UTAH NUTRIENT STRATEGY: TECHNOLOGY LIMITS

BACKGROUND

Nutrients provide critical support for both stream and lake food webs. However, excess accumulation of nutrients, particularly nitrogen (N) and phosphorous (P), causes numerous water quality problems that have been demonstrated to degrade aquatic life, drinking water, and recreations uses. Resulting economic losses from these degraded conditions are considerable—in the United States estimated costs exceed $2 billion annually. More importantly, these problems threaten the sustainability of our water resources and diminish our quality of life. Problems associated with excess nutrients in water bodies (collectively called cultural eutrophication) have been documented for almost two centuries. However, they've been rapidly increasing in extent and magnitude over the past 50 years due to the combination of widely available commercial fertilizers and exponential population growth. Many water resource professionals and regulatory agencies—including the United State Protection Agency (EPA) and Utah's Division of Water Quality (UDWQ)—now consider cultural eutrophication to be among the greatest threats to our lakes, rivers and estuaries.

There are many ways that excess nutrients can potentially degrade surface water quality. Many of these processes are associated, directly or indirectly, with excess plant and algae growth. For most people, this particular problem is most obvious because, at least at extremes, the growth is unsightly and degrades the aesthetics of our lakes and streams. Less obvious are very low levels of Dissolved Oxygen (DO) that occur when these plants and algae decompose. Sometimes, these low DO problems are sufficiently bad that they cause extensive fish kills. Another subtle consequence of cultural eutrophication is the loss of biodiversity in lakes and streams. These losses of resident species typically start with changes in water chemistry (e.g., lowered DO) and habitat degradation (e.g., increased sedimentation, reduced water clarity), which then continues as species adapted to high nutrient conditions and exclude more sensitive species. Such losses are important because they diminish the ecological resilience of these water bodies to extreme events such as droughts and floods. In lakes, excessive primary production sometimes manifests as growth of cyanobacteria (or blue-green algae), which can produce toxins that are harmful to people and animals. These toxins directly threaten the security of culinary water supplies because they cannot be easily removed with standard treatment processes. Sometimes, the toxicity of these "blooms" can even be deadly, which has resulted in the death of dogs and cattle. Groundwater culinary sources are also threatened by excess nutrients because they can become contaminated with nitrite—a form of nitrogen—at concentrations that are toxic to infants.

All of these deleterious responses to excess nutrients, among others, have been observed in Utah. The science that links these responses to excess nutrient inputs continues to improve. However, it remains difficult to generalize about the specific concentrations of N or P that initiate deleterious effects on beneficial uses, in part because responses are mediated by numerous physical and biological site-specific attributes. Social and political challenges also affect efforts to address nutrient pollution, because there are many different nutrient sources, with an equally diverse group of potentially affected stakeholders. Despite these challenges, UDWQ remains committed to solving these problems. To accomplish this goal, UDWQ and stakeholders have been developing a comprehensive nutrient reduction strategy. This strategy consists of several elements which broadly attempt to identify water bodies with nutrient-related problems and then seeking appropriate nutrient reductions with programs directed at various nutrient sources. **This document describes a proposal to implement technology-based limits (TBLs) as an adaptive first step to remove nutrient sources from point source discharges.**

FOUNDATIONAL CONCLUSIONS

There are several foundational conclusions that underpin the decision to develop TBLs:

- Consensus among water quality experts concludes that nutrient reduction and management is needed in many waters of the United States and in Utah.

- The specific nutrient concentrations that cause harm to aquatic life or recreation uses vary from water body to water body.

- The science necessary to support site-specific nutrient critieria remains incomplete for most of Utah's waterbodies, and in many cases considerable research will be required before defensible site-specific criteria can be established.

- Important site-specific research topics include: characterization of background conditions; natural variation in both nutrients and ecological responses; the recovery potential of the watershed; and the potential for shifts from one stable ecological state to another (i.e., ecological regime shifts). Insights gleaned from these research efforts will help define what is attainable and appropriately protective of the water body's beneficial uses.

- EPA and UDWQ have set a goal to ultimately implement nutrient water quality standards, specifically Nitrogen (N) and Phosphorous (P) numeric criteria, for all surface waters. In order to expedite this process, EPA proposed ecoregion values based on the distribution of N and P as a starting place for numeric nutrient criteria. However, EPA encourages states to refine these values with state-specific data. UDWQ has used a "weight of evidence" approach for assessment of wadeable streams, and is currently completing a report using this approach to develop numeric criteria for anti-degradation Category 1 (exceptional recreational or ecological significance) waters that are mostly contained within U.S. Forest Service boundaries. The results of that report will also be used as an assessment screening tool for all other waters.

- Although the initial thrust for numeric nutrient criteria is in areas where there are few or no point-source dischargers, there is also a need to address nutrient concerns elsewhere. Due to the cost of research required to evaluate each of these streams individually, DWQ proposes an alternative approach that increases protection to Utah's waters from point sources while acknowledging the resource limits for research.

- Many of the point source discharges in Utah either directly or indirectly discharge into Great Salt Lake (GSL) and surrounding wetlands. There are many studies being carried out on one or more of the GSL segments to assess nutrient impacts. As yet, the results of these studies are insufficient to identify appropriate response variables or make conclusions about what nutrient standards are necessary to protect the beneficial uses of the GSL ecosystem. It is likely that years of additional research will be needed before defensible conclusions about appropriately protective GSL nutrient limits, if any, can be made.

- The effect on the average household sewer bill to increase the removal of nutrients at Utah's wastewater treatment plants ranges from $1 to $15 per month, depending on how many improvements must be made at a facility. For instance, a technology-based nutrient limit of 1 mg/L total phosphorus (TP) and 10 mg/L total inorganic nitrogen (TIN), would reduce instream TN and TP by approximately 50%, and result in an average increase in household sewer bills of approximately $3.50 per month.

- Results from a contingent valuation survey showed that Utahans who do not visit lakes and rivers are willing to pay about $7 per month/household in higher water and sewer bills to prevent further deterioration of water quality associated with nitrogen and phosphorus pollution, while Utahans who recreate on or near lakes and rivers are willing to pay about $13 per month/household more. Implementation of nutrient reduction measures that are intended to improve water quality were valued across all Utah households at $25 per month.

ADAPTIVE MANAGEMENT

An adaptive management approach is proposed to facilitate immediate action toward addressing nutrient pollution, while uncertainty associated with appropriate site-specific numeric nutrient criteria is addressed. Adaptive management is based on the management principle of "plan-implement-monitor-assess".

This process begins with development of immediate action plans based on current information, followed by phased implementation. As actions are implemented, concurrent monitoring is used to identify the success in comparison with the plan's objectives. Finally, the plan is either maintained or modified based on the analysis of the results and the process is continued until objectives are realized.

An EPA online training document defines adaptive management as:

"…the process by which new information about the health of the watershed is incorporated into the watershed management plan. Adaptive management is a challenging blend of scientific research, monitoring, and practical management that allows for experimentation and provides the opportunity to 'learn by doing.' It is a necessary and useful tool because of the uncertainty about how ecosystems function and how management affects ecosystems."

With respect to Utah's nutrient reduction program these adaptive management approaches seemed appropriate because despite considerable effort on the part of UDWQ and our collaborators, several areas of uncertainty regarding the effect of nutrients on designated uses remain. For example, in most cases site-specific modifiers to nutrient responses are insufficiently understood to establish site-specific numeric criteria that are neither over- nor under-protective of designated uses. Socioeconomic conditions also vary considerably among watersheds, which affects the extent to which TBL reductions are feasible.

Utah's nutrient reduction program incorporates adaptive approaches across several regulatory programs including: monitoring and assessment efforts aimed to identify nutrient-related impairments, prioritization of scientific research, prioritization of responses to nutrient-related impairments and evaluating the effects of incremental nutrient reductions from both point and non-point nutrient sources. This document describes early steps in these adaptive management plans for point sources.

MONITORING

One of the requirements of the adaptive approach is increased monitoring of all discharges and receiving waters. Point source dischargers of nutrients to surface waters will be required to monitor both P and N compounds from their influent and effluent. Point source dischargers will also be encouraged to monitor for these parameters from waters that receive their discharge to better understand the ecological outcome of these efforts. Data obtained from these efforts can be used to more accurately assess nutrient inputs from discharges relative to other sources. This information could then be used, for instance, to refine permits limits or identify opportunities for nutrient reductions from other nutrient sources.

PROCESS OPTIMIZATION

Another adaptive practice would encourage point source dischargers to investigate optimization of their existing processes to maximize removal of N, and avoid costly "bricks and mortar" solutions. Changes such as solids residence time, dissolved oxygen concentrations, and changes in recycle management may allow optimization in nutrient reduction prior to moving to more expensive construction solutions. UDWQ will continue to work with stakeholders to discuss how optimization options can be fairly integrated into these adaptive management procedures.

TECHNOLOGY BASED LIMITS

MECHANICAL TREATMENT PLANTS

This adaptive approach, the *Utah Nutrient Strategy*, is predicated on the idea that nutrient reduction in Utah's watersheds is reasonable, economical and an appropriate, cost-effective first step toward maintaining or improving water quality. In watersheds without numeric nutrient criteria or TMDL limits, the adaptive step of near-term nutrient reductions would be applied to most mechanical wastewater treatment plants. It should be noted that this adaptive step does not infer that ecological improvements will definitely follow these nutrient reductions, especially over relatively short time scales. Instead, the plan reflects the fact that nutrients are high enough in many watersheds that reductions in nutrients are unlikely to cause harm and may result in environmental improvements.

Monitoring following implementation of TBLs will provide valuable data with regard to potential ecological improvements downstream of treatment facilities. However, it must be understood that recovery can take years or decades given legacy accumulation, particularly for phosphorus. Whether or not immediate improvements to downstream conditions are observed, the proposed strategy helps reduce the risk that increasing levels of nutrients from ongoing growth will cause or exacerbate nutrient problems. This adaptive logic behind these reductions applies to both N and P for all water bodies except for GSL. The GSL is unique because N reductions have the potential to harm the ecosystem because N may limit the abundance of brine shrimp, and potentially brine flies, that are of critical importance as food to the millions of birds that depend on the GSL ecosystem.

The next step is picking appropriate Technology Based Limits (TBLs). ***The Nutrient Core Team has determined that the TBL should be 1 mg/L total-P and 10 mg/L TIN, both expressed as annual averages***.

RATIONALE

The Nutrient Core Team made the decision to use 1 mg/L total P and 10 mg/L total inorganic nitrogen (TIN) as the selected TBLs. These concentrations were selected in an attempt to strike a balance between the costs of treatment technology in comparison with the benefits of nutrient removal from receiving waters.

TREATMENT TECHNOLOGY OF WASTEWATER

In general, there is little disagreement that a well-constructed treatment facility can comply with a 1 mg/L P limit using biological treatment and 10 mg/L TIN limit using biological treatment without the need for supplemental carbon addition. In addition, a 1 mg/L P limit can be achieved chemically without having to use excessive metal salts. Finally, many mechanical plants in Utah can either now meet, or with the addition of minimal facilities, could meet in the future a 10 mg/L TIN limit. Treatment technology currently exists that allows 1 mg/L P and 10 mg/L TIN limits to be met effectively. Even though technology is available to meet the TBLs at all facilities, decisions may need to be made at some facilities whether to sustain higher construction costs to go beyond meeting the minimum TBLs. An example is an aging trickling filter plant. At this type of plant a decision could be made to minimize construction costs and provide chemical P reduction and a polishing step for TIN compliance. Or a decision could be made to replace the plant with a newer technology treatment facility that biologically reduces P and meets the TIN requirement and would be expandable to meet lower limits that could be imposed in the future. Either approach would meet the TBL, but the cost of each would be significantly different.

ECONOMICS

In 2009, Utah performed a statewide study to assess the cost of nutrient reduction at Utah WWTPs. While the 2009 study did not include the 1 mg/L P and 10 mg/L TIN endpoints, it did include enough information to estimate the cost for these endpoints. The available information suggests that a $3.50/month incremental cost increase would be realized in “average” statewide households to achieve both TBLs.

ANTICIPATED LOAD REDUCTIONS

Few Utah facilities now remove either biologically or chemically excess P from wastewater. A 1.0 mg/L P limit would reduce the P load to Utah’s watersheds by 50% to 75%. For TIN the reduction percentages are very facility-specific, but an estimated statewide reduction would be from 30% to 50%.

BENCHMARKING WITH OTHER STATES

Several States have opted to implement similar TBLs, as summarized in the following table:

STATE	TIN Limit mg/L	TN Limit mg/L	P Limits mg/L
Chesapeake Bay Backstops		3	0.1
Maryland		4	0.3
2007 NRDC EPA Petition		8	1.0
Montana (as a variance)		10 (> 1 mgd) 15 (< 1mgd)	1.0 (> 1 mgd) 2.0 (< 1 mgd)
Colorado		15 (existing) ; 7 (new)	1.0
Iowa		10	1.0
Minnesota (Watershed Specific)		10	1.0
Utah (proposed)	10		1.0
Pennsylvania	8 to 12		1.0 to 3.0
Illinois (new and expanded)			1.0
Ohio			1.0
Michigan			1.0
Georgia			1.0

What is clear from reviewing similar approaches in other states is that there are significant differences among the approaches each takes. What is also clear is that when states have established TBLs they are in the same range as those selected for Utah.

IMPLEMENTATION SCHEDULE

Since water quality information is still being gathered from many watersheds, the strategy will require influent and effluent monitoring to be initiated within several months of program implementation. Other aspects of this component of the *Utah Nutrient Strategy* have extended time frames. Proposed TBL implementation deadlines are longer for TIN than TP, in part, due to the increased cost and complexity of treating nitrogen. The proposed implementation window allows sufficient time for new information to be gathered that could potentially be used to justify a watershed-specific TBL exception. The extended timeframe also allows time to plan for the TBL reductions including financing, design, system testing, and construction.

The following table provides key steps in the proposed 10-year TBL **implementation schedule**:

Three Years After Program Implementation

- Dischargers provide DWQ with scientific justification for no P requirement
- **Or**, provide DWQ with design for meeting P to 1mg/L

Five Years After Program Implementation

- Comply with P TBL
- Implement "TIN" TBL into rule for all waters except GSL

Seven Years After Program Implementation

- Discharges provide DWQ with scientific justification for no TIN requirement
- **Or** provide DWQ with design for meeting a TIN of 10 mg/L

Ten Years after Program Implementation - Full Compliance with TBLs for both P and TIN

This schedule would be applied to all treatment works with a reasonable potential to discharge nutrients to all surface waters except direct discharge to GSL. For GSL the TP reductions will follow the same timeline, whereas a TBL to reduce TIN will occur only after it can be demonstrated that the TBL is necessary to protect GSL's beneficial uses.

The steps outlined in this schedule are part of a more comprehensive program that aims to eliminate nutrient-related water quality problems. These adaptive management processes, and other concurrent efforts aimed at different nutrient sources, will continue until site-specific nutrient criteria are established for the receiving water or until a determination is made that no additional nutrient control steps are needed in the watershed.

MONITORING REQUIREMENTS

Implementation of the phosphorus phase of the TBL will also include requirements for dischargers to analyze their influent and effluent for total phosphorus and nitrogen compounds. Minimum sampling frequency requirements will vary, from once per year to monthly, depending on the size of the facility. The water bodies where the nutrient reductions occur will also be monitored by UDWQ (POTWs will be encouraged to collaborate) to quantify the nutrient reductions and resulting ecological responses that can be observed. Data from these monitoring efforts will provide feedback as to the effects of reduced nutrient levels in the watersheds. This information will help inform the development of numeric nutrient criteria and will help identify possible changes to the adaptive management plans.

ANTICIPATED BENEFITS

One of the benefits of implementing TBLs is a significant reduction in anthropogenic nutrient loads in water bodies below point source discharges. For waters such as Utah Lake, Jordan River, or GSL, nutrient impacts are undetermined and significant research remains to determine if nutrients are pollutants of concern. In these watersheds the TBL reductions, in effect, would dial back the pollutant load to the water body allowing continued time for research to determine the relative role of nutrients and other stressors in the degradation of beneficial uses. Given that these watersheds are in areas with extensive urbanization, with many irreversible alterations, the research will also need to identify achievable restoration objectives. All of this critical research will take time to complete. Hence, these TBL reductions allow time for these investigations to occur, while also minimizing risks to beneficial uses by eliminating increases in N or P (relative to current conditions) that would otherwise be expected from anticipated population growth.

LAGOON SYSTEMS

For municipal discharging lagoon systems no TBL would be applied. Instead, the first adaptive step for lagoons will be to cap their existing nutrient effluent loads at 125% of the facility's current level. By capping the annual P and TIN loads at this level, lagoon facilities can then be evaluated to determine what can be done near-term and long-term to maintain their discharges below the capped loads. Since these mass loading limits are site-specific and require no additional facilities in order to be met, they would be developed in year zero and, for P, implemented by year three. The cap for TIN would be developed in year zero and implemented by year seven.

EXCEPTIONS FOR MECHANICAL PLANTS AND DISCHARGING LAGOONS

A few exceptions to the TBLs are discussed below. The general intent is that these apply to only a small number of WWTPs or discharging lagoons.

EXISTING TMDLS

Where an existing TMDL has allocated a nutrient wasteload to a WWTP that wasteload will take precedence over the TBL. If the TMDL allocated load is only for either nitrogen or phosphorus, the TBL for the other pollutant will still apply.

INCONSEQUENTIAL REDUCTIONS IN RECEIVING WATERS

The TBL will not be required for a WWTP whose discharge, without the implementation of the TBL, would have a *de minimis* effect on the receiving water and associated watershed. *De minimis* means so minor as to merit disregard. In this context, UDWQ defines *de minimis* as a discharge that results in no more than a 10% increase in the TP or TN concentrations in the WWTP's receiving water during critical low flow conditions. If this is the case, an exception to comply with the TBL may be requested.

ECONOMIC HARDSHIP

The TBL will not be required where it would cause an economic hardship to the community such that the projected per connection service fees are greater than 1.4% of the latest median adjusted gross household income (MAGHI), the current affordability criterion now being used by the Water

Quality Board in its wastewater revolving loan program.

NOT NECESSARY TO PROTECT USES

The TBL for P and/or TIN will not be required if the State, the discharger, or any third party provides sufficient evidence to demonstrate that the TBL is unnecessary to either maintain support or prevent degradation of downstream beneficial uses from responses associated with excess nutrients.

NITROGEN TBLS FOR GREAT SALT LAKE DISCHARGES

The Total Inorganic Nitrogen TBL for WWTPs that discharge directly into GSL will not be required until it can be demonstrated that the lack of a TBL would be likely to harm the beneficial uses of the lake. WWTPs that discharge directly into GSL or drainage ditches into the GSL include Salt Lake City Water Reclamation Facility, Central Davis Sewer District's treatment plant, the Willard/Perry wastewater treatment plant and the North Davis Sewer District's treatment plant.

The basis for this exception is that Great Salt Lake is a unique ecosystem so the body of scientific literature on nutrient responses in not applicable. As a result, there is uncertainty regarding the benefit or harm to aquatic life and waterfowl from excess nitrogen. Indeed, production of brine shrimp and their cysts, a primary food for many birds and a harvested commodity important to aquaculture world-wide, is sustained by nitrogen in the ecosystem. In order to insure continued ecosystem vitality and before nitrogen reduction mechanisms are put in place, studies must demonstrate these mechanisms are necessary to protect the beneficial uses of Great Salt Lake.

SUMMARY AND CONCLUSIONS

Utah has determined that there is technical justification to reduce nutrient waste loads prior to the establishment of nutrient criteria in many waters. As part of an adaptive management process, Utah has chosen to set technology based limits for phosphorus of 1 mg/L and for nitrogen of 10 mg/L as total inorganic nitrogen and has proposed a time frame for compliance. Exceptions to compliance with the TBLs are explained and the justifications for the numeric values are identified.