Idaho Pollutant Discharge Elimination System

Effluent Limit Development Guidance Supplemental

State of Idaho
Department of Environmental Quality

December 2018

Printed on recycled paper, DEQ Month Year, PID #, CA code. Costs associated with this publication are available from the State of Idaho Department of Environmental Quality in accordance with Section 60-202, Idaho Code.

Idaho Pollutant Discharge Elimination System

Effluent Limit Development Guidance Supplemental

December 2018

Prepared by
Idaho Department of Environmental Quality
Water Quality Division
1410 N. Hilton
Boise, ID 83706

Acknowledgments

The Association of Idaho Cities (AIC) assisted DEQ with the subjects and content of this Effluent Limit Discharge Guidance Supplemental (Supplemental) in the interest of the citizens of the State of Idaho while protecting the water resources of the State and promoting the advancement of our communities.

Table of Contents

List of Tables

List of Figures

1 Introduction

This Effluent Limit Development Guidance Supplemental (Supplemental) supports the Effluent Limit Development Guidance (ELDG; DEQ 2017) by addressing special topics not covered within the ELDG. The IPDES Program faces challenging issues (e.g., toxics, temperature, and nutrients) and the Supplemental is meant to address some of these challenging issues by providing additional guidance to IPDES permit writers.

Because every circumstance and permit is unique, this Supplemental provides additional tools for permit writers to use when developing effluent limits that appropriately address protect beneficial uses and comply with the water quality standards. Permit writers may include in permits an approach or approaches described in the Supplemental when:

- Requested by applicants and deemed appropriate for the conditions by DEQ, and/or
- Determined that approaches in the ELDG are insufficient to meet water quality standards.

These tools adhere to Clean Water Act (CWA) requirements and associated state and federal rules, regulations, and implementation policies while providing additional approaches to benefit water quality and Idaho's citizens.

1.1 Purpose and Need

Using the ELDG and Supplemental as references, permit writers can make reasonable assumptions and consider innovative approaches to develop permits. The Supplemental addresses the following:

- Nutrients
- Temperatures
- Select Toxics
- ~~Monte Carlo~~
- Offsets
- Bubble/Watershed Permitting
- Adaptive Management
- Integrated Planning

1.2 Relationship to Existing Rules and Guidance

This guide supports implementation of the CWA, Idaho Code and administrative rules, federal regulations, and state and national policies, guidance, and standards and complies with Idaho's "Water Quality Standards" (IDAPA 58.01.02), "Wastewater Rules" (IDAPA 58.01.16), and "Rules Regulating the IPDES Program" (IDAPA 58.01.25). This guide does not replace, supplant, or change any requirements under state or federal rules and regulations.

1.3 Relationship to Effluent Limits

The special topics in the Supplemental pertain to water quality-based effluent limits (WQBELs) and not technology-based effluent limits (TBELs). As WQBELs in IPDES permits are a mechanism to achieve and maintain water quality standards in specific receiving waters, the special topics generally are a function of both the effluent and receiving water. These should be considered through the perspective of effectively supporting and attaining protective water quality goals. The application of these special topic approaches may result in changes to the magnitude, duration and/or frequency of effluent limits with the effect of providing a more practicable and effective permit for both the State and the permittee while still attaining and supporting water quality criteria.

1.4 Special Topics

The special topics are subjects DEQ believes may impact effluent limits and are beyond the scope of straightforward calculations. Each section discusses the nuances of a special topic and how permit writers may work to address the topic and incorporate relevant limits, if necessary, in the permit. Use of these special topics may result in differences in how the effluent limitations are expressed and/or special conditions in a permit such as requirements for additional monitoring or special studies, best management practices (BMPs), or compliance schedules.

The permit writer is not required to use the special topics within a permit. DEQ strives to work with communities and businesses to develop permits that adhere to Clean Water Act (CWA) requirements and associated state and federal rules, regulations, and implementation policies. The Supplemental provides additional tools to meet those objectives.

2 Nutrients (Nitrogen and Phosphorus)

Nutrients, except ammonia, are not toxic pollutants under the Clean Water Act (CWA) and thus the need for effluent limits can be evaluated differently than toxics. In some cases suspected water quality problems due to nutrients may best be handled by the TMDL process. Because permit effluent limits must be consistent with an existing TMDL, the process for addressing nutrients may require coordination with the surface water program to determine the best path forward. It is important to consider variability and reliability of effluent performance from advanced nutrient removal facilities. These technologies are highly effective in nutrient removal despite their inherent variability in effluent quality, particularly at low phosphorus and nitrogen concentrations (WERF 2010, WERF 2011, and WERF 2016). Permits may include water quality trading or offsets to improve water quality and meet nutrient discharge limitations.

Nitrogen and phosphorus can be subdivided into compounds. Nitrogen compounds are represented as organic nitrogen, ammonia, nitrate, and nitrite. Phosphorus compounds are represented as organic phosphorus and dissolved phosphorus. These compounds may be further defined as labile (biologically available) or refractory (biologically unavailable). Some of these compounds, including ammonia and nitrite/nitrate, can be both plant nutrients and toxic to aquatic species. The ELDG addresses nutrient speciation in Section 3.7.1.1 Nutrient Speciation (DEQ 2017).

Nutrient speciation is an important consideration in monitoring programs and an area of potential confusion in vocabulary and laboratory analysis, especially at low concentration levels. A comparison of commonly used terminology in wastewater effluent monitoring and ambient receiving water quality monitoring and modeling is shown in Clark 2016b.

Not all of the information to define nutrient species is available from conventional laboratory analysis. For nitrogen, a majority of the fractions may be analyzed in the laboratory with the remaining fractions calculated from the analyzed values, or estimated. Estimations may be necessary for the labile and refractory fractions. For phosphorus, a minority of the fractions may be analyzed in the laboratory with the remaining fractions calculated from the analyzed values, or estimated. A different approach should be taken when very low nutrient concentrations become more important and there is a need to understand refractory compounds. For refractory compounds, the methods of analysis are more complex and may use newly evolving methods (Brett 2015, Li 2013, and Sedlak 2003).

The adequacy of water quality monitoring data for use in permitting should correspond to and complement the level of decisions to be made with the resulting management scenarios. For example, nutrient speciation and bioavailability can be expected to be an important factor under the following circumstances:

- A receiving water body with low nutrient concentration targets;
- Management scenarios where nutrient reductions are planned, especially those approaching the limits of treatment technology; or
- Enhanced nutrient removal processes are currently utilized.

When these circumstances are present, DEQ may recommend to the applicant the implications of nutrient speciation on their treatment options and the conservatism of not addressing these within the effluent limits. The applicant may choose to undertake the study of the speciation of their effluent. The applicant will need to submit technical evidence demonstrating refractory speciation for DEQ's review and approval, which will also be made available for public comment as part of the draft permit and fact sheet if the results of the analysis are used as a basis for nutrient effluent limits.

DEQ may develop nutrient effluent limits using a ratio of refractory to total to adjust the total nutrient concentration and/or load. For example, if the current total nutrient effluent limit is 1 mg/L but 50 percent is refractory, then the preliminary adjusted total nutrient effluent limit may be 2 mg/L, since half the concentration is not immediately available to the environment. In order to ensure that nutrient speciation is protective of the receiving water and a net increase in water quality is attained the permit writer should also incorporate a factor of uncertainty.

The permit should also be conditioned so the operational treatment process that produced a certain refractory percentage is maintained. An additional permit condition may be that any changes to the operational treatment process which would affect nutrient treatment require a restudy of the speciation, and that a restudy of the speciation be performed with each permit renewal application.

If the permittee wishes to pursue nutrient speciation in the permit DEQ may require the permittee to provide a trophic state classification study as described in EPA's Nutrient Criteria Technical Guidance Manual: Rivers and Streams (EPA 2000a), and Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs (EPA 2000). This study will be taken into consideration when the DEQ is evaluating the applicability of a nutrient speciation plan.

Additionally, items that the permittee may be required to provide as part of a study could include:

- Identifying the stability of effluent nutrients through measures of
  - The refractory nature of each nutrient
  - The conversion of nutrients from refractory to available
- Submitting proposed test methods to identify the individual nutrient species so that monitoring and reporting can assure the actual loads discharged

Further investigation into the system of concern may be necessary to better understand the potential impacts of both labile and refractory forms of nutrients may have on the system. EPA has developed stressor and response modeling guidance (EPA 2010) that may be helpful in this process.

Nutrient speciation applicability should be evaluated on a case by case basis. The amount of bioavailable nutrient discharged should in some cases be considered the sum of the currently bioavailable nutrient form and nutrient forms that have the potential to be bioavailable in the future. Simply monitoring for a nutrient species that is of concern may be appropriate for a localized immediate impact on the receiving water, but it may not be appropriate when considering far field impacts in a freshwater system. A study examining the bioavailability of varying forms of phosphorus in freshwater found, “The rate of orthophosphate mobilization from different P compounds is highly variable depending on the type of mobilization mechanism involved. Bioavailability must thus be determined and discussed with a certain time perspective in mind,” (Boström et al., 1988).

3 Temperature—316(a) Variance Approach

The ELDG in Sections 3.3.2.1.2 (water quality standards), 3.4.3.7.2 (thermal plumes), and 3.7.2 (WQBELs) provide the permit writer with guidance specific to temperature.

This section provides the permit writer with information and an example of the technical and implementation aspects of a 316(a) demonstration. This will assist in the early consultation and screening of a 316(a) application from a permittee, and subsequent review of the submitted demonstration. The example used is based on the 316(a) demonstration for the Boise River submitted by the City of Boise (Boise 2018), and thus is applicable to thermal discharges from municipal facilities (POTWs).

Temperature is not a toxic pollutant under the Clean Water Act (CWA) and thus the need for effluent limits can be evaluated differently than toxics. The Idaho Water Quality Standards require the permit writer to evaluate temperature impacts of the discharge on beneficial uses of the receiving waters (IDAPA 58.01.02 .250), and within a mixing zone (IDAPA 58.01.02 .060.01.d.ii.). Additionally, there are specific requirements for point source wastewater treatment discharges that will need to be considered (IDAPA 58.01.02.401).

In some situations, there are no cost-effective treatment options for temperature. Cooling towers and chillers are expensive and not environmentally responsible (very high energy use and associated greenhouse gas emissions). Therefore in some situations the permit writer may choose to use the next permit cycle to collect enough temperature data during the critical season to evaluate thermal discharge effects on beneficial uses. Data should be collected to characterize effluent and background receiving water temperatures, and the available dilution during critical conditions. Water quality variances may also be a means of addressing temperature requirements.

Section 316(a) of the Clean Water Act provides that the EPA (and delegated state agencies) may authorize alternate thermal conditions in NPDES permits where the effluent limit is more stringent than necessary to assure the protection and propagation of a balanced, indigenous ~~community~~ population (BIP~~C~~) of shellfish, fish, and wildlife in and on the body of water into which the thermal discharge is made. The applicant seeking the thermal variance has the burden of making the necessary demonstration that a variance is justified. In order for the permitting agency to determine whether a variance is warranted, the permit applicant typically must conduct scientific investigations to demonstrate, either through predictive or empirical means that a BIP is currently protected, and will be maintained under a 316(a) temperature variance.

3.1 Receiving Water Considerations for 316(a)

Hydrologic alteration, in many cases, substantially changes the natural temperature regime. One key and common situation in Idaho is storage of water in large reservoirs that thermally stratify, with release from low level outlets during the summer irrigation season. This water management shifts water temperatures downstream on a seasonal basis because the reservoirs act as "thermal capacitors," storing cold snow melt runoff in spring and early summer, releasing colder hypolimnetic (bottom) water during the summer, and then releasing warmer water than would be present naturally during the fall and early winter seasons when air temperatures fall faster than released water temperatures. Another common hydromodification in Idaho is diversion of water from rivers and streams for various uses, including domestic and industrial water supplies and irrigation water. Reduction in stream and river flow may allow more solar warming than would otherwise occur naturally. Thus, hydromodifications can either decrease or increase water temperatures compared to natural conditions, or even both on a seasonal basis. Another critical consideration for temperature is that many streams and rivers naturally warm longitudinally as water flows downstream due to solar radiation inputs and hot air temperatures in a semi-arid and hot climate (especially southern Idaho).

Thermal discharges also tend to equilibrate to ambient temperatures downstream of the discharge. This is because temperature is a "non-conservative" pollutant. Below is a relevant discussion taken from Washington Department of Ecology guidance (Water Quality Program Guidance Manual, *Procedures to Implement the State's Temperature Standards through NPDES Permits, Revised October 2010*):

> Non-conservative pollutants are defined as those that are mitigated by natural biodegradation or other environmental decay or removal processes in the receiving stream after in-stream mixing and dilution has occurred. The concentration of non-conservative pollutants is reduced after they are discharged into the receiving stream as a result of these removal processes.
>
> The temperature in effluent is considered a non-conservative pollutant and is reduced (i.e., cooled) after it is discharged into a cooler receiving stream. Cooling happens as a result of the transfer of thermal energy from the warmer effluent to the cooler stream and the thermal energy loss associated with evaporation of the effluent/ receiving water mixture. The rate of effluent temperature reduction is dependent upon many

factors: dew point, radiant energy from the sun, receiving water surface temperature, flow, and currents and tides.

It is important to remember that thermal energy is not "in" the water in the same sense that copper atoms and ammonium ions are in water. Thermal energy is absorbed by the water molecules, which is manifested as temperature and a property of the water.

3.2 316(a) Process

The regulatory process followed in a 316(a) variance demonstration is summarized in Figure 1. The left side of Figure 1 pertains to the short-term applicability of the 316(a) process for existing and near-term effluent discharges (that is, for the next permit cycle or so). This short-term, Type I demonstration is based on EPA regulations for existing discharges to demonstrate, based on field studies, that "no appreciable harm" has occurred to the BIP from a discharge, per 40 Code of Federal Regulations (CFR) 125.73(c)(1). The right side of Figure 1 pertains to the longer-term, Type II demonstration of the 316(a) process for future growth and development that is expected to occur in a city over time to the point where design flows are being treated at each POTW. Thus, the modeling for the thermal mixing zones and far-field thermal modeling at design flow conditions are integrated with the biothermal assessment to demonstrate that the balanced indigenous ~~community~~ population (BIP~~C~~), as characterized by representative important species (RIS), will be protected at these future conditions for the thermal component of those discharges.

Figure 1 also shows the inter-relationship between the short-term process and longer-term process, and the concept that the longer-term implementation of the process involves periodic monitoring and potential reassessment (e.g., for each 5 year permit cycle).

Note that a Type I and II demonstration may not both be needed at the time of permit issuance or reissuance. For example, if a particular municipality does not expect substantial growth over the next several permit cycles, then the Type I, current condition, analysis alone may be sufficient for many years. The same could be true for an industrial discharger that does not anticipate a future increase in production, discharge flow or temperature.

One outcome of a 316(a) demonstration is to develop alternative thermal effluent limits (ATELs) that are included in the permit. These typically are numeric temperature and/or thermal load limits, and may also include standards of performance, per EPA regulations as summarized in the ELDG.

~~In the City of Boise 316(a) application, a portfolio of temperature management actions was incorporated into the demonstration and implementation process, as summarized below. The example may provide useful information to the applicant and DEQ permit writer regarding such demonstrations elsewhere in Idaho. Hydrological, thermal and biological conditions vary considerably for each receiving water and thus it is critical that the applicant and DEQ confer on the prospective methods in each case prior to submittal of the formal demonstration.~~

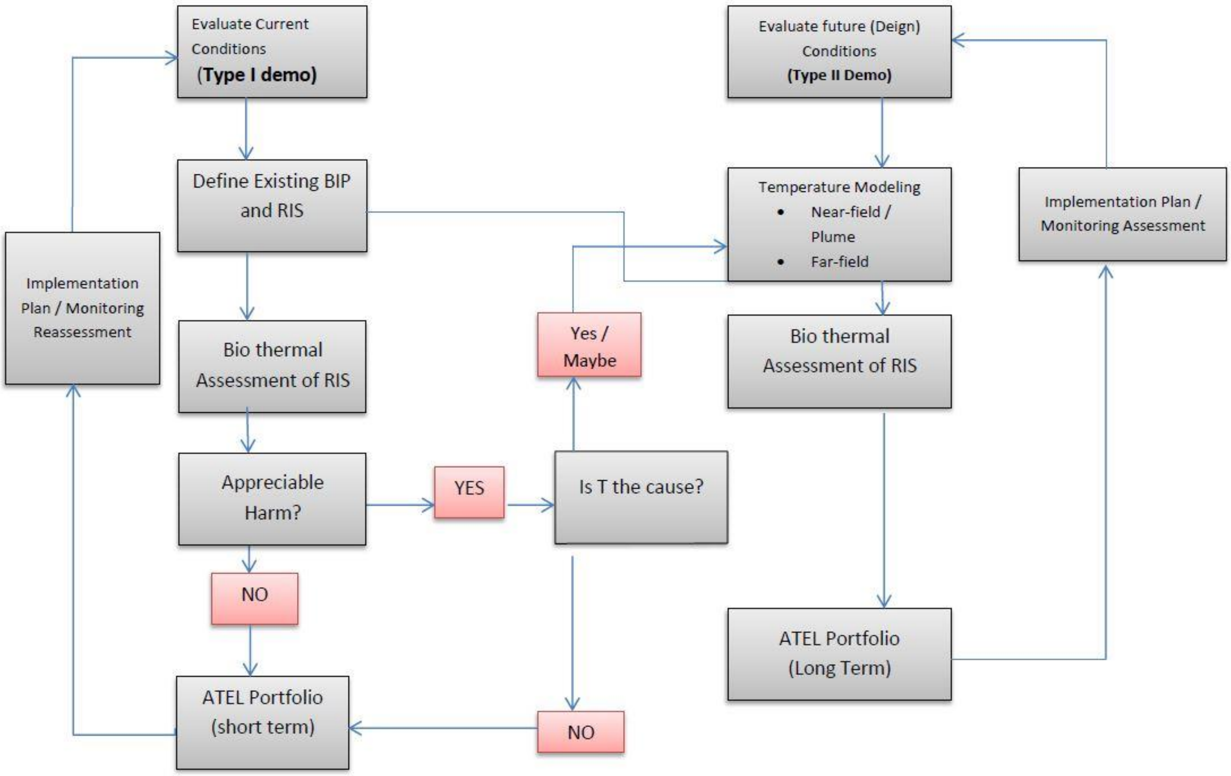

Figure 1. 316(a) bioassessment methodology.

In the City of Boise 316(a) application, a portfolio of temperature management actions was incorporated into the demonstration and implementation process, as summarized below.

Boise City 316(a) Demonstration Study

In the winter, snowmelt and runoff from the upper Boise River watershed are stored in three large reservoirs (Anderson Ranch, Arrowrock and Lucky Peak). During summer, water released from Lucky Peak to the lower Boise River is much cooler than would naturally occur (promoting a productive cold water fishery for many miles downstream). Although cold water biota criteria are usually met during this period, they may be exceeded or nearly exceeded a small percentage of the time (a low enough percentage of the time that this section of the river is not considered impaired for temperature and a TMDL thus is not required be developed or implemented). Similarly, during the fall, water released is sometimes warmer than would naturally occur, and may at times approach or exceed applicable salmonid spawning temperature criteria (although again, not often enough to prompt an impairment listing or TMDL). This was in fact the case for NPDES permits issued by EPA in 2012 to the City for the Lander Street and West Boise Water Renewal Facilities (WRFs). These WQBELs were lower than existing WRF discharge temperatures and could only be met using effluent cooling and chilling technology which was prohibitively costly and environmentally unsustainable. Consequently, the City developed a 316(a) variance demonstration.

The City of Boise's draft demonstration using the methodology in Figure 1 is summarized below:

- The Type I Demonstration for current conditions involved the following:
  - The BIP were defined as the fish and macroinvertebrate communities that exist in the river upstream and downstream of the WRFs.
  - The RIS were defined as a subset of the BIP, specifically fish genera and species of resident trout and whitefish (Salmonidae), sculpin (Cottidae), suckers (Catostomidae), dace (Cyprinidae).
  - The BIP evaluation of "no appreciable harm" consisted of application and interpretation of RIS longitudinal distribution and fish and BIP ~~community~~ attributes (using DEQ bioassessment indices and temperature-specific community metrics) for the BIP and RIS upstream and downstream of each WRF.
- The Type I Demonstration was based on three lines of evidence:
  - One: Comparison of RIS presence:
    - No longitudinal trends except for the mottled sculpin and shorthead sculpin
    - Shorthead sculpin consistent reduction in presence going downstream
  - Two: Comparison of fish and benthic macroinvertebrate community condition:
    - No longitudinal trend in River Fish Index.
    - Mixed results of longitudinal trend in River Macroinvertebrate Index.
  - Three: Comparison of temperature-specific community metrics:
    - Trending towards warm-water species, but the trend is incremental and not punctuated at WRFs.
- Potential stressors
  - Non-point thermal loading from multiple sources could have led to incremental trending of temperature-specific community metrics.
  - Increased embeddedness, decreased habitat connectivity, and decreased habitat complexity may have led to decreased sculpin presence.
- The Type II Demonstration for future effluent design flow conditions involved the following:
  - The river temperatures in the near-field and far-field were modeled with EPA-approved models to show how the increased future discharges affected the river.
  - Biothermal criteria specific to the RIS (i.e., RIS thermal limits) were compared to the modeled river temperatures to assess if the RIS would be adversely affected.
- The Type II Demonstration was based on two lines of evidence:
  - One: Comparison of far-field modeling
    - No exceedance of RIS thermal limits
    - Some incremental warming during "shoulders" of spawning season
  - Two: Comparison of near-field modeling design flows meets IDEQ Mixing Zone Guidance:
    - The thermal effluent from both the Lander Street and West Boise WRFs is less than 32 °C
    - Less than 5 percent of the cross-sectional areas of both mixing zones are greater than 25 °C
    - Less than 25 percent of the cross-sectional areas of both mixing zones are greater than 21 ºC

- In spawning and incubation areas, the river temperatures do not exceed 13 ºC more than 10 percent of the time

The example above may provide useful information to the applicant and permit writer regarding demonstrations in Idaho. Hydrological, thermal, and biological conditions vary considerably for each receiving water and it is critical that the applicant and DEQ confer on the prospective methods in each case prior to submittal of a formal demonstration. On a case by case basis, the permit writer will work closely with the DEQ surface water program to determine how to best approach temperature considerations and the applicability of 316(a) variances.

4 Select Toxics

Toxics encompass a large group of compounds that for the most part are covered by the ELDG, there are some unique scenarios that do not fit within that context and are described here. One of the key challenges is that the detection levels of some toxics are below what is achievable from a treatment technology standpoint.

4.1 Arsenic

The ELDG addresses approaches to parameters such as arsenic in Section 2.2.2.7.3 Effluent Limit Guidelines Variances, Waivers, and Intake Credits (2017 Version). Arsenic is common throughout Idaho due to the geology and occurs in many minerals and is present naturally in many Idaho surface waters. Subsurface anoxic conditions release naturally occurring arsenic from sediments into the groundwater. Ground water is commonly used as a water supply and thus arsenic can be present in the drinking water. ~~DEQ is working through the negotiated rulemaking process for arsenic.~~

4.2 Phthalates (Bis (2-ethylhexyl) phthalate)

Bis (2-ethylhexyl) phthalate is a manufactured chemical that is commonly added to plastics to make them flexible (EPA 2015). The prevalence of plastics in the environment and even sampling equipment and laboratory analysis can result in random detections of concentrations in monitoring results. It may take additional resources and extra precautions to achieve reliable samples without contamination. In the response to comments on the city of Meridian's draft permit, EPA wrote:

> The EPA has determined that there is insufficient information to demonstrate that the facility has the reasonable potential to cause or contribute to excursions above water quality standards for this pollutant. The EPA has determined that it is possible that the bis (2ethylhexyl) phthalate measurements upon which the reasonable potential finding was based could have been biased due to contamination during sample collection and analysis (EPA 2016).

In 2016 the EPA replaced EPA Method 625 with EPA method 625.1 in which it raised the ML for Bis (2-ethylhexyl) phthalate from 0.5 ug/l to 7.5 ug/l. This new ML will help account for contamination of samples. The facilities should be made aware of the potential for sample contamination and take the necessary steps to ensure proper sampling techniques are followed. Facilities can also be advised to utilize field and method blanks to assess test validity.

The permit writer is cautioned in using only one or two detection values of a parameter such as bis (2-ethylhexyl) phthalate when making a reasonable potential determination. This is a national issue in understanding and addressing random detection of parameters such as bis (2-ethylhexyl) phthalate and permit writers should carefully examine the data. The ELDG addresses data in Section 1.5 Data Analysis and Considerations (2017 Version), and references Section 12 (Data Analysis and Considerations) of DEQ's Idaho Pollutant Discharge Elimination System User's Guide to Permitting and Compliance Volume 1—General Information. If the permit writer concludes there are issues with data, then the permit should include language regarding additional monitoring. Example fact sheet language includes "The permit requires more frequent effluent monitoring in order to determine if water quality-based effluent limits are necessary."

4.3 Chlorinated Hydrocarbons

Chlorinated hydrocarbons are organic compounds containing at least one covalently bonded atom of chlorine that has an effect on the chemical behavior of the molecule. Chlorinated hydrocarbons have the same issues as described under Phthalates (bis (2-ethylhexyl) phthalate) along with additional challenges regarding monitoring including: low detection level method not approved, blank correction issues, multiple congeners to assess.

Polychlorinated biphenyls (PCBs) are a subset of the broad family of chlorinated hydrocarbons. PCBs are a group of man-made organic chemicals consisting of carbon, hydrogen and chlorine atoms. PCBs, even at low concentrations, are of concern based on the bio-magnification properties and potential health risks involved with this pollutant. Since PCBs are not one constituent, but 209 constituents (congeners) comprising a total, and the analytical methods needed to detect each of these constituents at low concentrations are costly, it may become an expensive challenge for Idaho's dischargers, especially many of the smaller entities. Although the criteria is based on total PCBs, to make advancements in reducing the source, the 209 congeners will likely need to be investigated.

Where PCBs are present, the permit writer should work with the applicant to explore source tracing through the use of adaptive management and a toxic management plan. ~~Although the criteria is based on total PCBs, to make advancements in reducing the source, the 209 congeners will likely need to be investigated. PCBs, even at low concentrations, are of concern based on the bio-magnification properties and potential health risks involved with this pollutant.~~ However, testing for chemicals at low concentrations can be challenging and source tracing efforts are not always successful. Any monitoring plan developed to trace PCB sources will require extensive forethought and account for each system's unique circumstances. Additionally, some facilities have multiple wastewater streams that combine before the monitored outfall. In such cases it may be required to limit PCBs at internal monitoring locations where concentrations are expected to be greatest (IDAPA 58.01.25.303.08).The objective of the permit requirements should be to identify and reduce the sources of greatest concern and concentration.

~~The permit writer may require the permittee to use~~ EPA Method 1668 may be used for PCB monitoring because it is the most sensitive method available, and it analyzes for all 209 of the individual PCB congeners (EPA 2013). As stated in 40 CFR Part 136 "Method 1668C may be useful for determination of PCBs as individual chlorinated biphenyl congeners." ~~While~~ EPA

Method 1668 is appropriate for monitoring~~, the permit writer is cautioned about potential effluent limits~~ but not for determining compliance with limits.

> EPA methods 1668 and 8082 are not approved methods under 40 CFR Part 136, thus, if effluent limits for total PCBs are established in the future, methods 1668 or 8082 could not be used to determine compliance with such effluent limits unless those methods are approved under 40 CFR 136 for either nationwide or limited use at the time such limits are established (EPA 2013).
>
> EPA regulations require that samples and measurements taken for purposes of monitoring shall be representative of the monitored activity. [40 CFR 122.41(j)(1) & 122.48(b)] EPA has approved test methods under 40 CFR Part 136 for use as compliance monitoring requirements in an NPDES permit. [40 CFR 122.41(j)(4)] Where an authorized State wants to include in an NPDES permit requirements to monitor for informational purposes with methods more sensitive than the measurement capabilities of methods approved in Part 136, the State may specify the suitable method. Under these circumstances, the State is not bound to require the use of a Part 136 method because no such method exists to provide data at required levels. The NPDES permitting authority is responsible for ensuring that the specified test method will yield results at concentrations of concern that are reliable enough to meet the needs for permit monitoring under the Clean Water Act. In addition, if an appropriate non-136 method is required for the use in the permit, the NPDES permitting authority should specify in the permit Fact Sheet/Statement of Basis not only the selected method but also state the rationale for specifying the selected method. (VDEQ 2009)

When ~~some~~ water quality criteria are lower than the approved methods for permit compliance, the permit writer should consider using a practical quantitation level or minimum level as the ~~effective limit~~ compliance level until such time as analytical methods are approved that are capable of measuring down to the potential effluent limits. The IPDES *User's Guide to Permitting and Compliance Volume 1* (DEQ 2016a) explains this scenario in detail in sections 12.3.2 (Sufficiently Sensitive Methods) and 12.4 (Compliance with WQBELs below MDL or ML).

~~5 Monte Carlo~~

~~The permit writer may refer to the Technical Support Document (TSD) (EPA 1991) for instructions regarding the use of probabilistic methods, including Monte Carlo. The standard mass balance steady-state equation can result in a single, worst-case concentration based on critical conditions that are unlikely to coincidentally occur. An alternative to the steady-state method is dynamic simulation using probabilistic techniques as outlined in the 1991 TSD. As described in the 1991 TSD (p. 98), probabilistic models "…use estimates of effluent variability and the variability of receiving water assimilation factors to develop effluent requirements in terms of concentration and variability..." and "…account for the daily variations of and relationships between flow, effluent, and environmental conditions and therefore directly determines the actual probability that a water quality standards exceedance will occur."~~

~~Monte Carlo "is a stochastic modeling technique that involves the random selection of sets of input data for use in a repetitive model in order to predict the probability distributions of receiving water quality" (EPA 1991). It is a method for using the full probability distributions for each of the parameters in the mass balance approach to develop effluent limits. The general underlying assumptions to be met under the probabilistic approaches are those of general statistical analysis. Since the Monte Carlo analysis uses a statistical distribution, the data used to~~

~~develop that distribution must be representative of a range of conditions corresponding to the period of the water quality criteria.~~

~~This probabilistic method usually requires considerably more data than is typically required by a NPDES permit application. Additionally, the data collection should occur during a period with conditions representative of those anticipated during the future. If the data are from periods of significant hydrological modification, long-term changes due to technology-based treatment, or periodic changes due to industrial or municipal plant closings or expansions, the data may not be representative. If the data are not of sufficient size or quality to use Monte Carlo, then additional monitoring during the next permit will be necessary in order to use Monte Carlo in the development of future permit renewals. Since at most only a few parameters are likely to have a monitoring record with sufficient number of data points to represent conditions, the burden on the permit writer is not anticipated to be significant. However, not having enough data to use Monte Carlo does not preclude the permit writer from developing an effluent limit if reasonable potential exists using the basic steady state model.~~

~~The EPA suggests a tiered method for determining when the Monte Carlo analysis is value-adding. The permit writer would begin with a simple screening level model (RPTE) and progress to more sophisticated and realistic models based on the findings. If the conservative RPTE produces a reasonable limit, a Monte Carlo analysis might not be necessary. However, if the conservative method produces limits that are technically or financially infeasible, the Monte Carlo method could be used for comparison and to produce more practicable permit limits while still protecting the water body (EPA 1997). When the permit writer develops the distributions, the results should be compared to the data used in the RPTE analysis to confirm that the data aligns and the Monte Carlo analysis is appropriately defining the risks.~~

~~The permittee should be cautioned that the Monte Carlo method does not guarantee different discharge limits. However, since the RPTE provides a conservative comparison as a check point, the permit writer has an indicator of potential errors, issues, or nuances with the analysis.~~

~~The historical usage of Monte Carlo for assessing permissible discharges is largely unknown. The usage may only be documented in permit fact sheets, which are difficult to search, but also are not permanent and are lost with each renewal of the permit.~~

~~One application of a Monte Carlo simulation is to use the effluent and receiving water flow and concentration data and calculate the probability distribution for the downstream mixed conditions. Receiving water and effluent data must cover the appropriate timeframes and conditions. For example, growing communities should include last the 2 or 3 years of effluent flow data to better reflect the future condition. Similarly, receiving water flow data should avoid skewing the distribution resulting from major (e.g., 1 in 500 year) flow events.~~

~~With this Monte Carlo analysis, the permit writer can test multiple combinations of parameter values based on statistical distributions. A hypothetical example of the defining values for probability distributions of the receiving water and effluent parameters are shown in Table 1 (*Data presented in Appendix XYZ to be provided by AIC*).~~

~~Table 1. Hypothetical example of probability distributions for receiving water and effluent.~~

~~Parameter~~	~~Mean~~	~~Standard Deviation~~	~~Minimum~~	~~Maximum~~
~~Receiving water flow (cfs)~~	~~1,183~~	~~1,663~~	~~86~~	~~9,560~~
~~Receiving water constituent (mg/L)~~	~~0.029~~	~~0.018~~	~~0.010~~	~~0.090~~
~~Effluent flow (cfs)~~	~~8.33~~	~~0.94~~	~~5.06~~	~~12.92~~
~~Effluent constituent (mg/L)~~	~~0.11~~	~~0.17~~	~~0.01~~	~~2.00~~

~~This example pertains to the application of Monte Carlo simulation to a nutrient such as phosphorus. The probability distributions are used within a model that performs Monte Carlo simulations to determine the effluent concentration for a range of downstream concentrations. Table 2 shows that if the receiving water target of 0.07 mg/L is required to be satisfied on a 95th percentile basis, then the effluent concentration can average 0.42 mg/L. Table 2 also shows that if the effluent is required to be the same concentration as the in-stream target at the end-of-pipe, then the resulting downstream concentration will be much lower than the criteria the vast majority of the time. That is, the median (50th percentile) downstream concentration will be 0.026 mg/L, whereas the 95th percentile downstream concentration will be 0.061 mg/L.~~

~~Table 2. Hypothetical example summary statistics from Monte Carlo simulation of downstream concentrations resulting from alternative effluent phosphorus levels.~~

~~Effluent Characteristics~~	~~Resulting Downstream Concentration (mg/L)~~	
	~~50%~~	~~95%~~
~~Mean 3.3 mg/L, Standard Deviation 0.17 mg/L~~	~~0.070 mg/L~~	~~0.204 mg/L~~
~~Mean 0.42 mg/L, Standard Deviation 0.17 mg/L~~	~~0.033 mg/L~~	~~0.070 mg/L~~
~~Mean 0.07 mg/L, Standard Deviation 0.17 mg/L~~	~~0.026 mg/L~~	~~0.061 mg/L~~

~~The resulting statistics of the Monte Carlo simulation can then be used to develop the permit limits. For non-toxic parameters, such as phosphorus used in this example, the permit writer will need to select the seasonality of the loading for effluent limits. One possibility could be a March through October seasonal average limit of 29.2 lbs/day (0.42 mg/L x 8.33 cfs x 8.34).~~

~~Another Monte Carlo simulation example is to use a mass balance model to calculate downstream concentrations of a toxic substance (i.e., zinc) and a parameter that affects toxicity (i.e., hardness) based on randomly simulated inputs per each repetitive calculation. Each variable (effluent and river flow, and effluent and river hardness and zinc concentrations) was simulated on a daily basis by randomly generating data based on the mean and standard deviation of each using a log-normal distribution using the program @Risk (Palisades Corp.) (Table 3;~~ ~~*Data presented in Appendix XYZ to be provided by AIC*~~~~). The mean and standard deviation of each parameter were selected to approximate the same hypothetical data set used for the steady-state analyses. This random simulation for each parameter for each day was done for a 21-year period (7,663 daily values).~~

~~Table 3. Hypothetical example summary of statistical characteristics of the Monte Carlo-simulated data where these values were used as inputs to steady-state methods.~~

	~~1Q10~~	~~7Q10~~	~~Mean~~	~~Standard Deviation~~	~~5th~~	~~95th~~	~~Geometric Mean~~
~~River flow, cfs~~	~~138~~	~~258~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~River zinc, µg/L~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~5.3~~	~~2.2~~
~~River hardness mg/L~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~41~~	~~NA~~	~~59~~
~~Effluent. flow, mgd~~	~~NA~~	~~NA~~	~~20 design~~ ~~14.5 daily~~ ~~13.8 weekly~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Effluent zinc, µg/L~~	~~NA~~	~~NA~~	~~15.8~~	~~6.9~~	~~NA~~	~~28.8~~	~~NA~~
~~Effluent hardness, mg/L~~	~~NA~~	~~NA~~	~~111~~	~~NA~~	~~87~~	~~NA~~	~~111~~

~~*For purposes of this example, NA means not available or not calculated.~~

~~This process was repeated using successively different long term average (LTA) effluent zinc concentrations until the model shows compliance with the water quality criteria for zinc. This is done separately for both acute and chronic criteria. The allowable frequency of excursion above the standard was once in 3 years (1 per 1095 days) as recommended in the TSD and included in Idaho water quality standards. The effluent LTA needed to protect for acute and chronic toxicity (LTAa and LTAc) obtained from the model outputs are used to calculate the Maximum Daily Limits and Average Monthly Limits (MDLa, MDLc AMLa, AMLc) using the TSD method. Note that the iterated LTAa and LTAc turned out to be 13.2 and 14.0 µg/L, respectively, for this Monte Carlo simulation, about a 9% reduction in the LTA compared to the originally simulated effluent dataset.~~

~~Table 4 summarizes the outcome of the Monte Carlo simulation compared to a steady-state method. For this particular dataset, the Monte Carlo approach resulted in protective but less restrictive limits. For a WQBEL that is being established for the first time for a given parameter in a given permit, the more technically sound approach with Monte Carlo is a straightforward application. To modify existing WQBELs in a reissued or modified permit, the permit writer must also ensure that anti-backsliding procedures are followed per Section 5.7.7 of the TSD.~~

~~Table 4. Hypothetical comparison of Monte Carlo and steady-state methods.~~

	~~Monte Carlo Method~~		~~Steady-State Method~~	
~~Effluent Limit~~	~~Once per month sampling frequency~~	~~Four times per month sampling frequency~~	~~Once per month sampling frequency~~	~~Four times per month sampling frequency~~
~~Max. daily limit, µg/L~~	~~36~~	~~36~~	~~17~~	~~17~~
~~Average monthly limit, µg/L~~	~~33~~	~~24~~	~~13~~	~~10~~

~~*Note*: Steady-state method assumed 95th-percentile zinc and 5th-percentile hardness concentrations in the upstream receiving water.~~

~~Another application of Monte Carlo simulation is for ammonia WQBELs in relation to toxicity to aquatic life. Ammonia toxicity is related to pH, temperature, and ammonia values in both the receiving water and effluent. This may also be the case for Biotic Ligand Model (BLM) criteria,~~

~~such as copper, that are related to an even larger number of environmental parameters in the effluent and receiving water (dissolved organic carbon, pH, temperature, anions, cations, etc.).~~

5 Water Quality Trading

State water quality trading guidance for Idaho (DEQ 2016b) outlines some of the details required for water quality trading. However, this guidance does not provide sufficient detail to a permit writer on how to incorporate water quality trading into permits. Rather, more detailed trading specifics must be identified in a DEQ-approved trading framework as outlined in the water quality trading guidance (DEQ 2016b). The permit writer may then outline in the permit, specific trading compliance requirements for the permittee and trading entities. Such trading language may be inserted under the permit conditions, special considerations, and/or compliance schedule sections. The permit may reference other documents and agreements between entities, such as point and non-point source relationships with the required accounting and banking of credits; however, the permit writer has the flexibility to outline the details on the specific trade within individual permits.

Key topics that may need to be addressed in a permit include:

- Compliance plans
- Schedules of compliance
- Credit project plans
- Trading ratios
- Special conditions such as authorized activities, trading limitations, monitoring, and reporting

As nonpoint sources are not always regulated or monitored any point/nonpoint source water quality trading might require provisions in the permit for third party monitoring and reporting on nonpoint source projects used for permit compliance (DEQ 2016b).

TMDLs typically provide the basis for water quality trading by setting a cap on a specific pollutant and developing waste load allocations (WLAs). If a TMDL is not in place, a similar analysis of pollutant loading is required for DEQ review, approval, and public comment. Nutrients, temperature, and suspended solids may be considered for trading. DEQ does not anticipate trades involving bacteria and bioaccumulative toxics.

~~5.1 Water Quality Trading Example~~

As an example, the State of Virginia allows a permittee to operate under an umbrella permit for total nitrogen and total phosphorus discharges and trading, while maintaining individual permits referencing the watershed permit for total nitrogen and total phosphorus discharges and nutrient trading. This allows for limited text in individual permits (VAC 2018). Every facility owner is required to submit annual compliance plan updates to DEQ, either individually or cooperatively, through the Virginia Nutrient Credit Exchange Association. These updates outline capital improvements and implementation schedules to achieve nitrogen and phosphorus reductions to comply with individual and combined WLAs. DEQ requires each permittee to maintain annual trading ledgers that are compiled for each basin (Exchange 2017). These trading ledgers provide the delivered WLA for all participants and the declared load, or the maximum delivered load that a facility can discharge and still meet its commitments to either supply or purchase credits. For a credit seller, the declared load is the delivered WLA minus the credits supplied. For a credit buyer, the declared load is the delivered WLA plus the credits purchased (Exchange 2017). The expected load is also provided which is a forecast of the aggregate load of all participating facilities, neglecting the credit exchange, and thereby provides a more comprehensive depiction of the nutrient reduction trends in the basin as a whole.

6 Offsets

A water quality offset occurs when a permittee implements or finances the implementation of controls for point and/or nonpoint sources to reduce the levels of a parameter discharged by the permittee to provide capacity equivalent to, or greater than the discharge parameter (WAC 2018). The purpose of a water quality offset is to sufficiently reduce the discharge of the parameter to levels in a water body so that the applicant's actions do not cause or contribute to a violation and so that they result in a net environmental benefit. A single entity may offset a discharge through actions alternative to traditional treatment to achieve greater results.

6.1 Permit Examples

Examples of offsets in Idaho and other states where it has been implemented include the following.

The 2012 NPDES permit for the West Boise Wastewater Treatment Facility (ID-002398-1) included an offset. This offset was an off-site treatment project called the Dixie Drain offset. The permit language included: “The permittee may meet the final effluent limits for total phosphorus through a combination of removal of total phosphorus at the West Boise Wastewater Treatment Facility and from the Dixie Drain at the Dixie Drain Treatment Facility” (EPA 2012).

The 2011 NPDES permit for the Spokane County Regional Water Reclamation Facility (WA-0093317) included an offset. The permit language included “the Permittee may use the “offset” total phosphorus from septic tank eliminations identified in the approved wastewater facilities plan as amended in November 2011, to offset the dissolved oxygen depleting value of CBOD5, total ammonia, or total phosphorus up to the value of the total phosphorus used in the approved offset scenario submitted to and approved by Ecology” (Ecology 2011). Spokane County had provided sewer service to areas using septic systems. These septic systems were contributing a load of total phosphorus to the Spokane River. By treating and reducing this load, Spokane County earned a reduction credit that was then used to offset loads from the water reclamation facility during its initial permit.

The City of Twin Falls has been allocated a WLA for TSS in the 2000 EPA-approved Upper Snake Rock Subbasin TMDL. The city in cooperation with DEQ proposed allocating a portion of the nonpoint source sediment load allocation to the city as a WLA. In return the city would agree to implement nonpoint source reduction programs. Specifically, the city will focus on two projects that will construct wetlands where agricultural return drains discharge into the Middle Snake River. The wetlands filter out a sufficient quantity of sediment to offset the additional amount the point source discharges. Additionally, the wetlands provide treatment such as pathogen and nutrient reduction. This project demonstrates how offset projects can be developed to reduce the financial burden on the permittee while reducing the overall pollutant load entering the receiving water.

The 2013 permit for the City of Santa Rosa incorporates a nutrient offset program via resolution and attachments to the permit (CA 2013). The city conducts stream stabilization projects, and works with farmers to reduce non-point source loads in to the system. The permit language includes “If the mass discharged is greater than the mass controlled, then the Permittee may use nutrient offset credits generated via the Regional Water Board Resolution No. R1-2008-0061 approving the Santa Rose Nutrient Offset Program (Attachment H)” (CA 2013). The permittees calculate the loads controlled and discharged to achieve a combined limit through the use of the offsets.

6.2 Offset Requests

Requests for offsets must be submitted by the permit applicant since these are usually unique projects undertaken by the permittee. DEQ will review and approve the technical analysis demonstrating the equivalency in the requested pollutant offset. DEQ will need to develop unique permit language to include within the permit to address the offset.

The most likely constraint to developing an offset is opportunities within the same watershed, water body, and discharge entity. The further the facilities are apart the more challenging it will be to demonstrate equivalency. For example, a company with two industrial facilities in nearby but different watersheds will be unlikely to demonstrate equivalency. However, if the two facilities are near the downstream end of a watershed and the receiving waters converge into the same downstream waterbody; the possibility exists to demonstrate equivalency.

7 Bubble/Watershed Permitting

Watershed-based NPDES permitting is a process that addresses a variety of related water quality stressors within a hydrologic drainage basin, rather than individually addressing pollutant sources. Watershed-based permitting can encompass a variety of activities such as synchronizing permits within a basin; utilizing water quality-based effluent limits from multiple discharger modeling and analysis (e.g., TMDLs); or apportioning a total (“bubble”) load among multiple facilities to foster intra-municipal trading (see section 5, Water Quality Trading). The ultimate goal of watershed permitting is to develop and issue NPDES permits that better protect entire watersheds (EPA, 2014).

Suitable applications for watershed permitting may exist in a number of Idaho watersheds and provide advantages over the preparation and renewal of individual permits. In most cases, the goal of watershed permitting is to facilitate the implementation of TMDLs, water quality trading, adaptive management, surface water monitoring strategies, source water protection, or other programs (WDNR 2014). Watershed permitting provides flexibility in compliance and implementation efforts while applying creative approaches that meet entire watershed goals. Opportunities for collaboration and optimization of management efforts can be supported with watershed permitting for individual entities interested in shared responsibility for watershed-based bubble limits.

7.1 Implementation

The initiation of a bubble or watershed permit would generally be at the request of an applicant or group of applicants. An applicant with multiple facilities discharging to the same water body may request a bubble permit. Two or more applicants discharging to the same water body may agree to work together to use their facilities to meet a single watershed permit. The applicants will need to demonstrate to DEQ that such a request is technically and operationally feasible.

A potential Idaho example is dischargers to the Boise River. The City of Boise could request a "mini" bubble permit that incorporates all three of their permitted facilities. For parameters with some allowable flexibility, the effluent limits tables could include protective maximums for each facility, but also a combined maximum that would allow the City to vary discharges from the facilities. The combined permit would maintain the individual facility effluent limits for parameters such as acute toxics.

Bubble or watershed permits benefit DEQ by reducing the total number of permits and creating coordinated efforts in the protection of water bodies as a whole and benefits applicants by providing additional flexibility in operations. The advantages of considering the entire water body aligns with other DEQ programs such as TMDLs. Merging permits together when appropriate supports this concept rather than evaluating a single point source discharge. However, the effluent limits will be more complex and require additional technical analysis by the applicant and DEQ. Therefore, the applicant will need to submit technical evidence supporting proposed combined effluent limits for DEQ's review and approval. An example method of the technical analysis is the use of a water quality model and/or other tools as used for setting the TMDL that are simulated with the proposed alternative conditions.

7.2 EPA Policy

EPA has published a significant amount of information about the watershed approach to permitting (e.g. EPA, 1996; EPA, 2003a; EPA, 2007). EPA released four policy statements regarding watershed-based NPDES permitting during the 2002 to 2003 period.

- *Committing EPA's Water Program to Advancing the Watershed Approach*—a memo in appendix A of EPA's *Watershed-Based NPDES Permitting Implementation Guidance* (EPA 2003b) discussed that although the watershed approach had been embraced by EPA for nearly a decade, substantial gaps in actual implementation existed. It also requested efforts to develop and issue NPDES permits on a watershed basis be accelerated.
- *Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Policy Statement* (Mehan 2003a) emphasized that the memorandum recommendations are not binding and do not substitute for provisions or regulations.
- *Watershed-Based NPDES Permitting: Rethinking Permitting as Usual* (EPA 2003) is a summary fact sheet describing the process and differs from the memoranda because specific nutrient case studies are mentioned.

- *Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance* (Mehan 2003b) provided implementation guidance as an attachment, focusing on program implementation, but not technical, procedural, or administrative actions related to permit issuance.

The four documents from EPA on watershed permitting lay the foundation for a watershed framework for NPDES permitting, but provide flexibility for state permit writers by not dictating a "one size fits all" type of framework. Watershed goals are often mentioned, implying that TMDLs and/or water quality standards are necessary. This suggests that a given state has developed nutrient TMDLs and/or water quality standards that result in the need for nutrient discharge permitting in a given watershed.

7.3 Case Study Watershed Permitting Examples

EPA has provided several examples of watershed-based NPDES permitting (EPA, 2014). Nationwide, there are a number of widely recognized receiving waters where watershed permitting has been applied in creative ways that may illustrate potentially applicable approaches for consideration in Idaho. Case study examples of watershed permitting for nutrients that highlight some key features are summarized in the following sections for these watersheds:

- Tualatin River, Oregon
- Jamaica Bay, New York
- Chesapeake Bay, Virginia
- Las Vegas Wash, Nevada
- San Francisco Bay, California
- Mississippi River-Lake Pepin, Minnesota

The discussions presented in the following sections highlight both the unique nature of watershed permitting as it is applied to individual watersheds, as well as some similarities in characteristics. It is clear that watershed permitting has been an attractive approach to stakeholders in many diverse watersheds across the country. The discussions that follow highlight the broader watershed considerations. The details of the resulting individual permit structures can be found in the permits themselves (see Reference list), and in other reports (Clark, 2016).

7.3.1 Tualatin River, Oregon

Clean Water Services of Washington County operates four treatment plants in the suburban Portland, Oregon area with innovative discharge permits. In 1988, Total Maximum Daily Loads (TMDLs) were established for ammonia and total phosphorus to address low dissolved oxygen (DO) and high pH levels in the Tualatin River, a sub-basin of the Willamette River in Oregon. The TMDLs were updated in 2001 and expanded to include new parameters (water temperature, bacteria, and dissolved oxygen in tributaries).

In the late 1990s and early 2000s, several individual NPDES permits were expiring, allowing a unique opportunity for the Oregon Department of Environmental Quality (ODEQ) to consolidate Clean Water Services'(CWS) permits for 4 wastewater facilities and their storm water discharges with the Municipal Separate Storm Sewer System (MS4) permit into a single watershed NPDES permit (ODEQ, 2004). Oregon DEQ issued a single, watershed-based, integrated NPDES permit to CWS. This permit incorporated the NPDES requirements for four advanced wastewater treatment facilities, one municipal separate storm sewage system (MS4) permit and individual storm water permits for the Durham and Rock Creek Advanced Wastewater Treatment Facilities.

In 2012, a revised TMDL to address dissolved oxygen and phosphorus also included the creation of a new phosphorus trading program (ODEQ, 2012). Phosphorus wasteload allocations (WLAs) for the treatment facilities were revised, and trading of phosphorus load among the facilities was implemented under the watershed permit reissued in April 2016. The 2012 TMDL update provided a bubble allocation for the Forest Grove, Hillsboro, and Rock Creek facilities, which placed a ceiling on the combined allowable discharge load from the three facilities. The bubble allocation provides CWS with the flexibility to adopt innovative treatment at one or more, of the upstream treatment facilities (Forest Grove and Hillsboro), knowing that minor variations in phosphorus treatment at the upstream facilities can be offset by proven advanced treatment technology already in place at the downstream facility (Rock Creek) (ODEQ, 2012). While the Forest Grove and Hillsboro facilities were online at the time of the 2001 TMDL, they had not been discharging during the summer months. Instead, during the summer, raw wastewater from these treatment facilities was conveyed to the Rock Creek facility. As the population in the Tualatin Basin increases, CWS proposes (ODEQ, 2012) to increase treatment capacity by maintaining the current capacity at its Rock Creek and Durham facilities, and by commencing summertime discharges at its Forest Grove and Hillsboro facilities (along with proposed plant upgrades to reduce nutrients prior to summer discharge). The Rock Creek and Durham facilities will increase capacity as needed once Forest Grove and Hillsboro are operating at full capacity during the summer.

For the initial implementation of the 2012 TMDL, CWS has elected to apply the bubble concept to the Forest Grove and Rock Creek facilities. In addition, CWS has recently implemented a Natural Treatment System at the Forest Grove facility to provide additional tertiary treatment and other environmental benefits for the watershed.

This type of trading, also called intra-municipal trading, allows CWS to manage multiple discharges as a system, apportioning a total load among multiple facilities. In this case, DEQ had already issued a watershed permit that includes all four discharges under a single permit order. In this example a permit writer can observe how to incorporate intra-municipal trading into watershed permits for facilities that have a nutrient WLA as a bubble load in the TMDL. One requirement for this type of trade is a demonstration that localized impacts are not expected at any of the discharge locations (ODEQ, 2012). This was demonstrated by extensive water quality modeling and assessment for the 2012 TMDL and 2016 permit reissuance.

The phosphorus bubble limits in the 2016 permit are shown Table 5 (note: Outfall D001 is Durham, R001 is Rock Creek, and F001A is the Forest Grove facility):

Table 5. Phosphorous limits in Clean Water Services Watershed Permit (ODEQ 2016).

Table A7: Phosphorus Limitations

Outfall Number	Parameter	Monthly Median Limit	Seasonal Median Limit	Applicable Time Period
D001	Total Phosphorus	0.11 mg/L	Not Applicable	May 1 – October 15**
R001	Total Phosphorus	0.10 mg/L	Not Applicable	May 1 – September 30**
F001A	Total Phosphorus	81.6 lbs/day – (calculated monthly median total phosphorus mass load from R001 [lbs/day])*	66.1 lbs/day – (calculated seasonal median total phosphorus mass load from R001 [lbs/day])*	May 1 – September 30**

* Phosphorous limitations for F001A based upon Table 2-13 in Chapter 2 of 2012 Tualatin TMDL. The monthly median limit at F001A will be calculated as follows: [Monthly median load (81.6 pounds per day) - ((Monthly median Rock Creek discharge concentration of total P mg/L) × (Actual monthly median Rock Creek effluent volume MGD) × (8.34 conversion factor))]. The seasonal median limit at F001A will be calculated as follows: [Seasonal median load (66.1 pounds per day) - ((Seasonal median Rock Creek discharge concentration of total P mg/L) × (Actual seasonal median Rock Creek effluent volume MGD) × (8.34 conversion factor))].

** Phosphorus limitations do not apply after September 15th provided diversions to Lake Oswego have ceased and the 7-day-average river flow at the Farmington Gauge is ≥ 130 cfs.

7.3.2 Jamaica Bay, New York

Jamaica Bay is located at the southern end of Brooklyn and Queens, and abuts the JFK airport. The Bay has experienced dissolved oxygen water quality standard violations associated with ongoing hypoxia issues. The primary driver of the hypoxia is nitrogen input from the watershed. Four major New York City wastewater treatment plants discharge into Jamaica Bay (Coney Island, Jamaica, Rockaway, and 26th Ward). To address the hypoxia issue, the four treatment plants are subject to a total nitrogen limit that is imposed through the First Amended Nitrogen Consent Judgment (NYSC, 2011). The limit is an aggregate 12 month rolling average mass limit, with incremental total nitrogen limits to be implemented as performance-based limits following completion of treatment plant upgrades which provide biological nitrogen removal (Table 6). The performance-based total nitrogen limits incrementally step down in phases 19 months after commencement of operations of the upgraded facilities. The schedule for wastewater treatment plant upgrades is outlined in a compliance schedule (NYSC, 2011), which anticipates completion of upgrades for the Jamaica and 26th plants by 2016, and completion of upgrades for the Rockaway and Coney Island plants by 2020.

Table 6. Total nitrogen interim effluent limits for Jamaica Bay (NYDEC 2013).

Effective Date	Jamaica Bay Limits[a]
November 1, 2009	41,600 lbs/day
January 1, 2012 (19 months after commencement of operation of the Level 2 upgrade at the 26th Ward WWTP on June 1, 2010).	36,500 lbs/day
19 months after commencement of operation of the interim chemical addition facility for AT#3 at the 26th Ward WWTP.	Performance-Based Limit.
19 months after the last of commencement of: (a) the Level 3 BNR upgrades at the 26th Ward WWTP, or (b) the Level 2 BNR upgrades at the Jamaica WWTP.	Performance-Based Limit.
19 months after the last of: (a) construction completion of the Level 1 BNR upgrade at Coney Island WWTP; or (b) construction completion of the Level 1 BNR upgrade at the Rockaway WWTP.	Performance-Based Limit.

a. These interim limits are step-down aggregate limits for all four Jamaica Bay WWTPs, expressed as a 12-month rolling average.

A final aggregate nitrogen limit of 7,400 lbs/day was established for the four Jamaica Bay treatment plants (NYDEC, 2013). A comprehensive report (NYC DEP, 2006) determined that the nitrogen discharges from the four treatment plants would have to be equal, or close to zero, in order to attain water quality standards for dissolved oxygen. The aggregate limit was calculated from the current limit of technology for nitrogen treatment which reflects a concentration of 3.0 mg/L and a projected flow of 296 mgd for the four Jamaica Bay plants in 2045. Therefore, the four plants have one combined nitrogen limit. The report was approved by the NYC DEC and the projected 2045 flows were used in additional modeling efforts for projected performance to include impacts from population increases.

7.3.3 Chesapeake Bay, Virginia

In 2000, the states in the Chesapeake Bay watershed signed an agreement to reduce nitrogen and phosphorus loads into the Bay (CBP, 2000), with WLAs assigned to major river basins in each state. The Virginia DEQ developed strategies for each of its tributaries entering the Bay (Eastern Shore, Potomac, Rappahannock, York, and James), assigning nutrient load allocations to both point and nonpoint sources. A watershed based general permit was developed to encompass 125 dischargers in 2006 (EPA, 2007; VA, 2014), as well as a nutrient trading program.

A “delivery factor” has been assigned to each of the dischargers to address each facility’s distance to the water body of concern and the fate of the pollutant on its way there. For a given facility, different delivery factors are assigned for total nitrogen and total phosphorus. To date, all five river basins have met their WLAs assigned in the general permit for total nitrogen, total phosphorus, as well as total suspended solids. It is anticipated that the existing general permit will be extended.

Dischargers have two basic options for compliance, either directly meet their annual WLA for nitrogen and phosphorus in their discharge, or obtain nitrogen and phosphorus credits to offset nitrogen and phosphorus loads exceeding their WLAs. Effluent limits in the permit are set as annual WLAs (i.e., lbs/yr of total nitrogen and total phosphorus). Concentration limits typically are included in individual VPDES permits when the treatment plant has received state Water

Quality Improvement fund grants or revolving load funds to construction nutrient removal upgrades. The concentration limits are set as annual average (mg/l) limits and are technology-based and depend upon what the wastewater utility indicates to the state that the treatment process is designed to achieve. The technology-based concentration limits are used to ensure that the facility is operating the nutrient removal process as intended. Since most discharge flows are below the plant design flow (upon which the WLA is based), concentration-based limits also help ensure that dischargers are able to generate nitrogen and phosphorus credits for trading.

In 2010, the EPA finalized the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment (EPA, 2010). As part of compliance requirements, each state in the watershed is required to develop Phase I and Phase II Watershed Implementation Plans (WIPs), which contain details on how each state intends to implement TMDL provisions in their own permitting programs and consider trading and other strategies. For example, the Virginia Phase I WIP (VA, 2010) included creation of a watershed cap on nutrient loads from significant point source dischargers. The Virginia Phase II WIP (VA, 2012) focuses primarily on agricultural, storm water, and septic issues, but also reports on the expansion of the nutrient credit trading program. Regarding wastewater, the Phase II WIP provides some technical changes to Phase I WIP strategies and presents an updated approach for permitting of combined sewer overflows (CSOs).

7.3.4 Las Vegas Wash, Nevada

Wastewater facilities serving City of Las Vegas, Clark County Water Reclamation District, and the City of Henderson discharge into the Las Vegas Wash, which ultimately flows into Lake Mead and the Colorado River. TMDLs were developed for total ammonia as nitrogen and phosphorus in 1989. Seasonal phosphorus and ammonia limits apply to the dischargers and mass load allocations to the Las Vegas Wash are shared between three wastewater utilities. The dischargers were assigned individual WLAs and a cumulative total loading, as shown in Table 7.

Table 7. Las Vegas Wash wasteload allocations for phosphorus and ammonia.

Constituent	City of Las Vegas IWLA	Clark County Sanitation District IWLA	City of Henderson IWLA	Sum of Waste Load Allocations ΣWLA
Total Phosphorus	123 lb/day	173 lb/day	38 lb/day	334 lb/day Note: This WLA only applies March 1 - October 31; no limit applies the rest of the year. Non-point source load is 100 lb/day.
Total Ammonia	358 lb/day	502 lb/day	110 lb/day	970 lb/day Note: This WLA only applies April 1 - September 30; no limit applies the rest of the year. No non-point source load.

Note: IWLA = Individual Waste Load Allocation

The associated NPDES permits include language which allows allocation trading between the dischargers. This permit condition constitutes a cooperative agreement between the utilities to allow discharge flexibility. Each facility has an Individual Waste Load Allocation (IWLA) and there is a Sum of Waste Load Allocations (∑WLA) defined for all three of the facilities.

Annually, the dischargers may modify their individual allocations by transferring or receiving loadings from another discharger. The annual re-allocation must be documented and signed by all three dischargers and is to be submitted to the state May 31st. The notification is required to include the flow, waste load discharged, and treatment plant removal efficiency. An annual re-allocation is considered a minor modification to the permit as long as the cumulative total load allocation is not changed.

Temporary trading of loadings is allowed and is again required to be documented in writing and signed by all three dischargers. The documentation must include the amount of the individual load allocation transferred, the length of time the transfer is effective, and the basis for the transfer to identify the last monthly flows and waste load discharged for each discharger. Transfers are binding on the parties and cannot be revoked without a notification signed by all three dischargers. The transferred load reverts back to the original applicant at the end of the specified time.

7.3.5 San Francisco Bay, California

The San Francisco Bay estuary has long been known to be nutrient-enriched. Despite this, the abundance of phytoplankton in the estuary is lower than would be expected due to a number of factors, including strong tidal mixing; high turbidity, which limits light penetration; and high filtration by clams. The estuary ecosystem is quite complex, with food web components being influenced by both anthropogenic and natural drivers over decadal time scales (Cloern and Jassby, 2012). While nutrient discharges to the San Francisco Bay have not yet resulted in impairment problems (e.g., excessive algal growth), recent studies have shown that the Bay's historic resilience to nutrient loading may be weakening. As a result, nutrients are a growing concern for the health of the ecosystem.

Since 2006, the California State Water Resources Control Board (SWRCB) and the San Francisco Bay Regional Water Quality Control Board (SFRWQCB) have been facilitating development of Nutrient Numeric Endpoints (NNEs) for the Bay. Additional activities include examination of nutrient management strategies (SFRWQCB, 2012) and development of a nutrient assessment framework (SFRWQCB, 2013).

The Bay Area Clean Water Agencies (BACWA) is a joint powers agency formed under the California Government Code by the five largest wastewater treatment agencies in the San Francisco Bay Area (BACWA, 2014). The BACWA, SFRWQCB, and the San Francisco Estuary Institute (SFEI) have had a strong working relationship for many years. One of the initial efforts was to better understand the nutrient loadings to the Bay. SFEI compiled data which found municipal wastewater treatment plants represent about 63% of the annual nitrogen load to the Bay (SFEI, 2013). About 90% of the annual nitrogen load from municipal wastewater treatment plants is from facilities that have a permitted design flow of 10 mgd or greater.

In 2012, BACWA requested a nutrient watershed permit concept evaluation (Grovhoug et al., 2012a). The evaluation considered seven different regulatory approaches and five different overarching frameworks, along with several evaluation criteria. It was concluded that there were three best apparent alternatives for the regulatory approach to nutrient management (individual NPDES permits, nutrient watershed permit, and narrative objective implementation) and two for the overarching framework (Basin Plan Amendment and Memorandum of Agreement/

Memorandum of Understanding (MOA/MOU)). A follow-up evaluation (Grovhoug et al., 2012b) examined implementation of a narrative objective implemented in a nutrient watershed permit (i.e., regulatory approach) with an MOA/MOU and subsequent basin plan amendment (i.e., overarching framework).

BACWA then approached the SFRWQCB with a proposal for a nutrient watershed permit. Many ideas were exchanged between BACWA and the SFRWQCB regarding the content of the NPDES permit, with little involvement from the EPA. The nutrient watershed permit was signed in April 2014 (SFRWQCB, 2014) with an effective date of July 1, 2014 and an expiration date of June 30, 2019. Thirty-seven dischargers with cumulative permitted discharge capacity nearing 860 mgd are participating in this permit. The design flows and existing nutrient loadings from the five largest dischargers who are the Principal Members of BACWA out of the total group of 37 dischargers are summarized in Table 8.

Table 8. Design flows and existing nutrient loadings from principal members of Bay Area Clean Water Agencies (BACWA).

Discharger	Design Flow (mgd)	Average Annual Load (kg/day)	
		Total Nitrogen	Total Phosphorus
San Jose/Santa Clara WPCP	167	5,233	332
City and County of San Francisco (Southeast Plant)	150	8,307	101
East Bay Municipal Utility District (EBMUD)	120	10,583	973
East Bay Dischargers Authority (EBDA)	107.8	8,641	555
Central Contra Costa Sanitary District (CCCSD)	53.8	4,187	138

Special provisions of the nutrient watershed permit require that each facility conduct or support the following three main areas to address nutrient reduction and receiving water quality:

1. Evaluation of Potential Nutrient Discharge Reduction by Treatment Optimization and Side-Stream Treatment. This evaluation focuses on options and costs for nutrient discharge reduction by optimization of current treatment works and side-stream treatment opportunities.
    - Describe the treatment plant, treatment plant process, and service area.
    - Evaluate site-specific alternatives, along with associated nitrogen and phosphorus removal levels, to reduce nutrient discharges through methods such as operational adjustments to existing treatment systems, process changes, or minor upgrades.
    - Evaluate side-stream treatment opportunities along with associated nitrogen and phosphorus removal levels.
    - Describe where optimization, minor upgrades, and side-stream treatment have already been implemented.
    - Evaluate beneficial and adverse ancillary impacts associated with each optimization proposal, such as changes in the treatment plant's energy usage, greenhouse gas emissions, or sludge and biosolids treatment or disposal.
    - Identify planning level costs of each option evaluated.

- Evaluate the impact on nutrient loads due to treatment plant optimization implemented in response to other regulations or requirements.

2. Evaluation of Potential Nutrient Discharge Reduction by Treatment Upgrades or Other Means. This evaluation focuses on identification of options and costs for potential treatment upgrades for nutrient removal.

   - Identify potential upgrade technologies for each treatment plant category along with associated nitrogen and phosphorous removal levels.
   - Identify site-specific constraints or circumstances that may cause implementation challenges or eliminate any specific technologies from consideration.
   - Include planning level capital and operating cost estimates associated with the upgrades and for different levels of nutrient reduction, applying correction factors associated with site-specific challenges and constraints.
   - Describe where Dischargers have already upgraded existing treatment systems or implemented pilot studies for nutrient removal. As part of this description, document the level of nutrient removal the upgrade or pilot study is achieving for total nitrogen and phosphorus.
   - Evaluate the impact on nutrient loads due to treatment plant upgrades implemented in response to other regulations and requirements.
   - Evaluate beneficial and adverse ancillary impacts associated with each upgrade, such as changes in the treatment plant's energy use, changes in greenhouse gas emissions, changes in sludge and biosolids treatment or disposal, and reduction of other pollutants (e.g., pharmaceuticals) through advanced treatment.

   Nutrient removal by other means includes evaluation of ways to reduce nutrient loading through alternative discharge scenarios, such as water recycling or use of wetlands, in combination with, or in-lieu of, the treatment plant upgrades to achieve similar levels of nutrient load reductions.

   - Reduction in potable water use through enhanced reclamation.
   - Creation of additional wetland or upland habitat.
   - Changes in energy use, greenhouse gas emissions, sludge and biosolids quality and quantities.
   - Reduction of other pollutant discharges.
   - Impacts to existing permit requirements related to alternative discharge scenarios.
   - Implications related to discharge of brine or other side-streams associated with advanced recycling technologies.

3. Monitoring, Modeling, and Embayment Studies. This provision focuses on science plan development and implementation, as well as monitoring nutrients in receiving waters.

   - Support the science plan development and implementation.
   - Support receiving water monitoring for nutrients.

The NPDES permit allows the wastewater facilities to perform the permit tasks collectively as a group, or individually. All 37 participating facilities decided to perform the efforts collectively as a group. The first two tasks are being performed by a consulting firm team, whereby a report for each facility will be produced to address these task requirements for nutrient removal optimization and upgrade.

The third task, supporting the science plan is an on-going effort led by SFEI. The key elements that comprise the science plan are as follows:

- Monitoring special studies (e.g., algal toxin pigment studies).
- Modeling of San Francisco Bay.
- Loads analysis (e.g., moored sensors data).
- Developing a water quality assessment framework.
- The emphasis is to integrate across the plans to develop an overarching nutrient strategy framework for San Francisco Bay.

7.3.6 Mississippi River-Lake Pepin, Minnesota

The Mississippi River - Lake Pepin watershed extends over 205,747 acres and includes the metropolitan Minneapolis area. Lake Pepin is 21 miles long and is the naturally widest part of the Mississippi River bordered by the states of Minnesota and Wisconsin. Lake Pepin is impaired by high levels of nutrients that cause excessive growth of algae, as well as high levels of sediment. The Minnesota Pollution Control Agency (MPCA) prepared Lake Pepin Site Specific Eutrophication Criteria, which were adopted as part of amendments to state water quality standards and consist of the following:

- Total Phosphorus 100 ug/L
- Chlorophyll-a 28 ug/L

The Metropolitan Council Environmental Services (MCES) operates seven wastewater treatment facilities in the Minneapolis metropolitan area that discharge to the Mississippi River - Lake Pepin watershed. Over the past 15 years, MCES has made improvements to these facilities that have resulted in a dramatic reduction of effluent phosphorus loads discharged to the river. The implementation of biological phosphorus removal at the Metropolitan Wastewater Treatment Plant (Metro Plant) decreased the phosphorus effluent load by approximately 90 percent between 2000 and 2011. Metro Plant performance has been at, or below 0.6 mg/L, operating under the historical effluent discharge limit of 1 mg/L total phosphorus.

7.3.6.1 Metropolitan Council Total Phosphorus Permit

In September 2015, the MPCA issued a total phosphorus discharge permit for the 5 MCES wastewater facilities discharging to, or upstream of, the Mississippi River Pools 2, 3, and 4 and Lake Pepin. This permit defined the specific conditions to implement a combined Total Phosphorus Water Quality Based Effluent Limit (WQBEL) for the 5 wastewater facilities covered by the permit.

The Total Phosphorus Water Quality Based Effluent Limit covers the following MCES wastewater facilities: Eagles Point WWTP, Empire WWTP, Hastings WWTP, Metropolitan WWTP, and Seneca WWTP. Table 9 provides a summary of the wastewater facilities covered by the phosphorus bubble permit.

Table 9. MCES wastewater facilities covered in Mississippi River Bubble Discharge Permit for phosphorus.

Facility Name	Average Wet Weather Design Flow (mgd)	Treatment Process Description
Eagles Point	11.9	Biological Phosphorus Removal
Empire	28.6	Biological Phosphorus Removal
Hastings	2.69	Conventional Activated Sludge
Metropolitan	314	Biological Phosphorus Removal
Hastings	38	Biological Phosphorus Removal

The permit authorizes MCES to aggregate the total phosphorus limit among the 5 wastewater facilities with the total mass loading limits as shown in Table 10. The permit covers only the discharge of phosphorus. Individual permits for the five facilities address all other conditions associated with the discharges to the Mississippi River.

Table 10. MCES total phosphorus limits for five facilities[a].

Parameter	Limit	Limit Type	Effective Period	Sample Frequency
Total Phosphorus	159,349 kg/yr	12 Month Moving Total	Jan - Dec	1X Month
Total Phosphorus	916.8 kg/day	Calendar Month Average	Jan - Dec	1 X Month

a. Combined limit for 5 MCES wastewater facilities included in Mississippi River Bubble Discharge Permit for Phosphorus

7.3.6.2 Bubble Permit Appeal

In May of 2015 MPCA published a draft of the total phosphorous bubble permit for the five MCES facilities and the Minnesota Center for Environmental Advocacy (MCEA) submitted comments opposing the permit. MPCA responded to the MCEA comments and issued the permit in September 2015. MCEA petitioned to challenge the issuance of the permit. MCEA argued that the MPCA decision to issue the permit was arbitrary and capricious because the effluent limits relied on voluntary reductions in unregulated nonpoint source pollution and that the permit violated federal law by allowing discharges in excess of water quality standards.

The Minnesota Court of Appeals issued a ruling in June 2016 that affirmed the permit as issued by MPCA. The appeals court found that while MPCA must consider point and nonpoint sources of pollution in setting effluent limits, the fact that the permit by itself does not ensure meeting water quality standards does not render the permit arbitrary and capricious. Further, the appeals court found that there was substantial evidence that voluntary reductions from nonpoint source have occurred in the past and can be reasonably expected to occur in the future. A Nutrient Reduction Strategy report that found that phosphorus pollution from nonpoint sources had been reduced by 8 percent in the Mississippi River basin since 2000 was cited. The appeals court also found that since the MPCA based the phosphorus limit on long-term summer concentrations, that the intent was not to focus on a single summer, and therefore MPCA did not act arbitrarily and capriciously in issuing the permit.

8 Adaptive Management in Permits

Adaptive management is an iterative process that involves implementing certain controls to reduce pollutant loads, allowing time to evaluate the effectiveness of the controls and obtain additional information, and then using this new knowledge to guide the next implementation step. Adaptive management is a process to work towards water quality improvements by making successive improvements. It is a phased approach of monitoring water quality responses to management activities. It also allows for permit adaptability and advancement if attainment of receiving water objectives is achieved at an intermediate level. It incorporates flexibility to allow for the most significant results by providing the permittee with flexibility to employ many different approaches to achieving the desired outcome.

The relationship between nutrients in streams and aquatic life indices is not entirely linear or predictable. Therefore, permit writers may use an adaptive management approach to planning and tracking successive permit iterations towards accomplishing water quality objectives, particularly in locations with insufficient data and limited ability to modify receiving water conditions. Rather than requiring that a treatment facility comply with new effluent requirements as final limits in a single step, interim limits and a compliance schedule may provide the time needed for adaptive management to guide the approach to final compliance in a more optimal manner. A phased approached that initiates effluent discharge reductions and provides time to monitor the effectiveness of treatment and the water quality response, may then support the determination of the extent to which additional phases of improvements are necessary. Various references are available for selecting the levels of a stepped approached (EPA 2007, MDEQ 2017, WERF 2016).

When a facility discharges to a nutrient impaired water body, the permit should require monitoring of effluent nutrient discharges, as well as upstream and downstream receiving water conditions to establish a basis for assessing the influence of the discharge. These facilities must develop a study that evaluates the technical and financial capability of reducing nutrients to various levels from the facility. The study will be used to develop a plan for pollution reduction in the receiving water that will be submitted to DEQ for approval and implementation.

The permit will require receiving water to be consistently monitored and attainment of WQS to be assessed at appropriate and predetermined times. If after assessment it is determined that goals are not being attained it may require that further treatment improvements be implemented and/or the permittee may propose alternate reduction strategies to achieve future reductions. The strategies could include point source-nonpoint source trading, point source-point source trading, habitat restoration offsets, physical watershed alterations and other approved nutrient management/reduction strategies.

Adaptive management examples are found inherently in many permits, although they may not be stated as such explicitly. The term ‘adaptive management’ can be found in permits for storm water MS4 and combined permits that include municipal and storm water discharges. For example, the Clean Water Services permit in Washington County, Oregon (101141, 101142, 101143, 101144, and MS4) uses the term adaptive management.

> The permittee must follow an adaptive management approach to annually assess, and modify as necessary, existing SWMP components, and adopt new or revised SWMP components to achieve reductions in

> stormwater pollutants to the MEP, including applicable 303(d) and TMDL pollutants. The adaptive management approach must include, but is not limited to, the following...

More commonly the principles of adaptive management are incorporated in some fashion into the permit development and/or implementation such as in the following examples.

The term ‘adaptive management’ is not found in the September 30, 2014 Coeur d’Alene (ID0022853) permit, but the concept is incorporated into many aspects of the permit. The Coeur d’Alene permit incorporates adaptive management by connecting the schedules of compliance section and the interim requirements for schedules of compliance (Coeur d’Alene permit sections I.C and I.D.) The Coeur d’Alene permit uses annual compliance reports to ensure accountability for performance and to inform future decisions about the progression of subsequent treatment technology improvements.

The Coeur d’Alene NPDES permit includes a ten year compliance schedule that spans two five year permit cycles. Table 11 highlights the compliance requirements in the permit by year with comments about the decisions to be made in the course of three potential phases of improvements. The Spokane River dissolved oxygen TMDL resulted in very restrictive wasteload allocations for phosphorus, carbonaceous biochemical oxygen demand (CBOD), and ammonia nitrogen. The allocations were so challenging that treatment technology pilot studies were undertaken to determine the best approach to compliance. The permit compliance schedule provided the time necessary to scale up pilot testing results to full scale, monitoring the performance of the initial improvements, and then revised design and sizing criteria for subsequent improvement phases.

Table 11. Example compliance schedule with adaptive management features from City of Coeur d'Alene NPDES Permit.

Year	Final NPDES Permit December 1, 2014	Facilities Plan Capital Improvement Plan	Comments
1 2014 - 2015	Preliminary Engineer Report, Cost, & Schedule Submittal to EPA & IDEQ - November 30, 2015	Design and Build Phase 1 Tertiary Improvements	Revise/Improve Facility Plan to Take Advantage of 2010/12 Pilot Testing Findings; Near Term Ammonia Compliance + New BOD Limits
2 2015 - 2016	Submit Progress Reports – November 30, 2016	Complete Phase 1 Tertiary Improvements, Operate, and Gather Data	Assess Nitrifier Seeding and Tertiary Membrane Filter (TMF) Performance
3 2106 - 2017	Notify EPA & IDEQ of Pilot Testing - November 30, 2017	Performance Assessment & Design of Phase 2 Tertiary Improvements	Decisions: More TMF, MBR or Full Phase Tertiary Improvements
4 2017 - 2018	Submit Progress Reports -- November 30, 2018	Build Phase 2 Tertiary Improvements	Match Capacity to Existing Flows
5 2018 - 2019	Design Completion and Bid Award - November 30, 2019	Build Phase 2 Tertiary Improvements	Permit Expires -- November 30, 2019
6 2019 - 2020	Annual Report to EPA & IDEQ Submit Progress Reports -- November 30, 2020	Design Phase 3 Tertiary Improvements (Only if necessary based on flows and loads, or treatment performance)	Decisions: More TMF, MBR or Full Phase 1, 2 and 3 Tertiary Improvements (Full Facility Plan)
7 2020 - 2021	Annual Report to EPA & IDEQ Submit Progress Reports -- November 30, 2021	Build Phase 3 Tertiary Improvements	Triggered Based on Growth in Flows and Loads, or Treatment Performance
8 2021 - 2022	Notify EPA & IDEQ Construction Completion - November 30, 2022	Design and Build Additional Facilities for 6 mgd	Implement Final Phase 3 Tertiary Improvements
9 2022 - 2023	Submit Progress Reports -- November 30, 2023	Performance Assessment and Optimization	City Operations to Focus on Optimization for 2 Year Period Prior to Final Limits
10 2023 - 2024	Report to EPA & IDEQ on Completed Start-up and Optimization (2 Years Operating Data) - November 30, 2024	Performance Assessment and Optimization	Full Compliance Required with New NPDES Permit Limits (Ammonia & Phosphorus)

For example, the interim requirements in the permit are:

1. "The permittee must provide a preliminary engineering report to EPA and IDEQ outlining estimated costs and schedules for completing capacity expansion and implementation of technologies to achieve final effluent limitations." The facilities plan section design and build phase 5C.1 was revised and improved to take advantage of pilot testing findings.
2. "The permittee must provide written notice to EPA and DEQ that pilot testing of the technology that will be employed to achieve the final limits has been completed and must submit a summary report of results and plan for implementation." The City completes facilities plan item 5C.1 including operating and gathering data to assess nitrifier seeding and the tertiary membrane filter.

Additional reporting is required to EPA and DEQ. The City then makes a decision on adding more tertiary membrane filters, membrane bioreactors, or going to full phase. This is followed by the City ramping up the treatment abilities to match capacity to existing flows. The annual reporting continues to demonstrate advancement along the compliance schedule. The ultimate result is a process where the City was able to take incremental steps, monitor progress, and make smart decisions on how to upgrade the treatment process. This adaptive management approach will result in full compliance with new ammonia and phosphorus limits at the end of the compliance schedule.

9 Integrated Planning

In June 2012, the EPA released an Integrated Municipal Stormwater and Wastewater Planning Approach Framework (EPA 2012) to help local governments meet CWA water quality objectives and prioritize capital investments. According to the EPA (EPA 2017):

> An integrated planning approach offers a voluntary opportunity for a municipality to propose to meet multiple CWA requirements by identifying efficiencies from separate wastewater and stormwater programs and sequencing investments so that the highest priority projects come first. This approach can also lead to more sustainable and comprehensive solutions, such as green infrastructure, that improve water quality and provide multiple benefits that enhance community vitality.

In developing the framework, EPA offers communities the operating principles and elements of a plan that will justify the prioritization of local implementation actions relevant to storm and wastewater facilities. Integrated Plan components are shown in Figure 2.

The National Association of Clean Water Agencies (NACWA) described EPA's Integrated Planning Framework as "…a pragmatic yet effective path for communities to more affordably address water quality obligations." Simply put, integrated planning allows a community to prioritize its obligations so communities can spend their limited resources on the most pressing water quality challenges first. The Framework puts in place a path toward greater opportunities for innovation and strategic prioritization that can usher in a smarter way of doing business: achieving net environmental benefit outcomes that protect water quality and public health at the most efficient ratepayer cost" (NACWA 2017).

A permittee should work with DEQ before undertaking an integrated plan. Without working together, there is no guarantee that IPDES permits will be developed to facilitate the planning. A key component of integrated planning is scheduling. This scheduling must be reflected in interim effluent limits, compliance schedules, and other elements of timing within IPDES permits. A permittee must submit an integrated plan with the supporting technical analysis for review and approval by DEQ before any changes to the permits may occur. The integrated plan must demonstrate with assurances that the proposed schedule of activities can be met.

All or part of an integrated plan can be incorporated into an IPDES permit as appropriate. Limitations and considerations for incorporating integrated plans into permits include:

- Compliance schedules which incorporate integrated plan components with the most sensitive uses prioritized.
- Green infrastructure approaches and related innovative practices that provide more sustainable solutions by managing storm water as a resource should be considered and incorporated, where appropriate, where they provide more sustainable solutions for municipal wet weather control.

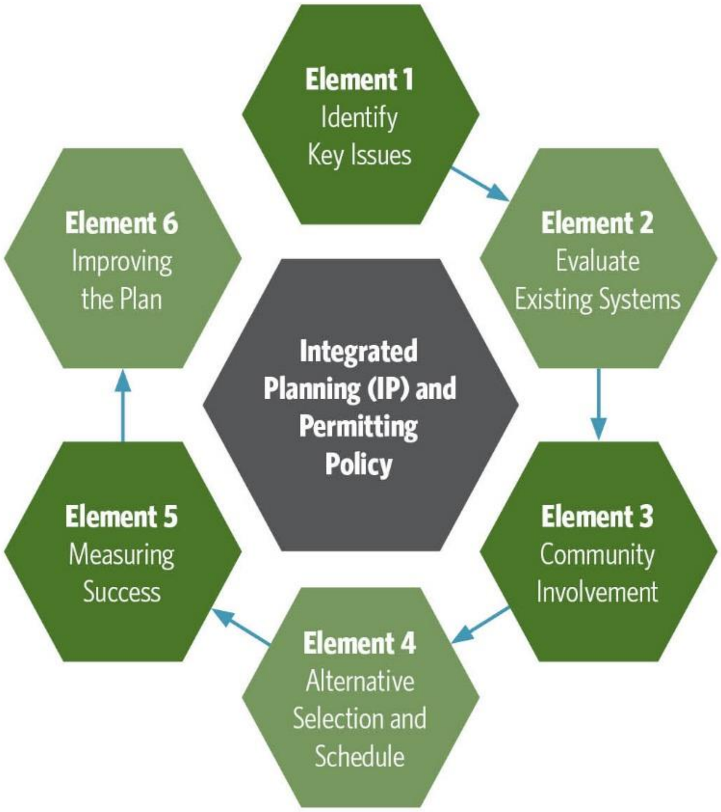

Figure 2. Integrated planning and permitting policy approach provides the flexibility to make smart decisions based on community priorities.

9.1 Connecting Elements into an Integrated Plan

Integrated planning encourages the use of sustainable and comprehensive solutions, including green infrastructure, to protect human health, improve water quality, manage storm water as a resource, and support other economic benefits and quality of life attributes that enhance the vitality of communities. Through the integrated planning process, these solutions are prioritized, taking into consideration stakeholder input and community values, the cost and benefits of water quality improvement projects, and the community's ability to afford these costs over time (HDR 2016).

Further discussion with the U.S. Conference of Mayors (USCM) regarding the EPA's use of the median household income (MHI) to assess a community's ability to afford water quality improvements led to the EPA's issuance of a January 2013 memorandum, Assessing Financial Capability for Municipal Clean Water Act Compliance that allows for a broadened scope for assessing affordability. Subsequently, in a collaborative effort with the American Water Works Association (AWWA), and the Water Environment Federation (WEF), the USCM published the Affordability Assessment Tool for Federal Water Mandates (Assessment Tool) to help further define the alternative ways affordability may be viewed in any given community (HDR 2016).

Adopting an integrated approach to CWA obligations is a voluntary and locally driven process, requiring a collaborative effort between the permitted agency, local permit authorities, the EPA, and local enforcement officials. The benefits help an applicant manage budget and schedule to reduce delays in committing to improvements that benefit the environment and water quality.

9.2 Integrated Planning and Permits in the Northwest

Integrated planning may provide the basis for a compliance schedule that reflects local priorities and affordability in ways that link the timing of technical studies and construction of infrastructure improvements in a logical and interconnected way. The order and schedule of infrastructure improvements is important because that may inform the pace at which necessary improvements can be accomplished for compliance with discharge permit requirements. In such cases, discharge permits may include a compliance schedule and interim effluent limits that characterize what needs to be attained at various stages of a program. The following are examples of applications of integrated planning in the Northwest that may influence discharge permits.

9.2.1 Seattle Public Utilities

Seattle Public Utilities (SPU) has an Integrated Plan that charts the course for investments in combined sewer overflow (CSO) and storm water projects from now until 2030. The relatively small CSO projects remaining have a high-cost per gallon to implement. The integrated plan concludes that alternate storm water projects will yield higher value in terms of pollution avoided. SPU expects to meet or exceed the integrated plan pollutant removal estimates, which were based on conservative assumptions using a Monte Carlo simulation.

SPU’s Integrated Plan proposes to delay correcting six low-frequency, low-volume CSOs for five years. In exchange, SPU will implement a near-term storm water project and two programs to remove a substantially greater pollutant load from area waters. The storm water project consists of the South Park Water Quality Facility (WQF) removing pollutants entering the Lower Duwamish from a 250-acre basin. The WQF leverages a local flood control project whose pump station will deliver storm water flows to the treatment facility. As part of the integrated plan, SPU will monitor the project to make sure project goals are met. The two programs implemented as large pollution reducers in the Integrated Plan are the Natural Drainage Solutions Program and the “Street Sweeping for Water Quality” programs. The Natural Drainage Solutions Program is a program in which the SPU partnered with the Seattle Department of Transportation (SDOT), the Office of Sustainability and Environment and community groups to develop roadside rain gardens that also serve as traffic calming facilities. This program aligns with the City’s “Green Goal” and “Neighborhood Greenways Initiative.” The successful “Street Sweeping for Water Quality” program, initiated in 2011, doubles the frequency of arterial sweeping to weekly, and extends the number of weeks of sweeping each year. A perhaps unexpected benefit is that facilities not scheduled for construction in the foreseeable future will now be implemented because of the water quality benefits they will deliver, drawing praise from the Washington Department of Ecology for innovation.

9.2.2 City of Billings

The City of Billings is facing many water management challenges. First, their discharge permit from their central wastewater treatment plant to the Yellowstone River is due for renewal, three major local industries have asked for connection to City sewer service, and multiple Total Maximum Daily Loads (TMDLs) are scheduled for development on the Yellowstone River. Second, their drinking water treatment facility is nearing capacity. Third, the City is facing new storm water quality regulations from the Montana Department of Environmental Quality (MDEQ) as part of its Phase 2 MS4 program. Rather than handle these issues independently, the City chose to look at these issues together and contemplate ways the water-related utilities could work together to meet multiple objectives through integrated planning.

The emphasis of the integrated plan was to blend the goals of the City with stakeholder input to identify potential programs and actions that provide positive enhancements to the future utility operations, as well as address present and future regulatory challenges. Six overall water management alternatives were developed and each included wastewater, drinking water, and storm water components. A stakeholder group helped develop the criteria and weighting for evaluation of alternative water management approaches. The stakeholder group included political interests (City Council, Utilities Board, and County) as well as economic interests (Chamber of Commerce, large local industries/refineries, and realtors) and members of the regulatory community (Montana Department of Environmental Quality and USEPA). The permit renewal is still under development, so incorporation of the integrated planning results into the language of the permit is yet to be determined.

References Cited

AIC. 2016. New Arsenic Criteria Expected to Impact More Than 66 Idaho Municipal NPDES Permittees. *http://idahocities.org/blogpost/1235530/259344/New-Arsenic-Criteria-Expected-to-Impact-More-Than-66-Idaho-Municipal-NPDES-Permittees*

Bay Area Clean Water Agencies (BACWA). 2014. Bay Area Clean Water Agencies Webpage. http://bacwa.org/

Boise City. 2018. 316(a) Demonstration. Boise, ID.

Boström, B., Persson, G. & Broberg, B. 1988. Bioavailability of different phosphorus forms in freshwater systems, Hydrobiologia. 170: 133

Brett, Michael T. 2015. The Bioavailable Phosphorus (BAP) Fraction in Effluent from Advanced Secondary and Tertiary Treatment. WERF NUTR1R06m

CA. 2013. Order No. R1-2013-0001 NPDES NO. CA0022764 WDID NO. 1B83099OSON Waste Discharge Requirements and Master Reclamation Permit for the City of Santa Rosa Sub-regional Water Reclamation System Sonoma County.

Clark, D.L., Dupuis, T., Falconer, H., Hatch, L., Kasch, M.S., and Neethling, J.B. 2016. “Nutrient Management Volume III: Development of Nutrient Permitting Frameworks.” WE&RF Report NUTR1R06z.

Cloern, J.E. and Jassby, A.D. 2012. Drivers of change in estuarine-coastal ecosystems: Discoveries from four decades of study in San Francisco Bay, Rev. Geophys., 50, RG4001, doi:10.1029/2012RG000397. *http://www.restorethedelta.org/wp-content/uploads/2012/11/CloernJassbyDriversofChange.pdf*

Code of Federal Regulations. 40 CFR 122.47 Schedules of Compliance.

Colorado. 2017a. Colorado Department of Public Health and Environment. Water Quality Control Commission. Regulation No. 31 The Basic Standards and Methodologies for Surface Water. 5 CCR 1002-31.

Colorado. 2017b. Colorado Department of Public Health and Environment. Water Quality Control Commission. Regulation No. 85. Nutrients Management Control Regulation. 5 CCR 1002-85.

Colorado. 2017c. Colorado Department of Public Health and Environment. Water Quality Control Commission. Policy 17-1 Voluntary Incentive Program for Early Nutrient Reductions. Regulation #85 – Section 85.5(1.5). Approved: October 10, 2017. Expires: December 31, 2020

Connecticut Department of Energy & Environmental Protection (DEEP). 2000. A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound. http://www.ct.gov/deep/lib/deep/water/lis_water_quality/nitrogen_control_program/tmdl.pdf

Connecticut Department of Energy & Environmental Protection (DEEP). 2010. General Permit for Nitrogen Discharges. *http://www.ct.gov/deep/lib/deep/water/municipal_wastewater/2011_2015_nitrogen_gp.pdf*

Connecticut Department of Energy & Environmental Protection (DEEP). 2013. Report of the Nitrogen Credit Advisory Board for Calendar Year 2012 to the Joint Standing Environment Committee of the General Assembly. *http://www.ct.gov/deep/lib/deep/water/municipal_wastewater/nitrogen_report_2012.pdf*

DEQ (Idaho Department of Environmental Quality). 2008. Mercury in Surface Water. http://www.deq.idaho.gov/water-quality/surface-water/mercury/

DEQ (Idaho Department of Environmental Quality). 2016a. *Idaho Pollutant Discharge Elimination System User's Guide to Permitting and Compliance Volume 1—General Information*. Boise, ID: DEQ. *www.deq.idaho.gov/media/60178999/ipdes-user-guide-ipdes-permitting-compliance-0816.pdf*

DEQ (Idaho Department of Environmental Quality). 2016b. Water Quality Trading Guidance. Department of Environmental Quality, State of Idaho. Boise, ID.

DEQ (Idaho Department of Environmental Quality). 2017. Idaho Pollutant Discharge Elimination System. Effluent Limit Development Guidance. State of Idaho, Department of Environmental Quality. Boise, ID.

Ecology. 2011. National Pollutant Discharge Elimination System Waste Discharge Permit No. WA-0093317. Spokane County Regional Water Reclamation Facility. Issuance Date: November 29, 2011.

EPA (US Environmental Protection Agency). 1996. EPA Watershed Approach Framework. U.S. Environmental Protection Agency, Washington, DC. *http://www.epa.gov/OWOW/watershed/framework.html*

EPA (US Environmental Protection Agency). 1997. Guiding Principles for Monte Carlo Analysis. Risk Assessment Forum Staff. *https://www.epa.gov/sites/production/files/2014-11/documents/montecar.pdf*

EPA (US Environmental Protection Agency). 2000, Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs. EPA-822-B00-001. https://nepis.epa.gov/Exe/ZyPDF.cgi/20003COV.PDF?Dockey=20003COV.PDF

EPA (US Environmental Protection Agency). 2000a. Nutrient Criteria Technical Guidance Manual: Rivers and Streams. EPA-822-B-00-002. https://nepis.epa.gov/Exe/ZyPDF.cgi/20003CVP.PDF?Dockey=20003CVP.PDF

EPA (US Environmental Protection Agency). 2003. National Water Quality Trading Policy, Office of Water. *http://water.epa.gov/type/watersheds/trading/finalpolicy2003.cfm*

EPA (US Environmental Protection Agency). 2003. Watershed-Based NPDES Permitting: Rethinking Permitting as Usual. EPA-833-F-03-004.

EPA (US Environmental Protection Agency). 2003a. Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance, EPA 833-B-03-004. *http://water.epa.gov/polwaste/npdes/basics/upload/watershedpermitting_finalguidance.pdf*

EPA (US Environmental Protection Agency). 2003b. Watershed NPDES Permitting: Rethinking Permitting as Usual, EPA-833-F-03-004. *http://water.epa.gov/polwaste/npdes/basics/upload/watershed-basedpermitting_brochure.pdf*

EPA (US Environmental Protection Agency). 2007. Advanced Wastewater Treatment to Achieve Low Concentration of Phosphorus. EPA 910-R-07-002.

EPA (US Environmental Protection Agency). 2007. Memorandum from James A. Hanlon, Director Office of Wastewater Management to Alexis Strauss, Director Water Division EPA Region 9. Compliance Schedules for Water Quality-Based Effluent Limitations in NPDES Permits. May 10, 2007.

EPA (US Environmental Protection Agency). 2007. Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Technical Guidance, EPA 833-B-07-004. *http://water.epa.gov/polwaste/npdes/basics/upload/watershed_techguidance.pdf*

EPA (US Environmental Protection Agency). 2007. Watershed-Based Permitting Case Study: Chesapeake Bay Watershed, Virginia. *http://water.epa.gov/polwaste/npdes/basics/upload/wq_casestudy_factsht13.pdf*

EPA (US Environmental Protection Agency). 2010, Using Stressor-response Relationships to Derive Numeric Nutrient Criteria. EPA-820-S-10-001 https://nepis.epa.gov/Exe/ZyPDF.cgi/P100IK1N.PDF?Dockey=P100IK1N.PDF

EPA (US Environmental Protection Agency). 2012. United States Environmental Protection Agency. Authorization to Discharge under the National Pollutant Discharge Elimination System. West Boise Wastewater Treatment Facility, City of Boise. Permit No.: ID-002398-1.

EPA (US Environmental Protection Agency). 2013. NPDES Permit #ID0022853. Revised Fact Sheet. City of Coeur d'Alene Wastewater Treatment Plant.

EPA (US Environmental Protection Agency). 2014. Watershed-Based NPDES Permitting, *http://cfpub.epa.gov/npdes/wqbasedpermitting/wspermitting.cfm*

EPA (US Environmental Protection Agency). 2015. NPDES Permit #ID0020192. Fact Sheet. City of Meridian Wastewater Treatment Plant.

EPA (US Environmental Protection Agency). 2016. Response to Comments on the Draft NPDES Permit for the City of Meridian NPDES Permit Number ID0020192.

EPA (US Environmental Protection Agency). 2017. National Pollutant Discharge Elimination System (NPDES). Integrated Planning for Municipal Stormwater and Wastewater. *https://www.epa.gov/npdes/integrated-planning-municipal-stormwater-and-wastewater*

Exchange. 2017. Exchange Compliance Plan 2017 Annual Update. Submitted to the Virginia Department of Environmental Quality.

Grovhoug, T., Conners, D., and Clark, D. 2012a. Evaluation of BACWA Nutrient Watershed Permit Concept, Draft.

Grovhoug, T., Conners, D., and Kennedy, H. 2012b. Evaluation of BACWA Nutrient Watershed Permit Concept: Implementing the Best Apparent Alternative, Draft.

HDR .2016. Integrated Planning. The Time Is Now EPA's CWA Framework for Local Prioritization and Flexibility. Jeff Eger, Trent Stober, David Clark, Amanda McInnis and Jennifer Duffy. HDR, Inc. Omaha, NE.

Li, B. and Brett, M. 2013. "The Influence of Dissolved Phosphorus Molecular Form on Recalcitrance and Bioavailability." *Environmental Pollution* 182: 37–44.

MDEQ .2017. Department Circular DEQ-12B Nutrient Standards Variances. Montana Department of Environmental Quality, Helena, MT.Mehan, G.T. 2003a. EPA Office of Water Memorandum to Water Division Directors, EPA Regions 1-10, “Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Policy Statement.” *http://water.epa.gov/polwaste/npdes/basics/upload/watershed-permitting-policy.pdf*

Mehan, G.T. 2003b. EPA Office of Water Memorandum to Water Division Directors, EPA Regions 1-10, “Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance.” *http://water.epa.gov/polwaste/npdes/basics/upload/watershed_transmittal_memo.pdf*

Minnesota Pollution Control Agency (MPCA). 2015. Final Issued NPDES/SDS Permit Number MN0070629 Metropolitan Council – Mississippi Basin Total Phosphorus Permit.

NACWA. 2017. Written Testimony Submitted By: National Association of Clean Water Agencies, 1816 Jefferson Place NW, Washington, DC. Submitted for the Record of the Hearing: Building a 21st Century Infrastructure for America: Improving Water Quality through Integrated Planning. May 18, 2017, 10:00 AM, 2167 Rayburn House Office Building, Subcommittee on Water Resources and Environment, Transportation & Infrastructure Committee, U.S. House of Representatives.

New York City Department of Environmental Protection (NYC DEP). 2006. Comprehensive Jamaica Bay Report. *http://www.ciesin.org/jamaicabay/stakeholder/city_dep.jsp*

New York State Department of Environmental Conservation (NYSDEC). 2011. New York State Nutrient Standards Plan. New York State Department of Environmental Conservation (NYSDEC) (2013) 26th Ward Wastewater Treatment Plant SPDES Draft Discharge Permit NY0026212, Jamaica WWTP SPDES Draft Discharge Permit NY0026115, Rockaway Water Pollution Control Plant SPDES Draft Discharge Permit NY0026221, and Coney Island WWTP SPDES Draft Discharge Permit NY0026182. http://www.dec.ny.gov/permits/92038.html

New York Supreme Court .2011. First Amended Nitrogen Consent Judgment. *http://docs.nrdc.org/water/files/wat_11062901a.pdf*

Oregon Department of Environmental Quality (ODEQ). 2004. NPDES Watershed-Based Waste Discharge Permit, Clean Water Services. *http://www.cleanwaterservices.org/Content/Documents/Permit/Watershed-based%20Permit.pdf*

Oregon Department of Environmental Quality (ODEQ). 2010. Interim Procedure for Addressing Naturally Occurring Arsenic in NPDES Permits. http://www.oregon.gov/deq/Filtered%20Library/InterimArsenicIMDNonSigned.pdf

Oregon Department of Environmental Quality (ODEQ). 2012. Tualatin Subbasin Total Maximum Daily Load and Water Quality Management Plan), Oregon Department of Environmental Quality. *http://www.deq.state.or.us/WQ/TMDLs/docs/willamettebasin/tualatin/revision/Ch0CoverExecSummary.pdf*

Oregon Department of Environmental Quality (ODEQ). 2016. NPDES Watershed-Based Waste Discharge Permit, Clean Water Services permit # :101141, 101142, 101143, 101144, and MS4. [Oregon record number: DEWP/18/3615]

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB). 2012. San Francisco Bay Nutrient Management Strategy. http://bayareanutrients.aquaticscience.org/sites/default/files/u23/Nutrient_Strategy%20November%202012.pdf

San Francisco Bay Regional Water Quality Control Board (SFRWQCB). 2013. A Review of Scientific Approaches Supporting Nutrient Assessment Framework Development for San Francisco Bay, prepared for the San Francisco Regional Water Quality Control Board Basin Planning and TMDL Unit. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/SAG-June-2013/NNE_Framework_White_Paper.pdf

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB). 2014. Waste Discharge Requirements for Nutrients from Municipal Wastewater Discharges to San Francisco Bay, Order No. R2-2014-0014; NPDES No. CA0038873. http://www.waterboards.ca.gov/sanfranciscobay/board_decisions/adopted_orders/2014/R2-2014-0014.pdf

San Francisco Estuary Institute (SFEI). 2013. External Nutrient Loads to San Francisco Bay, Draft. *http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/NutrientLoadsDRAFT_Apr2013.pdf*

Sedlak, D. 2003. *The Speciation and Reactivity of Wastewater-Derived Organic Nitrogen*. Department of Civil and Environmental Engineering UC Berkeley. Berkeley, CA.

State of Minnesota in Court of Appeals A15-1622. June 13, 2016. Minnesota Center for Environmental Advocacy, Realtor, vs. Minnesota Pollution Control Agency, Respondent and Metropolitan Council Environmental Services, Respondent. Minnesota Pollution Control Agency Permit No. MN0070629.

VAC. 2018. Virginia Administrative Code, Title 9. Environment, Agency 25. State Water Control Board, Chapter 820. General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia

Virginia, Department of Environmental Quality. 2009. *TMDL Guidance Memo No. 09-2001. Guidance for Monitoring of Point Sources for TMDL Development using Low-Level PCB Method 1668.* Richmond, VA: VDEQ. *https://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/PCB/pcbmonguidance.pdf.*

Virginia Department of Environmental Quality (DEQ) (2012b) Chapter 820: General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for TN and TP Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia (9VAC25-820). *http://lis.virginia.gov/cgi-bin/legp604.exe?000+reg+9VAC25-820* http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/Baywip/vatmdlwipphase2.pdf

Virginia Department of Environmental Quality (DEQ) (2014a) 2013 Nutrient Loads Analysis. *http://www.deq.virginia.gov/Portals/0/DEQ/Water/PollutionDischargeElimination/PublishedLoa*ds2013.pdf.

Virginia Department of Environmental Quality (DEQ) (2014b) 2013 Nutrient Trading Report. http://www.deq.virginia.gov/Portals/0/DEQ/Water/PollutionDischargeElimination/NutrientTrade sReport2013.pdf.

Virginia Department of Environmental Quality (DEQ) (2014a) Administrative Code Chapter 820, Sections 10-80: General Virginia Pollutant Discharge Elimination System (VPDES) Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia. http://leg1.state.va.us/000/reg/TOC09025.HTM#C0040.

Virginia Department of Environmental Quality (DEQ) (2014b) Certification of Nonpoint Source Nutrient Credits, proposed text. *http://townhall.virginia.gov/L/ViewXML.cfm?textid=8436*.

Virginia Nutrient Credit Exchange Association (2014) Exchange Compliance Plan 2014 Annual Update. http://www.deq.virginia.gov/Portals/0/DEQ/Water/PollutionDischargeElimination/ExchangeCompliancePlan-2014AnnualUpdate.pdf.

WAC 2018. Water Quality Offsets. Washington Administrative Code 173-201A-450.

WDNR 2014. Watershed Permitting Guidance. Guidance Number: 3400-2014-01. Wisconsin Department of Natural Resources.

WERF 2010. Nutrient Management: Regulatory Approaches to Protect Water Quality. Volume 1 – Review of Existing Practices.

WERF 2011. Nutrient Management Volume II: Removal Technology Performance & Reliability.

WERF 2016. Nutrient Management Volume III: Development of Nutrient Permitting Frameworks.