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Negotiating Higher NPDES Permit Limits– Strategies for Optimizing Technology and Water Quality-based Effluent Limit Calculations for Petroleum Refining

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Introduction

The Clean Water Act is generally considered to be one of the most successful environmental statutes in terms of measurable progress towards pollutant reduction goals. This success is largely due to the National Pollutant Discharge Elimination System (NPDES) program, which regulates the control of pollutant discharges from point sources to waters of the United States. The NPDES program relies upon a system of permits comprised of effluent limitations and monitoring, record keeping, and reporting requirements. Through the self-monitoring program non-compliance is reported to regulatory agencies and made available to the public.

NPDES permit holders are required to submit a permit renewal application at least once every five years. At that time the effluent limitations are reviewed and revised as necessary to meet current regulatory requirements and water quality management objectives, as well as reflect changes to facility operations and discharges.

The Clean Water Act is a strict liability statute, meaning that permit holders are held liable for violations even if there was neither negligence nor any intent to violate. Not only can violations result in criminal and civil penalties, but citizens can also sue the NPDES authority or permit holders in the event of ongoing noncompliance. Therefore, it is imperative that the primary objective of any NPDES permit renewal be to obtain effluent limitations that are achievable. The “anti-backsliding” provisions of the Clean Water Act do not allow limits to be increased in future permit renewals; therefore, a permit holder has only one opportunity to claim the effluent limit allocations that are available based upon the information provided in the application at the time of permit renewal.

Facility compliance can be improved by planning for permit renewal and using strategic approaches when developing the permit renewal application. Given an understanding of the methodology, data, and assumptions used in development of effluent limitations, the application can be developed to provide the most favorable presentation of data and facilitate development of the highest possible limits allowed under the regulation. This paper provides an overview of strategic approaches that can be employed to optimize effluent limitations for petroleum refineries.

Effluent Limitations

Effluent limitations must be developed in accordance with the requirements of Title 40 of the Code of Federal Regulations (40 CFR)Part 122.44. The permit writer must provide a regulatory and technical basis for all permit conditions and limitations. This permit rationale is published in a Fact Sheet that is made available for public review and comment as part of the permitting process. Limits may be either technology-based effluent limitations (TBELs) or water quality-based effluent limitations (WQBELs).

Technology-based Effluent Limitations

Technology-based effluent limitations are established in accordance with federal regulations for minimum treatment standards. Treatment standards are established for industrial discharges as effluent limitation guidelines (ELGs) by the industrial sector. The effluent guidelines establish levels of treatment technology based on industry-specific consideration of the pollutants of concern, treatability, and economic factors. Limits are related to some measure of operation, such as production or effluent flow.

The Petroleum Refining ELG, found at 40 CFR Part 419, was initially promulgated in 1974 and was subject to considerable litigation before final promulgation in 1985. Most ELG directly calculate limits very simply as the product of an effluent limitation factor times a measure of operation: the petroleum refining guidelines for process wastewater were based on complex models that related flow to production for five subcategories of processes. Effluent limit allocations are determined for specific processes according to the following formula:

Effluent limit = effluent limitation factor x size factor x process factor x refinery feedstock rate

The size factor is based on the refinery feedstock rate, which is defined as the largest of any of the crude process feedstock rates. The process factor is based on process configuration. Process configuration is calculated for each subcategory by multiplying the ratio of process feedstock rate relative to refinery feedstock rate times a weighting factor. The total refinery process configuration is the sum of the process configuration values for each subcategory.

Process wastewater effluent limitations are the sum of the allocations for each subcategory. Final effluent limitations also include allocations for ballast water and contaminated stormwater that are developed by multiplying wastestream flow rate by effluent limitation factors.

Water Quality-based Effluent Limitations

In addition to authorizing discharges under the NPDES program, the Clean Water Act requires the regulatory authority to conduct certain water quality management activities, such as establishment of water quality standards, water quality assessment, reports to congress on the status of the nation’s waters, and establishment of Total Maximum Daily Loads (TMDLs) for pollutants that are impairing the use of waterbodies. These water quality management programs affect permits through the inclusion of WQBELs where the TBELs are not adequate to protect water quality and support attainment of standards. Discharges to water quality-limited receiving waters may require limitations for pollutants that are not regulated by the ELG or that are more stringent than the TBELS and may not be attainable using any known treatment technology.

The regulatory agency is required to establish that there is *reasonable potential* for the discharge to cause or contribute to a violation of state water quality standards in order to impose the more stringent WQBELs. EPA has published technical guidance for the reasonable potential analysis and development of water quality-based effluent limits; however, states are free to develop their own approaches.

The WQBELs are developed from wasteload allocations that are designed to support attainment of state water quality standards in-stream. On impaired streams where a TMDL is required, the development of a Wasteload Allocation (WLA) may involve a complex model with multiple point or nonpoint sources of pollutants. Where there is no TMDL, the wasteload allocation is developed by solving a simple, complete mix, conservative mass balance model for effluent concentration, given that the in-stream waste concentration cannot exceed the most restrictive applicable numeric water quality criteria (see Figure 1).

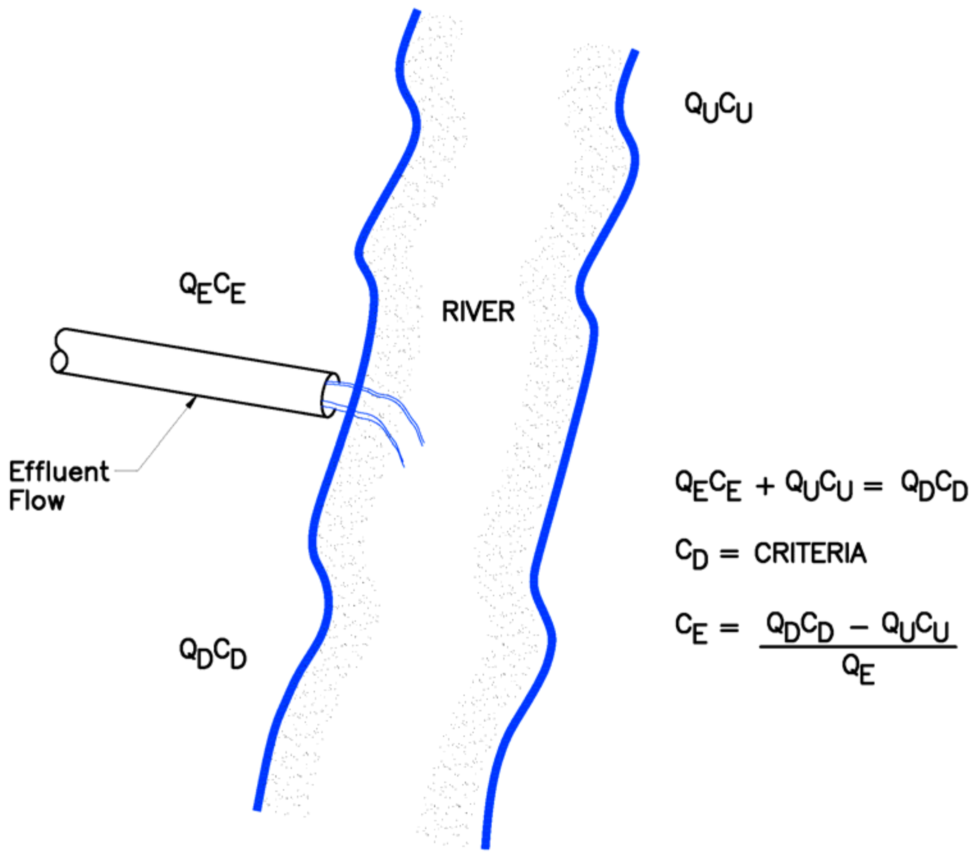

Figure 1

In most cases, state water quality criteria do not have to be met at the point of discharge, but rather at the edge of zones allowed for effluent dilution and mixing prior to the point of standards applicability. Figure 2 illustrates a typical zone of initial dilution and mixing. The acute water quality criteria cannot be exceeded at the edge of the zone of initial dilution, and the chronic water quality criteria cannot be exceeded at the edge of the mixing zone. State permitting policies and standards prescribe the permitting assumptions such as critical stream flow, critical effluent flow, fraction of stream flow allowed for dilution and mixing, effluent concentration and variability, and mixing assumptions.

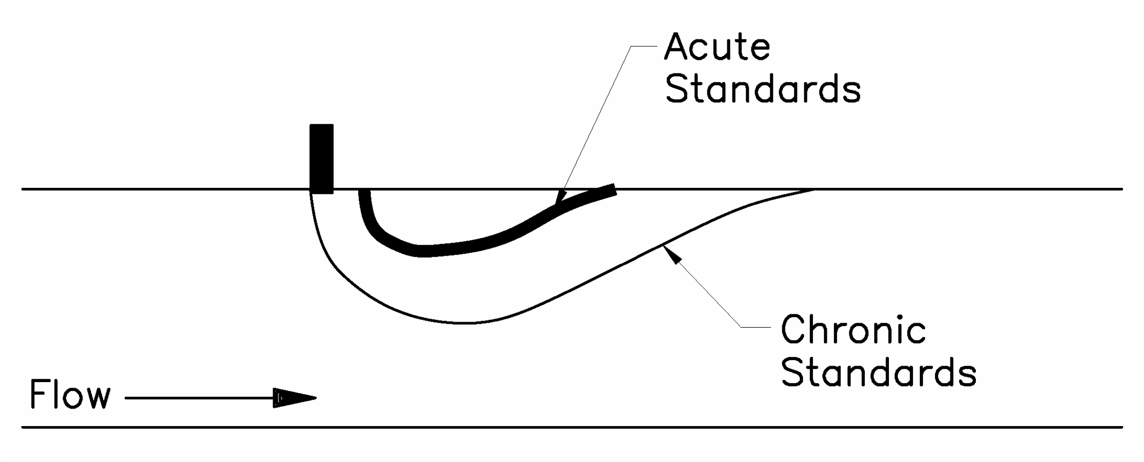

Figure 2

Developing Strategies

Permits are highly technical legal documents that take considerable resources and expertise to develop. As agencies are resource limited, permit writers often may not have practical experience with an industry category, or much time to spend researching site or industry-specific issues. In the interests of preventing permit backlogs and efficiently issuing permit renewals, permit writers are forced to rely upon established procedures and assumptions and readily available data garnered from permit applications and publicly available databases. Faced with limited data and considerable uncertainty, permit writers tend to make conservative assumptions in order to protect water quality.

However, most permit writers are open to consideration of alternate procedures, assumptions, or sources of data that are adequately supported. The permit application can advocate alternate approaches and provide for development of higher permit limits than would otherwise be calculated. An application that requests alternate approaches and provides a legally and technically defensible rationale is usually successful. The following general approach is effective in the development of permit strategies.

Evaluate Ability to Comply

Estimate the TBELS and WQBELs using readily available data and the standard assumptions outlined in state regulation and /or implementation policy. Compare the limits to historical effluent data to assess the ability to comply with the predicted permit limits. If the effluent 95th percentile exceeds the monthly average limit or effluent 99th percentile exceeds the daily maximum limit, there is a probability of non-compliance. This evaluation helps to identify the pollutants that present higher compliance risks and for which the cost of negotiating higher limits may be justified by the benefits of improved probability of compliance.

Identify Negotiable Aspects

Every data input and assumption in a permit calculation is a potential opportunity to negotiate a higher limit. When preparing a permit strategy, identify who has the discretionary authority regarding the input data and assumptions used to calculate the permit limit. Permit applicants have discretion with regard to the collection and presentation of application data (effluent and production data, site-specific receiving water studies). Permit writers have discretion with regard to selection of other input data (receiving water flow, upstream pollutant concentrations) and assumptions on a given permit. The agency has discretion in establishing and allowing variances from policy, but does not have discretion to change regulation through permit action. Some regulations may have provisions for site-specific variances that the agency has the discretion to approve.

Identify and Assess Options

When considering how a particular limit might be increased, there are often multiple options to be evaluated. The level of difficulty of obtaining a higher limit and the likelihood of success should be evaluated when formulating strategy. The issue should be resolved at the lowest level of effort in order to be most cost effective and have greater likelihood of success, as illustrated in Figure 3.

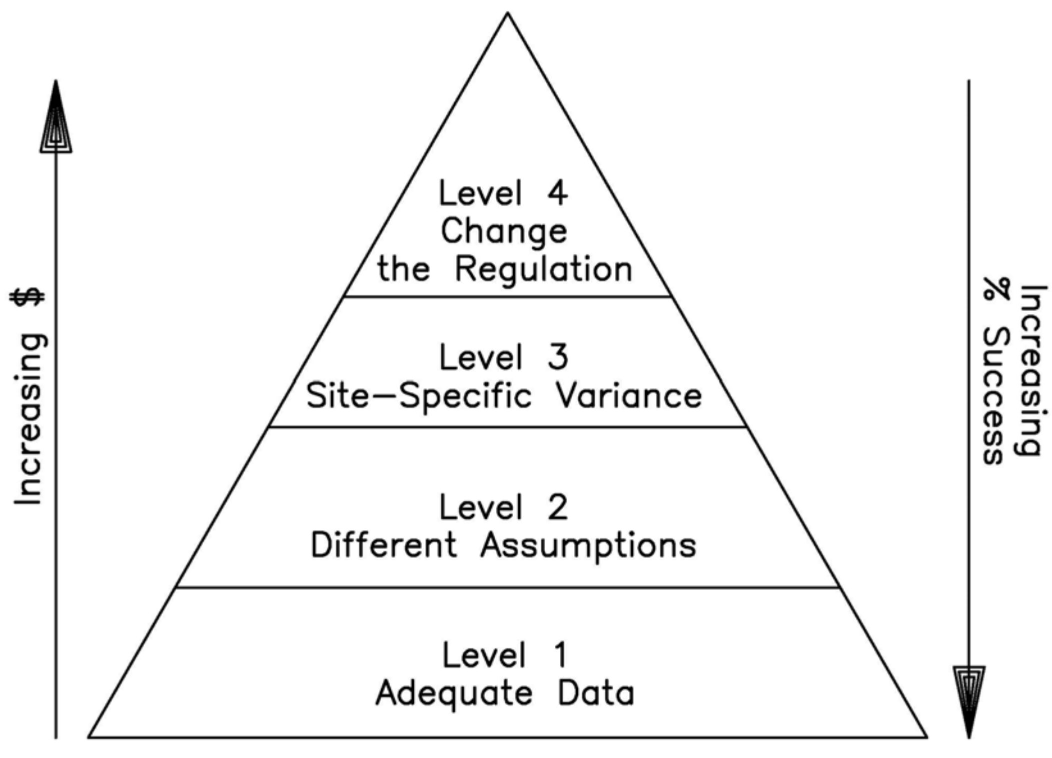

Figure 3

For instance, an effective strategy would attempt to develop an achievable WQBEL for zinc by first collecting representative data with appropriate quantification limits. If better analytical data did not resolve the issue, then bioavailability assumptions would be examined. Only if an achievable limit cannot be supported through new data and different assumptions would site-specific variances and regulation changes, such as establishment of site-specific criteria, be considered.

Strategies for TBELs

Optimize Production Data

The NPDES regulations at 40CFR Part 122.45 require that TBELs be based upon “not design capacity but reasonable measure of actual production.” EPA guidance refers to the use of production rates that are representative of the long-term average that might be anticipated during the five-year term of the permit. When preparing the production data for a permit application, five years of past production data is typically considered. While past performance may be an indicator of future expectations, adjustments are often needed because the application data should project anticipated production for the next five-year permit term. Professional judgment should be used to adjust estimates based on historic trends, market forces, or company plans.

Period of Record for Production Estimates

The following have all been accepted as reasonable measures of actual production:

- Long-term average,
- Highest month of the past year, or
- Highest year of the past five years.

The relationship between production data and effluent limits is not direct or easily predictable without actually running the calculations because the petroleum refining guidelines are based on complex flow models for multiple processes. The production data period of record with the highest crude throughout does not necessarily yield the highest permit limits because the processes are weighted differently and may vary relative to each other in different periods of record. The best approach is to develop estimates of production based on several different periods of record and run the permit calculations on each data set. The set producing the highest limits should be submitted on the permit application. The same period of record must be used for all processes in the calculations. Flows for stormwater and ballast water limit calculations should also be from the same period of record used for production data, unless unusual climatic conditions make it non-representative. Requesting that the agency use the maximum 30-day average for the period of record as the basis for the monthly average limit can optimize flow-based limits.

Units for Production Estimates

The NPDES regulations at 40CFR Part 122.21 (g)(5) state that TBELS should be based on “…. a reasonable measure of applicant’s actual production reported in units used in the applicable effluent guideline”. The effluent guidelines clearly indicate that size factor, process configuration, and process factors should be determined based upon production data in units of 1000 barrels of feedstock per stream day. Nonetheless, many regulatory agencies and the EPA permitting guidance documents often state that limits should be based on 1000 barrels per day, interpreted as per calendar day, for continuous discharges. Using barrels per stream day will result in higher factors and higher limits, and can be supported by regulatory authority that supercedes guidance or policy.

Building Block Approaches

In addition to the allocations for refining processes addressed in the ELG, allocations may be developed for other facility wastestreams when calculating final effluent limitations. Since the time that the process wastewater flow models were developed (1974-1979), most refineries have added additional units for production, water treatment, waste management, or pollution control that were not considered at the time of development of effluent guidelines. The cumulative effects over the years may be increased organic and hydraulic loading that was not considered when the level of treatment technology was established. If allocations for these other streams are not given, then, over time, refinery wastewater treatment must become even more efficient to meet the established technology-based standards.

Dischargers can request and receive allocations for additional units that are regulated under other effluent guidelines (such as Organic Chemicals, Plastics and Synthetic Fibers) or can request that limits be developed based on Best Professional Judgment (BPJ) where ELG do not exist. BPJ limits are frequently assigned to address pollutant loads introduced by utility-related wastestreams, such as boiler and cooling tower blowdowns, water and waste treatment residuals, and sanitary wastewater. Using a building block approach, the permit writer can add allocations for those units to the refinery ELG allocations.

Strategies for WQBELs

The strategies for developing optimum WQBEL typically include improving the input data sets and addressing analytical and bioavailability issues. Less frequently, site-specific variances and site-specific criteria may be required. Table 1 provides examples of tactics that may be employed in the development of a strategic input data set.

Table 1
Example Tactics for Input Data Sets

Input Data	Tactic
Effluent flow rate	Optimize period of record reported
Effluent pollutant concentration	Use analytical method that most closely measures toxic form of pollutant If there are data below detection limit (DL) and the agency is assuming present at DL or ½ DL, then collect data using lower DL methods Optimize period of record reported Report geometric means for data sets containing detect and nondetect values Examine statistical assumptions regarding data distribution and variability
Upstream flow rate	Identify additional tributaries, point source discharges, or drainage areas that contribute nonpoint source flows downstream of the gauging station and upstream of the facility

	Conduct site-specific studies to determine critical flow
Upstream pollutant concentration	Historical metals data are often falsely high; use improved methods (“Clean” sampling and analysis) to obtain better data If there are nondetects and the agency is assuming present at DL or ½ DL, then collect data using lower DL methods
Ambient Receiving Water Quality	Collect site-specific receiving water pH, total suspended solids (TSS), hardness

Analytical Issues

Analytical issues can make the difference between having a stringent WQBEL versus a less stringent TBEL or no limit at all. The water quality criteria are often near or below the method DLs. States typically establish a minimum quantification level[1] that must be achieved and policy regarding treatment of data that are reported as less than the established level. For example, if an applicant reports “less than DL” and the DL is greater than the established minimum quantification level, the policy may assume that the pollutant is present at the DL. However, if the minimum quantification level is achieved, the more favorable assumption that the pollutant concentration is zero or ½ the DL will be used.

Another analytical issue with water quality-based toxics control is that approved analytical methods do not measure the actual toxic fraction, but instead measure some larger fraction that includes the toxic form. Selection of the method that most closely measures the toxic fraction can improve the outcome of the “reasonable potential analysis” by not overestimating the concentration of the pollutant. For instance, instead of reporting total cyanide, report free available cyanide or cyanide amenable to chlorination.

Methods approved at 40 CFR Part 136 should be used where possible, but alternate methods can be used if they better measure the toxic fraction. Data developed using alternate test methods may be provided as supplemental application data without having to have the methods formally approved by EPA, however, the methods must be formally approved if used for permit compliance monitoring.

Bioavailability Issues

WQBELs for toxic pollutants are intended to protect designated uses, such as aquatic life propagation, by ensuring that the in-stream concentration of the toxic pollutant does not exceed the established water quality criteria for those uses. Ambient water quality can affect the bioavailability and toxicity of pollutants in-stream. Some water quality criteria therefore, are hardness or pH dependent. Water quality constituents, such as TSS or chloride, can also affect bioavailability of toxic fractions of pollutants.

[1] Also referred to as minimum analytical level, minimum level, or practical quantification limit.

Pollutants must be bioavailable to exert toxic effects. The laboratory toxicity tests that were used to develop the water quality criteria for the toxic metals used dissolved, highly bioavailable forms of the metals in pure laboratory water. The same metals concentration in ambient waters or effluents may not be as toxic because the metals tend to form dissolved organic complexes or bind with particulate matter. In addition, the water quality criteria for most toxic metals (with the exception of mercury and selenium) are expressed as dissolved concentrations (the more bioavailable fraction) while permit limits for metals must be as the total recoverable metal.

Strategies for dealing with these issues include using "translator" or partitioning equation procedures such as those established in the Texas and Louisiana water quality standards implementation policies. The dissolved criteria are translated to total criteria by multiplying times the total-to-dissolved ratio. The ratio is calculated using empirically derived equations, which relate partitioning to ambient receiving water TSS concentration. In some cases, site-specific partitioning studies are warranted to determine the actual partition ratio. Partitioning approaches do not actually change the water quality criteria, but adjust how it is factored into limit calculations. For silver, an additional translation can be made to calculate silver in its free ionic form (toxic fraction) based on a correlation between ambient dissolved chloride concentration and the percent of silver in free ionic form. Collection of site-specific ambient water quality data can favorably address bioavailability issues and result in higher criteria and higher permit limits.

Standards Issues

When lower levels of effort such as improved data collection or alternate assumptions cannot support development of an achievable WQBEL, it is often necessary to examine the standards. In some cases the designated uses are inappropriate. For instance, if a stream cannot support aquatic life due to severe irreversible hydrologic modification, then the aquatic life criteria may be inappropriate. Designated uses (and associated water quality criteria) can be removed if supported by a use attainability study.

Site-specific criteria can be developed based upon field studies, such as water effects ratio studies, or criteria recalculation procedures that incorporate new toxicity data or eliminate non-resident species data. Adoption of site-specific criteria as a water quality standard requires a change to the standards regulation during the triennial standards revisions.

Strategies for Anti-backsliding

The NPDES regulations require that when a permit is reissued or renewed, the limits and conditions be at least as stringent as those in the previous permit. Permit writers generally interpret this provision to mean that limits can never be increased once established. For this reason, it is critical to obtain the highest limits possible in each round of permitting. If higher limits are warranted but not pursued at the time of permit renewal, it is not possible to reclaim those allocations in future rounds of permitting. There are exceptions to the anti-backsliding provisions. For TBELs (including BPJ limits), increased limits are allowed if any of the following conditions apply:

- Material and substantial alterations or addition have occurred which would justify permit modification or revocation and reissuance;

- There is good cause due to events beyond the permittee's control for which there is no reasonable remedy;

- Permittee has installed and properly operated and maintained the technology, but still cannot meet the limits; or

- Technical mistake or mistake of law was made in the previous permit development.

Even if one of these exceptions applies, no relaxation of limits can occur if it will cause a violation of water quality-based limits or water quality standards. For WQBELs, relaxing limits for dischargers to nonattainment waters is prohibited unless the permit limit is based on a TMDL or other wasteload allocation and attainment of standards is assured. For waterbodies in attainment with standards, the revised WQBEL must be consistent with state anti-degradation policy. New information not available at the time of previous permit issuance can also be considered as an exception for WQBELs, but revised regulations, guidance, wasteload allocation, or test methods are not considered new information.

Material and substantial alterations are the most common exception utilized. When looking for exceptions to anti-backsliding provisions, do not limit consideration to the processes as defined in the effluent guidelines. Material and substantial changes to ancillary equipment and utilities wastestreams that discharge to treatment and are regulated in final limitations can constitute an exception to the anti-backsliding provision.

Case Studies

Case Study A

A refinery located on a water quality-limited waterbody had technology-based effluent limits that were based on BPJ and were roughly half the limits that would be allowed under the effluent guidelines. The refinery had relocated the effluent to a stream that was not water quality-limited and requested that increased TBELs be established in accordance with effluent guidelines. EPA ruled that due to anti-backsliding provisions, the limits could not be increased. The decision was based primarily on the fact that the facility production had not changed since the previous round of permitting. Review of historic operations data showed that while refinery production had not increased, influent organic loading had increased 30% and hydraulic loading had increased 50% during that time. The increases were attributed due to addition of units and processes not addressed in the effluent guidelines. EPA found this to constitute an exception to anti-backsliding requirements due to material and substantial changes. Additionally a building block approach was used to develop an allocation of 10 mg/L biological oxygen demand (BOD) and 10 mg/L TSS was allowed for the 0.8 million gallons per day (MGD) increased flow. The resulting permit limits were 2.1 times the previous limits.

Case Study B

An analysis of the production data was conducted for two refineries to identify the optimum production data basis. Limits were calculated for the long term (5-year) average, the highest year of the last 5 years, and the highest month of the last 12 months. The highest limits for one facility were calculated using the highest year of the last 5 years, while the highest limits for the second facility were based on the highest month of the last 12 months. The optimum permit limits were 6 to 10 % higher than using the long-term average data.

Case Study C

A water quality-based limitation for cyanide was successfully appealed using effluent monitoring data and technical arguments, including fate and transport assessment, which addressed the overly conservative agency assumptions. Additional effluent data was collected using the amenable cyanide method. Using the revised data, there was no demonstrated reasonable potential to exceed standards. The cyanide limits and monitoring requirements were removed from the permit.

Conclusion

NPDES permit holders face significant liability for noncompliance with effluent limitations. Permit applicants can obtain higher effluent limitations and improved probability of compliance by understanding the basis of permit limitations and preparing strategies to obtain optimum limits. Collection of appropriate effluent and receiving water data can increase limits, or in some cases, eliminate the need for a WQBEL by showing there is not reasonable potential to violate water quality standards. Through planning and use of strategic approaches based on an understanding of the methodology, data, and assumptions used in development of effluent limitations, the application can result in the highest limits allowed under the regulation.

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Biography for Robin S. Knox

A former permit writer with 5 years of experience with the Louisiana Department of Environmental Quality's (LDEQ) Water Pollution Control Division, Ms. Knox offers a broad perspective in water quality Ms. Knox graduated from Louisiana State University with a B.S. degree in Environmental Health and has completed graduate coursework in Civil Engineering. She has more than 20 years experience in the areas of NPDES permitting, wastewater treatment, water quality modeling, and water quality research. For the past 15 years, Ms. Knox has specialized in developing wastewater discharge permit and compliance strategies for major industrial, municipal and federal facilities. She is an experienced director of NPDES projects including more than 100 NPDES permit applications and /or water quality studies in 8 EPA regions, 20 states and the Commonwealth of Puerto Rico. Her background as a permit writer and her in-depth understanding of the permitting process has allowed her to consistently obtain NPDES permits in a timely manner containing achievable effluent limitations.