WRF 4973 Fact Sheet: ID 2201

Strategy: Regulatory Strategies

Regulatory Permitting and Optimization Strategies

Budd Inlet on Puget Sound, Olympia, Washington. LOTT Clean Water Alliance Budd Inlet Treatment Plant in Background.
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Spokane River, Coeur d'Alene, Idaho. City of Coeur d'Alene Advanced Wastewater Treatment Plant Effluent Diffuser Ports.
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Water quality conditions are the primary driver of regulatory requirements for nutrient management, including optimization to reduce nutrient discharges. The Clean Water Act (CWA) includes a two-tiered approach for effluent limits. The first tier is technology-based effluent limits (TBELs), or the technological feasibility of achieving industry standards. The second tier is water quality–based effluent limits (WQBELs), or requirements based on the water quality required to maintain the designated beneficial use of the receiving water.

TBELs for regulated pollutants are determined based on the industry and available technology. The goal is commonly referred to as a "performance goal" and ultimately, "zero discharge to the maximum extent practicable." Because national TBELs do not exist for nutrients, WQBELs may be developed, if necessary, to be protective of state water quality standards.

Opportunities for optimization are not limited solely to treatment facilities. Optimization of watershed nutrient management efforts may include both point source and nonpoint source nutrient reductions. Opportunities to optimize investments in holistic watershed improvements that optimize both point and nonpoint source reductions may be inadvertently limited by current regulatory frameworks.

Water Research Foundation (WRF) report 4974 (Clark et al. 2022) contains three themes for regulatory permitting and optimization strategies described below:

- **Theme 1:** Pursue Affirmative Discharge Permit Structures
- **Theme 2:** Foster Multiple Facility and Multiple Utility Collaboration Opportunities
- **Theme 3:** Embrace Adaptive Management

Fact Sheet Application Checklist

x = fact sheet relevant to item
p = fact sheet is potentially relevant to item depending on application, existing conditions, etc.

Category		
	p	Intensification
	p	Chemical addition
	p	Carbon management
	p	I&C strategies
	p	Sidestream mgmt.
	p	Energy savings
	p	Chemical savings
	p	Operational savings
	X	Other means of NutRem
Nutrient	X	Ammonia
	X	NOx
	X	TN
	X	Ortho-P
	X	TP
Scale (Design flow)	X	Small (<1 mgd)
	X	Medium (1–10 mgd)
	X	Large (>10 mgd)

Goal		
		Improve reliability
	X	Reduce nutrient
	X	Reduce O&M cost
Group	X	Optimize existing CNR
	X	Optimize existing TNR
	X	NutRem in secondary plant
Process	X	Small
	X	Pond
	X	Fixed film (secondary)
	X	Conventional act. sludge (CAS)
	X	Nitrifying act. sludge (NAS)
	X	Conventional NutRem (CNR)
	X	Tertiary NutRem (TNR)
	X	Other .

CAS = conventional activated sludge (BOD only)
NAS = nitrifying activated sludge (without denitrification)
CNR = conventional nutrient removal no chemical/no filter, etc.
TNR = tertiary nutrient removal with chemical, filter, etc.

Descriptions/Evaluation

Water quality conditions are the primary driver of regulatory requirements for nutrient management, including optimization to reduce wastewater nutrient discharges. Water quality impairment listings under CWA Section 303(d), total maximum daily loads (TMDLs) with waste load allocations (WLAs) to reduce nutrients, and National Pollutant Discharge Elimination System (NPDES) permits with effluent nutrient limits are all regulatory drivers that may link with nutrient optimization. Advanced nutrient removal treatment technology is very effective, has been successfully implemented in many locations, and has pushed the boundaries of treatment technology to ever more advanced levels. Current regulatory frameworks limit the ability to optimize both advanced levels of nutrient removal treatment and recovery with nonpoint source best management practices to maximize the water quality benefits.

Various regulatory constraints and barriers exist that affect certainty in decision making and therefore improvements in treatment. Constraints and barriers to optimize nutrient removal performance of a water resource recovery facility (WRRF) can take several forms. Case studies in the United States involving optimization for nutrient removal that demonstrate regulatory trends are presented. Case studies focus on the strategies to comply with regulatory nutrient load targets at various phases of nutrient regulations. Examples include Puget Sound, the San Francisco Bay Area, the Delaware River Watershed, and Iowa. In several case studies, previous and ongoing programmatic elements (e.g., policies, regulations, and institutional controls) have led to water quality improvement but receiving water endpoints are far from being met.

Regulatory permitting and optimization strategies were grouped into three themes. The first theme is to pursue affirmative discharge permit structures. The second theme is to foster multiple facility and multiple utility collaboration opportunities. The third theme is to embrace adaptive management.

Theme 1: Pursue Affirmative Discharge Permit Structures

The pursuit of affirmative discharge permit structures means communicating with the regulatory agency, permit writer, compliance officer, etc., by providing information about the WRRF and the implications of how permit requirements are written. The regulatory agency does not know the nuances about the operations of the permittee's WRRF. Permit structure means the written requirements, the implementation and interpretation of those, the integration with facility planning, and the resulting environmental result.

More appropriate nutrients discharge permits may be developed when conditions include the following:

- Collaboration between permit writers and permittees to craft flexible nutrient permits
- Shared understanding of the frequency and duration associated with watershed nutrient management objectives
- Shared understanding of the capabilities of advanced nutrient removal treatment
- Recognition of the environmental tradeoffs associated with nutrient removal treatment and discharge permit structures
- Recognition of the variability in effluent characteristics and the natural environment
- Application of more sophisticated methods, water quality models, and statistical tools to arrive at permit structures that better match actual receiving water requirements
- Improved water quality monitoring for continuous data collection and real-time data monitoring using field sensors, multiparameter sondes, satellite imagery, etc.

Emphasis in nutrient discharge permitting should focus on providing the greatest amount of flexibility possible in the structure of nutrient limits to preserve the opportunity for the most creative and economical approaches to managing nutrients. Traditional permit structures for publicly owned treatment works generally include both monthly and weekly limits on both a concentration and mass basis. This may inadvertently eliminate the most effective watershed solutions to nutrient management by creating disincentives to wastewater dischargers to explore combinations of advanced wastewater treatment and other watershed management practices.

The objectives of communication and information sharing are:

- Provide compliance flexibility and incentives that promote optimization at WRRFs
- Avoid disincentives that create compliance risks that discourage optimization

These objectives may be categorized further as shown in Table 1.

Table 1. Examples of Strategies for Affirmation Discharge Permit Structures.

Promote Structures	Avoid Distinctives
Narrative limits	Compliance risks
Interim limits	Maximum day limits
Mass loading	Both mass and concentration limits
Seasonal limits	Concentration limits
Combinations of filtered/unfiltered	Anti-backsliding
Safe harbor provisions	Effluent performance statistics (preserve capacity)
Extended/long compliance schedule	
Limited time of use of available reactor capacity	
Early nutrient reduction incentives	
Nonpoint source credits	
Loan and grant priorities	

Nutrient Reduction Incentives

Flexible permit structures that protect water quality yet encourage optimization and innovative solutions are needed. Permitting and legal structures that address all nutrient sources and reward solutions that reduce and eliminate nutrient pollution are beneficial. A combination of incentives or rewards for doing better, with flexible structures to allow effluent variability and foster innovation and new technologies, are helpful.

Avoiding Disincentives to Nutrient Reduction

Care should be taken in the formulation of watershed permits to avoid over-specifying effluent limits in ways that may create unintended disincentives to reducing nutrients. An example is when TBELs and WQBELs are both included in the same permit for the same parameter. TBELs may act as a disincentive to improve treatment because better performance can result in more stringent technology limits.

A potentially attractive tool in developing effective watershed-scale nutrient management plans is nutrient trading. It is important to structure discharge permits in a manner that avoids inadvertent disincentives to nutrient trading. Combinations of both effluent concentration and mass effluent limits for nutrients may constrain the development of trades or increase the complexity in accounting for trades. Watershed permits formulated with trading in mind may facilitate the implementation of water quality trading.

Regulatory practices that help to alleviate disincentives include the following:

- Safe harbor programs, which are voluntary programs that allow for optimization and experimentation with, or the piloting of, new or innovative approaches with limits on the regulatory disincentives or risks
- Stochastic permitting, which uses probability models to consider fluctuating pollutants over relatively long periods, rather than using highly prescribed, inflexible limits enforced on a weekly or daily basis

- Approaches to allow temporary use of current excess permitted capacity for cost-effective enhanced treatment, without triggering lower effluent discharge requirements

Theme 2: Foster Multiple Facility and Multiple Utility Collaboration Opportunities

Allow for creativity for WRRF managers to figure out the best ways to optimize nutrient reduction performance, cost of service, staffing, energy use, biosolids, asset management, etc. Again, communication and information sharing with the regulatory agency is key. A reactive approach results in over-specified permit conditions and challenging requirements because the permit writer does not understand the operations of the facility and must be conservatively restrictive with the requirements. Discussions with the regulatory agency on formulating affirmative permit structures that let the facility operators best figure out how to optimize and run the processes are necessary to provide confidence to the permit writer that the objectives of meeting environmental regulations and water quality standards will be met. Other methods beyond optimization to consider include trading, offsets, and cumulative load-shared “bubble” permits. Approaches to achieving these means include nonpoint source controls, agricultural and stormwater runoff, reuse, and other creative means. Such approaches have been applied in Boise, Chesapeake/James River, Las Vegas, Metropolitan Council Environmental Services (MCES), and Puget Sound.

Cumulative Load Bubble Permits

Watershed-based NPDES permitting is a process that emphasizes addressing all stressors within a hydrologically defined drainage basin, rather than addressing individual pollutant sources on a discharge-by-discharge basis. The type of permitting activity will vary depending on the unique characteristics of the watershed and the sources of pollution impacting it. The goal of this effort is to develop and issue NPDES permits that better protect entire watersheds.

With a bubble permit, each facility may have a separate WLA for total nitrogen (TN) and total phosphorus (TP). However, compliance will be judged relative to an annual aggregate loading limit (i.e., bubble limit). The aggregate or bubble limit represents as a sum of these discharged TN and TP loads across several facilities. A bubble allocation provides the flexibility to adopt innovative treatment at one or more of the WRRFs, knowing that minor variations in phosphorus treatment at one WRRF can be offset by proven advanced treatment technology already in place at another WRRF. A bubble load places a ceiling on the allowable discharge load from multiple sites combined.

Water Quality Trading

Water quality trading is an innovative approach to achieve water quality goals more efficiently. Trading can work because sources in a watershed can have very different costs to control the same pollutant. Trading programs allow dischargers facing higher pollution control costs to meet their regulatory obligations by purchasing environmentally equivalent (or superior) pollution reductions from another source at lower cost, thus achieving the same water quality improvement at lower overall cost. The basis of trading is that a water quality goal is established and that sources within the watershed have significantly different costs to achieve comparable levels of pollution control.

Theme 3: Embrace Adaptive Management

Embracing a comprehensive approach means a forward-looking regulatory strategy that uses adaptive management to optimize both within WRRFs (WRF 4973) and the Watershed (WRF 4974). Time to embrace elements of this approach is a critical factor. Time allows for testing to push optimization in existing facilities, prove out new technologies, establish reuse, develop reductions by other means, and monitor the results to understand the watershed water quality response. Avoid trying to do it all at once because that precludes the benefits of adaptive management, which may identify a better way that is more effective and costs less. Monitoring data must not only be collected but also analyzed in a timely manner to obtain feedback for continuous improvement within incremental steps.

Approaches to embrace from the watershed perspective are described by practices, policies, and partnerships within WRF 4974. Practices include the technical approaches for WRRF optimization in WRF 4973, along with items like phased implementation, new technologies, reuse, other means, best management practices, and climate change. Policies provides flexibility within a discharge permit that incentivizes optimization. Policies should foster extended compliance schedules, avoid final limits, provide safe harbor, provide incentives, and track the watershed water quality response and feedback. Partnerships provide the collaborations necessary for reuse and nutrient reduction by other means to optimize the overall WRRF and watershed management of nutrients. Partnerships provide the collaborations necessary for multiple utilities to optimize together and WRRFs with nonpoint source stakeholders. Partnerships also provide collaborations with other utilities such as drinking water for reuse and flood control for horizontal levees. Fostering trust with regulatory agencies and third-party nongovernmental organizations allows the time and flexibility needed at WRRFs to optimize without being over-regulated. Bridging the connection between WRRFs and watersheds, building trust, and looking for other means requires the creation of partnerships working together to meet the nutrient challenge.

2019 Water Infrastructure Improvement Act

Integrated planning is a powerful new adaptive management tool that allows consideration of local priorities and affordability to guide water quality management efforts and address the competing demands of compliance with multiple regulatory requirements. On January 14, 2019, the president signed into law H.R. 7279, the "Water Infrastructure Improvement Act," (Public Law 115-436 2019), which amends the Federal Water Pollution Control Act to provide for the use of green infrastructure to reduce stormwater flows. The bill includes codification of integrated planning concepts into the CWA; creates an Office of Municipal Ombudsman at the U.S. Environmental Protection Agency (EPA); emphasizes green infrastructure; provides for compliance with WQBELs over more than a single NPDES permit cycle; and allows for modification of compliance schedules, orders, and consent decrees under some conditions.

Integrated planning can be applied to nutrient management to guide the prioritization of nutrient management activities in context of other regulatory drivers and receiving water requirements. Although less widely known for application to nutrient management as compared to wet weather combined sewer overflow (CSO)/sanitary sewer overflow (SSO) compliance, integrated planning is equally applicable to nutrients.

Greater awareness of the applicability of integrated planning to nutrients may result in more widespread use, especially in circumstances when multiple water quality and compliance issues present challenges for wastewater utilities. The recent codification of integrated planning in the federal regulations will be helpful in expanding awareness of the applicability of this relatively new planning tool.

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Abbreviations

BOD	Biochemical oxygen demand
CAS	Conventional activated sludge: BOD removal only
CNR	Conventional nutrient removal
CSO	Combined sewer overflow
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
I&C	Instrumentation and controls
LIFT	Leaders Innovation Forum for Technology (now RIC and RISE)
MCES	Metropolitan Council Environmental Services
mgd	Million gallons per day
NAS	Nitrifying activated sludge
NO_x	Oxidized nitrogen (nitrate + nitrite)
NPDES	National Pollutant Discharge Elimination System
NutRem	Nutrient removal
O&M	Operations and maintenance
RIC	Research & Innovation Committee
RISE	Research and Innovation for Strengthening Engagement
SSO	Sanitary sewer overflow
TBEL	Technology-based effluent limit
TDL	Technology Development Level
TMDL	Total maximum daily load
TN	Total nitrogen
TNR	Tertiary nutrient removal
TP	Total phosphorus
UV	Ultraviolet
WLA	Waste load allocation
WQBEL	Water quality–based effluent limit
WRF	The Water Research Foundation
WRRF	Water resource recovery facility