOD_5 and TSS	–

According to 40 CFR §122.45(f), permit writers must apply these secondary treatment standards as mass-based limits using the design flow of the plant. Permit writers may also apply concentration-based effluent limitations for both 30-day and 7-day average limitations.

Example:

A POTW with a design flow rate of 2.0 mgd would have permit limits based on secondary treatment standards as follows:

Mass-Based Limit = Design Flow × Concentration-Based Limit × Conversion Factor

BOD

(30-day average) 2.0 mgd × 30mg/l × 8.34 (lb)(l)/(mg)(gal) = 500 lb/day
(7-day average) 2.0 mgd × 45mg/l × 8.34 (lb)(l)/(mg)(gal) = 750 lb/day

TSS

(30-day average) 2.0 mgd × 30mg/l × 8.34 (lb)(l)/(mg)(gal) = 500 lb/day
(7-day average) 2.0 mgd × 45mg/l × 8.34 (lb)(l)/(mg)(gal) = 750 lb/day

pH

(instantaneous) 6-9 s.u.

Removal

(30-day average) 85% BOD_5 and TSS removal

Where nitrification is occurring in a treatment process, BOD_5 may not provide a reliable measure of the oxygen demand of the effluent. This is because nitrifying bacteria use a large amount of oxygen to consume unoxidized nitrogen and ammonia-nitrogen and convert these to oxidized nitrate. In these instances, basing permit limits on carbonaceous BOD_5 ($CBOD_5$) instead of BOD_5 eliminates the impact of nitrification on effluent limits. EPA, therefore, allows for the use of $CBOD_5$ limits to minimize false indications of poor facility performance as a result of nitrogenous pollutants. Allowed under 40 CFR §133.102(a)(4), the permit writer does have the discretion to set effluent limits for $CBOD_5$ in lieu of a BOD_5 limit. EPA has studied the use of a $CBOD_5$ limit and has concluded that a 25 mg/l 30-day average and 40 mg/l 7-day average are effectively equivalent to the (30/45) BOD_5 limits.

Chemical oxygen demand (COD) and total organic carbon (TOC) laboratory tests can provide an accurate measure of the organic content of wastewater in a shorter time frame than a BOD_5 test (i.e., several hours versus 5 days). Pursuant to 40 CFR §133.104(b), the permit writer may substitute COD or TOC monitoring for BOD_5 when a long-term BOD:COD or BOD:TOC correlation has been demonstrated.

Municipal wastewater treatment facilities are required to meet secondary treatment standards with few exceptions. The exceptions, identified at 40 CFR §133.103, include:

- Treatment works that receive flows from combined sewers during wet weather can qualify for alternative monthly percent removal limits during wet weather events.
- Treatment works that receive wastes from industrial categories that have ELGs for BOD_5 and TSS less stringent than the secondary treatment requirements in 40 CFR Part 133, can qualify to have their BOD_5 and TSS limits adjusted upwards provided that: (1) the permitted discharge is less than would be permitted under the corresponding ELGs for direct discharges, and (2) the flow or loading of such pollutants introduced by the industrial category exceeds ten percent of the design flow or loading of the POTW.
- Treatment works that use waste stabilization ponds as the principal process for secondary treatment and whose operation and maintenance data indicate that the TSS values specified in the equivalent-to-secondary regulations (discussed in Section 5.2.2) cannot be achieved, can qualify to have their minimum TSS levels adjusted upwards.
- Treatment works that receive less concentrated wastes from separate sewer systems can qualify to have their percent removal limit reduced or receive a mass loading limit provided that: (1) the facility can consistently meet its permit effluent concentration limits but cannot meet its percent

removal limits because of less concentrated effluent water, (2) the facility would have been required to meet significantly more stringent limitations than would otherwise be required by the concentration-based standards, and (3) the less concentrated effluent is not the result of excessive infiltration/inflow (I/I).

[Note: The determination of excessive I/I is based on (1) the "excessive I/I" definition in 40 CFR §35.2005(b)(16) as the quantities of I/I which can be economically eliminated from a sewer system as determined in a cost-effectiveness analysis that compares the costs for correcting the I/I conditions to the total costs for transportation and treatment of the I/I and (2) I/I is not excessive if the total flow (i.e., wastewater plus I/I) to the POTW is less than 275 gallons per capita per day.]

- Treatment works receiving less concentrated wastes from combined sewers during dry weather can qualify to have their percent removal limit reduced or receive a mass loading limit provided that: (1) the facility can consistently meet its permit effluent concentration limits, but cannot meet its percent removal limits because of less concentrated effluent water, (2) the facility would have been required to meet significantly more stringent limitations than would otherwise be required by the concentration-based standards, and (3) the less concentrated influent wastewater does not result from either excessive infiltration or clear water industrial discharges during dry weather periods. If the less concentrated influent is the result of clear water industrial discharges, the treatment works must control such discharges pursuant to 40 CFR Part 403.

  [Note: The determination of excessive infiltration is based on (1) the "excessive infiltration" definition in 40 CFR §35.2005(b)(28) as the quantity of flow which is less than 120 gallons per capita per day (domestic flow and infiltration) or the quantity of infiltration which cannot be economically and effectively eliminated from a sewer system as determined in a cost effectiveness analysis and (2) the criterion that either 40 gallons per capita per day or 1,500 gallons per inch diameter per mile of sewer may be used as the threshold value for that portion of the dry weather base flow attributed to infiltration.]

The NPDES regulations also provide for a waiver from secondary treatment requirements for discharges into marine waters. In these instances, the POTW must file a modification request for a marine discharge in accordance with the requirements of 40 CFR Part 125, Subpart G. More detail on marine variance requests is provided in Section 10.1.3.

5.2.2 Equivalent-to-Secondary Treatment Definition

Following publication of the secondary treatment regulations, legislative history indicates that Congress was concerned that EPA had not “sanctioned” the use of certain biological treatment techniques that were effective in achieving significant reductions in BOD_5 and SS for secondary treatment. Therefore, to prevent unnecessary construction of costly new facilities, Congress included language in the 1981 amendment to the Construction Grants statutes [Section 23 of Pub. L. 97-147] that required EPA to provide allowances for alternative biological treatment technologies, such as a trickling filter or waste stabilization pond. In response to this requirement, definition of secondary treatment was modified on September 20, 1984, and June 3, 1985, and published in the revised secondary treatment regulations contained in 40 CFR §133.105. These regulations allow alternative limits for facilities using trickling filters and waste stabilization ponds that meet the requirements for “equivalent to secondary treatment.” Several important concepts form the basis for this revision of the regulations:

- Certain classes of biological treatment facilities that are capable of achieving significant reductions in BOD_5 and TSS, but cannot consistently achieve secondary treatment, should be defined as separate and distinct from secondary treatment facilities.
- These facilities (equivalent-to-secondary) are cheaper and easier to operate and, therefore, are utilized by smaller communities. The provisions established by EPA should provide for continued use of these technologies where possible.
- The technology-based effluent limitation approach used to establish secondary treatment should be retained for equivalent-to-secondary treatment limits.
- Water quality must not be adversely affected by the application of equivalent-to-secondary treatment.
- Costly treatment plant upgrading or replacement should be avoided where equivalent facilities are operating sufficiently (e.g., achieving their original design performance levels).
- Regulations should address variations in facility performance due to geographic, climatic, or seasonal conditions.

In recognition of the above factors, the revisions to include a definition for equivalent-to-secondary treatment entail a change in the traditional definition of secondary treatment for some POTWs. The capability and performance of an individual plant is assessed, and limits are selected from a range of possible values. Although this process has been used for industrial facilities, the concept has generally not been applied to municipal permits (with the exception of interim permit limits).

To be eligible for equivalent-to-secondary limitations, a POTW must meet all of the following criteria:

- The principal treatment process must be either a trickling filter or waste stabilization pond (e.g., the largest percentage of BOD_5 and TSS removal is provided by the trickling filter or waste stabilization pond system).
- The effluent quality consistently achieved, despite proper operations and maintenance, is in excess of 30 mg/l BOD_5 and TSS.
- Water quality is not adversely affected by the discharge.
- The treatment works as a whole provides significant biological treatment such that a minimum 65 percent reduction of BOD_5 is consistently attained (30-day average).

A treatment works that is operating beyond its design hydraulic or organic loading limit is not considered an eligible facility. If overloading or structural failure is causing poor performance, the solution to the problem is construction, not effluent limitations adjustment. There are several important implications of the equivalent-to-secondary treatment regulation as it applies to specific municipal permitting issues. These issues are discussed below.

New Facility Limitations

As specified in 40 CFR §133.105(f), the permitting authority must set more stringent limits for new facilities if an analysis of new plant performance shows that more stringent limits than the maximum equivalent-to-secondary limits (45/45) can be met. Recently, a wide range of designs (e.g., solids contact channels, covers) have been used on trickling filters to improve their performance. This situation creates a performance dichotomy between old trickling filters and current state-of-the-art plants. The regulations recognize this disparity and encourage States to establish separate limits for new trickling filters based on current design practices in the State. Where possible, an analysis of similar plants is the preferred method for establishing permit limits where in-state data on new trickling filters are not available. Where no performance data are available for determining new plant capability, literature values may be used.

Calculation of Permit Limits for Equivalent-to-Secondary Facilities

In most cases, the permit limits for equivalent-to-secondary facilities will be selected from the 30 to 45 mg/l BOD_5 and TSS monthly average, and 45 to 65 mg/l BOD_5 and TSS weekly average range established by the regulation. Obviously, not all permits will be set at the 45 mg/l monthly average and 65 mg/l weekly average top of the range. The selection should be based on current performance data for the last two years of operation, at a minimum.

Where the plant performance data contain erroneous values because of plant upsets, or other situations not associated with poor operation or maintenance, an adjustment to the permit limit calculation may be made. The data for the month in question may be adjusted by dropping the erroneous daily value and recalculating the monthly average based on the remaining daily values. Another alternative is to analyze monthly average values for a period greater than two years and drop the monthly averages that are erroneous because of explained upset situations. Discharge Monitoring Report (DMR) data should be used for calculations whenever possible. The DMRs must support the permit writer's decision for an equivalent to secondary facility. It should be noted that the burden of proof for performance data and demonstration of proper operation and maintenance is the responsibility of the municipality.

A trickling filter or lagoon will often be combined with another biological process (i.e., activated sludge process) in one treatment plant. In this case, if the trickling filter or lagoon qualifies for equivalent-to-secondary limits, the permit limits for the treatment plant can be derived by averaging the equivalent-to-secondary and conventional secondary treatment limits. To accomplish this, a flow-weighted average of the two effluent concentration limits should be calculated and applied as the outfall limitation for the permit. An alternative to this approach is the use of internal waste stream limitations as authorized by 40 CFR §122.45(h) for each biological process effluent line. The permit writer should encourage the continued use of existing trickling filters and lagoons, where appropriate, through the application of appropriate equivalent-to-secondary limits. However, the permit writer must be sure that these facilities are capable of meeting the proposed effluent limits without causing water quality impacts before the permit limits can be adjusted. If one cannot determine this, equivalent-to-secondary limits cannot be used in the permit.

Alternative State Requirements (ASRs)

The Alternative State Requirement (ASR) provision contained in 40 CFR §133.105(d) of the regulation allows States the flexibility to set permit limits above the maximum levels of 45 mg/l monthly average and 65 mg/l weekly average BOD_5 and TSS from lagoons meeting certain requirements. Where lagoon suspended solids requirements are already above 45 mg/l in accordance with 40 CFR §133.103(c), an ASR by the State is not necessary, unless higher limits are desired. To establish an ASR, the State must do two things:

- Identify a group of equivalent facilities that warrant different limits in exceedance of the equivalent-to-secondary values contained in 40 CFR Part 133
- Justify the higher permit limitations for these facilities.

The group of facilities can be selected because of climatic or geographic location, the type of technology used, or any other supportable criteria. The analysis of plant data for the group must be statistically sound and should follow the methods presented in EPA's *Technical Support Document for Water Quality-Based Toxics Control*.[12] The ASR must be approved by the EPA Region before permits can be written using the ASR values. The public notice of a proposed ASR is the responsibility of the State. EPA has published approved ASRs in 49 *FR* 37005, September 20, 1984. **Exhibit 5-7** is a summary of the ASRs for each State.

Carbonaceous BOD Limits

EPA recognizes that the carbonaceous BOD (CBOD) test can provide accurate information on treatment plant performance in many cases. However, the use of CBOD in permits should be focused on facilities with known or suspected nitrification

[12] USEPA (1991). *Technical Support Document for Water Quality-Based Toxics Control*. EPA-505/2-90-001. Office of Water Enforcement and Permits.

problems such as underloaded facilities and new facilities with long detention times. These conditions favor nitrifying bacteria and can lead to erroneous BOD_5 test results.

The equivalent-to-secondary treatment regulations in 40 CFR §133.105(e) allow optional use of a CBOD limit and test procedure in municipal permits as a substitute for the standard BOD_5. This substitution is at the discretion of the permitting authority. To establish a CBOD limit for an equivalent-to-secondary treatment facility, the permitting authority must have data to show that nitrifying bacteria in the treatment plant are causing the BOD_5 test results to be significantly impacted. Extensive BOD_5/CBOD comparisons should not be necessary because the actual CBOD limit will be established by (1) determining the BOD_5 limit that can be met through proper operation and maintenance, and (2) if the BOD_5 limit is between 30 and 45 mg/l, setting the CBOD limit 5 units lower (e.g., between 25 and 40 mg/l).

The EPA-approved test procedures in 40 CFR Part 136 now contain a CBOD (nitrogen inhibited) test procedure. The CBOD test can be specified for any municipal permit. However, the BOD_5/CBOD relationship (5 mg/l difference) may not apply outside the 30 to 45 mg/l BOD_5 range. If CBOD limits will be used for equivalent-to-secondary permits above 45 mg/l (BOD_5), a BOD_5/CBOD relationship should be established during the ASR process. Where parallel BOD_5/CBOD test data are available, they must be submitted to the EPA Regional office with the proposed ASRs for approval. For permit limits below 30 mg/l BOD_5 the corresponding CBOD limit should be developed during an advanced treatment review or from the wasteload allocation. The use of CBOD in the permit is not a substitute for nitrogen or ammonia limits if in-stream nitrification or ammonia toxicity is creating a problem.

EXHIBIT 5-7
State-Specific ASRs

Location	Alternate TSS Limit (30-day average) (mg/l)
Alabama	90
Alaska	70
Arizona	90
Arkansas	90
California	95
Colorado	
Aerated ponds	75
All others	105
Connecticut	None
Delaware	None
District of Columbia	None
Florida	None
Georgia	90
Guam	None
Hawaii	None
Idaho	None
Illinois	37
Indiana	70
Iowa	
Controlled discharge, 3 cell	Case-by-case but not greater than 80
All others	80
Kansas	80
Kentucky	None
Louisiana	90
Maine	45
Maryland	90
Massachusetts	None
Michigan: Controlled seasonal discharge	
Summer	70
Winter	40
Minnesota	None
Mississippi	90
Missouri	80
Montana	100

EXHIBIT 5-7
State-Specific ASRs (continued)

Location	Alternate TSS Limit (30-day average) (mg/l)
Nebraska	80
North Carolina	90
North Dakota	
North and East of Missouri River	60
South and West of Missouri River	100
Nevada	90
New Hampshire	45
New Jersey	None
New Mexico	90
New York	70
Ohio	65
Oklahoma	90
Oregon	
East of Cascade Mountains	85
West of Cascade Mountains	50
Pennsylvania	None
Puerto Rico	None
Rhode Island	45
South Carolina	90
South Dakota	120
Tennessee	100
Texas	90
Utah	None
Vermont	55
Virginia	
East of Blue Ridge Mountains	60
West of Blue Ridge Mountains	78
East slope counties: Loudoun, Fauquier, Rappahannock, Madison, Green, Albemarle, Nelson, Amherst, Bedford, Franklin, Patrick.	Case-by-base application of 60/78 limits.
Virgin Islands	None
Washington	75
West Virginia	80
Wisconsin	80
Wyoming	100
Trust Territories and N. Marianas	None

Source: 49 *FR* 37005; 9/20/84