Appendix A

Water Quality Trading Program Fact Sheets

Including Applicable NPDES Permit Conditions and Limits

Contents

Introduction

Appendix A to the U.S. Environmental Protection Agency's (EPA) *Water Quality Trading Toolkit for Permit Writers* contains a series of fact sheets on water quality trading programs nationwide. Water quality trading programs selected for this analysis are geographically representative and, on the basis of recent research, are likely to have (1) actual or proposed National Pollutant Discharge Elimination System (NPDES) permit language to facilitate trades and (2) actual trades. The programs selected for review and analysis are intended to be used to compare and contrast different approaches in water quality trading programs; the Office of Wastewater Management does not intend to highlight these programs as *model programs*.

The fact sheets are intended to document the relevant technical details on which each trading program is predicated. The fact sheets also contain some background information to help the reader establish a basic understanding of the context and functionality of each water quality trading program. As a result, some of the contextual information contained in the fact sheets might seem similar to the types of information collected and compiled through existing research on water quality trading. The primary difference between the collection of fact sheets researched and assembled for this report is the focus on the methodologies and technical rationale used in developing water quality trading programs and the associated NPDES permits.

The fact sheets summarize information from the following water quality trading programs:

1. Grassland Area Farmers Tradable Loads Program (California)
2. Long Island Sound Nitrogen Credit Exchange Program (Connecticut)
3. Lower Boise River Effluent Trading Demonstration Project (Idaho)
4. Rahr Malting Company Permit (Minnesota)
5. Southern Minnesota Beet Sugar Cooperative Permit (Minnesota)
6. Truckee River (Nevada)
7. Passaic Valley Sewerage Commission Pretreatment Trading Program (New Jersey)
8. Neuse River Basin Nutrient Sensitive Waters Management Strategy (North Carolina)
9. Great Miami River Watershed Trading Pilot (Ohio)
10. Clean Water Services (Oregon)
11. Virginia Nutrient Credit Exchange Program (Virginia)
12. Red Cedar River Watershed Nutrient Trading Pilot Program (Wisconsin).

Several fact sheets are followed by one or more flow charts that illustrate the connections among various programs, plans, and strategies integrated through water quality trading

programs, as well as the basic process used to administer trades. All fact sheets and associated flow charts are a work in progress, and they will be updated as new information is obtained.

The NPDES permits referenced in the fact sheets are part of EPA's inventory of NPDES permits containing water quality trading provisions. The inventory also contains additional NPDES permits not discussed in the water quality trading program fact sheets. For more information on the inventory of NPDES permit containing water quality trading provisions, contact Virginia Kibler in EPA's Office of Wastewater Management at kibler.virginia@epa.gov or by phone at 202-564-0596.

Grassland Area Farmers Tradable Loads Program
Lower San Joaquin River, California

Overview

Seven irrigation and drainage districts that are members of the San Luis & Delta-Mendota Water Authority have the discharges with the greatest impact on the San Joaquin River Basin. Referred to as the Grassland Area Farmers, the seven authority members are subject to a regional cap on selenium discharges set through the Grassland Bypass Project. If the regional authority exceeds the regional cap, it must pay an incentive fee that is a flat price based on five exceedance ranges (i.e., percent exceedance over the regional cap) that increase over time. Each of the seven members of the regional authority has an allocation of the regional cap referred to as a selenium load allocation. If a member of the regional authority exceeds its selenium load allocation, it may either pay its portion of the incentive fee or purchase selenium load allocations from another member.

Type of Trading

Nonpoint Source–Nonpoint Source*

Pollutant(s) Traded

Selenium

**Selenium loading from irrigated agriculture is accurately measured at drainage pumps and is regulated by state permits; therefore, the trading program is similar to a point source-to-point source trading program. Since irrigated agriculture is not regulated under the Clean Water Act, NPDES permits are not applicable.*

Number of Trades to Date

Thirty-nine formalized trades
Unknown number of informal trades

Who Is Eligible to Participate?

Seven of the irrigation and drainage districts that are members of the San Luis & Delta-Mendota Water Authority are in a sensitive grassland area and are therefore known as the Grassland Area Farmers. The individual farmers in each of the seven districts do not participate in trading; all trades are conducted at the district level among members of the Grassland Area Farmers. Other members of the San Luis & Delta-Mendota Water Authority are not eligible to participate.

What Generated the Need for Trading?

Agricultural activity in the Grassland Drainage Area depends on irrigation, which leaches salts and trace metals in soils and affects growing conditions. Installation of the San Luis drain helped to remove irrigation drainage, but it affected sensitive areas in the San Joaquin River watershed. The Grassland Bypass Project diverted irrigation drainage around sensitive grassland areas into the San Luis drain and eventually to the San Joaquin River. Under the Grassland Bypass Project, an agreement for use of the drain (Use Agreement), signed by the U.S. Bureau of Reclamation and the San Luis & Delta-Mendota Water Authority in 1995, set a district-level selenium cap (i.e., aggregate monthly and annual selenium discharge limits).

What Serves as the Basis for Trading?

Actions taken through the Grassland Bypass Project established the regional cap for selenium, which serves as the basis for the Grassland Area Farmers Tradable Loads Program. The 1995 Use Agreement signed by the Bureau of Reclamation (i.e., the owner of the section of the San Luis Drain used by the Grassland Area Farmers through the Grassland Bypass Project) and the San Luis & Delta Mendota Authority established the Grassland Bypass Project. The formal agreement contained the initial regional cap for selenium, which decreases over time; established an incentive fee system that increases over time; and stated that if the Grassland Area Farmers' discharges exceed the regional cap by more than 20 percent, the authority's use of the drain would terminate. The initial regional cap contained in the 1995 Use Agreement was developed using a consensus-based stakeholder approach and presented in the form of interim monthly and annual load limits for the first 5 years of the Grassland Bypass Project, (CRWQCB-CVR 2001a). The two parties signed on to the 2001 Use Agreement, which extends through December 2009.

At the time the 1995 Use Agreement was signed, the California Regional Water Quality Control Board (Regional Board) was developing an amendment to the existing basin plan for the San Joaquin River Basin. The 1996 Basin Plan Amendment contained a draft Total Maximum Daily Load (TMDL). The Regional Board set the load limits in the TMDL on a monthly and annual basis. In August 2001 the Regional Board published the *Total Maximum Daily Load for Selenium in the Lower San Joaquin River*, which establishes monthly load allocations for selenium depending on the type of water year (see *Determining Water Year Types* on the next page for more information).

In 1998 the Regional Board issued *Waste Discharge Requirements for San Luis and Delta-Mendota Water Authority and United States Department of the Interior, Bureau of Reclamation, Grassland Bypass Project Fresno and Merced Counties*, Order Number 98-171, which reflected the interim monthly and annual selenium load limits developed using a consensus-based approach under the 1996 Basin Plan Amendment. In September 2001 the Regional Board issued a new Waste Discharge Requirements Order Number 5-01-234, which uses the load limits contained in the 2001 Use Agreement. The load limits are designed to meet specific TMDL limits under the 2001 TMDL (CRWQCB-CVR 2001b).

At this point in time, the 2001 TMDL and the 2001 Waste Discharge Requirements Order Number 5-01-234 provide the current regional monthly and annual load limits for selenium and serve as the basis for water quality trading.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

2001 Total Maximum Daily Load for Selenium

The 2001 TMDL builds on previous load allocations calculated for the San Joaquin River. A simple spreadsheet model calculates monthly selenium load allocations based on critical flow. The model uses historical flow records, grouped by season and water year type to calculate design flow (low-flow) conditions for each flow regime. The 2001 TMDL uses the following water year type classifications: Critical, Dry/Below Normal, Above Normal, and Wet. Four seasonal groups used in the TMDL model represent the seasonality of flows in the San Joaquin

River Basin and the Grassland Area. The seasonal groups are September through November, December and January, February through May, and June through August. This approach resulted in 16 flow regimes, which allows dischargers to make adjustments to meet a season's load allocation. The design flows that correspond to a water year type and a season are key to calculating the TMDL monthly limits and the corresponding load allocations.

Determining Water Year Types

Water year type, as used in the San Joaquin TMDL model, is based on a classification scheme called the San Joaquin River Index of Unimpaired Flows. The index is a calculation of the percentage of the unimpaired runoff from the four major rivers in the basin during specific months of the year, as well as a percentage of the previous year's index.

The TMDL is the assimilative capacity of the waterbody. To calculate the TMDL, the design flow for a particular water year type and month is multiplied by the water quality objective and a conversion factor that converts acre-feet × micrograms per liter (µg/L) to pounds. A monthly load limit is established, rather than a daily limit, because most agricultural water districts lack the facilities needed to manage drainage on a daily basis.

Water Quality Objective *(µg/L) × Design flow (acre-feet) × 0.0027197 (conversion factor) = TMDL (pounds)*

Table 1. Example: Calculating the TMDL for Water Year Types in September

Time Period	Year Type	Water Quality Objective (µg/L)	Design Flow (ac-ft)	Conversion Factor	TMDL (lb)
September	Critical	5	5,016	0.0027197	68
September	Dry/Below Normal	5	20,298	0.0027197	276
September	Above Normal	5	22,667	0.0027197	308
September	Wet	5	27,850	0.0027197	378

Source: CRWQCB-CVR, 2001b

The TMDL must be distributed as a wasteload allocation for point sources, a load allocation for nonpoint sources, a margin of safety, and a background load. Because there are no point sources of selenium in the lower San Joaquin River Basin, there is no wasteload allocation. The margin of safety is 10 percent of the TMDL. The Grassland Bypass Project Area is the only nonpoint source in this TMDL and will receive the only load allocation. The load allocation is the TMDL minus the background load and the margin of safety. Similar to the TMDL, the load allocation and the background load vary according to season and water year type.

TMDL – *(Background Load + Margin of Safety) = Load Allocation*

Example: Calculating the TMDL and the Associated Load Allocation

The TMDL for the month of September during a wet year is determined by multiplying the water quality objective by the design flow for a wet year in September and the conversion factor of 0.0027197.

Water Quality Objective = 5 µg/L

Design Flow (September, Wet year) = 27,850 acre-feet (ac-ft)

Conversion Factor = 0.0027197

5 µg/L × 27,850 ac-ft × 0.0027197 = TMDL = 378 lb

The load allocation associated with a TMDL of 378 pounds for a wet year in September is the TMDL minus the background load and the margin of safety.

TMDL = 378 lb

Background Load = Loads produced at two upstream points and from wetlands during a Wet year in September (flow × concentration) = 8 lb

Margin of Safety = 10% of TMDL = 378 lb (TMDL) × 0.10 = 37.8 lb

378 lb – (8 lb + 37.8 lb) = LA = 332.2 lb

Waste Discharge Requirements Order No. 5-01-234 (2001)

The permit limits in the 2001 Waste Discharge Requirement Order reflect the load allocations by month and water year type in the 2001 TMDL adjusted by the selenium reduction goals in the 1996 Basin Plan Amendments, as well as stakeholder negotiations. As a result, no straightforward calculation is available to demonstrate how the 2001 TMDL load allocations translate to permit limits.

Are Permits Used to Facilitate Trades?

In California, the Regional Boards issue Waste Discharge Requirement Orders that serve the same function as permits issued under the National Pollutant Discharge Elimination System (NPDES) program. The Regional Board issued *Waste Discharge Requirements for San Luis & Delta—Mendota Water Authority and United Sates Department of the Interior Bureau of Reclamation Grassland Bypass Project, Fresno and Merced Counties*, Order No. 98-171, in 1998. The order contained the enforceable regional cap for selenium for the Grassland Area Farmers. In 2001 the Regional Board issued a new Waste Discharge Requirement

Order (No. 5-01-234) and rescinded the previous order. The 2001 Waste Discharge Requirement Order does not contain language that addresses trading. Trading is an internal tool that the Grassland Area Farmers use to comply with the regional cap for selenium.

How Are Credits Generated for Trading?

Formalized trading under the Grassland Area Farmers Tradable Loads Program occurred only during 1998 and 1999. To facilitate trading, a Steering Committee allocated the regional cap for selenium among the seven districts that compose the Grassland Area Farmers. The district-level allocations are referred to as selenium load allocations. Selenium load allocations for each district were calculated based on tilled acreage, total acreage, and historical selenium loads from each district (Anderson 2000). However, there is no precise formula for calculating the selenium load allocations because a consensus-based process involving the participating districts ultimately determined the final selenium load allocations (Linnemann 2004).

The Steering Committee, in conjunction with a project director and the seven drainage districts, developed draft rules to implement the trading program. Rules were developed for each water year (i.e., October 1 through September 30 of the following year). They specified the district-level selenium load allocations, the role of a regional drainage coordinator, and other requirements for reducing selenium loading (Anderson 2000).

Because credits are based on actual monthly selenium loads, the trades that have occurred have been retroactive in nature (Breetz et al. 2004). Trades can involve direct purchases of selenium load allocations or an exchange of allocations between districts (Anderson 2000). Districts that discharge below their selenium load allocation generate credits eligible for trading. Districts with discharges that exceed their selenium load allocation must trade with another district or pay their percentage of the regional incentive fee established through the rules for a particular water year. The percentage of the incentive fee owed by a district that exceeds its selenium load allocation is calculated by dividing the pounds of selenium above that district's selenium load allocation by the total exceedances of all districts (Anderson 2000).

Selenium load above selenium load allocation (pounds) / Total selenium load of all districts above regional selenium cap (pounds) = Incentive fee percentage

The monthly limit during October for the regional cap in water year 1999 was 348 pounds of selenium, with an annual limit of 6,327 pounds. In this example, the Grassland Area Farmers collectively exceeded the monthly regional selenium cap by 9 percent. The 1995 Use Agreement Performance Incentive System sets the monthly fee for exceeding the monthly regional selenium cap at between 0.1 and 10 percent for Year 2 of the program at $1,200. Therefore, the amount of incentive fee owed by each district to the Incentive Fee Account is as shown in Table 2.

Table 2. Example: Calculating District-Level Incentive Fees

District	October 1998 Monthly Selenium Load Allocation (lb) ①	October 1998 Monitored Selenium Load (lb) ②	Selenium Load Allocation Exceedance (lb) ③ ② - ① = ③	Incentive Fee Percentage ⑤ ③ / ④ = ⑤	Portion of Monthly Incentive Fee ($1,200)
1	169	180	11	11 lb/33 lb = 33 percent	$1,200 × 0.333 = $399.60
2	69	71	2	2 lb/33 lb = 6 percent	$1,200 × 0.061 = $73.20
3	46	48	2	2 lb/33 lb = 6 percent	$1,200 × 0.061 = $73.20
4	28	30	2	2 lb/33 lb = 6 percent	$1,200 × 0.061 = $73.20
5	18	26	8	8 lb/33 lb = 24 percent	$1,200 × 0.242 = $290.40
6	14	20	6	6 lb/33 lb = 18 percent	$1,200 × 0.182 = $218.40
7	4	6	2	2 lb/33 lb = 6 percent	$1,200 × 0.061 = $73.20
Total	348	381	33 ④	9 percent over monthly regional cap	$1,201.20

In water year 1999, the cost per pound of selenium was approximately $40.00.

One method used to reduce selenium loads was drainage recycling, where drainage water was applied to salt-tolerant crops (Breetz et al. 2004).

What Are the Trading Mechanisms?

When the program formally executed trades, participating districts signed bilateral trade agreements that named the parties involved and specified the month and year of the selenium load allocation being traded (Anderson 2000). Trades no longer occur using formal mechanisms such as trade agreements; instead, districts make informal agreements when trades occur that do not require any type of written documentation (Linneman 2004).

What Is the Pollutant Trading Ratio?

No trading ratio is used. Credits are based on actual monthly selenium loads measured by each irrigation district not on estimates of best management practice effectiveness (Breetz et al. 2004).

What Type of Monitoring Is Performed?

The drainage districts monitor selenium loads at the 62 sumps where water is pumped into the drain. A combination of flow measurements and analytical sampling is used to determine selenium loading, although farmers and districts can estimate weekly updates on loading. Selenium loading data generated by the districts' monitoring activities were processed over 1 to 2 months to calculate retroactive credits under the formalized trading procedures (Anderson 2000).

What Are the Incentives for Trading?

The districts are subject to *incentive fees* if they exceed their aggregate cap, and their use of the irrigation drain is cut off after a 20 percent exceedance. The selenium cap is lowered each year, and the incentive fee for exceedances is raised each year, providing a strong incentive for the districts to control their discharges. Rather than paying a portion of the incentive fee, a district may participate in trading to achieve the monthly and annual regional selenium caps for each water year.

What Water Quality Improvements Have Been Achieved?

Selenium loading has decreased every water year from 1995 to 2001, except the wet year in 1998, and regional selenium load targets have been met nearly every month through February 2004 (Breetz et al. 2004).

What Are the Potential Challenges in Using This Trading Approach?

Potential challenges associated with the approach used in the Grassland Area Farmers Tradable Loads Program include the following (Breetz et al. 2004):

- Time for processing the data necessary to calculate credits using actual loading data as opposed to estimated load reductions
- Resources for conducting continuous monitoring (e.g., irrigation monitoring)
- Negotiations to determine reasonable pricing

What Are the Potential Benefits?

Benefits associated with the Grassland Area Farmers Tradable Loads Program include the following (Breetz et al. 2004):

- High degree of certainty because trades are based on actual monitoring data
- No need to adjust credits for relative environmental impacts because there is a single discharge point
- No danger of noncompliance with trade agreements because trades are retroactive based on actual pollutant loads

Applicable NPDES Permit Language

As mentioned above, the Waste Discharge Requirement Orders issued by the Regional Board contain the applicable effluent limits to achieve the water quality objective for selenium. However, neither of the Waste Discharge Requirement Orders contains language that specifically references water quality trading to achieve the regional selenium cap set for the Grassland Bypass Project participants.

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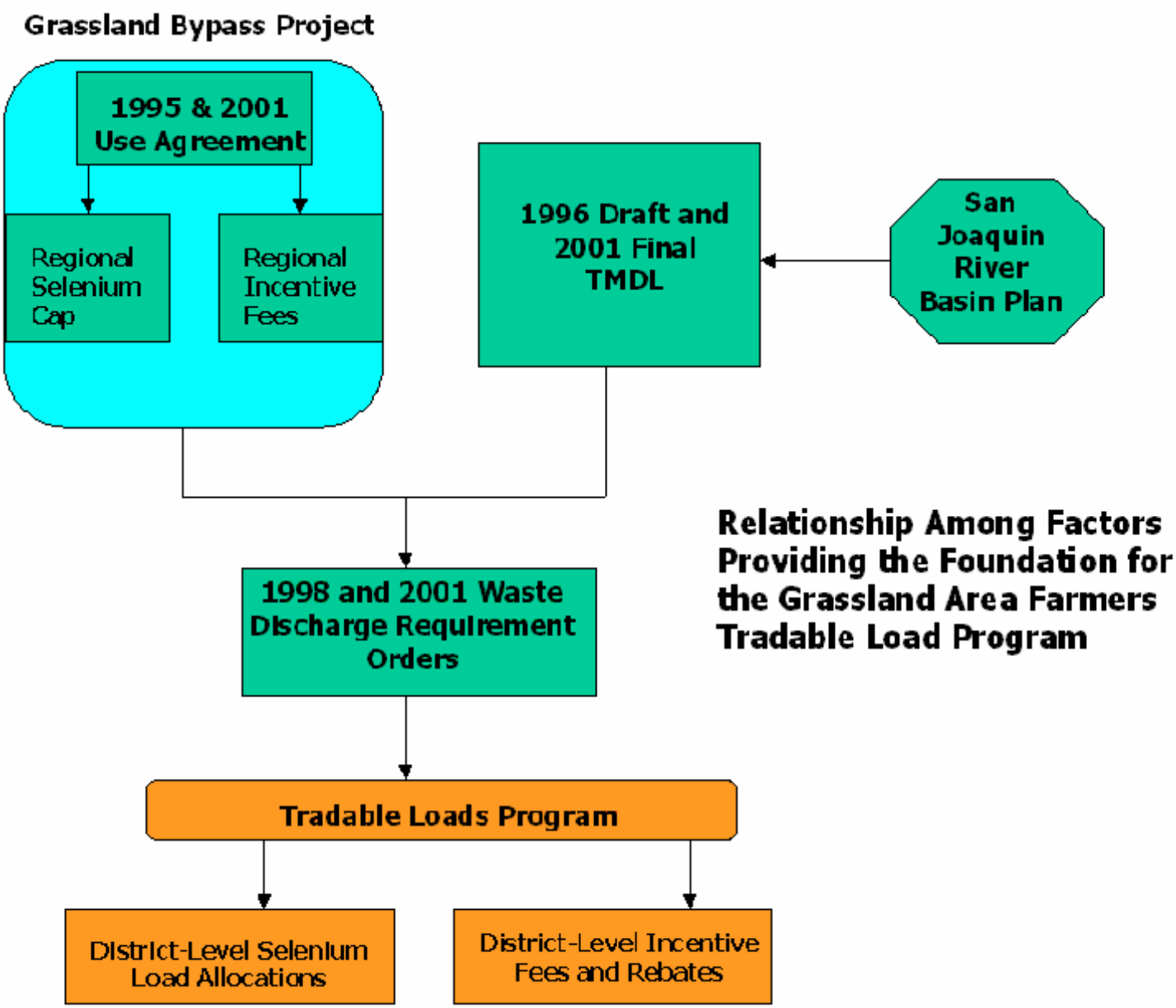

Relationship Among Factors Providing the Foundation for the Grassland Area Farmers Tradable Load Program

Long Island Sound Nitrogen General Permit and Nitrogen Credit Exchange Program *Connecticut*

Overview

The Connecticut portion of the Long Island Sound watershed encompasses approximately 79 publicly owned treatment works (POTWs) that contribute to the problem of seasonal hypoxia. The Connecticut Department of Environmental Protection (CTDEP) developed its watershed-based NPDES General Permit for Nitrogen Discharges (General Permit) and Nitrogen Credit Exchange Program to help POTWs achieve nitrogen reductions called for in the Total Maximum Daily Load (TMDL). POTWs must meet the annual average discharge limits in the permit or purchase the necessary credits to achieve their individual limits through the Nitrogen Credit Exchange Program administered by an advisory board and CTDEP. If the POTWs generate more credits than purchasing POTWs need, the state is obligated to purchase the remaining credits to ensure that the POTWs that made nitrogen reductions are appropriately awarded for their efforts.

Type of Trading

Point Source–Point Source

Pollutant(s) Traded

Total nitrogen

Number of Trades to Date

In 2002, 38 municipalities purchased credits and 39 municipalities sold credits (CTDEP 2003).
In 2003, 40 municipalities purchased credits and 37 municipalities sold credits (Stacey 2004c).
In 2004, 44 municipalities purchased credits and 35 municipalities sold credits (CTDEP 2006).
In 2005, 50 municipalities purchased credits and 28 municipalities sold credits (CTDEP 2006).

Who Is Eligible to Participate?

Seventy-nine municipal sewage treatment plants scattered throughout the state of Connecticut participate in the Nitrogen Credit Exchange Program.

What Generated the Need for Trading?

Seasonal hypoxia affects the bottom waters of the western half of the Long Island Sound during the summer. Monitoring, modeling, and research spanning 15 years indicated the need for Connecticut and New York to significantly reduce nitrogen loads. Connecticut and New York developed a bistate TMDL for nitrogen that EPA approved in 2001. The TMDL is based on the states' dissolved oxygen (DO) criteria.

What Serves as the Basis for Trading?

The TMDL's wasteload allocation developed for the Long Island Sound serves as the driver for trading among the 79 POTWs in Connecticut.

In 2001 EPA approved the CTDEP and New York State Department of Environmental Conservation (NYSDEC) TMDL calling for nitrogen reductions of 58.5 percent from their combined point and non-point sources from 2001 levels by 2014. The TMDL contains an uneven distribution between the wasteload and load allocations: Connecticut has a 10 percent reduction requirement from urban and agricultural land cover and a 64 percent reduction from point sources, which combined equal the 58.5 percent reduction in the TMDL (Stacey 2004c).

The TMDL was developed to attain DO criteria for Long Island Sound of 5 to 6 milligrams per liter (mg/L). Since TMDL adoption, Connecticut has revised its DO criteria establishing a minimum concentration of 3.5 mg/L with allowable exposure days within incremental ranges to 4.8 mg/L, based on EPA DO criteria. New York is in the process of revising its criteria along similar lines. The revised DO criterion, however, have not yet affected the wasteload or load allocations in the TMDL.

58.5 percent nitrogen reduction from in-basin sources + reductions in nitrogen and carbon from out-basin sources + non-treatment alternatives + margin of safety = TMDL for Long Island Sound

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

Ambient Monitoring

Year-round monitoring of the Long Island Sound began in 1988 and continues to date. Parameters include water temperature, salinity, all nutrient species for phosphorus and nitrogen, silicon, dissolved oxygen, chlorophyll *a*, and total suspended solids.

LIS 3.0 Hydrodynamic/Water Quality Model

Federal funding facilitated the development of a coupled, three-dimensional, time-variable hydrodynamic/water quality model called LIS 3.0. The LIS 3.0 model defined the unique transport mechanisms that distribute nitrogen throughout the Long Island Sound. The transport efficiencies identified through LIS 3.0 were key in understanding the relative importance of nitrogen sources from various locations around the sound in oxygen depletion (Stacey and Tedesco 2004). Information generated through the LIS 3.0 model also assisted in the developing of planned and completed DO criteria revisions relevant to Long Island Sound.

The model has been calibrated using ambient monitoring data collected over the 18-month period from April 1988 through September 1989 described earlier. The 18-month calibration period covers all seasons of the year; actual hydrological and meteorological conditions for that time period were input into the model. Tributary loadings and combined sewer overflows were also determined using time-variable rainfall and river flow data. Other factors that influence external boundary conditions and internal circulation within the Sound, such as hydrological and meteorological conditions (seasonal variations, such as wet and dry weather conditions), have been considered and are included in the model as well (CTDEP and NYSDEC 2000).

Nitrogen Management Zones and Equivalency Factors

In-basin loads of nitrogen (i.e., nitrogen originating within the Connecticut and New York portions of the Long Island Sound drainage basin, including those deposited directly on the sound's surface) were partitioned by location into 12 nitrogen management zones. Eleven of

the management zones surround the sound in Connecticut and New York, and the 12th zone is the surface of Long Island Sound. Zones 1 to 11 are considered terrestrial management zones that follow the natural river basin boundaries in Connecticut. Connecticut management zones (Zones 1 to 6) were further divided into tiers to account for nitrogen attenuation during transport from one tier to the next (CTDEP and NYSDEC 2000).

By using the LIS 3.0 model and U.S. Geological Survey monitoring data for major tributaries, CTDEP gained information on attenuation factors in Long Island Sound and during riverine transport, respectively, which are important for quantifying relationships between discharge points and actual delivery of nitrogen to Long Island Sound (CTDEP and NYSDEC 2000). These factors combined account for relative nitrogen impact on DO depletion in Long Island Sound from geographically distributed sources. They are used as trading ratios or equalization factors to put the 79 POTWs involved in trading on an equal basis, which is a critical component of the Nitrogen Credit Exchange Program (Stacey 2004b).

To calculate the overall equivalency factors, CTDEP multiplied the river delivery factor for a tier within a particular management zone by the Long Island Sound transport efficiency from Connecticut's six management zones once the nitrogen reached the edge of the sound to the area of hypoxia. Table 1, taken from the Long Island Sound TMDL, illustrates how CTDEP calculated the equivalency factor for two tiers within two management zones.

Table 1. Example: Calculating the TMDL for Water Year Types in September

Zone - Tier	River Delivery Factor	LIS Transport Factor	Combined Equivalency Factor
1-1 (Eastern Long Island Sound, along the shore)	1.00	0.17	0.17
2-3 (Northern tier of Connecticut River)	0.87	0.20	0.17

CTDEP expresses the factors as the decimal fraction of the nitrogen load delivered (CTDEP and NYSDEC 2000). CTDEP made the assumption that the tiers closest to the Long Island Sound have no nitrogen attenuation (i.e., they deliver 100 percent of the nitrogen load as shown for Zone-Tier 1-1 above) and assigned the value of 1 as the river delivery factor.

Aggregate and Individual Facility Nitrogen Load Baselines

During the TMDL development process, CTDEP had to come to agreement on the nitrogen loading from the 79 POTWs to establish a baseline and set reduction targets. Some facilities had 10 years of discharge volume data, but other facilities had not conducted nutrient monitoring until 1993 or later. For facilities that did not have nutrient monitoring in place, CTDEP applied estimated nitrogen and total organic carbon (TOC) concentrations (usually 15 mg/L for nitrogen and 20 mg/L for TOC) to 1990 measured flow to develop each zone's aggregate baseline load estimates (CTDEP and NYSDEC 2000). A facility was given a baseline nitrogen load by calculating the relative proportion of flow each individual facility contributed to the statewide total flow over a consistent time period for all facilities. The period 1997 to 1999 was selected for this purpose as representative of the current situation, and it was the starting point for implementing the wasteload allocation in the TMDL (CTDEP 2000).

Are Permits Used to Facilitate Trades?

The General Permit contains annual end-of-pipe (i.e., attenuation not applied) discharge limits for nitrogen for 79 POTWs in the Connecticut portion of the Long Island Sound. Permit limits are ramped down each year of the 5-year permit cycle, reflecting anticipated nitrogen removal projects coming on line among all 79 permittees. This approach helps ensure consistent and steady progress toward the nitrogen removal goals prescribed in the TMDL. Section 4 of the General Permit sets forth the conditions of the general permit, referencing annual discharge limits (listed in Appendix 1). Credits used on the exchange are *equivalent* credits, and attenuation factors are applied to each permittee's surplus or deficit below or above the end-of-pipe limit. Each permittee can meet its annual discharge limits through treatment or purchase of state-owned equivalent nitrogen credits in accordance with the Nitrogen Credit Exchange Program. Permittees that do better than their permit limit have credits to sell to the Nitrogen Credit Exchange Program.

How Are Credits Generated for Trading?

Each facility is responsible for monitoring its effluent discharge according to the General Permit's monitoring requirements as well as for reporting its monthly mass loading of total nitrogen (along with other required monitoring information). CTDEP compiles and analyzes monthly mass loading information for each facility, in conjunction with other required information, to determine the facility's annual mass loading of total nitrogen (i.e., the sum of monthly mass loading of total nitrogen for each month from January through December divided by 12 and rounded to the nearest whole number).

CTDEP then compares a facility's annual mass loading of total nitrogen to the facility's annual average discharge limit for that year, applies the appropriate equivalency factor or trading ratio, and determines the number of equivalent credits each facility must buy to achieve permit compliance. A facility has generated credits to sell through the Nitrogen Credit Exchange Program if it has performed better than its permit limit requires. All permittees are in compliance with the General Permit if they (1) meet the permit limit, (2) do better than the permit limit, or (3) purchase adequate equivalent credits to meet their permit limit.

Therefore, the number of credits a facility has to sell—or that a facility must purchase to remain in compliance—is the average annual loading above or below the annual discharge limit multiplied by the equivalency factor. Under the Nitrogen Credit Exchange Program, an equivalent pound of nitrogen is also referred to as an equalized nitrogen credit.

CTDEP works with the Nitrogen Credit Advisory Board to set prices and administer the Nitrogen Credit Exchange each year. Prices are based on the cost of the nitrogen removal projects implemented, the number of pounds of nitrogen removed by those projects, plus the cost of operating and maintaining those facilities where projects have been implemented. CTDEP and the Nitrogen Credit Advisory Board ensure that reporting and accounting are accurate and that bills and credits are disbursed in a timely manner, according to the schedule set forth in the Connecticut General Statutes.

End-of-pipe nitrogen loads × *Facility's equivalency factor = Equivalent pounds of nitrogen*

Example: Converting End-of-Pipe Nitrogen Discharges to Equivalent Pounds of Nitrogen for Trading in the Nitrogen Credit Exchange Program

In January 2002, Facility X discharged a monthly average of 2,594 lb/day of nitrogen. The equivalency factor for Facility X is 0.20. To convert the monthly mass loading into equivalent pounds of nitrogen generated, Facility X would perform the following calculation:

Total nitrogen loading (lb/day) × equivalency factor = equivalent pounds of nitrogen

2,594 lb/day × 0.20 = 518.8 equivalent pounds of nitrogen

During January 2002, Facility X's monthly mass loading of total nitrogen was 2,594 lb/day, which translates to 518.8 equivalent pounds of nitrogen.

(Annual discharge limit – Annual average mass loading of total nitrogen) × *(Facility equivalency factor) = Amount of equalized nitrogen credits to buy or sell*

Example: Calculating the Number of Equalized Nitrogen Credits Necessary to Achieve Permit Compliance

In 2002 Facility X had an annual average mass loading of 2120 lb/day of total nitrogen. Appendix 1 of the General Permit for Nitrogen sets an annual discharge limit for Facility X in 2002 at 1665 lb/day. The equivalency factor for Facility X is 0.20.

(Annual discharge limit – Annual average mass loading of total nitrogen) × (Facility equivalency factor) = Amount of equivalent nitrogen credits to buy or sell

(1665 lb/day – 2120 lb/day) × (0.20) = –91 equivalent pounds of nitrogen (or equivalent nitrogen credits)

Facility X's annual average mass loading exceeded its annual discharge limit by 455 lb/day of total nitrogen. Multiplied by the facility's equivalency factor of 0.20, the 455 lb/day of total nitrogen that exceeds the annual discharge limit translates to 91 equivalent pounds of nitrogen credits that Facility X must purchase to comply with its annual discharge limit under the General Permit for Nitrogen for 2002.

The Nitrogen Credit Advisory Board establishes credit prices based on *equivalent pounds* using final data from a particular year. For example, the Nitrogen Credit Advisory Board waited until monitoring data for January through December 2002 became available to calculate the value of credit. In March 2003 the Nitrogen Credit Advisory Board sent each facility a final invoice that itemized the facility's annual mass loading, its annual average discharge limit contained in the General Permit for Nitrogen, and the established value of a credit for 2002.

Therefore, facilities do not buy or sell credits for a calendar year until the following calendar year upon notification from CTDEP.

The Nitrogen Credit Advisory Board derives an annual value for equalized nitrogen credits by dividing the total annual cost of all implemented nitrogen removal projects, plus the annual operation and maintenance costs of operating the denitrification systems, by the reduction in equalized pounds of nitrogen. The total annual project cost is composed of two components: (1) total annualized capital costs to construct treatment facilities for nitrogen removal and (2) total eligible annual operation and maintenance costs for nitrogen removal treatment (CTDEP 2003). Total annualized capital costs are defined as the total amount of each project facility's loan from the Clean Water Fund attributable to the total eligible capital cost (i.e., 100 percent of the eligible capital costs, based on a 30 percent grant provided to the facility and the loan to finance the remaining 70 percent of the eligible capital costs) divided by a 20-year loan repayment period. Eligible capital costs are all costs associated with improvements for the planning, design, and construction costs for a nitrogen removal facility, excluding costs related to the modification of a facility for purposes other than the enhancement of the nitrogen treatment process (e.g., secondary treatment upgrades), and the costs of equipment and land necessary for nitrogen treatment. Total eligible annual operation and maintenance costs means the incremental increase in the cost of labor, administration, electricity, and chemicals to remove nitrogen. Operation and maintenance (O&M) costs are estimated using a survey sent to all facilities conducting nitrogen removal projects (project facilities). The reduction in equalized pounds of nitrogen is calculated by first subtracting the *baseline* loading established for the facility in the TMDL for Long Island Sound from the actual end-of-pipe pounds of nitrogen discharged by each of the project facilities to quantify the reduction from project implementation and multiplying by the appropriate equivalency factor, as shown above.

Total annual Nitrogen Removal Project cost/Total reduction in equalized pounds of nitrogen = Cost per equalized nitrogen credit

Capital costs (i.e., annual Clean Water Fund repayment amount for nitrogen treatment facilities) + O&M estimated costs (i.e., estimates of O&M costs associated with nitrogen treatment facilities from a survey of Project Facilities) = Total annual Nitrogen Removal Project cost

(Actual end-of-pipe pounds of nitrogen discharged by each Project Facility – baseline nitrogen loading for a Project Facility from the TMDL) (Project Facility's equalization factor) = Reduction in equalized pounds of nitrogen

Example: Calculating the Annual Value of Nitrogen Credits and Reductions in Equalized Pounds of Nitrogen

In 2003 the Nitrogen Credit Advisory Board established the value of an equalized nitrogen credit for FY 2002 at $1.65.

$1,765,432 Capital Costs + $2,944,013 O&M estimated costs = $4,709,445 Total Project Cost

Example: Calculating the Annual Value of Nitrogen Credits and Reductions in Equalized Pounds of Nitrogen *(continued)*

To find the total reduction in equalized pounds of nitrogen, it is necessary to look at each of the Project Facilities financing nitrogen removal projects. In 2002 a total of 23 Project Facilities achieved a reduction of 2,861,852 equalized pounds of nitrogen.

$4,709,445 Total Project Cost/2,861,852 total pounds of equalized nitrogen removed = $1.65 per equalized nitrogen credit

Each year CTDEP audits the performance of plants operating for the full calendar year (January 1 to December 31) to establish the value of nitrogen credits, taking into consideration increased capital costs of nitrogen removal for projects implemented the prior year (i.e., operational as of January 1 for each trading year), as well as added operation and maintenance costs of reduction methods. At the end of March each year, CTDEP determines the total number of credits to be bought and sold, publishes the annual value of nitrogen credits, and notifies each plant of its nitrogen credit balance. Plants have until the end of July to purchase credits from CTDEP to meet their discharge limit. By the middle of August, CTDEP must purchase all available credits and send payments to the facilities that generated the credits.

In 2002, 38 facilities generated approximately 1,671,105 equalized nitrogen credits to sell at $1.65 per credit for a total value of $2,757,323. In 2002, 38 facilities were required to purchase a total of 798,317 equalized nitrogen credits to remain in compliance with the General Permit; at $1.65 per credit, the total amount of purchased credits was $1,317,223. As a result, approximately 872,788 equalized nitrogen credits were not needed by facilities to achieve permit compliance in 2002. The Nitrogen Credit Exchange Program required CTDEP to purchase the remaining 872,788 equalized nitrogen credits at a total cost of $1,440,100.

In 2003, 37 facilities generated approximately 1,134,876 equalized nitrogen credits to sell at $2.14 per credit for a total value of $2,428,636. To remain in compliance with the General Permit, 40 facilities purchased equalized nitrogen credits; at $2.14 per credit, the total amount of purchased credits was $2,116,875. CTDEP purchased the excess 145,682 equalized nitrogen credits for a total cost of $311,761.

In 2004, 35 facilities generated approximately 1,399,896 equalized nitrogen credits to sell at $1.90 per credit for a total value of $2,659,804. To remain in compliance with the General Permit, 44 facilities purchased equalized nitrogen credits; at $1.90 per credit, the total amount of purchased credits was $1,786,736. CTDEP purchased the excess 459,509 equalized nitrogen credits for a total cost of $873,068.

In 2005, 28 facilities generated approximately 623,408 equalized nitrogen credits to sell at $2.11 per credit for a total value of $1,315,392. To remain in compliance with the General Permit, 50 facilities purchased equalized nitrogen credits; at $2.11 per credit, the total amount of purchased credits was 1,169,553 for a total cost of $2,467,757.

Number of equalized nitrogen credits *(equivalent lb/day) × 365 days = Annual total of equalized nitrogen credits*

Total cost of annual equalized nitrogen credits to achieve permit compliance = Annual total of equalized nitrogen credits × Annual value of equalized nitrogen credits

Example: Calculating the Cost of Equalized Nitrogen Credits Necessary to Achieve Permit Compliance

In the previous example, Facility X was required to purchase 91 equalized nitrogen credits to comply with its annual discharge limit under the General Permit for 2002.

CTDEP will send Facility X a letter that indicates the facility's annual average mass loading for 2002, the annual discharge limit for 2002 under the General Permit, the number of equalized nitrogen credits that the facility must purchase to achieve permit compliance and the value of an equalized nitrogen credit for 2002. To calculate the total number of credits and the total cost, CTDEP will make the following calculations:

Number of equalized nitrogen credits (equivalent lb/day) × 365 days = Annual total of equalized nitrogen credits

Total cost of annual equalized nitrogen credits to achieve permit compliance = Annual total of equalized nitrogen credits × Annual value of equalized nitrogen credits

Therefore, the letter from CTDEP to Facility X will indicate that the facility must purchase 91 equalized nitrogen credits (equivalent lb/day) for 365 days, for a total of 33,215 equalized nitrogen credits. At a cost of $1.65 per credit, Facility X will spend a total of $54,804.75 to achieve permit compliance in 2002.

What Are the Trading Mechanisms?

CTDEP sends a final invoice to each POTW at the end of March each year. The final invoice indicates the total number of credits to be bought or sold and the annual value of equalized nitrogen credits.

What Is the Pollutant Trading Ratio?

CTDEP considers a trading ratio to be a factor that adjusts for variability among sources. Using this definition, CTDEP considers the equivalency factors for each of the management zones to be the trading ratios of the Long Island Sound Nitrogen Credit Exchange Program (Stacey 2004b). The equivalency factors were published in the TMDL and in Connecticut's enabling legislation.

What Type of Monitoring Is Performed?

Since 2002 treatment plants have been required to monitor flow and total nitrogen, reporting to the state on a monthly basis. All treatment facilities must monitor daily flow continuously to calculate their average daily flow volume. Depending on the facility's flow rate, it must monitor the final effluent either once per week (if its flow rate is less than 10,000,000 gallons per day) or twice per week (if its flow rate is greater than or equal to 10,000,000 gallons per day). Each month, municipalities must enter the results of analyses for the total nitrogen and the average daily flow volume of the effluent on Monthly Operating Reports and Nitrogen Analysis Reports, which they present to the CTDEP. Plants are also subject to annual inspections. CTDEP inspects each of the 79 municipal facilities regulated under the General Permit at least once during each year of the program, evaluating all aspects of the facility's operation and monitoring procedures.

What Are the Incentives for Trading?

CTDEP is authorized to conduct compliance audits of the annual operating data for plants that participate in the program. Any plant that fails to meet its individual wasteload allocations and does not purchase the appropriate amount of credits is subject to existing statutory water pollution control enforcement provisions. Within 5 days of learning of a violation under the General Permit, a point source must determine the cause of the violation, institute plans to correct the violation, mitigate its effects, and prevent further forms of it. The permittee is also required to report the violation and subsequent corrective action to the state. The state reserves the right to revoke or modify a point source's authorization under the General Permit.

What Water Quality Improvements Have Been Achieved?

Actual nitrogen removal has been ahead of the reduction targets established in the TMDL for nitrogen.

What Are the Potential Challenges in Using This Trading Approach?

Upgrades to municipal treatment plants require stable, multiyear funding. The single factor most critical factor to the continued progress of the program is the continued availability of Clean Water Fund dollars to support the infrastructure of nitrogen removal.

What Are the Potential Benefits?

CTDEP's approach to the Nitrogen Credit Exchange Program establishes a well-defined trading structure supported and regulated by limits mandated in state law. Equivalency factors and all accounting methodologies were specified in the state enabling legislation to formalize all calculations used in trading. This might help reduce technical challenges to the program as opposed to, for example, just including equivalency factors in the TMDL and the General Permit (Stacey 2004a).

Applicable NPDES Permit Language

CTDEP initially issued the General Permit for Nitrogen Discharges in January 2002. The permit was reissued in December 2005. The following excerpts contain trading provisions found in the 2005 permit.

Section 4.(b) Compliance During Term of Permit

(1) A permittee shall be in compliance with its annual discharge limits of this general permit if:

(A) the POTW's annual mass loading of total nitrogen is less than or equal to the discharge limit set forth in Appendix 1; or,

(B) the permittee has secured state-owned equivalent nitrogen credits equal to the amount the POTW exceeded the annual discharge limit set forth in Appendix 1 in accordance with the Nitrogen Credit Exchange Program and Sections 22a-521 through 527 of the Connecticut General Statutes.

(2) A permittee shall be out of compliance with the annual discharge limits of the general permit and subject to the enforcement provisions of chapter 446k of the Connecticut General Statues if:

(A) the POTW's annual mass loading of total nitrogen is greater than the discharge limit set forth in Appendix 1; and

(B) the permittee fails to secure sufficient state-owned equivalent nitrogen credits in a timely manner in accordance with the Nitrogen Credit Exchange Program and Sections 22a-521 through 527 of the Connecticut General Statutes.

Section 4. (m) Other Applicable Law

Nothing in this general permit shall relieve the permittee of the obligation to comply with any applicable federal, state and local law, including but not limited to the obligation to obtain and comply with any authorizations required by such law. In the event a POTW is subject to a more stringent nitrogen limitation than set forth in this general permit, the Permittee shall comply with that more stringent limitation and may not purchase or transfer nitrogen credits to comply with that additional limitation.

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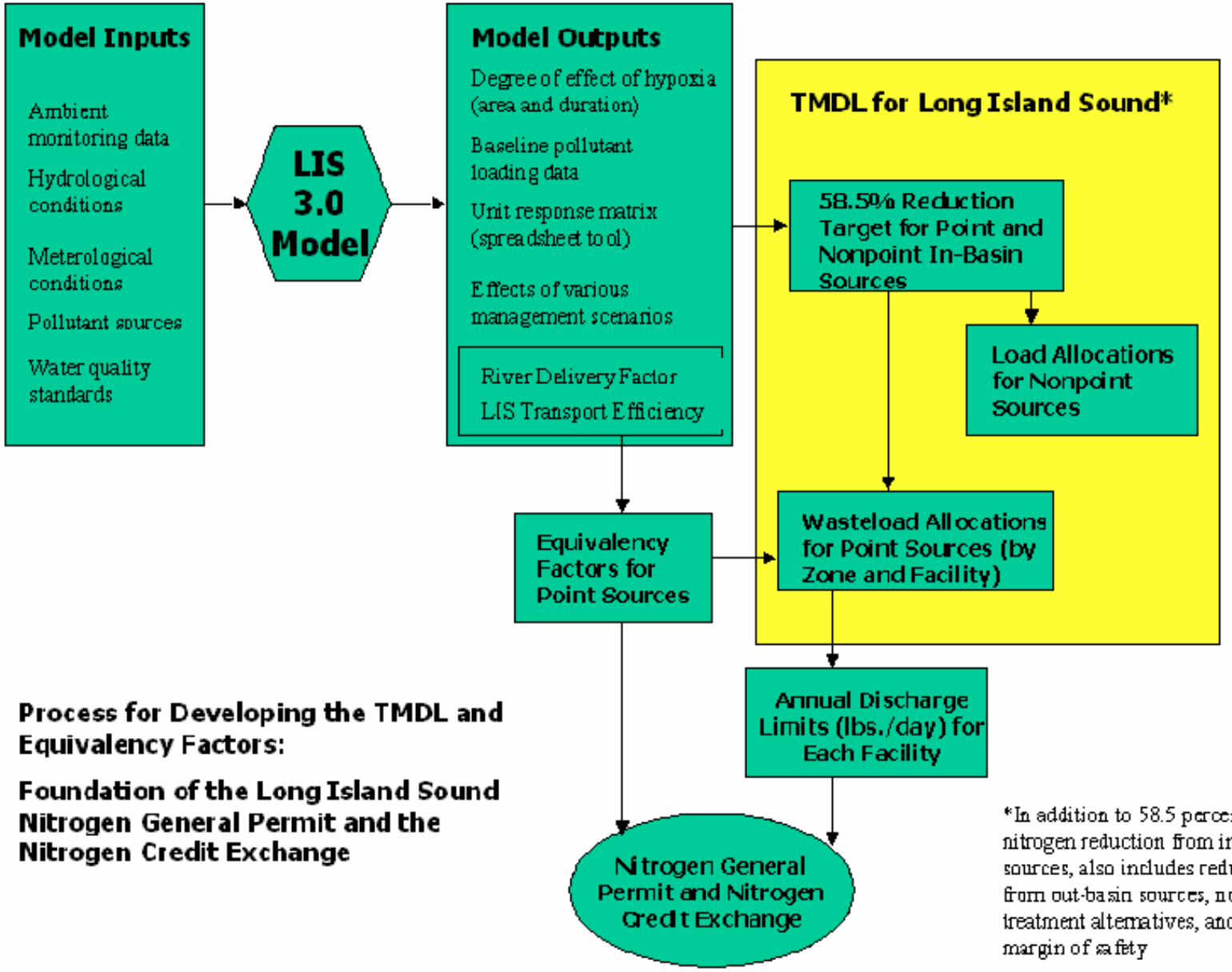
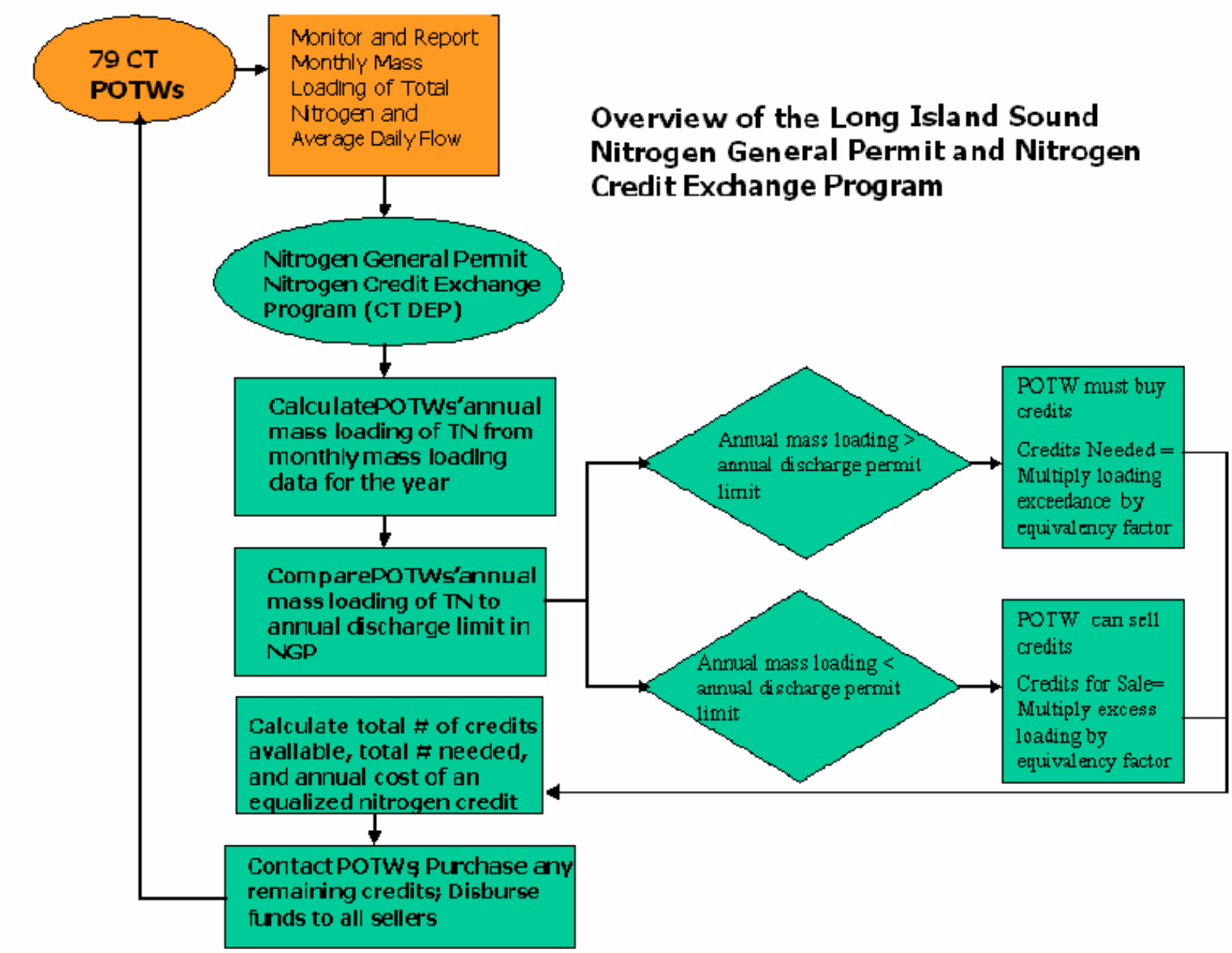


Process for Developing the TMDL and Equivalency Factors:

Foundation of the Long Island Sound Nitrogen General Permit and the Nitrogen Credit Exchange

*In addition to 58.5 percent nitrogen reduction from in-basin sources, also includes reductions from out-basin sources, non-treatment alternatives, and a margin of safety


79 CT POTWs
Monitor and Report Monthly Mass Loading of Total Nitrogen and Average Daily Flow
Overview of the Long Island Sound Nitrogen General Permit and Nitrogen Credit Exchange Program
Nitrogen General Permit Nitrogen Credit Exchange Program (CT DEP)
Calculate POTWs' annual mass loading of TN from monthly mass loading data for the year
Compare POTWs' annual mass loading of TN to annual discharge limit in NGP
Annual mass loading > annual discharge permit limit
POTW must buy credits
Credits Needed = Multiply loading exceedance by equivalency factor
Annual mass loading < annual discharge permit limit
POTW can sell credits
Credits for Sale= Multiply excess loading by equivalency factor
Calculate total # of credits available, total # needed, and annual cost of an equalized nitrogen credit
Contact POTWs; Purchase any remaining credits; Disburse funds to all sellers

Lower Boise Effluent Trading Demonstration Project
Idaho

Overview

The Lower Boise Effluent Trading Project will allow point and nonpoint sources to trade phosphorus credits generated by approved nonpoint source best management practices (BMPs). These BMPs have been assigned an effectiveness ratio and an uncertainty discount. Trades will be coordinated through contracts and specified forms and tracked in a statewide database.

Type of Trading

Point Source–Point Source
Point Source–Nonpoint Source

Pollutant(s) Traded

Total phosphorus

Number of Trades to Date

None

Who Is Eligible to Participate?

Point source NPDES permit holders (e.g., wastewater treatment plants, industrial dischargers) and nonpoint sources (e.g., farmers and irrigation districts) are eligible to participate.

What Generated the Need for Trading?

The states of Idaho, Oregon, and Washington worked with EPA Region 10 to explore water quality trading as a tool for managing water resources prior to developing and implementing total maximum daily loads (TMDLs).

What Serves as the Basis for Trading?

Nutrient reductions in the Lower Boise River TMDL were deferred until the completion and approval of the Snake River-Hells Canyon TMDL (Idaho DEQ and Oregon DEQ 2004). The TMDL for Snake River-Hells Canyon addresses nutrients and sets nutrient reduction goals for the Lower Boise River because loading to the river has a significant impact on nutrient loading and nuisance aquatic growth in downstream portions of the Snake River-Hells Canyon watershed. In the interim, the Lower Boise River TMDL called for no net increase of total phosphorus (Breetz et al. 2004). Trading has been delayed until the completion and approval of the Snake River-Hells Canyon TMDL.

In September 2004, EPA approved the Snake River-Hells Canyon TMDL. The final TMDL provides an allocable phosphorus load for three segments. The final TMDL provides only phosphorus wasteload allocations for point sources that discharge directly to the Snake River. Tributaries to the Snake River, including the Lower Boise River, must set wasteload allocations for point sources through separate tributary TMDL processes. Therefore, point sources

in the Lower Boise River Basin do not yet have specific wasteload allocations as a result of the Snake River-Hells Canyon TMDL. A Watershed Advisory Group (WAG) is developing the Lower Boise TMDL. After the WAG completes the TMDL, the Idaho DEQ will review and revise it and submit it for EPA approval. The current target is to complete the TMDL process by the end of 2007 (Schary 2007).

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

After it is complete, the Lower Boise River Nutrient TMDL, which will reflect allocations based on the Snake River-Hells Canyon TMDL, is likely to serve as the basis for trading.

Phosphorus Load Baseline

Appendix J of the 1999 report *Lower Boise River TMDL Subbasin Assessment, Total Maximum Daily Loads* contains an overview of Idaho Department of Environmental Quality's (DEQ) methodology for establishing the proposed no net increase total phosphorus loads. The methodology describes the steps as follows (Idaho DEQ 1999):

1. Create a best-fit model to predict the total phosphorus concentration, using the FLUX model or non-linear model. Use seasonal or flow stratification, if necessary, to minimize error.
2. Use daily 1996 flow data and the model from step 1 to predict daily total phosphorus concentrations.
3. Calculate daily total phosphorus loads for the entire 1996 calendar year.
4. Summarize the daily loads seasonally, annually, by averages, and by mass totals.

The FLUX model used in step 1 is a U.S. Army Corps of Engineers program that predicts nutrient loads on the basis of sample data and daily flow information. The FLUX model uses three averaging and three linear regression techniques (Idaho DEQ 1999). Idaho DEQ will reassess the 1996 phosphorus baseline load because of land use changes in the Lower Boise River; the reassessment process will use the same methodology described in Appendix J (Horsburgh 2004).

Phosphorus Allocations

Although Idaho DEQ has not yet completed the process of determining phosphorus load and wasteload allocations, it has developed a work plan that outlines the tasks involved in generating the Lower Boise River Nutrient TMDL. According to the work plan, the technical analysis related to developing the phosphorus load and wasteload allocations will involve updating the phosphorus mass-balance spreadsheet for the Lower Boise River with recent hydrologic and phosphorus concentration data; developing four phosphorus allocation scenarios and associated cost-estimates for each scenario; and addressing other technical issues related to the TMDL, such as evaluating methods to add a margin of safety to phosphorus allocations (Idaho DEQ 2004).

Are Permits Used to Facilitate Trades?

Point sources have discharge limits in their NPDES permits that serve as the basis for their trading. The future wasteload allocations established to reflect the phosphorus reduction targets identified under the approved Snake River-Hells Canyon TMDL will eventually be

translated into new permit limits for point source dischargers in the Lower Boise River. EPA Region 10, the NPDES permitting authority in Idaho, is responsible for updating NPDES permits to reflect the new wasteload allocations.

How Are Credits Generated for Trading?

In the Lower Boise River Pollutant Trading Program, credits are defined as "reductions of a pollutant below a level set by a TMDL" (Idaho DEQ 2003). If a TMDL requires a reduction of 100 pounds per day, a source would need to reduce its pollutant load by 101 pounds per day to satisfy the requirements of the TMDL and to generate one credit eligible for trading.

For point source–nonpoint source trading, there are two approaches to determine the credits generated by nonpoint sources: (1) the calculated approach and (2) the measured approach. The calculated approach estimates an average reduction for a specific BMP using existing data and *management factors* or trade ratios. For measured credits, actual grab samples taken during a BMP's operation are used to determine reductions (ISSC 2002). A more detailed description of each approach is provided below.

The calculated credit approach is taken from the Idaho Soil Conservation Commission's (ISSC) BMP List document (ISSC 2002), which describes the methodology for determining BMP effectiveness and calculating credits. The first step is to identify the BMP to be used to generate phosphorus reductions and the associated effectiveness discount (i.e., the percent of estimated efficiency of the BMP) and the uncertainty discount (i.e., a multiplier that reduces the number of credits generated by a nonpoint source because of variability in the effectiveness of the practice). The next step is to determine the estimated phosphorus losses, also referred to as the nonpoint source's baseline load. This is done by using the Surface Irrigation Soil Loss (SISL) tool to calculate the amount of soil loss in tons and then multiplying the soil loss by 2 pounds of phosphorus per ton of soil loss to calculate the equivalent pounds of phosphorus. The estimated phosphorus reduction generated by a BMP is the nonpoint source's baseline load multiplied by the BMP effectiveness discount minus the uncertainty discount.

Soil loss (tons) × 2 (lb/ton) = Estimated phosphorus loss (or the nonpoint source's baseline load)

Nonpoint source's baseline load × (BMP Effectiveness discount – BMP Uncertainty discount) = Estimated BMP Phosphorus Reduction

Credits are generated only after the TMDL reduction is met. Therefore, it is also important to calculate the nonpoint source's share of the reduction needed to achieve the TMDL load allocation. To calculate this, the nonpoint source's baseline load is multiplied by a *water quality contribution percentage* that represents the individual nonpoint source's share of the reduction amount needed to achieve the load allocation assigned in the TMDL. For example, if the load allocation specified in the TMDL is 100 pounds of phosphorus per day and the nonpoint source must make a phosphorus reduction of 50 pounds per day to achieve that load allocation, the nonpoint source's *water quality contribution* is 50 percent. Therefore, the nonpoint source's phosphorus reductions must exceed its 50 percent water quality contribution before generating any credits to sell. To determine the reductions that are eligible to become tradable credits, the nonpoint source's water quality contribution reduction is subtracted from

the amount of reduction generated by a BMP. The phosphorus reduction eligible for sale as credits is calculated as the difference between the estimated phosphorus reduction generated by the BMP and the phosphorus reduction required to achieve the TMDL load allocation (Breetz et al. 2004).

Nonpoint Source Baseline Load × Water Quality Contribution Percentage = Phosphorus reduction required to achieve the TMDL load allocation

Estimated BMP Phosphorus Reduction – Phosphorus reduction required to achieve the TMDL load allocation = Phosphorus reduction eligible for trading

After determining the estimated phosphorus reduction eligible for trading, final credits are calculated by applying three other factors that adjust credits according to location. The geographic factors are referred to as the (1) river location ratio, (2) site location factor, and (3) drainage delivery ratio. The three factors are essentially categories of transport factors that take into consideration losses of phosphorus as it travels from the point of discharge through the Lower Boise River to the mouth of the drainage (referred to as *Parma* for the town at the mouth of the Lower Boise River). For more on these factors see *What Is the Pollutant Trading Ratio?*

Estimated Phosphorus Reduction Eligible for Trading × *Site Location Factor* × *Drainage Delivery Ratio* × *River Location Ratio* = *Phosphorus Credits (Parma Pounds) for sale*

Credits are generated and used on a monthly basis. Nonpoint source credits are created at the end of the month, and point sources must use those credits to offset nutrient loading during the same month (Idaho DEQ 2003).

Example: Estimating Phosphorus Reductions and Calculating Phosphorus Credits

Adapted from *Pollutant Trading Guidance* (Idaho DEQ 2003).

A nonpoint source wants to generate phosphorus credits for trading by converting a 30 acre surface irrigated field to a sprinkler system capable of eliminating all sedimentation loss (100 percent effectiveness) but with a 10 percent uncertainty discount. The average annual Surface Irrigation Soil Loss (SISL) load is determined to be 7.3 tons per acre for the 30 acres of field, for a total of 219 tons of soil loss per irrigation season.

The TMDL requires a 78 percent phosphorus reduction from all sources, and therefore the nonpoint source's water quality contribution is equal to the 78 percent required reduction.

The nonpoint source used Idaho's *Pollutant Trading Guidance* to determine the applicable trading ratios. The Site Location Factor is 0.8, because there is potential reuse, but not through a canal. The distance from the river to the entry point at the channel is 2.5 miles, which gives a 0.975 Drainage Delivery Ratio. The River Location Ratio is 0.75, which will convert the pounds reduced into *Parma Pounds* or tradeable credits.

Example: Estimating Phosphorus Reductions and Calculating Phosphorus Credits *(continued)*

To calculate the tradeable credits, the nonpoint source works through the following calculations:

Soil loss (tons) × 2 (lb/ton) = Estimated phosphorus loss (or the nonpoint source's baseline load)
219 tons × 2 lbs/ton = 438 lb P

Nonpoint source's baseline load × (BMP Effectiveness - BMP Uncertainty discount) = Estimated BMP Phosphorus Reduction
438 lb P × (1.0 – 0.10) = 394.2 lb P

Nonpoint Source Baseline Load × Water Quality Contribution Percentage = Phosphorus reduction required to achieve the TMDL load allocation
438 lb P × 0.78 = 341.64 lb P

Estimated BMP Phosphorus Reduction–Phosphorus reduction required to achieve the TMDL load allocation = Phosphorus reduction eligible for trading
394.2 lb P – 341.64 lb P = 52.56 lb P

Estimated Phosphorus Reduction Eligible for Trading × Site Location Factor × Drainage Delivery Ratio × River Location Ratio = Phosphorus Credits (Parma Pounds) for sale
52.56 lb P × 0.8 × 0.975 × 0.75 = 30.75 Parma Pounds of phosphorus credits

What Are the Trading Mechanisms?

The Lower Boise Trading Framework relies on several trading mechanisms to facilitate and report on trading activities. The first mechanism is the Trade Notification Form, which is required for each trade. It is the official document that registers the trade, transfers credits, and adjusts pollutant limits. The next mechanism is the Reduction Credit Certificate, which documents the nonpoint source reduction and creates the credit for a point source–nonpoint source trade. After signing and submitting the Reduction Credit Certificate, the point source may use credits generated by the nonpoint source. A third mechanism is the Discharge Monitoring Report (DMR) prepared by the point source, as required by its NPDES permit. As a trading participant, the point source submits information pertaining to the trade with the DMR, including its actual average monthly discharge, the amount of credits bought or sold, and the adjusted discharge. A fourth mechanism is the Trade Summary Report, which is sent by the Idaho Clean Water Cooperative (the nonprofit responsible for tracking trades) to point sources involved in trading for submission to EPA with the DMR (Idaho DEQ 2003).

What Is the Pollutant Trading Ratio?

A series of pollutant trading ratios are used in the Lower Boise River Pollutant Trading Program. For BMP effectiveness, the ISCC assigned each approved BMP an effectiveness ratio and an uncertainty discount. The uncertainty discount is to be subtracted from the effectiveness ratio.

Phosphorus reductions that are eligible to generate credits for trading (i.e., reductions that exceed those required by a TMDL) are calculated using three geographic ratios that function as transport factors because they are intended to account for phosphorus losses from the site of the BMP, through the Lower Boise River, to the mouth. The three ratios are as follows:

- *River Location Ratio*. This ratio accounts for phosphorus losses due to irrigation diversions that remove flow from the river at many points. A mass-balance model that accounts for phosphorus inputs, withdrawals and groundwater is used to calculate the river location ratio. The river location ratio is calculated from each source relative to Parma; therefore, phosphorus credits are measured in *Parma Pounds* (Idaho DEQ 2003).
- *Site Location Factor*. This ratio takes into account phosphorus losses due to wastewater reuse and natural sediment-phosphorus relationships. Total phosphorus lost at the field is less likely to reach the subwatershed's channel due to travel distance and the chance of reuse. Three site location factors take these variables into consideration (Idaho DEQ 2003).
- *Drainage Delivery Ratio*. This ratio also takes into account phosphorus losses in the subwatershed's main channels by using the linear calculation:

  (100 – distance in miles to mouth of the drain from the project's point of discharge on the drain) / 100 (Idaho DEQ 2003).

Idaho DEQ will review the ratios at least every 5 years using trading information from the trading database. Revisions will be made if Idaho DEQ determines that there is a 30 percent discrepancy from the published ratios (Idaho DEQ 2003).

What Type of Monitoring Is Performed?

Point sources must submit a monthly DMR, and purchased credits will be checked against the DMRs in audits of NPDES permits. A Trade Summary Report from the Trade Trading System must accompany the DMR. For measurable nonpoint reductions, water quality monitoring of inflow and outflow verifies the exact amount of reduction. For calculated nonpoint sources reductions, BMP installation is monitored by the point source before the creation of credit, and maintenance inspections are conducted by the point source to document monthly credits. The point source inspects the nonpoint source projects at least once a year after installation and before seasonal operation (Idaho DEQ 2003).

What Are the Incentives for Trading?

The incentive for point sources to participate in trading is that trading offers a flexible approach to meeting the NPDES permit limits, which will soon reflect the phosphorus wasteload allocation in the Snake River-Hells Canyon TMDL. Although nonpoint sources will have a load allocation under the Snake River-Hells Canyon TMDL, mechanisms to achieve the load allocation are largely voluntary. Therefore, the primary incentive for farmers to participate is the partial financial compensation for BMP installation and maintenance (Breetz et al. 2004).

What Water Quality Improvements Have Been Achieved?

No trading has occurred in the Lower Boise River to date; therefore, no water quality improvements are associated with trading in the Lower Boise River.

What Are the Potential Challenges in Using This Trading Approach?

The Lower Boise River Pollutant Trading Program might face a few challenges. The need to have the Lower Boise River Trading Framework revised to reflect the recently approved Snake River-Hells Canyon TMDL will delay the trading program. Many of the BMP verification requirements and much of the paperwork associated with completing the required trading documents appear to be the responsibility of participating point sources. Another challenge associated with the approach used in the Lower Boise River, and possibly throughout Idaho, is the fact that EPA Region 10 is the NPDES permitting authority for the state of Idaho. The fact that the NPDES permits that will facilitate point source trades are not developed by Idaho DEQ might necessitate an additional layer of coordination and facilitation between the state and EPA Region 10.

What Are the Potential Benefits?

Potential benefits of the approach used by the Lower Boise River Pollutant Trading Program include a comprehensive trading tracking database that allows Idaho DEQ and other stakeholders to easily assess progress and trends in trading activities. In addition, this approach appears to have a thorough process for incorporating BMP uncertainties into trades by using effectiveness ratios and uncertainty discounts for each BMP, rather than a blanket trade ratio that applies to all point source–nonpoint source trades. The plan to conduct a 5-year review of all ratios is also beneficial, ensuring that trade ratios reflect actual watershed conditions.

Applicable NPDES Permit Language

No trades have occurred at this time; therefore, no NPDES permits contain trading language. However, the Lower Boise Effluent Trading Demonstration Project did produce permit outlines for three types of trades: (1) point source–point source upstream trades, (2) point source–point source downstream trades, and (3) point source–nonpoint source trades. The permit outline available for point source–nonpoint source trades does not have the support of EPA Region 10, the NPDES permitting authority for the state of Idaho. Ideally, Idaho DEQ would like to have permit language developed for point source–nonpoint source trades that is dynamic and will allow this type of trade without having to reopen or rewrite permits. EPA Region 10, however, has concerns regarding the most effective mechanism for demonstrating the pollutant reductions achieved by participating nonpoint sources.

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Rahr Malting Company Permit
Minnesota

Overview

To expand production and reduce costs, the Rahr Malting Company (Rahr) wanted to construct its own wastewater treatment plant (WWTP) instead of discharging to a regional WWTP; however, a 1985 wasteload allocation (WLA) for 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) in the lower Minnesota River prohibited any new discharges to the river that added to the pollutant loading levels (MPCA 1997c; Breetz et al. 2004). In an effort to find a solution, Rahr negotiated an agreement with the Minnesota Pollution Control Agency (MPCA) to offset $CBOD_5$ discharge from its new wastewater treatment plant by funding upstream nonpoint source pollutant reductions.

Rahr was issued a NPDES permit incorporating trading in 1997. The permit allowed Rahr to discharge approximately the same amount it currently discharged to the regional WWTP but imposed concentration-based effluent limits as well as nonpoint source trading requirements to offset the pollutant loading. Rahr was required to establish a $250,000 trust fund to pay for its nonpoint source offsets.

In 5 years, Rahr achieved the needed nonpoint source loading reductions through four nonpoint source offsets (Fang and Easter 2003). Over the course of the permit cycle, MPCA observed opportunities for further refinement of the program and crediting process. This fact sheet describes the initial permit and best management practices (BMPs); however, future permits may incorporate adjustments to the trade ratios and potentially remove the use of nitrogen reduction for $CBOD_5$ credits (Klang 2006c).

Type of Trading

Point Source–Nonpoint Source

Pollutant(s) Traded

Phosphorus
Nitrogen
$CBOD_5$
Sediment

Number of Trades to Date

Rahr has implemented four nonpoint source BMP implementation projects to offset loadings from the facility. Two projects at the junction of the Cottonwood and Minnesota Rivers involved riparian vegetation restoration on sites that were then donated to the city of New Ulm. They resulted in reductions of 28.8 and 71.1 lbs/day $CBOD_5$ respectively (Sparks and Wallace 2006). The other two, on 8-Mile Creek and Rush River, stabilized eroding banks (Klang 2006a; Sparks and Wallace 2006). 8-Mile Creek's project involved the planting of a bank stabilization area as well as livestock exclusion and reduced 13.4 lbs/day $CBOD_5$ (Sparks and Wallace 2006). To protect the Rush River site's eroding cliff face, a bench terrace was constructed and the channel was diverted. This project reduced 98.6 lbs/day $CBOD_5$ (Sparks and Wallace 2006).

Who Is Eligible to Participate?

Rahr is the only point source eligible to trade under the permit. The only limitation placed on nonpoint source BMP sites were that they must be upstream of Shakopee in the Minnesota River Basin.

What Generated the Need for Trading?

By constructing and operating its own WWTP, Rahr could increase production by 20 percent and still reduce costs. Rahr's increased production and discharge would have cost an additional one million dollars if Rahr continued to have its discharge treated at the regional WWTP facility (Breetz et al. 2004). However, because of the lower Minnesota River's WLA for $CBOD_5$, all the pollutant load was already allocated to existing sources and Rahr could not obtain the allocation necessary to construct a WWTP. Though the regional WWTP possessed the necessary wasteload allocation for Rahr's discharge, Rahr could not get the discharge rights transferred, therefore Rahr came up with a strategy of offsetting its load through nonpoint source trading (Breetz et al. 2004).

What Serves as the Basis for Trading?

In 1985 EPA, MPCA and the Metropolitan Council (the regional planning agency for the Twin Cities area) negotiated a wasteload allocation, described in the Lower Minnesota River Wasteload Allocation Study, for the lower 26 miles of the Minnesota River. The WLA required a 40 percent reduction of upstream and sediment $CBOD_5$ concentrations. Most of the $CBOD_5$ came from loading from WWTPs and manure from feedlots. The Minnesota River Assessment Project (MRAP), completed in 1992, identified that the eutrophication in the river supplied a significant amount of $CBOD_5$ load as dead algae.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

A RMA-12 model was used in the development of the 1985 Waste Allocation Study for point sources on the Minnesota River. This is a version of the QUAL-II model, which is a one dimension model for stream quality. The RMA-12 model differs from the QUAL-II model by changing the growth equation for algal biomass and redefining the nitrogen cycle. While the QUAL-II model considers nitrogen as Kjeldahl nitrogen, the RMA-12 model allows for organic- and ammonia-nitrogen to be considered separately. The RMA-12 also allows for uptake of ammonia-nitrogen by algae as opposed to only allowing nitrate-nitrogen uptake by algae as in the QUAL-II model (MPCA 1985).

The RMA-12 model is a one-dimensional model and simulates the effects of wasteloads, nitrification, sediment oxygen demand, and algal photosynthesis (USEPA 1992). It uses an advective-dispersive equation to solve for 11 water quality constituents numerically (MPCA 1985). The constituents include

1. Phytoplankton algae
2. Chlorophyll *a*
3. CBOD
4. Dissolved Oxygen
5. Benthic oxygen demand
6. Atmospheric reaeration
7. Organic nitrogen
8. Ammonia nitrogen
9. Nitrite nitrogen
10. Nitrate nitrogen
11. Orthophosphate

The model considers 30 different transformation pathways for the above constituents including sources/sinks for $CBOD_5$ by settling or resuspension, loss of ammonia nitrogen to the atmosphere, and uptake of phosphorus into phytoplankton biomass. It also uses a finite-difference technique to solve the mass balance equations taking into account various stream effects. Since the critical period of concern for low dissolved oxygen was the summer low-flow period, the RMA-12 model was used in steady-state mode for the study (MPCA 1985).

While water quality calibration data existed from an intensive river survey in 1965 and a summer low flow survey in 1974, the existing data lacked sufficient measurements of algal productivity and benthic demands. Therefore another intensive river survey was conducted during a seasonally warm and low-flow period in August 1980, and the resulting data was used to calibrate the RMA-12 model (MPCA 1985). Though data existed for nine days, only four days were used for calibration because unsteady flow and rainfall conditions prevailed during the latter part of the study period. A period of 4 days was sufficient because it captured one complete flow through of the study reach. The model was verified by simulating water quality responses observed in the 1974 survey (MPCA 1985).

The Wasteload Allocation Study assumed that no additional load would be added to the Minnesota River. The two existing WWTPs, Blue Lake and Seneca, operated at secondary treatment requirements which resulted in effluent averaging 25 mg/L $CBOD_5$. In the spring and fall, the WWTPs did not need additional treatment to ensure the river met the 5 mg/L dissolved oxygen minimum requirement (MPCA 1985). In the summer, additional treatment as well as a reduction in the headwater and sediment oxygen demand was required to maintain the 5 mg/L dissolved oxygen minimum requirement. The model predicted that additional treatment to 10 mg/L $CBOD_5$ by the WWTPs and a 40 percent reduction in headwater and sediment $CBOD_5$ concentrations would be required to meet the dissolved oxygen requirement during critical summer conditions (MPCA 1985). The model also predicted that additional treatment may also be required in the winter due to limited atmospheric reaeration caused by ice cover; however, it is difficult to quantify the amount of ice cover on the river. Under complete ice cover, a reduction to 10 mg/L $CBOD_5$ would be required by the WWTPs. If a 6 percent reduction in ice cover was possible, no additional treatment (beyond 25 mg/L $CBOD_5$) would be necessary to maintain the dissolved oxygen requirement (MPCA 1985).

Are Permits Used to Facilitate Trades?

Rahr's permit required the company to install and maintain limits-of-technology controls at the wastewater treatment facility, in addition to the trading requirements included. The permit contains a BOD effluent limit of 12-mg/L year round and a phosphorus monthly average limit of 2 mg/L in addition to the requirement to offset 150 lbs/day of $CBOD_5$. The permit authorized trading of several pollutants that negatively impact water quality: nitrogen, phosphorus, and sediment to create $CBOD_5$ credits.

Section II.A.2.a of the permit outlines the effluent limitations for the facility. In addition to these limitations, the permit requires Rahr to reduce $CBOD_5$ mass loadings in accordance with Section II.A.2.b or "obtain $CBOD_5$ nonpoint load reduction [units] equal to or greater than its actual $CBOD_5$ discharge." This section specifies that one nonpoint source load reduction unit is the equivalent of one pound per day of $CBOD_5$ discharge. In addition, this section requires that Rahr obtain 20 units of reduction before start up of the wastewater treatment facility (if start up is after December 31, 1997).

The permit specifies that the permittee must spend a $250,000 trust fund within the 5-year permit term by implementing projects approved by MPCA, and if 150 units can be obtained for less than this amount, the permittee is required to extend the time period of project expenditure to 10 years.

This section also outlines the types of projects that the MPCA would approve. Provision II.A.2.b.4 states that "the Permittee shall submit proposed projects for review in accordance with two referenced documents: the *Point-Nonpoint Source Trading Summary* and the *Nonpoint Source Crediting Calculations*" (both dated January 8, 1997). These documents are included in full as a separate PDF file on the Toolkit Web site. This section also states that the "Commissioner is solely responsible for determining the amount of creditable $CBOD_5$ nonpoint source load reduction to be credited to the project."

It was uncertain whether agreements for nonpoint source reductions were likely to be made because this was the first permit of its kind. Therefore, to provide an alternate method of earning credits, Rahr accepted a phosphorus limit of 2 mg/L even though MPCA did not have numeric standards for rivers. MPCA had proposed a limit of 3 mg/L limit and by accepting the more stringent limit, Rahr could earn a credit of 30 units of phosphorus to be applied to the cumulative load reduction for every year the facility maintained this level of discharge. In addition, MPCA allowed the facility to use up to 10 units of this credit in either 1998, 1999, or 2000 to satisfy any shortfalls that year in nonpoint source load reductions to maintain compliance with permit requirements.

In addition, the facility accepted a year-round $CBOD_5$ limit of 12 mg/L instead of the seasonal limit of 12 mg/L (June–September) and 25 mg/L at other times not covered under the TMDL requirements (October–May) as proposed by MPCA. For this reason, MPCA allowed a 30 unit credit to be applied to the cumulative value for 2001 and subsequent years provided the permittee's discharge remained at 12 mg/L.

Point–Nonpoint Source Trading Summary

The *Point–Nonpoint Source Trading Summary* is incorporated by reference into the permit and basically explains the premise for Rahr's point–nonpoint source trading process and the concepts involved in developing the trading program. The summary document explains how the ratios were developed to assess the impact of phosphorus and nitrogen loading on $CBOD_5$ in the river and outlines the basic concept of point–nonpoint trading in the watershed. In addition, the summary document highlights methods that will be used to minimize associated risks such as pollutant equivalency ratios, safety factors for estimating phosphorus content in loading from soil erosion, calculation of a *field loss factor* for nitrogen to account for volatilization of ammonia and the assimilation of nitrogen prior to entering a surface water, and *delivery ratios* to account for the distance a nonpoint source site is from the stream. Trading-eligible BMPs are also described in this document. And finally, the summary document explains how the trading agreement and administration of the trades were to occur during the permit term. This document also references the Nonpoint Source Trade Crediting Calculations document and requires that all pollutant reduction estimation follow the formulas included therein.

Nonpoint Source Trade Crediting Calculations

The *Nonpoint Source Trade Crediting Calculations* document details the various trade calculations necessary to determine nonpoint source loading reduction units for all nonpoint source trades required in Rahr's permit. Pollutant Equivalency Credits are detailed to determine how many pounds/day of reduction of phosphorus, $CBOD_5$, nitrogen and how many tons/ day of sediment are necessary to equate to a specified number of units in each of two areas of the

river. A more detailed explanation is included under *What Is the Pollutant Trading Ratio?* and in the full version of the document.

The document also details a list of conditions the permittee must use when selecting appropriate BMPs. The conditions are based on a set of assumptions regarding physical process constraints inherent in assessing nonpoint source loading and BMP removal effectiveness.

For each type of BMP identified for point-nonpoint source trading in the watershed, this document details the calculation procedures necessary to estimate pollutant reductions. As previously stated, the discharger's permit requires that these calculations be used and submitted to the MPCA for approval by the Commissioner.

How Are Credits Generated for Trading?

According to the discharge permit, Rahr can generate credits by implementing nonpoint source BMPs that reduce gully erosion (not including high-residue tillage), stabilize gully and bank erosion, exclude livestock from stream or river riparian zones, rotate grazing with livestock exclusion from riparian zones, or treat stormwater runoff with constructed wetlands (Riggs and Hartwell 2000). MPCA justified its BMP selection in the permit's fact sheet. The BMPs selected provide equivalent water quality improvement to downstream point source reductions, can be visually tracked or monitored, and promote additional nonpoint source reduction opportunities that are not widely used (Riggs and Hartwell 2000). The phosphorus, nitrogen, and sediment loading reduction resulting from the implementation of the nonpoint source BMPs were then converted into $CBOD_5$ credits through the use of trading ratios. The permit's supporting documentation details how reductions were calculated for the different types of approved BMPs.

What Are the Trading Mechanisms?

The permit required that a trust fund be established to fund nonpoint source projects. Rahr was required to spend $250,000 to implement BMPs to reduce loading by 150 lbs/day of $CBOD_5$. In addition, the permit specifies that if the reductions can be achieved for less than $250,000, "the time period for full expenditure of the $250,000 will be extended to ten years from the date of the permit issuance."

A board of citizens concerned with water quality conservation including people from grass roots organizations, state offices, and Rahr representatives oversaw the final selection of BMP sites, but the process of initial trade identification was very *network-driven* and depended on local environmental organizations and agency personnel (MPCA 1997c; Breetz et al. 2004). The Commissioner of the MPCA gave final approval for each nonpoint source project and determined the amount of $CBOD_5$ credits generated (MPCA 1997a).

For two of its BMP sites, Rahr contracted with the landowner while in the other two, Rahr bought the land from the landowner, the city of New Ulm, and then sold the land for a dollar, with provisions and restrictions needed for preservation and upkeep, back to the city of New Ulm as a wildlife park under a permanent easement (Klang 2006a).

The credits were granted in a schedule to give the point source greater flexibility in meeting the permit requirements: 45 percent were granted when the contractual agreements were reached, 45 percent when the nonpoint source controls have been implemented, and 10 percent when vegetation establishment criteria were reached (Breetz et al. 2004).

What Is the Pollutant Trading Ratio?

The unit of trade is one pound of $CBOD_5$. Phosphorus, nitrogen, and sediment can all be traded for $CBOD_5$ but require the use of trading ratios, because of the varying degrees of persistence in the river and mechanisms for exerting oxygen demand (MPCA 1997b). The trading ratios estimate how much $CBOD_5$ would be reduced in the TMDL zone by a related amount of nutrient or sediment reduction upstream.

For phosphorus, the $CBOD_5$ conversion ratio was 1:8, meaning that an upstream reduction of one pound of phosphorus results in a reduction of 8 pounds of $CBOD_5$ in the TMDL zone. This ratio varies depending on the nutrient needs of the biological life forms, flows, turbidity impacts on photosynthetic activity and the bio-availability of phosphorus. The ratio of 1:8 is conservative; the ecoregion mean estimate of the ratio is closer to 1:17.

For nitrogen, the $CBOD_5$ ratio was 1:4. By balancing the applicable chemical equation, one pound of total Kjeldahl nitrogen requires 4.6 pounds of oxygen; however, it is less persistent in the river because of atmospheric loss, and it exerts its demand more rapidly than phosphorus. So a ratio of 1:4 is used in the Metro Reach, and a 1:1 ratio is used for upstream reaches (MPCA 1997c). Calculation of load reductions from livestock management BMPs include a 50 percent *field loss factor* to account for atmospheric nitrogen losses prior to transport into the water column (MPCA 1997b).

Controlling sediment loss reduces oxygen demand associated with turbidity. The program required one ton of sediment loss reduction for 0.5 $CBOD_5$ credits.

The previously described trading ratios are the only ratios required in the TMDL zone. Beyond the TMDL zone exists a *BOD trading zone* that extends up to river mile 107. Additional ratios are applied in the BOD trading zone and described by Table 2 in the *Point-Nonpoint Source Trading Summary* supporting permit documentation (MPCA 1997c). Beyond river mile 107, one percent of the pounds removed are credited (MPCA 1997c).

For more information on the trade ratios, refer to the *Nonpoint Source Trade Crediting Calculations* and *Point-Nonpoint Source Trading Summary* supporting documents to the permit (MPCA 1997b; MPCA 1997c).

Example: Calculating $CBOD_5$ Credits Achieved through a Critical Area Set-Aside of a River Flood Scoured Area

A landowner near river mile 29 has 40 acres of land that are susceptible to flooding. Long term records from the U.S. Army Corps of Engineers were used to indicate an annual average rate of 500 cubic feet of silt loam soil per acre are swept into the river. The landowner is interested in establishing woody vegetative cover with structural BMPs to reduce the sediment runoff and in turn the $CBOD_5$ loading to the stream. The *Nonpoint Source Trade Crediting Calculations* document was used to calculate the number of credits generated by this BMP as follows.

1. Calculate the annual sediment loading (SED):
   SED = AREA × VOL × Dry Density × FREQ

   The dry density is found in a table on p. 10 of the *Nonpoint Source Trade Crediting Calculations* document. A silt loam soil has a dry density of 0.0425 tons/ft^3.

Example: Calculating $CBOD_5$ Credits Achieved through a Critical Area Set-Aside of a River Flood Scoured Area *(continued)*

$$SED = 40 \text{ acres} \times \frac{500 \text{ ft}^3/\text{acre}}{\text{yr}} \times \frac{0.0425 \text{ tons}}{\text{ft}^3} = \mathbf{850} \ \frac{\mathbf{tons}}{\mathbf{yr}}$$

2. Calculate the amount of sediment reduced by the BMPs.
   According to the *Nonpoint Source Trade Crediting Calculations* document, the Scott County SWCD locally demonstrated that a site with scour erosion rates of 75 tons/acre/yr could, by establishing woody vegetative cover and installing some structural BMPs, reduce its erosion rate to 3 tons/acre/yr, which is a 96 percent reduction. Applying the same reduction ratio to this site, it is found that:

$$SEDReduced = 850 \ \frac{\text{tons}}{\text{yr}} \times 0.96 = \mathbf{816} \ \frac{\mathbf{tons}}{\mathbf{yr}}$$

3. Calculate the amount of phosphorus and nitrogen present in the annual sediment loading.
   The table on p. 17 of the *Nonpoint Source Trade Crediting Calculations* document provides the phosphorus and nitrogen contents based on soil type. Silt soil contains 1.00 lbs P/ton and 2.00 lbs N/ton.

$$P = \frac{816 \text{ tons}}{\text{yr}} \times \frac{1.00 \text{ lbs}}{\text{ton}} = \mathbf{816} \ \frac{\mathbf{lbs}}{\mathbf{yr}} \qquad N = \frac{816 \text{ tons}}{\text{yr}} \times \frac{2.00 \text{ lbs}}{\text{ton}} = \mathbf{1632} \ \frac{\mathbf{lbs}}{\mathbf{yr}}$$

4. Calculate the total $CBOD_5$ credits.
   The *Pollutant Equivalency Credits* table on p. 2 of the *Nonpoint Source Trade Crediting Calculations* document provides conversions from the trade parameter to $CBOD_5$ credits based on whether the nonpoint source reduction takes place in the TMDL zone or upstream. For upstream reductions, the $CBOD_5$ percent remaining is given in the *$CBOD_5$ Percent Crediting Table* on p. 3 based on river mile. One pound of phosphorus reduced upstream is equivalent to 8 units of $CBOD_5$ credit and one pound of nitrogen reduced upstream is equivalent to one unit of $CBOD_5$. One ton of sediment reduced upstream is equivalent to 0.5 units of $CBOD_5$ credit. 89 percent of $CBOD_5$ reduced at mile 29 remains when it reaches Rahr Malting Co.

$$P \text{ credits} = \frac{816 \text{ lbs P}}{\text{yr}} \times \frac{8 \text{ units } CBOD_5}{1 \text{ lb P}} = \mathbf{6528} \ \frac{\mathbf{units\ CBOD_5}}{\mathbf{yr}}$$

$$N \text{ credits} = \frac{1632 \text{ lbs N}}{\text{yr}} \times \frac{1 \text{ unit } CBOD_5}{1 \text{ lb N}} = \mathbf{1632} \ \frac{\mathbf{units\ CBOD_5}}{\mathbf{yr}}$$

$$\text{Sediment credits} = \frac{816 \text{ tons}}{\text{yr}} \times \frac{0.5 \text{ unit } CBOD_5}{1 \text{ ton sediment}} = \mathbf{408} \ \frac{\mathbf{units\ CBOD_5}}{\mathbf{yr}}$$

Finally, the $CBOD_5$ units are summed and converted to daily credits.

$$\mathbf{Total\ credits} = \frac{8568 \text{ units}}{\text{yr}} \times \frac{1 \text{ year}}{365 \text{ days}} = \mathbf{23.5} \ \frac{\mathbf{credits}}{\mathbf{day}}$$

What Type of Monitoring is Performed?

Rahr monitors its wastewater outfall but does not conduct water quality monitoring at the BMPs. The estimated reductions from the BMPs are determined by calculation as described in the permit's supporting documentation. Some data were collected on initial phosphorus concentrations in the soil and used in the reduction calculations (Klang 2006a). Rahr is responsible for submitting technical and engineering reports detailing the design and installation of the BMPs, including structural specification, operation plans, and detailed photographs, to MPCA before and after each trade (Breetz et al. 2004). The permit also requires annual reports accounting for nonpoint source credits. MPCA monitors the implementation of BMPs with periodic site inspections; however, MPCA does not verify pollution reduction with systematic monitoring, which would be very expensive and would have to be long term to generate conclusive results (Breetz et al. 2004).

What Are the Incentives for Trading?

Engaging in trading allowed Rahr to build its own WWTP which reduced costs and provided the ability to expand production.

The BMPs installed improved water quality and improved or protected property. In the cases of the Cottonwood and Minnesota River sites, the landowners were financially compensated for their land by Rahr who restored then donated the land to the city of New Ulm. In the cases of the Rush River and 8-Mile Creek projects, the landowners were worried about the effects of bank erosion on their land and homes and were eager to participate in the trading arrangement with Rahr. Bluff/channel stabilization BMPs were installed on one landowner's property in return for the landowner excluding livestock and maintaining the BMP, while another landowner was responsible for the bioengineering maintenance required for the BMP on his site (Klang 2006a; Sparks and Wallace 2006).

What Water Quality Improvements Have Been Achieved?

Rahr offset its pollutant loading beyond the necessary amount. Rahr obtained nonpoint source credits for 212 lbs/day of $CBOD_5$, which exceeded the permit requirement of 150 lbs/day of $CBOD_5$ traded (Breetz et al. 2004).

What Are the Potential Challenges in Using This Trading Approach?

One significant challenge was defining the appropriate trade ratio between upstream nonpoint source phosphorus loadings and $CBOD_5$ discharges from Rahr's WWTP (Riggs and Hartwell 2000; Fang and Easter 2003). The MPCA was able to determine a 1:8 trading ratio by conducting studies relating phosphorus to chlorophyll-a and chlorophyll-a to $CBOD_5$ (Breetz et al. 2004).

Local environmentalists initially objected to the trading program, but Rahr gained their support by cooperatively working with and accepting input from environmental organizations.

The permit required approximately 0.25–0.50 full-time equivalency of MPCA staff for permit trade calculation development. Immediately after permit completion, some critical time, on the order of weeks, was spent setting up the trades. Now MPCA spends only a few days a year managing the program (Klang 2006b).

What Are the Potential Benefits?

Rahr achieves cost savings through trading. Cost per credit, as determined by Fang and Easter, is approximately $8.56/lb phosphorus when including engineering, construction, materials, design, and transaction costs. Because costs cannot be estimated for getting to zero phosphorus discharge, which would have been required of Rahr if they had discharged without trading, Rahr's costs were compared to that of WWTPs with comparable design flow that have to reduce to one mg/L of phosphorus. These costs ranged between $4 and $18/lb/day phosphorus reduced (Fang and Easter 2003). Therefore, implementing nonpoint source reductions was very likely cost effective for Rahr.

Ancillary environmental benefits are created by implementing nonpoint source BMPs. For example, riparian buffers can reduce sediment loss as well as remove nitrogen and phosphorus from surface water. At two of the sites, the bank stabilization BMPs provided benefits to the landowners, who were already experiencing property loss, by improving land stability. The other two sites were sold to the city of New Ulm at virtually no cost creating wildlife parks for the city (Klang 2006a).

The trading program raised watershed awareness and provides a good example of both community cooperation and allowing for growth on impaired waters (Klang 2006b).

Applicable NPDES Permit Language

b. The Permittee is authorized to discharge $CBOD_5$ in accordance with the following effluent limitations in addition to those in Part II.A.2.a. One unit of trading credit is the equivalent of 1 pound per day of $CBOD_5$ discharged.

1. The Permittee shall comply with the cumulative $CBOD_5$ nonpoint load reduction specified in the table below or obtain $CBOD_5$ nonpoint load reduction equal to or greater than its actual $CBOD_5$ discharge. The actual $CBOD_5$ discharge shall be measured as the annual average or the highest monthly average when the river flow at the Jordan USGS gauging station is less than 500 cfs as a monthly mean during June through September, whichever is greater.

DATE	NONPOINT LOAD REDUCTION	CUMULATIVE
December 31, 1997	0 units	0 units
December 31, 1998	30 units	30 units
December 31, 1999	30 units	60 units*
December 31, 2000	30 units	90 units
Permit Expiration Date	60 units*	150 units

* The Permittee has accepted a phosphorus limit of 2 mg/l instead of the 3 mg/l limit MPCA would otherwise propose at this time. Due to this, a 30 unit credit may be applied to the cumulative load reduction during the year 2001 and subsequent years provided the Permittee's phosphorus limit remains 2 mg/l or less. In addition, up to 10 units of the phosphorus credit may be used in either 1998, 1999 or, 2000 for permit compliance purposes to satisfy any shortfall in the year's nonpoint source load reduction requirement. The Permittee has accepted a year-round $CBOD_5$ limit of 12 mg/l instead of the limit MPCA would otherwise propose at this time of 12 mg/l $CBOD_5$ from June through September and 25 mg/l $CBOD_5$ from October through May. Due to this, a 30-unit credit may be applied to the cumulative value for the year 2001 and subsequent years provided the Permittee's year-round $CBOD_5$ limit remains 12 mg/l or less.

2. The Permittee shall obtain 20 units of nonpoint load reduction prior to start-up of their wastewater treatment facility if start-up is after December 31, 1997;

3. The Permittee shall spend all of the $250,000.00 dedicated to $CBOD_5$ nonpoint source load reduction within 5 years of permit issuance to obtain $CBOD_5$ non-point source load reduction by implementing projects approved by the MPCA. If 150 units of actual nonpoint source load reduction are obtained for less than $250,000.00 during the five-year period, the time period for full expenditure of the $250,000.00 will be extended to ten years from the date of permit issuance.

4. The Permittee shall achieve the nonpoint source load reduction units specified above by undertaking projects subject to (1) land purchase or (2) easement(s) or other contractual obligation(s) in place for the duration of $CBOD_5$ discharge. Projects shall be Soil Erosion BMP's, Livestock Exclusion, Rotational Grazing With Livestock Exclusion, Critical Area Set Aside or Wetland Treatment Systems. The Permittee shall submit such proposed projects to the MPCA for review in accordance with the Point-Nonpoint Source Trading Summary dated January 8, 1997, and the Nonpoint Source Crediting Calculations dated January 8, 1997. The permit language shall control if any inconsistency arises from the referenced pollutant trading documents: The Commissioner is solely responsible for determining the amount of creditable $CBOD_5$ nonpoint source load reduction to be credited for

5. If the Permittee has not obtained 150 nonpoint source load reduction units within the term of this permit because of the Permittee's actual $CBOD_5$ discharge, in accordance with Part II.A.2.b.1, is less than 150 pounds per day and if the Permittee is authorized to continue to discharge 150 pounds per day $CBOD_5$, the Permittee shall obtain the remainder of the 150 nonpoint source load reduction units within 10 years of the issuance of this permit.

6. The Permittee may request the Commissioner to modify Part II.A.2.b.1. of this permit for schedule revisions in the event that the Permittee does not commence construction of its wastewater treatment facility by September 1, 1999.

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Southern Minnesota Beet Sugar Cooperative Permit
Minnesota

Overview

The Southern Minnesota Beet Sugar Cooperative (SMBSC) is a farmer-owned cooperative with a beet-processing facility located in southern Minnesota (MPCA 1999). The processing facility treated process wastewater by storing it in lagoons during the processing season and spray-irrigating it over 500 acres of alfalfa and grassland during the growing season; however, the SMBSC wanted to build a wastewater treatment plant (WWTP) to serve the facility. This would allow SMBSC to expand sugar production and resolve odor problems.

A carbonaceous biochemical oxygen demand ($CBOD_5$) wasteload allocation (WLA) had been developed and approved on the lower Minnesota River in 1988, however, which prohibited the additional loading (MPCA 1997). The Minnesota Pollution Control Agency (MPCA) allowed SMBSC to obtain a permit for the proposed WWTP provided they offset all of the additional loading through nonpoint source projects that reduced total phosphorus. The permit required SMBSC to establish a $300,000 trust fund to finance the projects, which was overseen by a trade board made up of a processing plant official, SMBSC's consultant, a Soil and Water Conservation District official, the Hawk Creek watershed coordinator, and an environmental advocacy representative (Breetz et al. 2004).

SMBSC's permit requires that the needed nonpoint source reduction be based on the actual discharge. To accomplish this, the actual discharge is grouped into categories that create thresholds for the actual nonpoint source reduction needed and that requirement reflects the 2.6 to 1 trade ratio. The largest category or tier of nonpoint source trade offsets requires 13,000 lbs total phosphorus/yr. To date, the facility is achieving nearly 2.5 times the permit's required nonpoint source reductions (Klang 2006b).

Type of Trading

Point Source–Nonpoint Source

Pollutant(s) Traded

Total phosphorus

Number of Trades to Date

SMBSC contracts for spring sugar beet cover cropping best management practices (BMPs). In 2005 SMBSC had contracts on 579 sites totaling 58,832 acres yielding 14,292.5 lbs total phosphorus reduction/yr. One contract was established for cattle exclusion and bluff/channel stabilization BMPs yielding 1,475 lbs total phosphorus reduction/yr. SMBSC also has one surface tile intake credit as part of a contract with a watershed district; however, because of to problems with the agreement the contract was broken off and the credit was not included in their total. SMBSC's total approved credit count is 15,767.5 lbs total phosphorus/yr (Klang 2006b).

Who Is Eligible to Participate?

SMBSC is the sole point source covered by the permit. Landowners, including sugar beet farmers and cattle ranchers, in the lower two-thirds of the Minnesota River Basin are eligible nonpoint sources. Landowners do not have to be members of SMBSC. There are 600 beet growers in this region (Breetz et al. 2004).

What Generated the Need for Trading?

Before 1999, SMBSC disposed of its sugar beet process wastewater by storing it in lagoons during the processing season and spray-irrigating it over 500 acres of alfalfa and grassland during the growing season. This process resulted in unpleasant hydrogen sulfide odors that brought complaints from neighboring areas. To resolve this problem and accommodate a 40 percent production expansion, in 1999 SMBSC proposed building a WWTP to treat the wastewater and discharge into a tributary of the Minnesota River. However, in 1985 a $CBOD_5$ WLA was developed and approved, which prohibited new $CBOD_5$ loading. A permit was issued by MPCA, which required SMBSC to offset all of the WWTP's $CBOD_5$ loading by funding the installation of nonpoint source BMPs (Breetz et al. 2004).

What Serves as the Basis for Trading?

In 1985 EPA, MPCA and the Metropolitan Council (the regional planning agency for the Twin Cities area, negotiated a wasteload allocation) described in the Lower Minnesota River Wasteload Allocation Study, for the lower 26 miles of the Minnesota River. The wasteload allocation required a 40 percent reduction of upstream and sediment $CBOD_5$ concentrations. Most of the $CBOD_5$ came from loading from wastewater treatment plants and manure from feedlots. The Minnesota River Assessment Project (MRAP), completed in 1992, identified that eutrophication in the river supplied a significant amount of $CBOD_5$ load as dead algae. SMBSC's WWTP would have discharged into Beaver Creek, a tributary to the Minnesota River and so SMBSC's permit was developed using knowledge gained from these projects (Klang 2006a). SMBSC was located far enough upstream that its $CBOD_5$ loading was not of concern; however, since 70 percent of the upstream $CBOD_5$ loading was caused by dead algae decaying and phosphorus is the limiting nutrient for algal growth in the basin, SMBSC was required to limit phosphorus (Klang 2006d).

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

A RMA-12 model was used in the development of the 1985 Wasteload Allocation Study for point sources on the Minnesota River. This is a version of the QUAL-II model, which is a one-dimension model for stream quality. The RMA-12 model differs from the QUAL-II model by changing the growth equation for algal biomass and redefining the nitrogen cycle. While the QUAL-II model considers nitrogen as Kjeldahl nitrogen, the RMA-12 model allows for organic- and ammonia-nitrogen to be considered separately. The RMA-12 also allows for uptake of ammonia-nitrogen by algae as opposed to only allowing nitrate-nitrogen uptake by algae as in the QUAL-II model (MPCA 1985).

The RMA-12 model is a one-dimensional model and simulates the effects of wasteloads, nitrification, sediment oxygen demand, and algal photosynthesis (USEPA 1992). It uses an

advective-dispersive equation to solve for eleven water quality constituents numerically (MPCA 1985). The constituents include

1. Phytoplankton algae
2. Chlorophyll *a*
3. CBOD
4. Dissolved Oxygen
5. Benthic oxygen demand
6. Atmospheric reaeration
7. Organic nitrogen
8. Ammonia nitrogen
9. Nitrite nitrogen
10. Nitrate nitrogen
11. Orthophosphate

The model considers 30 different transformation pathways for the above constituents including sources/sinks for $CBOD_5$ by settling or resuspension, loss of ammonia nitrogen to the atmosphere, and uptake of phosphorus into phytoplankton biomass. It also used a finite-difference technique to solve the mass balance equations taking into account various stream effects. Since the critical period of concern for low dissolved oxygen was the summer low-flow period, the RMA-12 model was used in steady-state mode for the study (MPCA 1985).

While water quality calibration data existed from an intensive river survey in 1965 and summer low-flow survey in 1974, the existing data lacked sufficient measurements of algal productivity and benthic demands. Therefore another intensive river survey was conducted during a seasonally warm and low-flow period in August 1980 and the resulting data was used to calibrate the RMA-12 model (MPCA 1985). Though data existed for 9 days, only 4 days were used for calibration because unsteady flow and rainfall conditions prevailed during the latter part of the study period. A period of 4 days was sufficient because it captured one complete flow through of the study reach. The model was verified by simulating water quality responses observed in the 1974 survey (MPCA 1985).

The Wasteload Allocation Study assumed that no additional load would be added to the Minnesota River. The two existing WWTPs, Blue Lake and Seneca, operated at secondary treatment requirements which resulted in effluent averaging 25 mg/L $CBOD_5$. In the spring and fall, the WWTPs did not need additional treatment to ensure the river met the 5 mg/L dissolved oxygen minimum requirement (MPCA 1985). In the summer, additional treatment as well as a reduction in the headwater and sediment oxygen demand was required to maintain the 5 mg/L dissolved oxygen minimum requirement. The model predicted that additional treatment to 10 mg/L $CBOD_5$ by the WWTPs and a 40 percent reduction in headwater and sediment $CBOD_5$ concentrations would be required to meet the dissolved oxygen requirement during critical summer conditions (MPCA 1985). The model also predicted that additional treatment may also be required in the winter because of limited atmospheric reaeration caused by ice cover; however, it is difficult to quantify the amount of ice cover on the river. Under complete ice cover, a reduction to 10 mg/L $CBOD_5$ would be required by the WWTPs. If a 6 percent reduction in ice cover was possible, no additional treatment (beyond 25 mg/L $CBOD_5$) would be necessary to maintain the dissolved oxygen requirement (MPCA 1985).

Are Permits Used to Facilitate Trades?

SMBSC's permit specifies that the new WWTP must meet effluent limitations and offset its load through nonpoint source projects. Treated process wastewater and non-contact cooling water can be discharged to County Ditch (CD) 45 via Surface Discharge Station (SD) 005 at a rate of 3.5 cfs between September and March. Between April and August, no discharge is allowed to CD 45. During this time and when the flow effluent limitations cannot be met between September and March, treated process wastewater is diverted to

wastewater storage ponds. The pond water is land applied over 11 parcels for treatment. The permit contains effluent limits for the relevant outfalls. SD 001 and SD 005 must meet a 15-mg/L monthly average and a 34-mg/L monthly maximum $CBOD_5$ concentration. SD 005 also has a total phosphorus yearly average limit of 0.75-mg/L year-round and a yearly total of 1,135- kg/yr (approximately 2,500-lbs/yr) between September and March. Outfalls SD 003 and 004 must meet a 25-mg/L daily maximum concentration of $CBOD_5$ year-round.

Chapter 12.1 of SMBSC's NPDES permit describes the provisions for trading under its *Phosphorus Management Plan*. The permit specifies that Soil Erosion Best Management Practices, Cattle Exclusion, Rotational Grazing with Cattle Exclusion, Critical Area Set Aside, Constructed Wetland Treatment Systems, Alternative Surface Tile Inlets, and Cover Cropping are acceptable nonpoint source practices that can be used to generate credits. Other BMPs must be approved by MPCA. The formulas used to calculate phosphorus credits from each BMP are detailed in the document *Phosphorus Trade Crediting Calculations* that is incorporated into the permit (MPCA 2004b). The permit goes on to describe the project eligibility criteria, the membership and role of the phosphorus trade board, the schedule for granting credits, the project and credit approval processes, and requirements for annual reporting.

Also according to the permit, SMBSC is liable for ensuring nonpoint source phosphorus reductions take place (Breetz et al. 2004). SMBSC is responsible for retaining an independent auditor to certify project completion as described in section 12.1.22 of the permit (MPCA 2004a). If BMPs are not properly implemented or maintained, the SMBSC will be responsible for identifying another project (Breetz et al. 2004).

The permit includes a document entitled *Phosphorus Trade Crediting Calculations* which provides a brief explanation of the trade ratios and expands upon the requirements for the approved BMPs. The document largely focuses on how to calculate the number of phosphorus credits that each BMP generates; however, it also provides some information on the purpose of the BMP and how it should be implemented (MPCA 2004b). The entire document is attached to the end of the permit fact sheet.

How Are Credits Generated for Trading?

MPCA specified that acceptable BMPs to reduce phosphorus included cattle exclusions, buffer strips, constructed wetlands, set-asides, alternative surface tile inlets and cover cropping, all of which are designed to reduce the runoff of phosphorus to surface waters.

According to the discharge permit, SMBSC must propose a BMP site to MPCA for approval. Some specifics the proposal must include are documentation of the use and condition of the site over the previous 5 years, the BMP(s) to be implemented and specifics on the implementation process, operation and maintenance, and the detailed calculations justifying the phosphorus credits applied for. The permit specifies the formulas used to calculate phosphorus credits generated by the phosphorus loading reduction assumed for each type of BMP. After the project is implemented, SMBSC must submit an implementation report to MPCA and a third-party auditor. The auditor will inspect and certify the project implementation. If the project is implemented according to MPCA's approval, the auditor will recommend the issuance of credits. MPCA will then approve or deny the credits (MPCA 2004a).

What Are the Trading Mechanisms?

A nonpoint source BMP must first be approved by the trade board and then by MPCA. SMBSC's permit prescribes how to document BMPs in order to submit for approval. SMBSC has annual contracts for cover crops with the sugar beet farms that are participating and a 9-year contract for cattle exclusion and bluff/channel stabilization site (Klang 2006a). The land managers are paid through these contracts based on annual credits.

For each project, SMBSC will receive credits on the basis of the ratio of its financial contributions to that of public sources. It will not receive credits for the portion funded by public sources (MPCA 2004a). The credits are granted in a schedule to give the point source greater flexibility in meeting the permit requirements: 45 percent are granted when the contractual agreements are reached, 45 percent when the nonpoint source controls have been implemented, and 10 percent when vegetation establishment criteria are reached (Breetz et al. 2004). SMBSC is required to obtain credits amounting to 2.6 times its annual phosphorus mass discharge limit.

What Is the Pollutant Trading Ratio?

The trade ratio specified in the SMBSC permit is 2.6:1. This means that for every 2.6 pounds of total phosphorus reduced through nonpoint source BMPs, one pound is reduced at the wastewater treatment plant. Therefore, one credit is given for every 2.6 pounds of total phosphorus reduced by a nonpoint source BMP.

The trade ratio includes three different components: a base of 1:1 to offset the discharge, +0.6 as an explicit *engineering safety factor* which, in addition to conservative assumptions implicit in the calculations, accounts for variations among sites, and +1 to allow for water quality improvement which takes into account MPCA's existing plans to improve water quality including the MPCA water quality interim target for the Minnesota River Basin, the MPCA dissolved oxygen TMDL on the lower Minnesota River, and the MPCA Phosphorus Strategy (MPCA 2004b).

What Type of Monitoring is Performed?

SMBSC monitors its wastewater outfall but does not conduct water quality monitoring at the BMPs. The reductions from the BMPs are estimated by using calculations described in the permit. Some data were collected on initial phosphorus concentrations in the soil and used in the reduction calculations (Klang 2006a). SMBSC is responsible for submitting technical and engineering reports, including structural specification, operation plans, and detailed photographs, to MPCA before and after each trade (Breetz et al. 2004). The permit also requires annual reports accounting for nonpoint source credits. SMBSC is responsible for submitting an implementation report to MPCA and its third-party auditor for comparison with the auditor's findings. If the auditor finds the project was completed as approved, he or she can recommend the issuance of credits, which MPCA can then grant or deny (MPCA 2004a). Previously, MPCA fulfilled the auditors role (Breetz et al. 2004); however, since December 2004 (when the permit was reissued) MPCA now requires SMBSC to retain an auditor to certify implementation. The auditor can be a professional engineer, certified crop advisor, or a representative of a local watershed interest (Klang 2006a; MPCA 2004a). The auditor must certify that the project was completed and recommend issuance of credits the first time the BMP is implemented. For each year following, SMBSC must certify in the *Phosphorus Trading*

Site Annual Report that the BMP sites remain active. The report is to include photographs of each site taken during the previous year or the landowner's written certification that the project remains in-place and effective (MPCA 2004a).

What Are the Incentives for Trading?

The trading program allowed SMBSC to construct and operate its own WWTP which alleviated the land application problems and allowed it to expand the processing operation. In addition, SMBSC pays members to plant cover crop BMPs, and they also receive the ancillary benefit of protecting young sugar beet plants (Klang 2006a).

What Water Quality Improvements Have Been Achieved?

SMBSC has exceeded its offset requirements by implementing sugar beet spring cover crops, cattle exclusion, and bluff/channel stabilization. Because SMBSC's total phosphorus limit is 2,500 lbs/yr, the permit requires that the wastewater treatment plant offset 6,500 lbs of total phosphorus/year and to date, the nonpoint source BMPs generated reduction credits for 15,767.5 lbs total phosphorus/year (Klang 2006b). In addition, the new WWTP has solved the land application odor problem that was a significant community nuisance.

What Are the Potential Challenges in Using This Trading Approach?

The environmental community was initially hesitant to support the trading arrangement due to past permit compliance issues at SMBSC. To remedy these concerns, MPCA required SMBSC to develop a plan and compliance schedule before the permit was issued (Breetz et al. 2004).

Another concern of the environmental community was that not enough documentation was required by the previously issued Rahr Malting Co. trading permit. SMBSC's permit contains many more detailed documentation requirements such as a site-proposal package with specific components detailed in the permit, an implementation report and certification by a third-party auditor, as well as the specifics regarding what should be included in the *Phosphorus Trading Site Annual Report* (Breetz et al. 2004; MPCA 2004a). A remaining concern from some of the local conservationists is that the permit is not restrictive enough regarding the crediting program set up for sugar beet spring cover crop nonpoint source reductions even though the NRCS standard equations are used for the erosion estimates.

A concern of the SMBSC representatives is the equity issue of offering one shareholder a cost incentive that the other shareholders may not have available to them because they live outside of the watershed. SMBSC was able to resolve this issue after the 2004 Summer Low Flow Dissolved Oxygen TMDL, which manages the upstream requirements of the 1985 Wasteload Allocation Study, was completed. The TMDL required no discharge during the summer critical flow months. SMBSC accepted this by spray irrigating its wastewater during this time. Even though SMBSC was no longer required to trade because it did not directly discharge during the critical flow months, it chose to continue trading and negotiated an agreement in the permit to require 80 percent of the trades to take place inside the Minnesota River basin and allow the other 20 percent to be in the adjacent Crow River watershed, resolving the equity issue.

Historically there have been tensions between some ranchers and sugar beet farmers which have made it difficult for SMBSC to obtain ranchers as trading partners (Breetz et al. 2004; Klang 2006c).

The permit required approximately 0.25–0.50 full-time equivalency of MPCA staff for permit trade calculation development. Immediately after permit completion, some critical time, on the order of weeks, was spent setting up the trades. Now MPCA spends only a few days a year managing the program (Klang 2006c).

What Are the Potential Benefits?

This approach allowed SMBSC to expand its processing operation and alleviate the problems associated with land application by building a wastewater treatment plant.

Fang and Easter (2003) found that in 2000–2001, it cost farmers $18.65/lb phosphorus reduction, which is comparable to the cost for a 1–2 mgd WWTP to treat its effluent to meet a 1 mg/L phosphorus limit. However, SMBSC was required to completely offset its discharge, meaning that in the absence of trading, it would have to meet a 0.0 mg/L phosphorus limit. Therefore, SMBSC believes that trading provided cost savings over treatment (Breetz et al. 2004). The representatives from SMBSC also believe the cost estimate does not include the production costs saved by avoiding the occasional replanting that may be necessary if the young sugar beet plants are not protected by cover crop BMPs.

The trading program raised watershed awareness and provides a good example of both community cooperation and allowing for growth on impaired waters (Klang 2006c).

Applicable NPDES Permit Language

Permit MN0040665

Chapter 12. Total Facility Requirements

1. Phosphorus Management Plan

General Requirements for Phosphorus Trading

1.1 The Permittee shall achieve the phosphorus trade reduction credits by implementing projects subject to contractual arrangements. Projects shall be Soil Erosion Best Management Practices (BMPs), Cattle Exclusion, Rotational Grazing With Cattle Exclusion, Critical Area Set Aside, Constructed Wetland Treatment Systems, Alternative Surface Tile Inlets, or Cover Cropping. The Permittee shall calculate the proposed trade credits for these projects according to the terms of this permit and the "Phosphorus Trade Crediting Calculations" appended to and incorporated into this permit. The MPCA is responsible for approving the number of phosphorus trade credits for the proposed projects.

1.2 BMPs, other than those specified above, cannot be employed without MPCA approval.

1.3 A contractual arrangement that the Permittee enters into for trade sites shall require the performance of what the MPCA has approved for the sites. However, the Permittee retains responsibility for the proper construction, installation, operation and maintenance of the projects the MPCA has approved for phosphorus trade credits

under this permit notwithstanding the contractual arrangements that the Permittee may have entered into regarding the projects.

1.4 Credits generated from this program, in excess of those required by this permit, can be transferred to other Permittees, if approved in writing by the MPCA.

1.5 It is the intent of this permit that the Permittee shall achieve and maintain MPCA-approved phosphorus trade reduction active credits for the life of the wastewater treatment plant discharge to surface waters.

General Project Eligibility Criteria

1.6 The Permittee shall achieve and maintain MPCA-approved phosphorus trade reduction credits in the amount of 2.6 times the annual phosphorus mass discharge limit (1,130 kg/yr or 2,500 lbs/yr) for SD009 (2.6 × 2,500 lbs P per year = 6,500 credits).

1.7 Phosphorus trade credit projects shall not include activities required to be permitted by the MPCA and/or by other entities according to MPCA rules.

1.8 Phosphorus trade credits shall not be proposed or approved for sites which simultaneously track benefits for other environmental programs, including but not limited to wetland mitigation under the Wetland Conservation Act. If a site for which trade credits already have been approved or granted under this permit is entered into another environmental program, the Permittee shall immediately inform the MPCA to revoke the trade credits for that site.

1.9 Phosphorus trade credit project best management practices shall be additional to those occurring prior to1999 for existing trade projects and for cover crop BMP in general and during at least the previous five years for new sites proposed for trade credits.

1.10 At least eighty percent (80%) of the required credits shall be located in the Minnesota River drainage basin, excluding landlocked areas, lakes, or reservoirs with significant phosphorous assimilative capacity.

Phosphorus Trade Board

1.11 The Permittee shall establish and maintain a Phosphorus Trading Board. The Board shall consist of no more than seven members. At least one of these members shall be a local, watershed manager, at least one shall be a non-MPCA government representative knowledgeable in the field of agriculture, and at least one shall be the leader of a locally based water resources organization. The Phosphorus Trading Board shall review and approve the sites proposed by the Permittee before these sites are proposed for approval to the MPCA. The MPCA shall provide copies to the Phosphorus Trading Board of its correspondence regarding its review of these proposed sites, including MPCA approval and denial decisions on these sites.

Granting Phosphorus Trade Credits

1.12 Forty-five percent of the project's potential phosphorus credits for a site shall be granted when the MPCA approves a proposed project

1.13 Forty-five percent of the project's potential phosphorus credits for a site shall be granted when construction is complete, according to the MPCA-approved plans and specifications, and the MPCA's requirement for review has been satisfied.

1.14 Ten percent of the project's potential phosphorus credits for a site shall be granted when vegetation establishment criteria have been achieved at the site, the Permittee submits required documentation, and the MPCA's requirement for review has been satisfied.

1.15 Credits shall not be considered active until they have been granted as described above.

1.16 The MPCA may at any time revoke previously approved phosphorus trade credits. In order to revoke credits, the MPCA shall make the following findings:

1. The project as credited by the MPCA was not constructed or installed as approved; or
2. The project as credited by the MPCA was not operated or maintained as approved; or
3. The project contractual arrangement(s) have not been honored.

Project Submittal and Review

1.17 To propose a site for phosphorus trade credit approval by the MPCA, the Permittee shall provide to the MPCA, at least 90 days before the Permittee expects to receive an approval response from the MPCA, the following information for the site:

1. Site name and location, as detailed on a USGS 7.5-minute quad map with lat/long location identified to the nearest second. Identification of the major and minor watersheds, and HUC reach codes, in which the site is located. The extent to which lakes or reservoirs are downstream of the site.
2. Landowner name and mailing address.
3. Documentation, including photos as needed, of the vegetation species, land use and specific drainage practices at the site over the previous 5 years.
4. Type of BMPs proposed to be implemented at the site.
5. Copy of the signed contractual arrangement that stipulates future management requirements and length of term and that stipulates that the construction will not begin until MPCA approves the project.
6. Plan view of the project, and engineering plans, specifications and, for structural practices, the professional engineer's certification, for the project, if needed. Operation and maintenance plans.
7. Vegetation establishment and maintenance criteria and plans to achieve 100 pct active crediting for the project.
8. The total annual pounds (kg) of phosphorus credit applied for, and the basis for this value, including the detailed calculations.
9. Those projects with vegetative components shall include establishment and maintenance criteria and plans to ensure a dense stand, including the dates of seeding.

1.18 Those projects that treat sediment by filtering or settling shall include operation and maintenance plans that include, but are not limited to, procedures to:

1. Ensure sheet flow conditions are maintained in upland flow areas;
2. Remove accumulated sediment that may hinder the operation of the BMP;
3. Inspect and, if needed, reestablish a structure or vegetation after major storm events or fire; and

4. Remove harmful infestations, including carp from treatment wetlands, destructive insects from vegetation, and beavers from bioengineering sites.

1.19 The MPCA shall in writing approve, or deny with comments, the proposed project. The MPCA shall, in its approval of proposed project, certify that appropriate contractual arrangements are in place for the site, confirm the project's potential trade credits, and shall specify the information required to document construction completion and clarify the auditor's responsibilities.

1.20 The credit value for a project shall be based upon the ratio of the Permittee's financial contributions to the contributions from public sources. The Permittee shall not receive credits for those portions of a project financed by public funding sources.

Project Construction/Implementation, Documentation, Auditing, and Credit Approval

1.21 Project Construction shall not begin until MPCA written approval for the project is received.

1.22 The Permittee shall retain an independent auditor to certify project completion:

1. For engineered projects designed by a registered professional engineer, the auditor shall be a registered professional engineer. The professional engineer shall provide a construction documentation report for the project and the engineer shall certify that the project was completed in substantial conformance with the approved plans and specifications. The MPCA may require that photographs and/or record drawings be included in the report, depending upon the project complexity.
2. For cover crop, the auditor can be a registered professional engineer, a certified crop advisor, or a representative of a local watershed interest. The Permittee shall provide the list of MPCA approved cover crop contracts and the auditor shall select10% at random for a site inspection. The Permittee shall submit its implementation report to the MPCA and the auditor. The auditor will compare audit site information to Permittee's report, noting any inconsistencies in the auditors report submitted.
3. For other projects, or for portions of projects not designed by the registered professional engineer, the auditor can be a registered professional engineer, a certified crop advisor, or a representative of a local watershed interest. The auditor shall inspect the construction site as needed to confirm and document that the project was completed in accordance with the approved project.
4. For projects where vegetation establishment is required, the auditor shall provide written verification that the vegetation establishment criteria have been achieved.
5. The auditor will prepare a report to submit to the MPCA and the Permittee, the report will provide documentation required for that project. If the project was completed as approved, the report will recommend issuance of construction credits.

1.23 The MPCA shall respond to the Permittee's documentation reports and auditor's certification reports and either issue or deny construction credits or vegetation establishment credits.

Annual Reporting

1.24 The Permittee shall submit a Phosphorus Trading Site Annual Report: due on November 30 of each year following permit issuance.

1.25 The Permittee shall certify in the Phosphorus Trading Site Annual Report that the active sites approved by the MPCA for phosphorus trade credits, remain active according to the plans and specifications approved by the MPCA

1.26 The Report covering a site shall include photographs of each site taken during the previous year (these photographs shall correspond in view and detail to the initial photographs provided to the MPCA for that site) or landowner's written certification that the project remains in-place and effective.

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Truckee River
Nevada

Overview

The Truckee Meadows Water Reclamation Facility (TMWRF) provides wastewater treatment for the cities of Reno and Sparks in Nevada and is subject to wasteload allocations from a 1994 TMDL developed to address total nitrogen, total phosphorus, and total dissolved solids. TMWRF's permit, issued by the Nevada Division of Environmental Protection (NDEP), contains effluent limits that reflect the wasteload allocations for parameters covered by the TMDL. In addition, the permit identifies individual wasteload allocations and contains language that allows temporary trading of individual wasteload allocations. The permit also allows NDEP to modify the permit to allow water quality trading (or offset) projects that allow permittees to generate credits toward their wasteload allocations.

Type of Trading

Point Source–Point Source
Point Source–Nonpoint Source

Pollutant(s) Traded

Total nitrogen
Total phosphorus
Total dissolved solids

Number of Trades to Date

None

Who Is Eligible to Participate?

Under its permit, TMWRF is authorized to participate in water quality trading projects that could generate credits toward its wasteload allocation. Temporary trading of individual wasteload allocations is an activity authorized under the permit to take place between TMWRF and two other dischargers—(1) Vista Canyon Group, LLC, and (2) the city of Sparks–Sparks Marina Park.

What Generated the Need for Trading?

Impairments in the Truckee River are associated with low flows and heavy pollutant loading. According to TMWRF's Web site, the Truckee Meadows is one of the fastest growing metropolitan areas in the country. To accommodate growth, TMWRF needs to expand capacity, but it faces stringent nitrogen discharge limits as a result of the TMDL (Breetz et al. 2004).

What Serves as the Basis for Trading?

The wasteload allocations derived as part of the 1994 TMDL for total nitrogen, total phosphorus, and total dissolved solids serve as the basis for trading.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

The TMDL report for the Truckee River, adopted by NDEP in February 1994, contains a description of the data and methodologies used to calculate the wasteload allocations for total phosphorus, total dissolved solids, and total nitrogen.

TMDLs and Wasteload Allocations for Total Phosphorus and Total Dissolved Solids

NDEP used simple dilution calculations for total phosphorus and total dissolved solids. To calculate the TMDLs in pounds per day using flow data and pollutant concentration, NDEP calculated the value of a constant to use in the TMDL calculation. The TMDL in pounds per day (lb/day) is calculated by multiplying the average flow in cubic feet per second (ft^3/sec), the average concentration in milligrams per liter (mg/L) and the constant 5.394 lb-L-sec/mg-ft^3-day (NDEP 1994).

***TMDL (lb/day)** = (average flow in ft^3/sec) × (average concentration in mg/L) × (5.394 lb-L-sec/mg-ft^3-day)*

Example: Calculating the TMDL for Total Phosphorus and Total Dissolved Solids

NDEP used simple dilution calculations to develop TMDLs for total phosphorus and total dissolved solids, assuming the system is represented by average conditions over time (NDEP, 1994). Using average flow data from the U.S. Geological Survey, NDEP selected the time period 1973 to 1992 to calculate the average flow of 795 ft^3/sec; 1973 represented the last significant modification to flow control structures in the Truckee River Basin (NDEP 1994). The average concentration of phosphorus used by NDEP was 0.05 mg/L, and the average concentration of total dissolved solids was 210 mg/L.

(Average flow in ft^3/sec) × (Average concentration in mg/L) × (5.394 lb-L-sec/mg-ft^3-day) = TMDL (lbs/day)

For total phosphorus:
(795 ft^3/sec) × (0.05 mg/L) × (5.394 lb-L-sec/mg-ft^3-day) = 214 lb/day

For total dissolved solids:
(795 ft^3/sec) × (210 mg/L) × (5.394 lb-L-sec/mg-ft^3-day) = 900,528 lb/day

NDEP determined that of the 214 lb/day calculated as the total phosphorus TMDL, 80 lb/day was associated with nonpoint sources and background; therefore, the wasteload allocation for TMWRF is 134 lb/day of total phosphorus. TMWRF's wasteload allocation for total dissolved solids is a 30-day average load of 120,168 lb/day.

TMDL and Wasteload Allocation for Total Nitrogen

To calculate the TMDL for total nitrogen, NDEP used a different approach because it assumed total nitrogen to be a nonconservative pollutant (NDEP 1994). NDEP used the Dynamic Stream Simulation and Assessment Model (DSSAM III) to calculate the TMDL. Intensive sampling from September 1989 provided a snapshot of nutrient loading to the Truckee River; therefore, NDEP used those data to calibrate the DSSAM III model. NDEP used the model to run a series of simulations involving differing nutrient loadings to determine the appropriate TMDL. Simulation results indicated that nitrogen loads in excess of 1,000 lb/day may result in excessive growth of aquatic plants (NDEP 1994). Therefore, NDEP set the TMDL at 1,000 lb/day during summer low flows.

NDEP stated that existing data indicated that the average nonpoint source contribution of total nitrogen is approximately 500 lb/day (NDEP 1994). Therefore, TMWRF received a wasteload allocation of 500 lb/day as an average annual load from November 1 through April 30 and as a 30-day average load from May 1 through October 31.

TMWRF is using other modeling tools to revisit the TMDL for total nitrogen in a third-party TMDL development process. The results from this process could change the facility's wasteload allocation and the basis for future trading activities (Pahl 2007).

Are Permits Used to Facilitate Trades?

The NPDES permit issued to TMWRF by NDEP contains language that allows temporary trading of individual wasteload allocations and water quality trading projects, such as river restoration and septic system conversion, to offset wasteload allocations. However, individual wasteload allocation trading requires submission of a notification to NDEP. Water quality trading projects might require permit modifications to increase the permittee's wasteload allocation.

How Are Credits Generated for Trading?

To date, TMWRF has not developed a proposal to conduct trading. Such a trading proposal would contain information about the water quality trading project that would result in credits to offset a pollutant discharge load. It is likely that credits would be based on the Watershed Analysis Risk Management Framework (WARMF) model being developed for the Truckee River. The WARMF watershed model, completed in late 2004, would be used to estimate the predicted nutrient and sediment loading reductions from nonpoint source projects (Breetz et al. 2004).

What Are the Trading Mechanisms?

Temporary trading of individual wasteload allocations requires the submission of a notification signed by the transferring and the receiving dischargers. The notification must describe the amount of individual wasteload allocation to be transferred, the length of time of the transfer, and the basis for the transfer (i.e., last monthly flows and wasteload discharged for both dischargers). Water quality trading projects will most likely require TMWRF to submit a project proposal to NDEP for review. The permit does not specify requirements but does mention that NDEP will evaluate the effectiveness of projects as to their effectiveness through modeling simulations, pilot studies, and monitoring (NDEP 2003).

What Is the Pollutant Trading Ratio?

Not yet determined.

What Type of Monitoring Is Performed?

Not yet determined.

What Are the Incentives for Trading?

The language contained in the NPDES permit for TMWRF provides flexibility in how the permittee can achieve its wasteload allocation.

What Water Quality Improvements Have Been Achieved?

Not applicable.

What Are the Potential Challenges in Using This Trading Approach?

Potential challenges include negotiating terms of proposed water quality projects that involve nonpoint source offsets of TMWRF's pollutant load, particularly in defining the appropriate trade ratio and determining effectiveness.

What Are the Potential Benefits?

Potential benefits of the trading provisions integrated into TMWRF's NPDES permit include cost-effective solutions for achieving wasteload allocations and improving overall water quality conditions, as well as consideration of overall watershed conditions when evaluating the merits of proposed water quality trading projects.

Applicable NPDES Permit Language

c. Temporary Trading of IWLA: The Permittee may temporarily trade IWLA upon submittal of a notification signed by the transferring and the receiving dischargers describing the amount of IWLA transferred, the length of time the transfer is effective and the basis for the transfer. The basis for the transfer shall include the last monthly flows and wasteload discharged for both dischargers. The wasteload transfer shall be effective on the date of the submittal to the Division.

   Any designated transfer is binding on the dischargers and cannot be revoked without a notification signed by the transferring and the receiving dischargers. The transferred IWLA shall revert back to the original holder of the IWLA at the end of the time specified on the notification. A copy of the latest IWLA agreement and any agreements made during the reporting period shall be submitted with each quarterly report required by I.B.2.

I.A.5. Water Quality Trading: The Division may modify the permit to include specific water quality trading, or offset, projects based upon review of the results of scientific studies, as a major modification. Water quality trading entails the reduction in a pollutant load through implementation of a water quality management project that is credited towards the Permittee's wasteload allocation (WLA), thereby increasing the Permittee's allowable discharge load for a specific pollutant. Potential water quality trading opportunities include, but are not limited to, water augmentation, river restoration, septic system conversion, and stormwater management practices. These potential water quality management projects will be evaluated as to their effectiveness through watershed/water quality modeling simulations, field pilot studies and on-going water quality monitoring. Based on the results of the model simulations and pilot projects, the permit may be modified to incorporate the Permittee's increased WLA(s).

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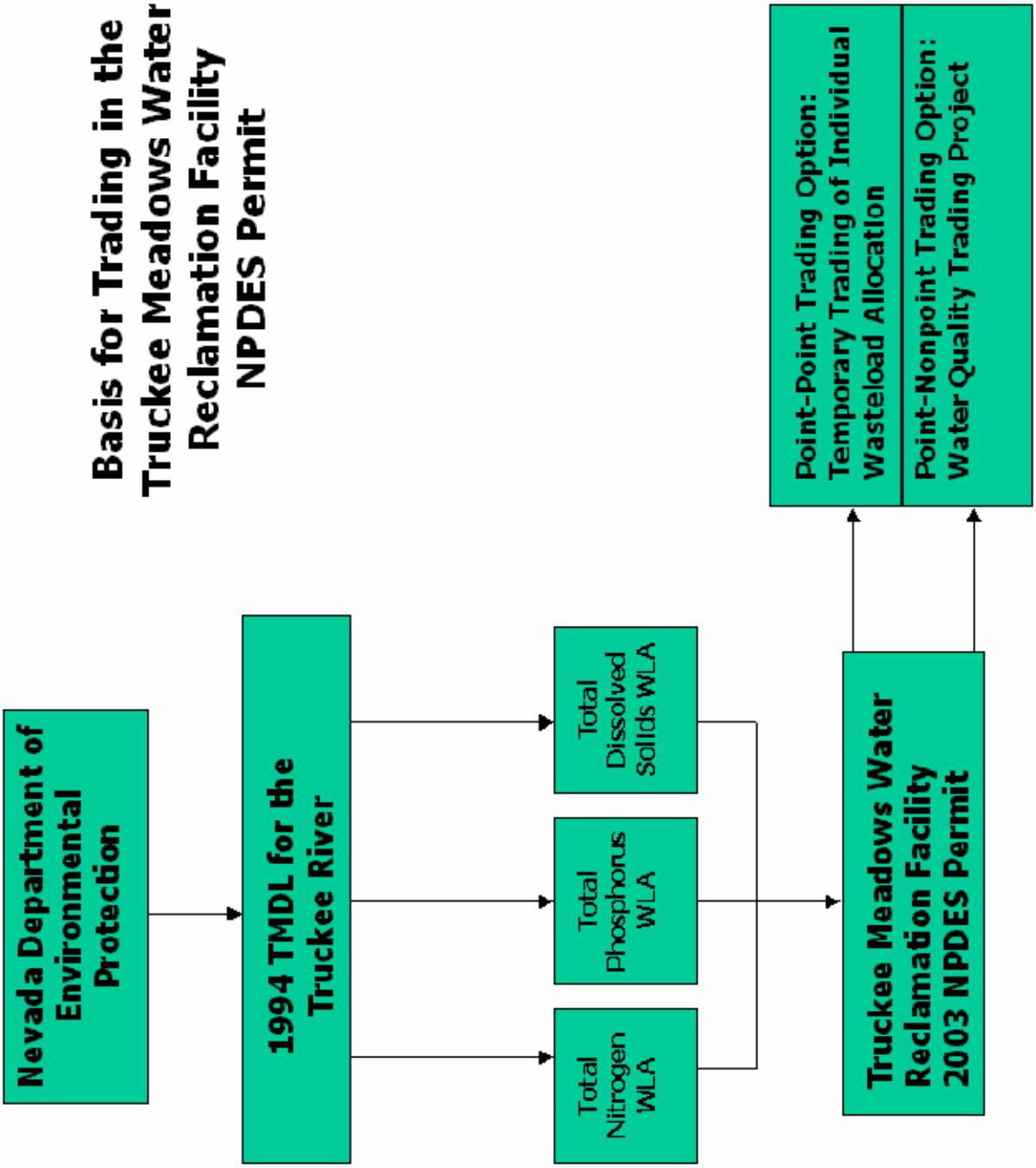
Basis for Trading in the Truckee Meadows Water Reclamation Facility NPDES Permit
Nevada Department of Environmental Protection
1994 TMDL for the Truckee River
Total Dissolved Solids WLA
Total Phosphorus WLA
Total Nitrogen WLA
Truckee Meadows Water Reclamation Facility 2003 NPDES Permit
Point-Point Trading Option: Temporary Trading of Individual Wasteload Allocation
Point-Nonpoint Trading Option: Water Quality Trading Project

Passaic Valley Sewerage Commissioners Pretreatment Trading *New Jersey*

Overview

The Passaic Valley Sewerage Commissioners (PVSC) operates a large publicly owned treatment works (POTW) that treats wastewater for northern New Jersey. PVSC participated with EPA and other partners in a pilot project for indirect dischargers to the POTW that would allow water quality trading to meet pretreatment local limits.

Number of Trades to Date

Two

The first trade was for copper between two organic chemical manufacturers; the buyer eventually went out of business. The second trade involved a pharmaceutical company that purchased zinc and copper credits from an organic chemical manufacturer (the seller in the initial trade).

Type of Trading

Point Source–Point Source

Pollutant(s) Traded

Heavy metals regulated through local pretreatment limits (cadmium, copper, lead, mercury, nickel, zinc)

Who Is Eligible to Participate?

Approximately 260 indirect dischargers within the PVSC service area, which encompasses 48 municipalities in 4 counties, can participate.

What Generated the Need for Trading?

PVSC established more stringent local pretreatment limits for certain heavy metals to meet *exceptional quality* standards for beneficial reuse of biosolids. Indirect dischargers raised concerns about more stringent local limits because many already had to meet federal categorical pretreatment standards.

What Serves as the Basis for Trading?

Trading to meet uniform local pretreatment limits by industrial facilities is allowed by PVSC in rules and regulations regarding indirect discharges that became effective in 1994, in accordance with state and federal pretreatment and residual management regulations. PVSC established stringent local pretreatment limits in 1994 for certain heavy metals to meet *exceptional quality* standards for the beneficial reuse of biosolids. PVSC required industrial users to comply with the local limits by June 1997.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

PVSC's technology-based local limits for certain heavy metals served as the basis for trading. Local limits are conditional discharge limits imposed by municipalities on industrial and commercial facilities that discharge to a POTW to prevent site-specific (e.g., POTW or environmental) problems. The methodology for calculating local limits depends on two factors: the maximum allowable headworks loading (MAHL) and the maximum allowable industrial loadings (MAIL). A MAHL is an estimate of the upper limit of pollutant loading to a POTW intended to prevent pass-through or interference and serve as the basis for local limits. The MAIL developed by the POTW represents the amount of pollutant loading the POTW may receive from industrial users and other controlled sources. After calculating the MAIL, the POTW assigns local limits to dischargers. To assign local limits, PVSC used what they refer to as a *hybrid* uniform allocation method that took into account reductions from the two largest dischargers to the POTW.

Data typically needed to develop local limits include pollutant concentration data from the POTW (influent, effluent, primary effluent, sludge), collection system, receiving stream, and industrial users, as well as flow data, including total POTW flow, POTW sludge flow to the digester, POTW sludge flow to disposal, industrial user flows, receiving stream, hauled waste, domestic flows, and commercial flows (USEPA 2004).

Are Permits Used to Facilitate Trades?

PVSC administers a pretreatment program according to NPDES regulations. Through its pretreatment program, PVSC issues sewer use permits to indirect dischargers. The sewer use permits contain adjusted permit limits that reflect the terms of an approved trade contained in a trading agreement (see *What Are the Trading Mechanisms?* below). PVSC approves trades using a set of criteria that requires the traded amount to be greater than 0.1 pound per day and traded in increments of no less than 0.05 pound per day. The 0.1 pound per day increment was selected because it was relatively large and would limit the number of potential participants (Caltagirone 2004).

How Are Credits Generated for Trading?

The seller is an industrial facility that demonstrates, using monitoring data and compliance records, a positive reduction in a heavy metal through control measures or pollution prevention techniques (i.e., pretreatment). The buyer is an industrial facility that cannot meet its local limits for a heavy metal and wants to negotiate with a seller to purchase credits through a contract. A seller may sell credits for a particular metal to a maximum of 10 buyers. A buyer may purchase credits for more than one metal, but it must purchase all credits for a particular metal from one seller.

Credits are traded on a mass basis, rather than a concentration basis; therefore, facilities participating in a trade must convert the discharge concentration in milligrams per liter (mg/L) to a mass-based unit in pounds per day (lb/day). The buyer may use only 80 percent of the purchased quantity because PVSC requires the buyer to retire or reserve 20 percent of the reductions for environmental benefit or future needs (Breetz et al. 2004). Therefore, facilities purchasing credits must take this retired/reserved percentage into account when calculating credits.

Current discharge concentration of a specific heavy metal–*Local limit of a specific heavy metal = Concentration exceeding local limit for a heavy metal*

Concentration exceeding local limit for a heavy metal (mg/L) × volume (mgd) × 8.344 (conversion factor) = Mass (lb/day) of pollutant exceeded

Mass (lb/day) of pollutant exceeded / 0.80 (percentage of purchased quantity that may be used) = Total credits that need to be purchased (lb/day)

Example: Calculating Copper Credits a Facility Must Buy to Comply with Local Limits

The PVSC local limit for copper is 3.02 mg/L. A chemical facility discharges 5.20 mg/L copper and has an average annual effluent discharge rate of 0.150 mgd.

Current discharge concentration of a specific heavy metal–Local limit of a specific heavy metal = Concentration exceeding local limit for a heavy metal
5.20 mg/L–3.02 mg/L = 2.18 mg/L

Concentration exceeding local limit for a heavy metal (mg/L) × Volume (mgd) × 8.344 (conversion factor) = Amount over local limit on a mass basis (lb/day)
2.18 mg/L × 0.150 mgd × 8.344 = 2.73 lb/day

Mass (lb/day) of pollutant exceeded / 0.80 (percentage of purchased quantity that can be used) = Total credits that need to be purchased (lb/day)
2.73 lb/day / 0.80 = 3.41 lb/day

PVSC's regulations require a buyer to purchase credits in minimum increments of 0.05 lb/day. As a result, the chemical facility would need to round 3.41 lb/day to 3.45 lb/day to determine the total amount of credits that it needs to purchase to comply with the local limits for copper.

Example taken from *Sharing the Load: Effluent Trading for Indirect Dischargers. Lessons from the New Jersey Chemical Industry Project—Effluent Trading Team* (USEPA 1998).

The seller would use a similar procedure to determine the amount of credits on a mass basis it has available to sell. If a facility plans to sell credits, it needs to determine what its adjusted permit limit will be after selling credits. PVSC modifies existing permits using the adjusted permit limit. The first step in calculating the adjusted permit limit is to determine the allowable discharge on a mass basis, which involves multiplying the local limit by the facility's volume and the conversion factor. The difference between the allowable discharge and the credits available for sale equals the adjusted discharge limit on a mass basis. Converting the adjusted discharge limit from a mass-based limit to a concentration-based limit requires dividing the mass-based limit by the product of the facility's volume and the conversion factor.

Local limit (mg/L) × Volume (mgd) × 8.344 (conversion factor) = Allowable discharge on a mass basis (lb/day)

Allowable discharge on a mass basis (lb/day)–Amount of credits available for sale (lbs/day) = Mass-based adjusted discharge limit (lb/day)

Mass-based adjusted discharge limit (lb/day) / (Volume (mgd) × 8.344 (conversion factor)) = Concentration-based adjusted discharge limit (mg/L)

Example: Calculating a Seller's Concentration-Based Adjusted Discharge Limit After Selling Credits

A facility has an average annual discharge rate of 0.20 mgd, and the local limit for copper is 3.02 mg/L. The facility wants to sell credits equaling 3.45 lb/day to a neighboring facility, but it first wants to calculate what its adjusted permit limit would be as a result of the sale.

The facility must first convert its allowable discharge to a mass-based limit.

> Local limit (mg/L) × Volume (mgd) × 8.344 (conversion factor) = Allowable discharge on a mass basis (lb/day) 3.02 mg/L × 0.20 mgd × 8.344 = 5.04 lbs/day

The facility is able to discharge 5.04 lb/day of copper and meet the local limit for copper. A sale of 3.45 lb/day to a neighboring facility would provide some additional discharge capacity.

> Allowable discharge on a mass basis (lb/day)–Amount of credits available for sale (lb/day) = Mass-based adjusted discharge limit (lb/day) 5.04 lb/day–3.45 lb/day = 1.59 lb/day

With the sale of 3.45 lb/day, the facility could still discharge 1.59 lb/day. Discharge limits in permits are concentration-based limits; therefore, the facility will have to convert the 1.59 lb/day to a concentration to determine the final adjusted discharge limit that will appear in its permit.

> Mass-based adjusted discharge limit (lb/day) / (Volume (mgd) × 8.344 (conversion factor)) = Concentration-based adjusted discharge limit (mg/L) 1.59 lb/day / (0.20 mgd) × (8.344) = 1.59 lb/day / 1.6688 = 0.95 mg/L

After the sale of credits, the facility's new permit would require an adjusted discharge limit of 0.95 mg/L of copper instead of the 3.02 mg/L local limit for copper in the original permit.

Example taken from *Sharing the Load: Effluent Trading for Indirect Dischargers. Lessons from the New Jersey Chemical Industry Project—Effluent Trading Team* (USEPA 1998).

What Are the Trading Mechanisms?

PVSC's rules and regulations state that buyers and sellers must submit documentation acceptable to PVSC that commits buyers and sellers to complying with regulations; PVSC does not require a standardized form. PVSC reviews documentation submitted as a contract to determine whether the contract fulfills the criteria contained in the rules and regulations for trading. Criteria include the following (USEPA 1998):

- Demonstrated compliance with all other POTW requirements
- Demonstrated ability to comply with adjusted discharge limits
- Traded amount is greater than 0.1 pound per day
- Traded amount is in increments of no less than 0.05 pound per day
- Defined price of credit and terms of payment (buyer and seller negotiate this amount)
- Established time frame of agreement, including timing of renewals and adjustments

What Is the Pollutant Trading Ratio?

The trading ratio is 10:8. The buyer may use only 80 percent of the purchased quantity; 20 percent of the reductions are retired or reserved for environmental benefit or future needs (Breetz et al. 2004). The determination that 20 percent of the reductions should be retired/reserved was arbitrary and not based on any specific analysis (Caltagirone 2004).

What Type of Monitoring Is Performed?

Facilities must perform monthly sampling, as specified in their permits, and PVSC compiles discharge monitoring data.

What Are the Incentives for Trading?

The primary incentive for participating in PVSC's pretreatment trading program is flexibility in complying with more stringent local limits. In addition, sellers are able to defray pretreatment costs through revenue gained from the sale of excess reductions (Breetz et al. 2004).

What Water Quality Improvements Have Been Achieved?

PVSC has demonstrated an improvement in the trend of metals concentrations and loads in the influent, effluent, and sludge upon establishing the local limits (PVSC 2003). However, the water quality improvements resulting from the two trades that have taken place are unknown.

What Are the Potential Challenges in Using This Trading Approach?

The case study report on PVSC's pretreatment trading program identifies several potential challenges, including PVSC's indirect dischargers' unfamiliarity with the concept of water quality trading and finding suitable trading partners. The case study report also identifies specific challenges associated with small-volume dischargers in negotiating trades and determining the appropriate price (USEPA 1998). Since the second trade, PVSC has not had any other facilities come forward with a proposed trade agreement; PVSC is uncertain as to why facilities have not shown any interest (Breetz et al. 2004).

What Are the Potential Benefits?

Administrative costs for PVSC are negligible, involving only reviewing proposed trade agreements and adjusting permit limits (Breetz et al. 2004). This approach is easily transferable to other pretreatment programs (USEPA 1998).

Applicable Permit Language

PVSC modifies the sewer use permits issued to indirect dischargers to reflect the adjusted discharge limit resulting from a trade. The permit shows the adjusted limits; and the parameters have asterisks. The explanation of the asterisks state that more information is available on a subsequent page. The other page contains three short paragraphs alluding to the adjusted limits. One paragraph states that the limits are adjusted pursuant to a signed contract on a specified date between the two parties (both named). One paragraph denotes the permittee as a buyer and the other facility as a seller, and it adds that the limits were calculated using the permittee's regulated volume. The last paragraph states that PVSC reserves the right to change the limit if the contract is terminated (Caltagirone 2004.)

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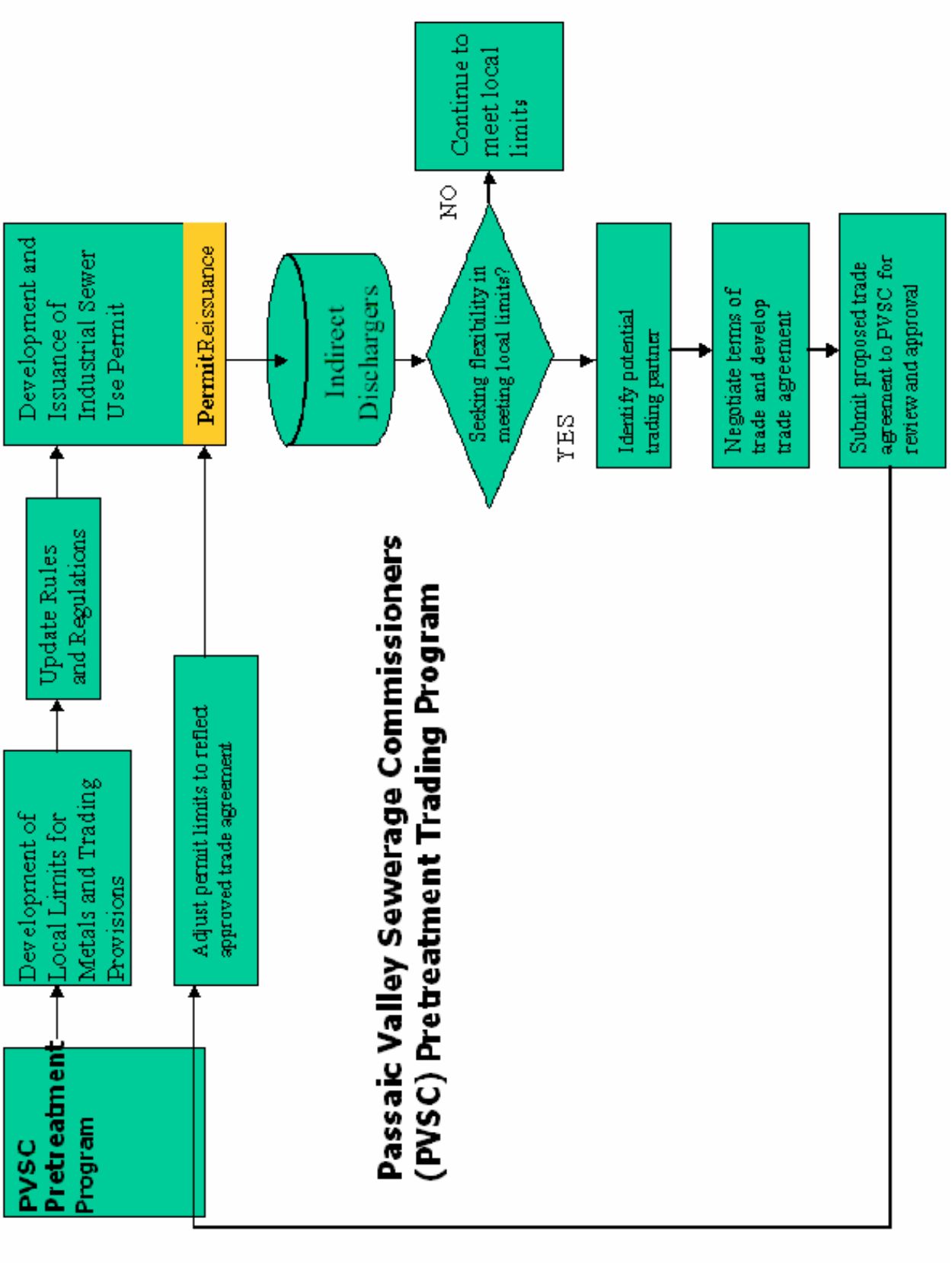
Passaic Valley Sewerage Commissioners
(PVSC) Pretreatment Trading Program
PVSC Pretreatment Program
Development of Local Limits for Metals and Trading Provisions
Update Rules and Regulations
Development and Issuance of Industrial Sewer Use Permit
Adjust permit limits to reflect approved trade agreement
Permit Reissuance
Indirect Dischargers
Seeking flexibility in meeting local limits?
NO
Continue to meet local limits
YES
Identify potential trading partner
Negotiate terms of trade and develop trade agreement
Submit proposed trade agreement to PVSC for review and approval

Neuse River Basin Nutrient Sensitive Waters Management Strategy *North Carolina*

Overview

Dischargers in the Neuse River Basin are subject to a wasteload allocation set through the Neuse River Basin Nutrient Sensitive Waters Management Strategy (Strategy). The rules developed to support implementation of the Strategy allow dischargers to participate in trading activities and establish group compliance associations to meet a collective allocation under a single NPDES permit. To date, approximately 23 facilities participate in one group compliance association referred to as the Neuse River Compliance Association (Compliance Association) and have coverage under a group compliance permit. Point–point transactions can occur between members of the Compliance Association or between members and non-members within the Neuse River Basin. If the Compliance Association does not meet its limit, the terms of the permit require the association to make an offset payment to the Wetland Restoration Fund to pay for nonpoint source controls. New or expanding dischargers that require additional allocation must also make a payment to the Wetland Restoration Fund.

Type of Trading

Point Source–Point Source
Point Source–Nonpoint Source

Pollutant(s) Traded

Total nitrogen

Number of Trades to Date

Trading has occurred; however, the number of trades is unknown because trading occurs within the Compliance Association.

Who Is Eligible to Participate?

Approximately 100 active facilities in the Neuse River Basin have a total nitrogen (TN) wasteload allocation and are therefore eligible to participate in trading. However, the 32 largest facilities have TN effluent limits and are the most likely to participate.

What Generated the Need for Trading?

The Neuse River is classified as a Nutrient Sensitive Water (NSW) because of nutrient impacts on the river's estuary. Major fish kills in 1995 provided the impetus for updating the 1988 Nutrient Management Strategy for the Neuse River Basin. The 1997 Strategy established a goal that required sources to reduce TN loads to the estuary by 30 percent from 1995 levels by the year 2005. Subsequently the North Carolina Environmental Management Commission (EMC) adopted a rules package in 1998 to support the Strategy. The rules were aimed at reducing nitrogen impacts in the watershed and supporting the Strategy by managing agriculture, stormwater, point sources, nutrient management activities and riparian areas. One of the rules under the Strategy, the Waste Discharge Requirements rule, establishes point source nitrogen allocations and control requirements and compliance options, including a group compliance association option (EMC 2002).

What Serves as the Basis for Trading?

The 1997 Strategy for the Neuse River Basin established a goal for both point and nonpoint sources to reduce TN loads to the estuary by 30 percent from the 1995 estuary level of 2.34 million pounds by 2005. Therefore, the Waste Discharge Requirements rule establishes an estuary wasteload allocation of 1.64 million pounds for dischargers in the Neuse River Basin. The North Carolina Division of Water Quality (NC DWQ) used a phased-approach to developing Total Maximum Daily Loads (TMDLs) for the basin. The Phase I TMDL, approved by EPA in 1999, concluded that the aggregate estuary wasteload allocation in the 1997 Strategy was appropriate. The Phase II TMDL, approved by EPA in 2002, used modeling tools to verify the 30 percent reduction target set in the Phase I TMDL.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

The 1997 Strategy contains the calculations used to determine the estuary wasteload allocations that serve as the basis for trading. Because of a lack of adequate data and technical tools (i.e., computer model for the Neuse River Basin), NC DWQ relied on best professional judgment when determining the nitrogen reduction target and other factors (e.g., transport factors) that provide a foundation for the estuary wasteload allocations and, therefore, the trading program (Templeton 2004a).

1995 Baseline TN Loading

To calculate the aggregate estuary wasteload allocation that represented a 30 percent reduction, NC DWQ had to first determine the 1995 baseline TN load. Determining the baseline TN loading required information about point and nonpoint source discharges to the Neuse River Basin. For larger dischargers and some small dischargers, NC DWQ had the necessary monitoring data from 1991 through 1995 to calculate an average concentration for each facility. For the smaller dischargers that did not conduct monitoring, NC DWQ used the average concentration of the smaller dischargers to estimate the TN concentration. NC DWQ had the necessary flow data from all dischargers during this time frame to calculate the average flow. The 1995 baseline TN loading at end-of-pipe was approximately 3 million pounds per year. The 1997 Strategy, however, was focused on nitrogen reductions to the estuary; therefore, the baseline TN loading had to be converted from and end-of-pipe baseline to an estuary baseline using each facility's applicable nitrogen transport factors. After applying transport factors, NC DWQ calculated the 1995 estuary baseline TN loading to be 1.64 million pounds per year.

Transport Factors

The Neuse River Basin is divided into 12 nutrient management zones, each with a transport factor of 10, 50, 70, or 100 percent, according to distance from the estuary. According to the Wastewater Discharge Requirements rule, a transport factor is the fraction of the TN in a discharge that is predicted to reach the estuary. NC DWQ used a first-order decay equation to estimate the loss of nitrogen from the point of discharge to the estuary; this equation established transport factors used in the 1997 Strategy, the Phase I TMDL, and the group compliance permit. Transport factors applied to the end-of-pipe baseline loading and wasteload allocation result in the estuary baseline loading and wasteload allocation. The Phase II TMDL uses a different transport model, referred to as the SPARROW model, to determine transport factors where decay is a function of the type of stream and not a function of time.

Wasteload Allocations

Determining wasteload allocations for individual facilities required an iterative process that relied on a trial-and-error method. Wasteload allocations were calculated using an equivalent concentration for individual facilities; for example, the mass equivalent of a discharge concentration below approximately 3 mg/L would not be technically feasible for facilities to achieve.

The Wastewater Discharge Requirements rule established annual discharge allocations (as opposed to estuary allocations) for groups of dischargers on the basis of the dischargers' location in the basin (i.e., upstream or downstream from Falls Lake Dam) and the size of their permitted flow. According to the rule, dischargers upstream of Falls Lake Dam with permitted flows greater than or equal to 0.5 mgd received an annual discharge allocation of 443,700 pounds of TN. Dischargers downstream of Falls Lake Dam with permitted flows greater than or equal to 0.5 mgd received an annual discharge allocation of 2,021,400 pounds of TN. NC DWQ divided dischargers into these groups to ensure that similar dischargers would have similar requirements.

The rule states that each individual discharger should receive an individual discharge allocation and the equivalent estuary allocation. The individual discharge allocation is calculated as the 1995 permitted flow divided by the total permitted flow of the group, multiplied by the group discharge allocation. To determine the equivalent estuary allocation, the individual discharge allocation is then multiplied by the facility's applicable transport factor. Appendix B of the group compliance permit contains a list of facilities subject to TN allocations and the applicable facility transport factor based on location in the Neuse River Basin.

(1995 permitted flow / total permitted flow of the group) × *Group discharge allocation = Individual discharge allocation*

Individual discharge allocation × Facility transport factor = Individual estuary allocation

Example: Calculating Individual Discharge and Estuary Allocations for a Facility in the Neuse River Basin

Facility X has a 1995 permitted flow of 0.5 mgd and is located upstream of Falls Lake Dam in the Neuse River Basin. NC DWQ tells Facility X that it is in subbasin NEU2 and has a transport factor of 50 percent. Because Facility X has a permitted flow of 0.5 mgd and is upstream of Falls Lake Dam, the Wastewater Discharge Requirements rule places it in the group with an annual discharge allocation of 443,700 pounds of TN. Facility X is also told by NC DWQ that the group's total permitted flow is 26.5 mgd.

Facility X uses the following calculations to figure out its individual discharge allocation and estuary allocation:

(1995 permitted flow / total permitted flow of the group) × Group discharge allocation = Individual discharge allocation

Individual discharge allocation × Facility transport factor = Individual estuary allocation
(0.5 mgd / 26.5 mgd) × 443,700 lb = 8,372 lb

Example: Calculating Individual Discharge and Estuary Allocations for a Facility in the Neuse River Basin *(continued)*

Facility X's individual discharge allocation is 8,372 lb of TN. To determine its individual estuary allocation, Facility X must multiply its individual discharge allocation by its transport factor of 50 percent.

8,372 lb × 0.5 = 4,186 lb

Facility X's individual estuary allocation is 4,186 lb of TN.

Are Permits Used to Facilitate Trades?

Approximately 32 of the point source dischargers in the Neuse River Basin have TN effluent limits because the Wastewater Discharge Requirements rule states that every facility with a permitted flow equal to or greater than 0.5 mgd is subject to a TN permit limit equal to its individual discharge allocation. Of the 32 point sources with TN effluent limits, approximately 23 participate as co-permittees in the Neuse River Compliance Association, sharing one NPDES permit. The group compliance permit issued to the Compliance Association is a mechanism that can help to facilitate trading.

The Compliance Association's TN limit for a given calendar year is equal to its estuary TN allocation. The overall estuary TN allocation is the sum of all estuary TN allocations for members of the Compliance Association, as listed in Appendix A of the permit. TN allocations of co-permittee members may change because of purchases, sales, trades, leases, and other transactions among Compliance Association members, affecting the Compliance Association's overall TN allocation. All TN transactions are expressed in terms of estuary allocations (i.e., individual discharge allocations multiplied by a facility's transport factor).

For the Compliance Association to remain in compliance, its estuary TN load for a year may not exceed its estuary TN allocation. If the Compliance Association exceeds its estuary TN allocation, co-permittees under the group compliance permit are subject to their individual TN limits (i.e., individual estuary TN allocations). Provisions of the group compliance permit state that when the Compliance Association exceeds its estuary TN allocation, it must make offset payments for the excess TN at a rate of $11 per pound for that calendar year. When the Compliance Association exceeds its estuary TN allocation, NC DWQ may take enforcement actions against it and any individual co-permittee that exceeds its individual estuary TN allocation (NC DWQ 2004).

Internal point source–point source trades are not subject to NC DWQ oversight except to ensure that allocations are verified and calculated correctly. The Compliance Association or affected dischargers must obtain a permit modification from NC DWQ to have the adjusted TN effluent limits reflected in the permit (Breetz et al. 2004).

How Are Credits Generated for Trading?

Members are allowed to purchase, sell, trade, or lease their estuary TN allocation among co-permittees covered under the group compliance permit; they may not exceed the Compliance Association's overall estuary TN allocation. A facility that has a TN estuary load less than its individual estuary TN allocation has credits available to sell, trade, or lease.

If the Compliance Association does not meet its limit, or if a new or expanding discharger needs an additional allocation, an offset payment to the Wetland Restoration Fund is required to pay for nonpoint source controls. Members of the Compliance Association must pay an offset rate of $11 per pound per year if they exceed their individual estuary TN allocations during a year that the Compliance Association exceeds the overall estuary TN allocation (EMC 1988). New and expanding dischargers must attempt to purchase estuary TN allocation from existing dischargers. If a purchase from existing dischargers is not possible, new and expanding dischargers must purchase a portion of the nonpoint source load allocation by making an offset payment to the Wetlands Restoration Fund at 200 percent the normal rate (i.e., at $22 per pound per year); however, the purchase must be sufficient to fund 30 years of nitrogen reduction (EMC 2002).

NC DWQ originally used rough cost information from a few offset projects to determine the $11/lb/yr cost of an offset payment. Since then, NC DWQ has worked with North Carolina State University to develop an updated cost that takes into consideration costs associated with land, project administration, and project operation and maintenance. The updated cost was estimated at $57/lb/yr. NC DWQ is working to set a final cost that will account for these additional factors and will not prove overly burdensome for Compliance Association members (Templeton 2007).

What Are the Trading Mechanisms?

The group compliance permit, as well as other individual NPDES permits that reflect TN effluent limits based on the 1997 Strategy wasteload allocations might help to facilitate trading because they contain estuary TN allocations and provide a compliance mechanism. However, the mechanism for negotiating trades and achieving agreements does not directly involve NPDES permits. Trade negotiations and agreements take place between point sources, without the involvement of a third party.

What Is the Pollutant Trading Ratio?

There is no trade ratio for point source–point source trades and no explicit trade ratio for point source–nonpoint source offsets (i.e., offset payments to the Wetlands Restoration Fund). However, an analysis of the $11/lb/year cost of an offset payment indicates that a 2:1 trading ratio may be incorporated into the cost (Breetz et al. 2004).

What Type of Monitoring Is Performed?

Co-permittees in the Compliance Association submit monthly Discharge Monitoring Reports to NC DWQ as specified in their individual permits. The Compliance Association compiles and submits members' TN monitoring information for its own reporting purposes.

What Are the Incentives for Trading?

Trading is a cost-efficient means to meet an individual estuary TN allocation while achieving the overall nutrient reduction goal for the Neuse River Basin. However, the Compliance Association has not made any offset payments into the Wetland Restoration Fund to date because members are running at approximately 40 percent of their total estuary TN allocation (Templeton 2004b).

What Water Quality Improvements Have Been Achieved?

Since 1995, the NRCA members have achieved a 69 percent reduction of TN loading at estuary. In addition, the combined estuary loading was approximately 50 percent of the allocation in 2004 (NCDWQ 2005).

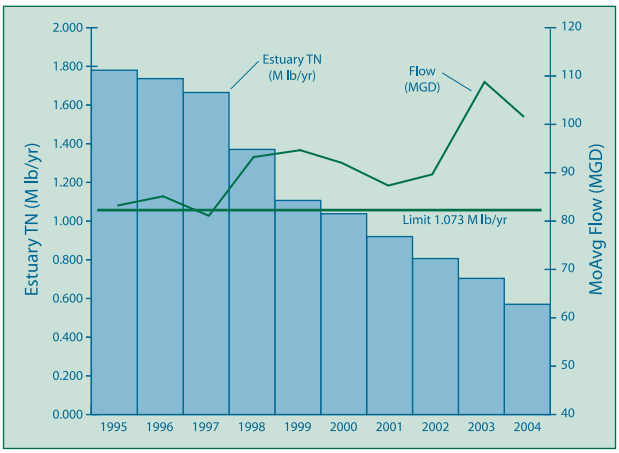

Figure 1. NRCA performance 1999–2004.

What Are the Potential Challenges in Using This Trading Approach?

One challenge of trading illustrated through the Neuse River Basin is determining the potential for localized water quality impacts due to shifting of wasteload allocations. The proposed trade agreement now under debate would result in an estuary TN load of approximately 61,000 pounds of TN per year near the headwaters. Concerned stakeholders initiated the involvement of NC DWQ in the proposed trade agreement; otherwise, the trade might have occurred because it is within the existing parameters for trading in the Neuse River Basin. Another challenge focuses on the potential for a co-permittee under the group compliance permit to attempt to sell some or all of its estuary TN allocation outside the Compliance Association. According to NC DWQ, this type of trade between a member and a nonmember would require the approval of the overall Compliance Association because it would affect the group's overall estuary TN allocation.

What Are the Potential Benefits?

Benefits of this trading example include minimal administration of the trading program by the regulating authority, although this might change pending the outcome of the proposed trade agreement. Using a Compliance Association approach might facilitate increased communication among dischargers in a watershed.

Applicable NPDES Permit Language

A.(2.) CO-PERMITTEES AND TN ALLOCATIONS

(a.) Co-Permittees to this Permit shall be the Neuse River Compliance Association (the "Association") and each of its Co-Permittee Members. The Co-Permittee Members, the Transport Factors assigned to each, the Members' individual TN allocations, and the Association Estuary TN Allocation shall be as listed in Appendix A, which is hereby incorporated into this Permit in its entirety.

(b.) Upon timely and proper notification by the Association as described elsewhere in this Permit, the Division shall revise Appendix A to incorporate changes in Association membership, allowable changes in TN Allocations, or reapportionment by the Association.

(i.) Changes in membership.

(A) Enrollment. In the event that a discharger joins the Association, the Division shall add the discharger and its TN Allocation to Appendix A as a Co-Permittee Member and adjust the Association's TN Estuary Allocation accordingly.

(B) Termination. In the event that a Co-Permittee Member's membership is terminated, the Division shall delete the departing Member and its TN Allocation from Appendix A and adjust the Association's TN Estuary Allocation accordingly.

(ii.) For the purposes of this Permit, allowable changes in TN Allocations include those resulting from purchase of allocation from the Wetlands Restoration Fund; purchase, sale, trade, or lease of allocation among the Association, its members, and non-member dischargers; regionalization; and other transactions approved by the Division.

(iii.) The Association may reapportion its TN Allocation among its Co-Permittee Members; however, the Division shall only incorporate the corresponding changes into Appendix A when specifically requested in writing by the Association.

(c.) Changes in Association membership and changes in individual or Association TN Allocations shall become effective only at the beginning of the following calendar year (January 1).

A.(3.) EFFLUENT LIMITATIONS

(a.) Beginning on the effective date of this Permit and lasting no later than the expiration date, the Co-Permittees are authorized to discharge Total nitrogen (TN) from the treatment facilities listed in Appendix A subject to the following effluent limitations.

(i.) Association TN Limitation. In any calendar year, the Association's Estuary TN Load shall not exceed its Estuary TN Allocation as specified in Appendix A: Association TN Limitation: For any calendar year,

Association Estuary TN Load < Association Estuary TN Allocation

Where

Association Estuary TN Load (or Allocation) =
Sum of Estuary TN Loads (or Allocations)
for All Co-Permittee Members

ii.) Co-Permittee Member TN Allocations. In any calendar year, a Co-Permittee Member shall be in compliance with its Estuary TN Allocation in Appendix A if:

(A) the Association Estuary TN Load complies with the Association Estuary TN Allocation in Appendix A, or

B) in the event that the Association Estuary TN Load exceeds its Estuary TN Allocation, the Co-Permittee Member's Estuary TN Load does not exceed that Member's Estuary TN Allocation in Appendix A.

(b.) Other Individual Limitations. In the event that a Co-Permittee Member's membership in the Association is terminated, the departing Member shall no longer be eligible for coverage under this Permit and shall become subject to the TN limitation set forth in its individual NPDES permit.

(i.) Termination of membership shall become effective only at the beginning of a calendar year (January 1). Re-imposition of a discharger's individual TN limitation shall become effective only at the beginning of a calendar year (January 1).

(ii.) The Association shall notify the Division if it determines that any Member will depart at the end of a calendar year and shall provide an accounting of all allowable changes in the Member's TN Allocation since the most recent issuance of the departing Member's individual NPDES permit.

(iii.) Upon receipt of the notification and accounting described above, the Division shall modify the TN limitation in the departing Member's individual NPDES permit, effective January 1 of the succeeding year, to reflect all allowable changes in the Member's TN Allocation since the most recent issuance of the departing Member's individual NPDES permit.

(iii.) Upon receipt of the notification and accounting described above, the Division shall modify the TN limitation in the departing Member's individual NPDES permit, effective January 1 of the succeeding year, to reflect all allowable changes in the Member's TN Allocation and shall also modify Appendix A of this permit accordingly.

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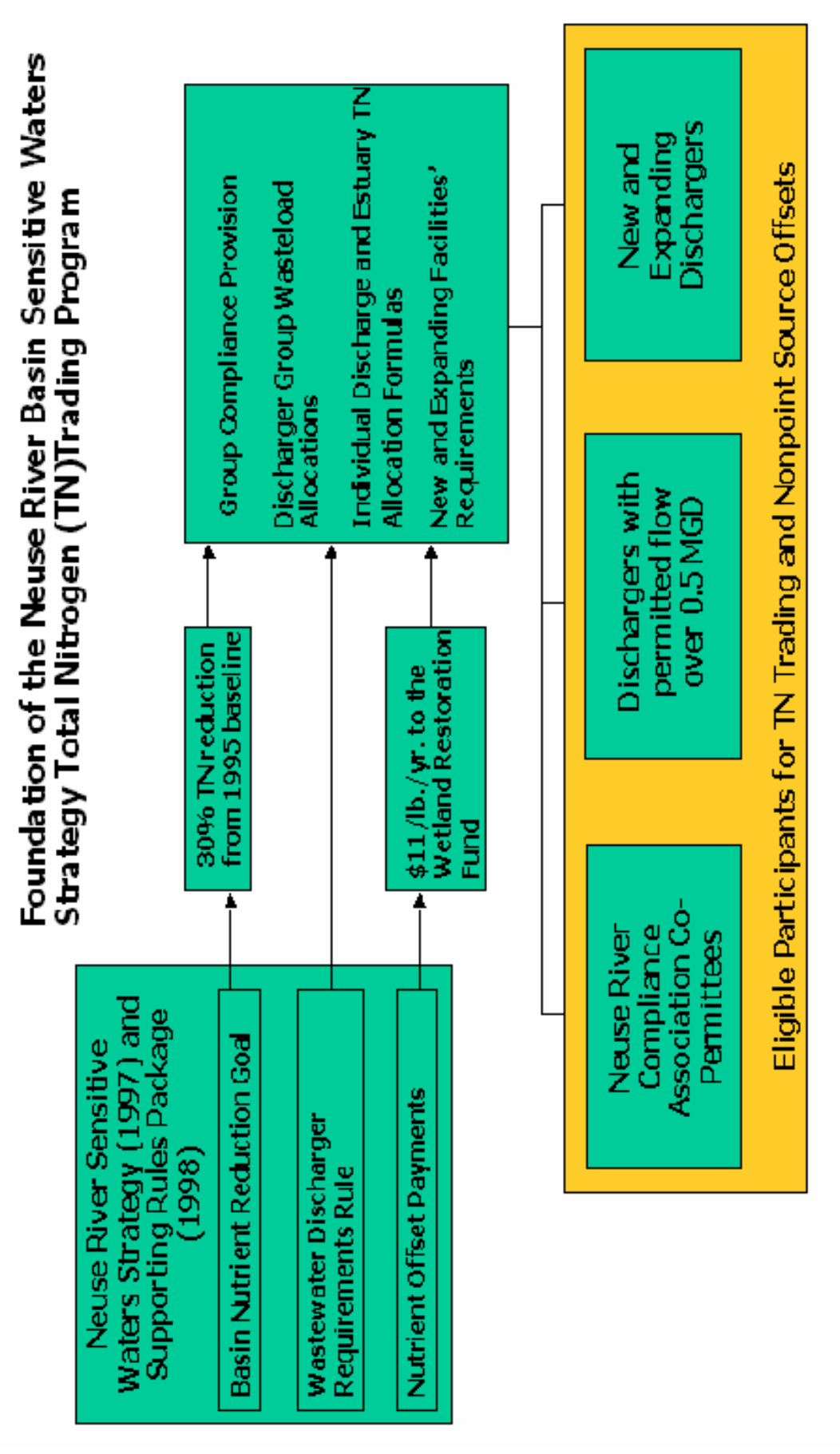
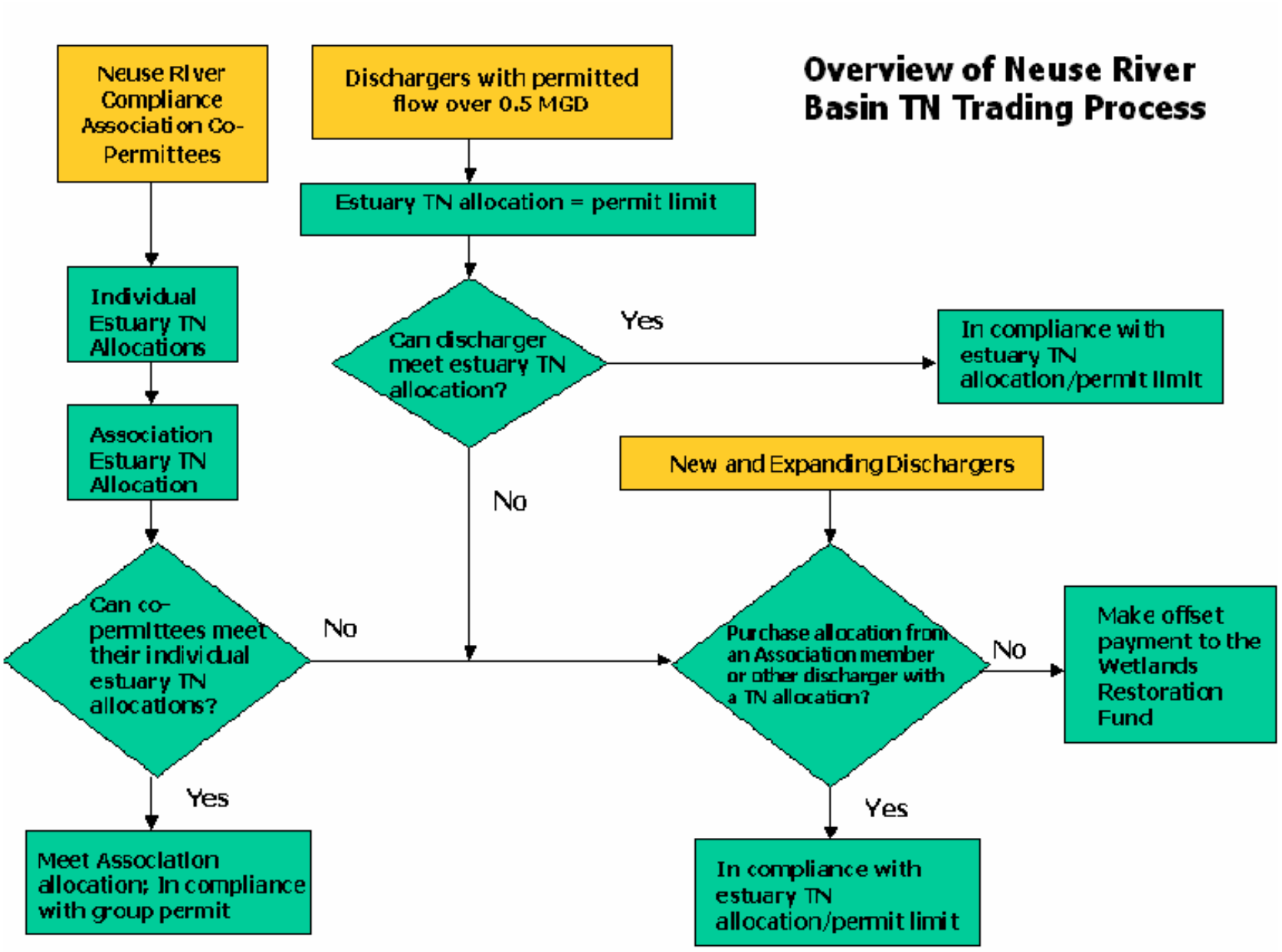

Foundation of the Neuse River Basin Sensitive Waters Strategy Total Nitrogen (TN)Trading Program
Neuse River Sensitive Waters Strategy (1997) and Supporting Rules Package (1998)
Basin Nutrient Reduction Goal
Wastewater Discharger Requirements Rule
Nutrient Offset Payments
30% TN reduction from 1995 baseline
$11/lb./yr. to the Wetland Restoration Fund
Group Compliance Provision
Discharger Group Wasteload Allocations
Individual Discharge and Estuary TN Allocation Formulas
New and Expanding Facilities' Requirements
Eligible Participants for TN Trading and Nonpoint Source Offsets
Neuse River Compliance Association Co-Permittees
Dischargers with permitted flow over 0.5 MGD
New and Expanding Dischargers


Overview of Neuse River Basin TN Trading Process
Neuse River Compliance Association Co-Permittees
Dischargers with permitted flow over 0.5 MGD
Estuary TN allocation = permit limit
Individual Estuary TN Allocations
Association Estuary TN Allocation
Can discharger meet estuary TN allocation?
Yes
In compliance with estuary TN allocation/permit limit
No
New and Expanding Dischargers
Can co-permittees meet their individual estuary TN allocations?
No
Purchase allocation from an Association member or other discharger with a TN allocation?
No
Make offset payment to the Wetlands Restoration Fund
Yes
Meet Association allocation; In compliance with group permit
Yes
In compliance with estuary TN allocation/permit limit

Great Miami River Watershed Trading Pilot Program
Ohio

Overview

The nutrient trading program administered by the Miami Conservancy District (MCD) for the Great Miami River Watershed allows NPDES permitted dischargers to purchase credits from best management practices (BMPs) installed by upstream nonpoint sources (i.e., agricultural producers) to offset nutrient loadings.

Type of Trading

Point Source–Nonpoint Source

Pollutant(s) Traded

Nitrogen
Phosphorus

Number of Trades to Date

As of 2007, two reverse auctions[1] have taken place, resulting in 335,636.5 lbs of nutrient reductions. Five NPDES permits are undergoing modification to allow participation in the trading program (Hall 2007).

Who Is Eligible to Participate?

Eligible participants include NPDES permitted dischargers and upstream agricultural producers within the Great Miami River Watershed. There are approximately 450 point source dischargers and over 80 percent of the agricultural lands in the watershed are eligible (ETN 2004).

What Generated the Need for Trading?

Over 40 percent of the rivers and streams in the Great Miami River Watershed are not meeting state water quality standards and will require Total Maximum Daily Loads (TMDLs). The watershed is the second largest contributor of nitrogen in the Ohio River Basin (ETN 2004). Stakeholders in the watershed would like to address water quality concerns before TMDLs are developed for the Great Miami River Watershed. In addition, more restrictive discharge limits for nitrogen and phosphorus are scheduled to take effect in the Great Miami River Watershed in 2007 as a result of nuisance conditions.

What Serves as the Basis for Trading?

Dischargers will have to eventually meet a total phosphorus discharge limit of 1.0 mg/L and a total nitrogen discharge limit of 10 mg/L, per the nutrient criteria under development by Ohio Environmental Protection Agency (Ohio EPA). The trading program is based on the premise that dischargers would rather pay upstream nonpoint source dischargers to achieve nutrient reductions than invest in treatment technology.

[1] Interested credit generators submit bids on the basis of the cost of their nutrient reduction project and their desired compensation. The most cost-effective projects are funded using a pool of money created by the buyers.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

Ohio EPA is developing nutrient criteria for streams and rivers with the expectation of adopting these nutrient criteria in 2007. Ohio EPA is using monitoring data from watersheds around the state, as well as modeling tools, to develop nutrient criteria.

Are Permits Used to Facilitate Trades?

Ohio EPA, the NPDES permitting authority in Ohio, has participated in the development of the Great Miami River Watershed trading program and will work with permitted dischargers to modify their NPDES permits to allow participation in the trading program (MCD 2005). Appendix C of the trading program's operation manual contains model draft language for inclusion in NPDES permits. Approximately five NPDES permits are undergoing modification to allow participation in trading (Hall 2007).

How Are Credits Generated for Trading?

Voluntary nutrient reductions made by upstream agricultural producers will serve as credits. One pound of total phosphorus removed is equal to one credit for phosphorus, and one pound of total nitrogen removed is equal to one credit for nitrogen (MCD 2005). The number of credits generated by a specific nonpoint source management practice is determined by a qualified soil and water conservation professional using a Load Reduction Spreadsheet (MCD 2005). In addition, a qualified soil and water conservation professional will also periodically inspect the management practice to ensure that it is still generating the allocated credits (MCD 2005). A management practice will generate credits only after it is installed.

The cost of each credit is determined by the market; it is likely to equal the sum of expenditures for the project (e.g., capital, operating, administrative, and ongoing maintenance costs) divided by the number of credits (MCD 2005).

The trading program includes two strategies to ensure NPDES permit compliance if a management practice should fail and no longer generates credits: (1) a management practice contingency plan, and (2) an insurance pool of credits. The insurance pool of credits contains credits generated in part by projects funded by eligible buyers in the *contributor* category (i.e., eligible buyers that participate in the trading program but not in advance of their more-stringent regulatory requirements) through their increased trade ratio requirements (see *What Is the Pollutant Trading Ratio?*). Other water quality improvement projects, subsidized by other sources of funds (e.g., Section 319 Nonpoint Source Program), might also generate credits for the insurance pool. Credits in the insurance pool have a life of 5 years from the date of deposit; if a credit is not used in that time frame, it is retired (MCD 2005).

What Are the Trading Mechanisms?

The trading program process involves the eight steps described below (MCD 2005).

Step 1. Request for Proposals Issued. MCD issues a request for proposals to announce that funds are available for qualified projects. A soil and water conservation district must be the applicant for the funds.

Step 2: Applicants Submit Proposals. All project proposals must address the criteria specified in the request for proposals.

Step3: Proposal Review and Selection. The Project Advisory Group, composed of stakeholders (local, state, and federal), will develop criteria for awarding funds paid by eligible buyers to credit-generating projects. The Project Advisory Group will also review proposals and make recommendations for funding.

Step 4: Applicants Notified of Projects Selected. MCD notifies all applicants of the selection process results.

Step 5: Project Funds Released. The trading program project funds provide the monies necessary to generate credits.

Step 6: Soil and Water Conservation District Contracted to Manage the Projects. MCD serves as the broker of the trading program and enters into a contract with the successful soil and water conservation district for project implementation. The soil and water conservation district then enters into a project agreement with the agricultural producer responsible for BMP implementation.

Step 7: Credit Management. MCD tracks credits generated by projects, allocates credits to eligible buyers, and prepares and submits an annual report to buyers, Ohio EPA, and EPA.

Step 8: Adaptive Management. Ohio EPA and Ohio Department of Natural Resources (DNR) established a Load Reduction Workgroup to evaluate and enhance the Load Reduction Spreadsheet used to determine the amount of credits generated by a management practice. This group will direct and oversee an evaluation of the accuracy of reduction estimates made for the trading program every 2 years.

What Is the Pollutant Trading Ratio?

The trading ratios are based on water quality conditions and programmatic status of the participant. The ratio varies with the type of eligible buyer and whether the receiving water is meeting water quality standards. Eligible buyers that fall under the *investor* category are those that participate in the trading program before they are subject to more stringent NPDES permit requirements for nutrients. Eligible buyers that participate in the trading program, but not before more stringent NPDES permit requirements for nutrients, fall under the *contributor* category. Investors have trading ratios of 1:1 if the receiving water is attaining water quality standards and 2:1 if the receiving water is not in attainment. Contributors have a trading ratio of 2:1 if the receiving water is fully attaining water quality standards and 3:1 if the receiving waters are impaired (MCD 2005).

What Type of Monitoring Is Performed?

Analytical validation of management practice performance will occur through site-specific water quality monitoring at farm fields. The goal is to collect project-specific data on a minimum of 5 percent of the total number of projects, with the ultimate goal of 10 percent. Analytical validation of the overall trading program will occur through a subwatershed water quality monitoring program that collects samples on a continuous basis at four locations (MCD 2005).

What Are the Incentives for Trading?

Incentives include the following:

- Potential sources of funding for implementing nonpoint source BMPs
- Potential elimination of the need for a TMDL or reduction in the stringency of the TMDL because of water quality improvement before TMDL development and implementation
- Economic incentive to trade using final credits as opposed to predicted credits due to variations in trading ratios and the need for predicted credit insurance

What Water Quality Improvements Have Been Achieved?

As of 2007, projects funded through two request for proposals have resulted in 335,636.5 lbs of nutrient reductions.

What Are the Potential Challenges in Using This Trading Approach?

Stakeholders involved in the development of the Great Miami River Watershed Trading Program cite potential challenges such as limitations on dischargers in the headwaters participation because of upstream nonpoint source requirements, the uncertainty associated with calculating nonpoint source reductions, and the cost of overcoming the uncertainty through increased monitoring (Breetz et al. 2004). Other trading programs have cited a lack of incentive to participate when relying solely on permit discharge limits (i.e., absence of a TMDL) to drive the program. Without a TMDL, an overall nutrient reduction goal that also helps dischargers to meet more stringent permit limits might serve as a more effective driver for trading.

What Are the Potential Benefits?

Potential benefits might include the attainment of water quality standards before TMDL development and implementation, as well as an incentive for nonpoint source involvement to achieve nutrient reductions.

Applicable NPDES Permit Language

Model draft language for inclusion in NPDES permits is contained in the trading program's operation manual as Appendix C. This model draft language is presented below.

Issued to (Investor-Status) Eligible Buyers in the
Great Miami River Water Quality Credit Trading Program

The City of Dayton (Permittee) is a voluntary participant in the Great Miami River Watershed Water Quality Credit Trading Program (Trading Program) that is managed through the Water Conservation Subdistrict of The Miami Conservancy District, a political subdivision of the State of Ohio. The Ohio Environmental Protection Agency and the Ohio Department of Natural Resources work in cooperation with the Water Conservation Subdistrict to implement the Trading Program. The Director has reviewed and approved the Operations Manual for the Great Miami River Water Quality Credit Trading Program.

Many stream and river miles within the Great Miami River Watershed currently fail to attain Ohio's water quality standards. Nutrients are frequently cited as a cause for failure to attain the standards. The Permittee is voluntarily participating in the Trading Program prior to new permit limits for nutrient discharges or the completion of Total Maximum Daily Load studies. This voluntary participation generates earlier water quality benefits in the watershed. Furthermore, by beginning the agricultural practices sooner the practices will be more reliable for subsequent use in generating credits for permit compliance.

The Trading Program has financial incentives for the Permittee to voluntarily fund projects prior to new permit limits for nutrient discharges. As provided for in the approved Operations Manual, voluntary early participation in the Program entitles the permittee to favorable water quality credit trading ratios as a Trading Program "Investor". The Director and the Permittee agree that the Investor ratios apply to the same substance(s) in the same amounts as the nutrient reductions voluntarily accomplished by the Permittee. In the event the Great Miami River is deemed by the Director to be impaired at the Permittee's discharge location, trading ratios will be modified pursuant to the Operations Manual.

If at any time the permittee no longer participates in the Trading Program the accrued benefit of the voluntary participation by the permittee will be used to offset the Permittee's current or future regulatory requirements. The specific offset will be determined in consultation with the Permittee and subject to the approval of the Director and may include higher discharge limits, delayed compliance schedules, or other actions deemed appropriate to achieve attainment of water quality standards throughout the Great Miami River Watershed.

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Clean Water Services
Oregon

Overview

Clean Water Services, a public utility in the Tualatin River Basin responsible for wastewater and stormwater management, received an integrated municipal watershed-based permit that provides coverage for four publicly owned treatment works (POTWs), one municipal separate storm sewer system (MS4), and two individual stormwater permits for two of the POTWs. The permit allows trading for two oxygen demanding parameters, carbonaceous biochemical oxygen demand ($CBOD_5$) and ammonia, between two POTWs and temperature to offset thermal loads from two of the POTWs. This fact sheet focuses on offsetting thermal load. No trading of oxygen demanding parameters has occurred to date.

Type of Trading

Point Source–Point Source
Point Source–Nonpoint Source

Pollutant(s) Traded

Oxygen demanding parameters ($CBOD_5$ and ammonia)
Temperature (thermal loads)

Number of Trades To Date

0 (Point Source–Point Source)
17 landowners enrolled for 2007 to conduct riparian planting to offset thermal load (Point Source–Nonpoint Source)

Who Is Eligible to Participate?

Trading for $CBOD_5$ and ammonia takes place between and within the Durham and Rock Creek Advanced Wastewater Treatment Facilities.

Trading involving thermal loads functions as an offset program to accommodate increased thermal loads for the Rock Creek and Durham Advanced Wastewater Treatment Facilities. Trading to offset thermal loads is limited to the area established by the August 2001 Tualatin Subbasin TMDL. Clean Water Services can *trade* their thermal load by taking a combination of the following actions:

1. Improving riparian shade along the river and its tributaries
2. Augmenting flow to increase base flows in the Tualatin
3. Using reclaimed water (effluent) for irrigation

What Generated the Need for Trading?

The 2001 Tualatin Subbasin TMDL developed by Oregon Department of Environmental Quality (DEQ) requires Clean Water Services to reduce the impact of its POTWs on the Tualatin River. For temperature, the technological control option available to Clean Water Services would be both expensive and have other negative impacts on the watershed. The 2001 Tualatin Subbasin TMDL also contains a wasteload allocation for ammonia. The same two wastewater treatment facilities both have NPDES permit limits for $CBOD_5$ and ammonia; the ability

to trade these parameters will provide Clean Water Services greater flexibility in plant operations while still protecting water quality.

What Serves as the Basis for Trading?

Oregon DEQ used the 2001 Tualatin Subbasin TMDL wasteload allocations for temperature and ammonia to determine the permit limits and conditions contained in the Clean Water Services' watershed-based NPDES permit. Temperature trading, however, is also based on information contained in the Temperature Management Plan and the Thermal Load Credit Trading Plan required under the permit.

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

Data and methodologies for trading of oxygen demanding parameters are found in the 2001 Tualatin Subbasin TMDL and the permit. Although the 2001 Tualatin Subbasin TMDL does contain wasteload allocations for thermal loads, data and methodologies for trading are found in other documents. The wasteload allocation for temperature, referred to as the allowable thermal load, changed under the permit, and the thermal load to offset changed under the Temperature Management Plan developed by Clean Water Services. All changes are authorized under the TMDL and the permit. Therefore, the data and methodologies for temperature trading are contained in the permit and the most recent version of the Temperature Management Plan. A brief overview of the data and methodologies used in determining the basis for trading is provided below.

Temperature

Trading of thermal load credits is dependent on several variables including (1) system potential temperatures, (2) allowable thermal loads, and (3) the thermal load to offset.

System Potential Temperatures

The system potential temperature is defined as a condition without human activities that disturb or remove vegetation (Clean Water Services 2004). The 2001 Tualatin Subbasin TMDL uses a system potential temperature approach to determine the thermal load allocations that will achieve the temperature water quality standard of 64 degrees Fahrenheit (°F) for the Tualatin River. A complex series of equations contained in the TMDL results in a system potential temperature of 58.5° F at the Rock Creek facility and 63.3° F at the Durham Facility. The TMDL states that the allowable thermal load (i.e., wasteload allocation) for each treatment facility is a thermal load that will cause no measurable increase in river temperature above system potential temperature, which means no more than a 0.25° F increase at the edge of the mixing zone.

Allowable Thermal Loads

The TMDL set initial wasteload allocations as allowable thermal loads. However, the permit revises the allowable thermal loads set by the TMDL due to changes in flow data using an equation that varies from the TMDL.

Allowable Thermal Load = $((Q_{ZOD} + Q_{PS}) \times (1000/35.3) \times 86{,}400 \times Max\,\Delta\,T_{ZOD} \times 5/9)$ kcals/*day*

Where:

Q_R = Upstream River Flow calculated as 7Q10 low flow statistic (cfs)

Q_{ZOD} = Q_R / Dilution Ratio (cfs)

Q_{PS} = Treatment Plant Effluent Flow (cfs)

$Max\,\Delta\,T_{ZOD}$ = 0.25° F

Example: Calculating Allowable Thermal Loads

Oregon DEQ must calculate the allowable thermal loads for the Durham and Rock Creek facilities. The following equation will provide the allowable thermal load values reflected in the final permit:

Allowable Thermal Load = $((Q_{ZOD} + Q_{PS}) \times (1000/35.3) \times 86{,}400 \times Max\,\Delta\,T_{ZOD} \times 5/9)$ kcals/day

Where:

Q_{ZOD} = 7Q10 River Flow (cfs)/ Dilution Ratio

Q_{PS} = Treatment plant effluent flow (cfs)

$Max\,\Delta\,T_{ZOD}$ = 0.25 °F

The values that Oregon DEQ uses to calculate the allowable thermal load for each facility are found in the table below.

	Durham	Rock Creek
Dilution Ratio	4.2:1	4.0:1
Q_{PS}	25.2	43.8
T_{PS}	71.0	71.0
Q_R	144	110

$$(Q_{ZOD} + Q_{PS}) \times \left(\frac{\text{Kcal}}{\text{Kg.}^{o}\text{C}}\right) \times \left(\frac{86{,}400 \text{ seconds}}{\text{day}}\right) \times (\text{Max}\,\Delta\,T_{ZOD}) \times \left(\frac{5^{o}\text{C}}{9^{o}\text{C}}\right) \times \left(\frac{\text{m3}}{35.31\text{ ft3}}\right) \times \left(\frac{264.2 \text{ gallons}}{\text{m3}}\right) \times \left(\frac{8.34 \text{ lb}}{\text{gallon}}\right) \times \left(\frac{\text{Kg}}{2.203}\right)$$

$$(Q_{ZOD} + Q_{PS}) \times (\text{Max}\,\Delta\,T_{ZOD}) \times \left(1{,}359652\,\frac{\text{Kcal} \cdot \text{sec}}{\text{day} \cdot \text{ft3}}\right)$$

Example: Calculating Allowable Thermal Loads *(continued)*

For Durham:

Q_R = 144 cfs

Q_{ZOD} = Q_R / Dilution Ratio (cfs) = 144/4.2 = 34.29 cfs

Q_{PS} = 25.2 cfs

$Max\ \Delta T_{ZOD}$ = 0.25 degrees F

Allowable Thermal Load (kcals/day) = (59.49) × (0.25) × (1,359,652.378)
= 20,221,430 kcals/day
= 2.0 x10^7 kcals/day

For Rock Creek:

Q_R = 110 cfs

Q_{ZOD} = Q_R / Dilution Ratio (cfs) = 110/4.0 = 27.5 cfs

Q_{PS} = 43.8 cfs

$Max\ \Delta T_{ZOD}$ = 0.25 degrees F

Allowable Thermal Load (kcals/day) = (71.3) × (0.25) × (1,359,652.378)
= 24,235,803.64 kcals/day
= **2.4 x10^7 kcals/day**

Thermal Load to Offset

The thermal load to offset is the amount of thermal load that exceeds the Allowable Thermal Load. This is the thermal load that Clean Water Services must reduce using selected temperature reduction methods, including trading through flow augmentation and shading. The 2001 Tualatin Subbasin TMDL and the permit contain the equations used to calculate the thermal load to offset at each wastewater treatment facility.

Current Excess Point Source Load Above System Potential (kcal/day) *– Allowable Point Source Thermal Load (kcal/day) = Thermal Load to Offset (kcal/day)*

Where:

Current Excess Point Source Load Above System Potential = $^{\Delta}T_{ZOD} \times (Q_{ZOD} + Q_{PS}) \times (1{,}000/35.3) \times (86{,}400 \times 5/9)$ kcal/day

Allowable Point Source Thermal Load = $((Q_{ZOD} + Q_{PS}) \times (1{,}000/35.3) \times 86{,}400 \times Max$

$^{\Delta}T_{ZOD} \times 5/9)$ kcals/day

$^{\Delta}T_{ZOD} = ((Q_{PS} \times T_{PS}) + (Q_{ZOD} \times T_{SP})) / ((Q_{ZOD} + Q_{PS}) - T_{SP})$ °F

Q_R = Upstream River Flow calculated as 7Q10 low flow statistic (cfs)

Q_{ZOD} = Q_R / Dilution Ratio (cfs)

Q_{PS} = Treatment Plant Effluent Flow (cfs)

$Max\ ^{\Delta}T_{ZOD}$ = 0.25 °F

T_{PS}= Treatment plant effluent temperature, °F

T_{SP}= System Potential temperature, °F

Other factors: 1,000 kg/m^3, 35.3 ft^3/m^3, 86,400 sec/day; 5/9 °C/°F

The permit states that the thermal load to offset for the Durham facility is 2.0 × 108 kcal/day and for the Rock Creek facility is 7.2 × 108 kcal/day (Oregon DEQ 2004).

Are Permits Utilized to Facilitate Trades?

The watershed-based NPDES permit for Clean Water Services contains the permit limits for oxygen demanding parameters, as well as the equations that Clean Water Services must use to conduct trades.

Schedule C of the permit requires Clean Water Services to develop a Thermal Load Credit Trading Plan as part of the Temperature Management Plan. Schedule C requires the Thermal Load Credit Trading Plan to include the following:

- A description of the thermal load to be offset based on equations contained in Schedule D of the permit and a specified baseline for thermal credit trading
- A discussion of how the permittee will create, purchase or arrange for thermal credits generated by flow augmentation and stream surface area shading
- The methodology for calculating the amount of thermal credit that will be generated by stream surface water shading through riparian revegetation and high-quality area protection
- Other proposed thermal credit trading options for consideration by Oregon DEQ
- Reporting requirements for thermal load trading credit

How are Credits Generated for Trading?

The permit defines water quality trading credits as one unit of pollutant reduction or other defined environmental improvement, multiplied by any applicable trading ratio detailed in the permit or in plans covered by the permit. The permit states the terms of credit use by requiring its application at the location where compliance with the baseline is measured for the applicable time period. Valid credits are those generated before or during the period they are applied to the permittee's baselines, except thermal credits generated by stream surface area shading in the Thermal Load Credit Trading Plan. Credits are pollutant reductions that exceed the reductions required by the permittee's baseline or other applicable requirements in the permit (Oregon DEQ 2004).

Clean Water Services' watershed-based NPDES permit and fact sheet provides a description of the process for trading oxygen-demanding parameters. Appendix B of the Revised Temperature Management Plan describes the methodologies for calculating the thermal load credits; Clean Water Services will soon make the Revised Temperature Management Plan available for public review and comment.

Oxygen Demanding Parameters

The process for generating credits for oxygen demanding parameters described in the permit is provided below.

(4) Water Quality Trading Plan for Oxygen Demanding Parameters

Water Quality Trading Credits for oxygen demanding parameters (CBOD5 and ammonia) between the Durham and Rock Creek Advanced Wastewater Treatment Facilities (AWTF) are authorized by Schedule D of this permit provided that the permittee uses the following equations to define the available assimilative capacity. Whenever the combined load as calculated by the equation in Schedule A, 1.a.(4)(b) is less than or equal to the combined load limitation as calculated by the equation in Schedule A, 1.a.(4)(a), (the baseline for purposes of water quality trading) the permittee shall be deemed to be in compliance with the CBOD5 and ammonia-nitrogen effluent limitations of this permit.

(a) Oxygen Demand Load Limitation

Outfall Number	Parameter	Combined Rock Creek and Durham Oxygen Demand Load Limitation at Oswego Dam (lb/day)
D001 , R001	$CBOD_5$ and NBOD	R001 NBOD Limit (lb/day) + R001 $CBOD_5$ Limit (lb/day) + D001 NBOD Limit (lb/day) + D001 $CBOD_5$ Limit (lb/day) Where, R001 NBOD Limit = Weekly R001 NH_3-N Load Limit, lb/day (see Schedule A.1.a.(3)) × 4.33 × Fraction R001 ammonia decayed at dam (see Table 2) R001 $CBOD_5$ Limit = Weekly R001 $CBOD_5$ concentration, mg/L, (see Table 1) × Actual Weekly Median Rock Creek Effluent Flow, mgd × 8.34 × 4.9 × Fraction R001 $CBOD_{ultimate}$ decayed at dam (see Table 2) D001 NBOD Limit = Weekly D001 NH_3-N Load Limit, lb/day (see Schedule A.1.a.(3)) × 4.33 × Fraction D001 ammonia decayed at dam (see Table 2) D001 $CBOD_5$ Limit = Weekly D001 $CBOD_5$ concentration, mg/L, (see Table 1) × Actual Weekly Median Durham Effluent Flow, mgd × 8.34 × 4.9 × Fraction D001 $CBOD_{ultimate}$ decayed at dam (see Table 2)

Note: 4.33 = NBOD:NH_3 ratio
4.9 = $CBOD_{ultimate}$:$CBOD_5$ ratio
8.34 = pound conversion

Water Quality Trading Credit for oxygen demanding substances authorized under the water quality trading program in Schedule A, 1.a.(4) shall not be allowed if the trade results in an exceedance of the $CBOD_5$ mass limitations for outfalls D001 or R001.

(b) Calculation of Combined Rock Creek and Durham Actual Discharged Oxygen Demand Load at Oswego Dam: (applies on a calendar week basis)

Actual Discharged Oxygen Demand Load at Oswego Dam (lb/day) =

R001 NBOD Discharge (lb/day) + R001 $CBOD_5$ (lb/day) + D001 NBOD Discharge (lb/day) + D001 $CBOD_5$ Discharge (lb/day)

Where:

R001 NBOD Discharge =
Actual Weekly Median R001 NH_3-N Concentration, mg/L × Actual Weekly Median Rock Creek Effluent Flow, mgd × 8.34 × 4.33 × Fraction Rock Creek ammonia decayed at dam (see Table 2)

R001 $CBOD_5$ Discharge =
Actual Weekly Median R001 $CBOD_5$ Concentration, mg/L × Actual Weekly Median Rock Creek Effluent Flow, mgd × 8.34 × 4.9 × Fraction Rock Creek $CBOD_{ultimate}$ decayed at dam (see Table 2)

D001 NBOD Discharge =
Actual Weekly Median D001 NH_3-N Concentration, mg/L × Actual Weekly Median Durham Effluent Flow, mgd × 8.34 × 4.33 × Fraction Durham ammonia decayed at dam (see Table 2)

D001 $CBOD_5$ Discharge =
Actual Weekly Median D001 $CBOD_5$ Concentration, mg/L × Actual Weekly Median Durham Effluent Flow, mgd × 8.34 × 4.9 × Fraction Durham $CBOD_{ultimate}$ decayed at dam (see Table 2)

Table 1. Weekly $CBOD_5$ Concentrations

Rock Creek	Durham
1.4 mg/L	3.9 mg/L

Table 2. Fraction Decayed at Oswego Dam

Farmington flow, cfs	River temperature, °C	Rock Creek		Durham	
		Ammonia	CBOD	Ammonia	CBOD
120 – 175	≤10	0.61	0.33	0.22	0.10
	>10 to 15	0.70	0.40	0.27	0.12
	>15 to 20	0.79	0.48	0.33	0.15
	>20 to 25	0.86	0.56	0.40	0.19
>175 – 200	≤10	0.48	0.24	0.15	0.07
	>10 to 15	0.56	0.29	0.19	0.09
	>15 to 20	0.65	0.36	0.24	0.11
	>20 to 25	0.74	0.43	0.29	0.14
>200 – 250	≤10	0.43	0.21	0.14	0.06
	>10 to 15	0.52	0.26	0.17	0.08
	>15 to 20	0.60	0.32	0.21	0.10
	>20 to 25	0.69	0.39	0.26	0.12
>250 – 300	≤10	0.37	0.17	0.11	0.05
	>10 to 15	0.44	0.22	0.14	0.06
	>15 to 20	0.52	0.27	0.17	0.08
	>20 to 25	0.61	0.33	0.22	0.10
>300 – 350	≤10	0.32	0.15	0.09	0.04
	>10 to 15	0.38	0.18	0.12	0.05
	>15 to 20	0.46	0.23	0.15	0.06
	>20 to 25	0.55	0.28	0.18	0.08

Values for each range set at low end of range for flow and high end for temperature

Temperature

Clean Water Services can trade the heat load from the Rock Creek and Durham wastewater treatment plants through flow augmentation and increased shading. Appendix B of the Revised Temperature Management Plan contains the process for calculating thermal load credits using flow augmentation and shade. A brief description of the process for calculating thermal load credits associated with flow augmentation and shading is provided below.

Shading

Thermal credits from shading are generated on a project-by-project basis. Credits generated by shading projects initiated in a given year are calculated by multiplying the solar load blocked for a project by a safety factor and an incentive factor. Solar load blocked is calculated by determining the potential solar load for a particular stream reach and the effective shade, which is a "fraction of the daily solar thermal energy flux that is prevented by vegetation from reaching the stream surface" (Clean Water Services 2004). Effective shade is determined by using a component of Oregon DEQ's Heat Source model, referred to as the *Shade-A-Lator* (Clean Water Services 2004).

Reach Width (ft) × Reach Length (ft) × 480 kcal/ft2/day = Potential Solar Load for a Reach

Potential Solar Load for the Reach × Effective Shade = Solar Load Blocked for a Reach

Solar Load Blocked for Project × Safety Factor of 0.5 × Incentive Factor = Thermal Credit per Project

A safety factor of 0.5 is applied to the solar load blocked for a project because of the uncertainty in using riparian restoration projects to generate shade (Clean Water Services 2004). An incentive factor is determined using the priority ranking of a particular stream on which a shading project will take place. An incentive factor of 4 is applied to projects that occur along high-priority streams, while all other streams receive an incentive factor of 1 (Clean Water Services 2004).

Flow Augmentation

The thermal energy decrease associated with the temperature change measured just upstream of each outfall caused by flow augmentation is the basis for calculating flow augmentation thermal credits (Clean Water Services 2004).

The annual thermal load contributed by each facility is the sum of the thermal load contributed by the facility, the allowed thermal load (as a negative value), and the thermal credit for flow augmentation (Clean Water Services 2004).

$$H_{FlowAug} = 1\text{kcal} / 1\text{ kg °C} \times Q_{River} \times 1\text{ m}^3 / 35.3\text{ ft}^3 \times 1{,}000\text{ kg} / 1\text{ m}^3 \times 86{,}400\text{ sec} / 1\text{ day} \times {}^{\Delta}T_{FlowAug}$$

Where:

For Rock Creek: ${}^{\Delta}T_{FlowAug} = 5.014\ (1 - e^{\text{Flow Augmentation / Farm Flow} - \text{RC-WWTP}})$

For Durham: ${}^{\Delta}T_{FlowAug} = (-0.02636)\ (\text{Flow Augmentation} / 1 + e^{(-0.03941)\ (\text{Farm Flow} - 145.5)})$

What are the Trading Mechanisms?

Trading of oxygen-demanding parameters occurs between two wastewater treatment plants operated by Clean Water Services. In addition, a single wastewater treatment plant may trade between CBOD and ammonia. Schedule D of the permit requires that Clean Water Services report all trading credit for oxygen-demanding parameters in the monthly Discharge Monitoring Reporting forms submitted to Oregon DEQ. No other trading mechanisms are used to facilitate trades of oxygen-demanding parameters.

The permit contains specific language about trade agreements for thermal load offsets. The language is as follows (Oregon DEQ 2004):

> The permittee may enter into one or more Thermal Credit Trading Agreements with one or more reputable land or water conservation organizations or governmental entities to implement one or more components of the Temperature Management Plan. The permit specifies that the Thermal Credit Trading Agreements must include the following terms:
>
> - A commitment by the Conservation Entity to fully implement the Trading Agreement in accordance with its terms, including initial planting and long-term maintenance, monitoring and reporting;
> - A provision that the Credit Trading Agreement is enforceable by Clean Water Services and Oregon DEQ and any successor agency. A breach of the Credit Trading Agreement by the Conservation Entity shall not be deemed a violation of this permit by the permittee. In the event of a breach, the permittee will be required to update its Clean Water Services Temperature Management Plan to demonstrate that they will still be able to offset the thermal load.

What is the Pollutant Trading Ratio?

Trading of oxygen-demanding parameters does not use a pollutant trade ratio. However, the calculations used for trading oxygen-demanding parameters include equivalency factors that take into account the different rates at which the river processes $CBOD_5$ versus ammonia and the different amounts of oxygen demand for each pound of material (Oregon DEQ No date). The equivalency factors used in the calculations might be considered a form of pollutant trade ratio.

The pollutant trading ratio used for thermal load offsets from stream surface shading is 2:1. According to the permit fact sheet, "To compensate for the fact that the heat load offset by shading will take years to establish, the Department has decided that at the end of the 20 years that the credit for shading is in effect, the offset heat load must be two times the actual thermal load to be offset" (Oregon DEQ No date).

What Type of Monitoring is Performed?

Schedule B of the permit contains an initial watershed monitoring plan. The two facilities eligible to trade oxygen-demanding parameters are required to monitor $CBOD_5$ and ammonia three times per week using a 24-hour composite sample. Monitoring for ammonia is required daily during the ammonia reduction period.

The draft Temperature Management Plan developed by Clean Water Services contains both in-stream and effluent temperature monitoring requirements. For in-stream temperature monitoring, Clean Water Services states that either grab samples or continuous monitoring will be used with monitoring sites just upstream from the point of discharge and at the edge of the mixing zone along the centerline of the plume (Clean Water Services 2003). For effluent temperature monitoring, Clean Water Services will monitor before discharge using thermistors in the waste stream at final treatment (Clean Water Services 2003). The Thermal Load Credit Trading Plan will contain information on temperature monitoring in the context of trading.

What are the Incentives for Trading?

For Clean Water Services, the incentive for offsetting thermal loads using shade credits as opposed to installing mechanical cooling equipment is the significant potential cost savings. It would cost approximately $40 to $50 million to install the necessary refrigeration equipment to comply at both facilities. The cost of riparian planting is estimated at $7 million over a 5-year period. Therefore, Clean Water Services estimates a cost avoidance of approximately $42 million over 5 years (Logue 2007).

What Water Quality Improvements Have Been Achieved?

In 2006 approximately 30,015 stream feet and seven landowners were enrolled in the riparian stream planting program. Those totals have gone up for 2007, with approximately 56,420 stream feet and 17 landowners enrolled in the program (Logue 2007). The water quality trading provision of Clean Water Services' permit has significantly increased the pace and quantity of riparian area restoration in the Tualatin Basin (USEPA 2006). The additional miles of stream planted will result in the prevention of 101 million/Kcal/day from reaching the Tualatin River tributaries that would otherwise result in additional increases in water temperature (USEPA 2006).

What Are the Potential Challenges in Using this Approach?

Ensuring that the necessary stream miles are shaded during the permit term may prove challenging for Clean Water Services. Also, the uncertainty and variability associated with riparian restoration projects may prove challenging in achieving the desired temperature reductions over time.

What Are the Potential Benefits?

Trading will allow Clean Water Services to improve the Tualatin River's water quality more efficiently by using approaches that will provide additional environmental benefits to the watershed.

Applicable NPDES Permit Language

The watershed-based permit contains a significant amount of permit language relevant to trading; therefore, it is too cumbersome to insert the relevant permit language in the fact sheet. Copies of the permit are available at <http://www.deq.state.or.us/wq/wqpermit/docs/individual/npdes/cws/permit.pdf>.

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Water Quality Trading in the Chesapeake Bay Watershed
Virginia's Nutrient Credit Exchange Program

Overview

The Virginia Department of Environmental Quality (DEQ) *2004 Virginia Water Quality Assessment 305(b)/303(d) Integrated Report* (303(d) List of Impaired Waters) showed that 83 percent of the Chesapeake Bay mainstem was impaired and could not adequately sustain its aquatic communities. Excessive nutrients (nitrogen and phosphorus) were causing algae blooms, decreases in dissolved oxygen, and a decline in habitat availability. This not only impaired the aquatic life of the Chesapeake Bay, it also took a toll on the food industry, tourism, and the local residents of the surrounding watershed (DEQ 2006).

In March 2003, the Chesapeake Bay Program (CBP) adopted new nutrient reduction goals as part of the Chesapeake 2000 Agreement. This agreement was established to protect and restore water quality in the Chesapeake Bay by January 1, 2011. The nutrient reduction goals established in this agreement aim to decrease the amount of nitrogen and phosphorus entering the bay by 110 million and 6.3 million pounds per year, respectively. The CBP established nutrient load allocations for each major watershed of the bay, and each state then developed tributary strategies to achieve each watershed's nutrient reduction goals.

The Virginia DEQ, in conjunction with the Virginia Department of Conservation and Recreation (DCR) and EPA, developed a set of tributary strategies, one for each major watershed draining to the Chesapeake Bay in Virginia. These include the Rappahannock, York, James, Shenandoah-Potomac, and the Eastern Shore watersheds. Each tributary strategy establishes total nutrient load allocations for the point and nonpoint sources within each watershed and outlines implementation plans to meet these allocations.

To help point and nonpoint sources meet nutrient load reduction goals in Virginia's tributary strategies, on March 24, 2005, the Governor of Virginia signed legislation that authorized the creation of the Chesapeake Bay Watershed Nutrient Credit Exchange Program (Exchange Program), which was codified in Article 4.02 of the Code of Virginia. Virginia's Exchange Program requires Virginia Pollutant Discharge Elimination System (VPDES) permitted facilities on the CBP Significant Discharger List (significant dischargers) as well as new and expanding facilities to register for coverage under the associated general permit to collectively meet annual nutrient load allocations established in the watershed. If point sources cannot achieve nutrient load reductions through facility upgrades, the Exchange Program authorizes nutrient credit exchanges or payment into the Water Quality Improvement Fund[2] (WQIF). Trades can be facilitated by the Virginia Nutrient Credit Exchange Association (the ExChange) or occur directly between trading partners.

[2] The purpose of Virginia's Water Quality Improvement Fund is, "to provide Water Quality Improvement Grants to local governments, soil and water conservation districts, institutions of higher education and individuals for point and nonpoint source pollution prevention, reduction and control programs and efforts" (Virginia Code section 10.1-2128 2006). The WQIF is established in section 10.1-2128 of the *Code of Virginia*.

Type of Trading

Point Source–Point Source (available initially)
Point Source–Nonpoint Source (anticipated as the program develops further)

Pollutant(s) Traded

Total Nitrogen (TN) and
Total Phosphorus (TP)

Number of Trades to Date

No trades to date; compliance plans for all significant dischargers are not due to be submitted until August 1, 2007. These plans will detail how each facility will meet water quality standards by January 1, 2011, as required by the Chesapeake 2000 Agreement. The DEQ will review the plans and determine when each individual facility can begin nutrient trading.

Who Is Eligible to participate?

Every significant discharger authorized by a VPDES permit that meets specific discharge criteria is required to register for coverage under the General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia (General Permit – VAN000000). Coverage under the general permit provides these dischargers with the ability to participate in the Exchange Program; however, participation in the Exchange Program is not required. The criteria for coverage under the general permit include any of the following:

- An existing facility that discharges 100,000 gallons or more per day from a wastewater treatment plant, or an equivalent load from an industrial process, directly into tidal waters
- An existing facility that discharges 500,000 gallons or more per day from a wastewater treatment plant, or an equivalent load from an industrial process, directly into nontidal waters
- A new or expanding facility that proposes to discharge 40,000 gallons or more per day from a wastewater treatment plant, or an equivalent load from an industrial process, directly into tidal or nontidal waters

There are 125 significant dischargers and about 12 new/expanding facilities required to register for coverage under the permit and are therefore eligible for participation in the Exchange Program. Other facilities can register for coverage under the permit to participate in the Exchange Program; however, they are not expected to do so because they do not have load limits imposed on them by the permit. Only significant dischargers can generate credits by discharging under their permit limit. Other facilities can only purchase credits from significant dischargers except for new/expanding facilities who can purchase credits achieved through nonpoint source BMPs if those credits are used to offset additional discharge and if no credits are available from existing significant dischargers in the same tributary watershed.

Each facility must complete a compliance plan by August 1, 2007, that explicitly details how each facility will meet nutrient standards by the compliance date of January 1, 2011, as directed by the Chesapeake 2000 Agreement. If the facility wishes to use nutrient credit trading to meet nutrient standards, the compliance plan will specify how. The DEQ might adjust the tributary-wide compliance dates depending on their review of the individual facility compliance plans.

What Generated the Need for Trading?

The Chesapeake 2000 Agreement set a deadline of 2010 to correct water quality issues related to excessive nutrients in the Bay and remove it from the 303(d) List of Impaired Waters. To achieve this goal, it would cost the discharging facilities in the Chesapeake Bay watershed an estimated $1.5 billion to upgrade their wastewater treatment technology (ExChange 2006). However, there are limited funds, contractors, and construction resources available. A balance needed to be struck between meeting these new stringent load limits and allowing for economic growth in the region and, as a result, the Exchange Program was developed to ease the demands and costs of construction while ensuring compliance with both current VPDES regulations and the Chesapeake 2000 Agreement.

What Serves as the Basis for Trading?

The Virginia tributary strategies describe the sources of nutrients in each of the major tributaries and their contributions to the water quality issues in the Chesapeake Bay mainstem. The CBP modeled the required nutrient load reductions for each major tributary. Table 1 presents the mass and percent reduction in TN and TP loading necessary for each watershed to meet tributary strategy goals.

Table 1. Loading reductions needed to meet the TN and TP allocations for each watershed.*

Watershed	Mass reduction[a]		Percent reduction	
	TN	TP	TN	TP
Rappahannock	2.66	0.33	34%	35%
York[b]	2.00	0.27	26%	36%
James[b]	10.86	2.54	29%	43%
Shenandoah-Potomac	9.96	0.56	44%	29%
Eastern Shore	0.94	0.15	45%	64%

Notes:
[a] In millions of pounds
[b] Allocations are considered interim until further water quality standards are adopted.
* Reductions are based on the 2002 values from each watershed and are derived from the tributary strategies (available for download at: http://www.naturalresources.virginia.gov/Initiatives/WaterQuality/).

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

A collaboration of federal and state government agencies, local universities, and the CBP compiled vast amounts of data for the development of the CBP Watershed Model. This model was used to set wasteload allocations for each major tributary and set the stage for the nutrient trading program. For more information on the watershed Model and other modeling techniques used, visit the CBP modeling Web site (http://www.chesapeakebay.net/model.htm).

The Chesapeake Bay Monitoring Program has assessed the chemical, physical, and biological characteristics of various stations throughout the watershed since 1984. The data obtained has aided in model improvement and helped to determine the need for a trading program.

Various other monitoring programs exist within the Chesapeake Bay watershed that also provide a wealth of information (http://www.chesapeakebay.net/monprgms.htm).

Are Permits Used to Facilitate Trades?

The DEQ has proposed the draft General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia (General Permit – VAN000000). The general permit addresses the TN and TP wasteload allocations (annual), compliance schedules, compliance plans, and monitoring/reporting requirements for all significant and new/expanding dischargers in the Chesapeake Bay. The public comment for the draft permit closed June 30, 2006. The Virginia State Water Control Board (SWCB) approved the General Permit Regulation on September 6, 2006, and the final permit was issued January 1, 2007. It will expire on December 31, 2011.

The general permit requires that all significant and new/expanding facilities in the Chesapeake Bay register for coverage. The DEQ maintains registration lists of facilities in each tributary covered by the general permit. These lists contain the load limits for the facilities that are enforceable under the general permit (http://beta.deq.virginia.gov/vpdes/homepage.html). The general permit supersedes the requirements of the facilities' individual VPDES permits pertaining to TN and TP, except where site-specific conditions (e.g., local water quality standards, TMDLs, or federal effluent guidelines) necessitate more restrictive limits.

Covered facilities must meet standardized effluent limitations, conditions, and monitoring requirements. The general permit establishes annual effluent loading limits for nitrogen and phosphorus and establishes the conditions by which credits (the difference in pounds between the facility's limit and the mass actually discharged) may be exchanged, or offsets (an alternate nutrient removal mechanism) may be purchased by existing facilities whose proposed expansion would otherwise cause the facilities to exceed their allocation or by new and expanded facilities that do not have an assigned a wasteload allocation.

In addition to point source–point source trading among permitted facilities, covered dischargers also have the option of complying with their existing load limits through treatment technology upgrades and payment into the WQIF. Payments to the WQIF for compliance credits are $11.06 for each pound of nitrogen and $5.04 for each pound of phosphorus.[3] WQIF compliance credits are only available as an option of last resort if there are no credits available through the ExChange.

Facilities seeking to offset proposed expansion or new construction have the additional option of purchasing nutrient reductions generated by nonpoint source best management practices (BMPs); the implementation process for this option is still under development. The ExChange will facilitate these and similar trading scenarios for the permitted facilities of each

[3] In 2002 the Nutrient Reduction Technology Task Force, assembled by the CBP, produced a report on the costs of nutrient reduction technology to point sources in the Chesapeake Bay watershed (NRT report). After the publication of the NRT report, Virginia developed tributary strategies with specific allocations and concentrations for each significant point source discharger. Using cost information from the NRT report as well as the load limits significant dischargers would be subject to and inflation since the report was published, the average cost per pound of nitrogen or phosphorus reduction for Virginia POTWs was determined. The WQIF payments for the general permit were set equal to this cost.

tributary that apply for voluntary membership. Permitted facilities choosing not to join the ExChange still have the option of trading, but must seek out trading partners independently.

How Are Credits Generated for Trading?

When a facility discharges less than its annual TP or TN limit, the difference (in pounds) between the limit and actual discharge will result in excess pounds available for conversion to saleable nutrient exchange credits using an applicable delivery factor. Credits are expressed as pounds per year of delivered TN or TP load. If a facility exceeds its TN or TP limit and chooses to exchange credits, it can purchase nutrient reduction credits from a more efficient point source facility.

What Are the Trading Mechanisms?

If a facility requests to have its annual load cap activated, that facility will be entitled to trade and acquire nutrient credits. Each facility is required to generate an annual report. Due by February 1 of each year, these reports indicate the number of nitrogen and phosphorus credits to be acquired or exchanged by the facility. Trading partners are then established (by the ExChange or individually) on the basis of credits generated and offsets required. Credits may be exchanged only between facilities within the same tributary watershed.

Facilities can conduct trading on an individual basis or can voluntarily participate in the ExChange. The ExChange coordinates and facilitates nutrient credit trading among its members. Authorized by the General Assembly, the ExChange is funded through the WQIF. Membership in the ExChange is free and open to all significant dischargers, and new/expanding facilities interested in participating. A $1,000 membership fee for consultant affiliates applies (http://www.theexchangeassociation.org/Default.htm).

Owners of multiple facilities have the option of combining the nutrient caps of those facilities, creating an aggregate nutrient cap. This allows the owner to meet the overall aggregate cap through collectively managing the nutrient loads of each individual facility, essentially creating its own trading network.

What Is the Pollutant Trading Ratio?

The Exchange Program uses a delivery factor for point sources that takes into account discharge location within the watershed and nutrient attenuation during riverine transport. These facility-specific delivery factors are calculated using the CBP Watershed Model. The model factors in the uptake of phosphorus during delivery caused by the movement of phosphorus-laden sediment on river bottoms—in other words, the model occasionally generates a delivery ratio of greater than 1.00 (i.e., greater than 100 percent of the phosphorus is delivered to the Chesapeake Bay). As a result, the DEQ decided to cap all ratios at 1.00 to provide a measure of consistency and equity among dischargers. In addition to the use of the delivery factor described above, offsets purchased from nonpoint source BMPs are traded at the ratio of 2 pounds reduced by the BMP for every pound the new or expanding facility proposes to discharge.

What Type of Monitoring Is Performed?

Each facility is required to be in compliance with TN and TP final effluent limits included in the general permit as soon as possible, but no later than January 1, 2011. The dates will be subject to DEQ revisions according to individual compliance plans. The general permit requires that monitoring and recordkeeping be conducted following approved methods. Monitoring frequency is based on design flow and is conducted as shown in Table 2.

Table 2. Monitoring requirements for facilities covered under the general permit

Design flow	**≥ 20.00 mgd**	**1.00–19.99 mgd**	**0.04–0.99 mgd**
Parameter	**Monitoring sample type/frequency**		
Total nitrogen	24 HC*/ 3 days per week	24 HC/ 1 days per week	8 HC/ 2 per month (> 7 days apart)
Total phosphorus	24 HC/ 3 days per week	24 HC/ 1 days per week	8 HC/ 2 per month (> 7 days apart)

*HC = hour composite (e.g. 24 HC = 24-hour composite sample)

Total monthly and year-to-date mass loads must be calculated as follows:

$$\mathbf{ML = ML_{avg} * d}$$

ML = total monthly load (lbs/mo)

ML_{avg} = monthly average load as reported on discharge monitoring report (lbs/day)

d = number of discharge days in sampling month

$$\mathbf{AL - YTD = \Sigma_{(January - current\ month)}\ ML}$$

AL-YTD = calendar year-to-date annual load (lbs/yr)

ML = total monthly load (lbs/mo) as reported on discharge monitoring report

Reporting dates are determined for each facility and are due the same date each month. Annual reports are due to the ExChange on or before February 1 of each year. These reports include the previous year's annual mass loads of TN and TP, the delivered total loads of nitrogen and phosphorus, and the number of nitrogen and phosphorus credits to be acquired or exchanged. For more information on the VPDES General Permit program and the Virginia nutrient trading program legislation and regulations, see http://www.deq.state.va.us/vpdes/.

What Are the Incentives for Trading?

The Exchange Program provides facilities with a flexible approach to meeting nutrient load allocations set forth in VPDES general permit, taken from the tributary strategies. Upgrading existing treatment systems would be expensive and could hinder growth within the Chesapeake Bay watershed. The Exchange Program, on the other hand, offers a market-based and cost-effective method for meeting nutrient caps while accommodating continued growth and development. It also allows for new upgrades to be phased in, easing construction and resource demand while expediting the process of meeting nutrient load allocations by the January 1, 2011, deadline.

What Water Quality Improvements Have Been Achieved?

No trading has occurred under the Exchange Program; therefore, no water quality improvements associated with nutrient trading in the Chesapeake Bay watershed have been made.

What Are the Potential Challenges in Using This Trading Approach?

Point source–point source trading will be conceptually easier than point source–nonpoint source trading, primarily because the previous year's effluent data from all potential trading partners will have been reported to, and published by, DEQ. Prospective trading partners should have little difficulty in identifying each other, and the regulation requires that facilities report their trades in sufficient time for DEQ to ascertain the compliance status of the respective facilities.

Nonpoint source trading brings about several potential challenges. Estimating nonpoint source loading and BMP load reductions is a difficult task. Inspecting nonpoint source BMP installation and implementation also poses a number of challenges because of questions surrounding enforceability, pollutant removal effectiveness, and monitoring. These issues are being investigated by DEQ and DCR.

What Are the Potential Benefits?

Trading offers a much more flexible approach to achieving nutrient load allocations for permitted significant dischargers. A number of options are available for facilities as opposed to solely employing costly treatment upgrades. Compliance could be achieved cooperatively with other facilities providing faster and more cost-effective results. If a facility decides to upgrade treatment technology, there is the possibility of offsetting the associated costs through the trading program. In some cases, and as a last resort, compliance may be achieved by simply making a payment to the WQIF.

The local food industry, tourists, and residents of the surrounding watershed all have the potential to benefit from the trading program because of its ability to expedite water quality improvement.

Applicable NPDES Permit Language

The following is pertinent language found in the general permit (9 VAC 25-820-10 et seq.):

PART I
SPECIAL CONDITIONS APPLICABLE TO ALL FACILITIES.

J. Compliance with wasteload allocations.

1. Methods of Compliance. The permitted facility shall comply with its wasteload allocation contained in the registration list maintained by the Department. The permitted facility shall be in compliance with its wasteload allocation if:
   a. the annual mass load is less than, or equal to, the applicable wasteload allocation assigned to the facility in this general permit (or permitted design capacity for expanded facilities without allocations);

b. the permitted facility acquires sufficient point source nitrogen or phosphorus credits in accordance with paragraph 2. of this subsection; provided, however, that the acquisition of nitrogen or phosphorus credits pursuant to this section shall not alter or otherwise affect the individual wasteload allocations for each permitted facility, or

c. in the event it is unable to meet the individual wasteload allocation pursuant to a. or b. (above), the permitted facility acquires sufficient nitrogen or phosphorus credits through payments made into the Water Quality Improvement Fund pursuant to paragraph 3. of this subsection; provided, however, that the acquisition of nitrogen or phosphorus credits pursuant to this section shall not alter or otherwise affect the individual wasteload allocations for each permitted facility.

2. Credit acquisition from permitted facilities. A permittee may acquire point source nitrogen credits or point source phosphorus credits from one or more permitted facilities with wasteload allocations [in Subsection C of Sections 50, 60, 70, 110 and 120 of the Water Quality Management Planning Regulation (9 VAC 25-720), including the Blue Plains wastewater treatment facility operated by the District of Columbia Water and Sewer Authority, only if:

a. the credits are generated and applied to a compliance obligation in the same calendar year,

b. the credits are generated by one or more permitted facilities in the same tributary,

c. the exchange or acquisition of credits does not affect any requirement to comply with local water quality-based limitations,

d. the credits are acquired no later than June 1 immediately following the calendar year in which the credits are applied,

e. the credits are generated by a facility that has been constructed, and has discharged from treatment works whose design flow or equivalent industrial activity is the basis for the facility's wasteload allocations (until a facility is constructed and has commenced operation, such credits are held, and may be sold, by the Water Quality Improvement Fund), and

f. no later than June 1 immediately following the calendar year in which the credits are applied, the permittee certifies on a credit exchange notification form supplied by the Department that he has acquired sufficient credits to satisfy his compliance obligations. The permittee shall comply with the terms and conditions contained in the credit exchange notification form submitted to the Department.

3. Credit acquisitions from the Water Quality Improvement Fund. Until such time as the Board finds that no allocations are reasonably available in an individual tributary, permittees that cannot meet their Total Nitrogen or Total Phosphorus effluent limit may acquire nitrogen or phosphorus credits through payments made into the Virginia Water Quality Improvement Fund established in § 10.1-2128 only if, no later than June 1 immediately following the calendar year in which the credits are to be applied, the permittee certifies on a form supplied by the Department that he has diligently sought, but has been unable to acquire, sufficient credits to satisfy his compliance obligations through the acquisition of point source nitrogen or phosphorus credits with other permitted facilities in the same tributary, and that

he has acquired sufficient credits to satisfy his compliance obligations through one or more payments made in accordance with the terms of this general permit. Such certification may include, but not be limited to, providing a record of solicitation or demonstration that point source allocations are not available for sale in the tributary in which the permittee is located. Payments to the Water Quality Improvement Fund shall be in the amount of $11.06 for each pound of nitrogen and $5.04 for each pound of phosphorus, and shall be subject to the following requirements:

a. the credits are generated and applied to a compliance obligation in the same calendar year,

b. the credits are generated in the same tributary,

c. the acquisition of credits does not affect any requirement to comply with local water quality-based limitations, as determined by the board.

4. This general permit neither requires, nor prohibits, a municipality or regional sewerage authority's development and implementation of trading programs among industrial users, which are consistent with the pretreatment regulatory requirements at 40 CFR Part 403 and the municipality's or authority's individual VPDES permit.

PART II
SPECIAL CONDITIONS APPLICABLE TO NEW AND EXPANDED FACILITIES

B. Acquisition of Wasteload Allocations.

Wasteload allocations required by this section to offset new or increased delivered total nitrogen and delivered total phosphorus loads shall be acquired in accordance with this section.

1. Such allocations may be acquired from one or a combination of the following:

a. Acquisition of all or a portion of the wasteload allocations from one or more permitted facilities, based on delivered pounds by the respective trading parties as listed by the Department.

b. Acquisition of nonpoint source load allocations, using a trading ratio of two pounds reduced for every pound to be discharged, through the use of best management practices that are:

(i) Acquired through a public, or private entity acting on behalf of the land owner;

(ii) Calculated using best management practices efficiency rates and attenuation rates, as established by the latest science and relevant technical information, and approved by the board];

(iii) Based on appropriate delivery factors, as established by the latest science and relevant technical information, and approved by the board;

(iv) Demonstrated to have achieved reductions beyond those already required by or funded under federal or state law, or by the Virginia tributaries strategies plans, and

(v) Included as conditions of the facility's individual Virginia Pollutant Discharge Elimination System permit; or

c. Until such time as the Board finds that no allocations are reasonably available in an individual tributary, acquisition of allocations through payments made into the Virginia Water Quality Improvement Fund established in § 10.1-2128; or

d. Acquisition of allocations through such other means as may be approved by the Department on a case-by-case basis.

2. Acquisition of allocations is subject to the following conditions:

a. the allocations shall be generated and applied to an offset obligation in the same calendar year;

b. the allocations shall be generated in the same tributary;

c. such acquisition does not affect any requirement to comply with local water quality-based limitations, as determined by the board;

d. the allocations are authenticated (i.e., verified to have been generated) by the permittee as required by the facility's individual Virginia Pollutant Discharge Elimination permit, utilizing procedures approved by the Board, no later than February 1 immediately following the calendar year in which the allocations are applied;

e. if obtained from a permitted point source, the allocations shall be generated by a facility that has been constructed, and has discharged from treatment works whose design flow or equivalent industrial activity is the basis for the facility's wasteload allocations, and

f. no later than June 1 in the year prior to the calendar year in which the allocations are to be applied, the permittee shall certify on an exchange notification form supplied by the Department that he has acquired sufficient allocations to satisfy his compliance obligations. The permittee shall comply with the terms and conditions contained in the exchange notification form submitted to the Department.

3. Priority of Options. The Board shall give priority to allocations acquired in accordance with subdivisions B.1.a and B.1.b. of this section. The Board shall approve allocations acquired in accordance with subdivisions B.1.c and B.1.d of this section only after the owner or operator has demonstrated that he has made a good faith effort to acquire sufficient allocations in accordance with subdivisions B.1.a and B.1.b, and that such allocations are not reasonably available taking into account timing, cost and other relevant factors. Such demonstration may include, but not be limited to, providing a record of solicitation, or other demonstration that point source allocations or nonpoint source allocations are not available for sale in the tributary in which the permittee is located.

4. Annual allocation acquisitions from the Water Quality Improvement Fund. The cost for each pound of nitrogen and each pound of phosphorus shall be determined at the time payment is made to the WQIF, based on the higher of (i) the estimated cost of achieving a reduction of one pound of nitrogen or phosphorus at the facility that is securing the allocation, or comparable facility, for each pound of allocation acquired; or (ii) the average cost, as determined by the Department of Conservation and Recreation on an annual basis, of reducing two pounds of nitrogen or phosphorus from nonpoint sources in the same tributary for each pound of allocation acquired.

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Red Cedar River Nutrient Trading Pilot Program
Wisconsin

Overview

Facing stringent phosphorus discharge limits, the city of Cumberland participated in a trading pilot project that involves paying farmers in the Red Cedar River watershed to install nonpoint source best management practices (BMPs). The nonpoint source BMPs reduce phosphorus discharges to the Red Cedar watershed and offset the phosphorus discharge from the City of Cumberland's publicly owned treatment works (POTW), helping the city to avoid costly upgrades.

Type of Trading

Point Source–Nonpoint Source

Pollutant(s) Traded

Phosphorus

Number of Trades to Date

More than 60 BMPs purchased

Who Is Eligible to Participate?

Eligible participants include the city of Cumberland's POTW and farmers in the Red Cedar River watershed.

What Generated the Need for Trading?

Eutrophication and algal blooms in Tainter Lake in the Red Cedar River watershed catalyzed watershed-wide management (Breetz et al. 2004). The mandated 1 mg/L phosphorus discharge limit for municipal wastewater treatment plants, and the challenge to achieve this limit, generated the need for trading. The 1 mg/L phosphorus discharge limit required of Cumberland's POTW caused the city to pursue water quality trading as a means of reducing compliance costs. The city believed that reducing phosphorus through nonpoint source discharges rather than removing chemical phosphorus at the POTW would benefit the watershed (Breetz et al. 2004).

What Serves as the Basis for Trading?

The primary regulatory driver for point sources is Chapter NR 217 of the Wisconsin Administrative Code. Chapter NR 217 mandated 1 mg/L phosphorus discharge limits for municipal treatment plants with a monthly discharge exceeding 150 pounds of phosphorus and industrial sources with a monthly discharge exceeding 60 pounds of phosphorus (Breetz et al. 2004).

What Types of Data and Methodologies Were Used to Calculate the Basis for Trading?

Cumberland was required to purchase 4,400 pounds of phosphorus credits to offset the phosphorus discharge from its POTW (Breetz et al. 2004). To determine the amount of phosphorus credits that the city had to purchase, calculations traditionally used in nonpoint source management programs that quantify soil delivery reductions and associated reductions in phosphorus loading were used (Prusak 2004).

Two computer models have been used to facilitate development of the trading pilot program in the Red Cedar River watershed. The first model was the Simulator for Water Resources in Rural Basins, used to help establish loading rates and make allocations to various land uses. The SWAT model is now being used for other impoundments in the watershed. Results from both models will help to establish goals and reduction rates (WDNR 2002).

Are Permits Used to Facilitate Trades?

The NPDES permit for the city of Cumberland's POTW states that the city must commit to trading or take actions to meet the 1 mg/L standard; the permit does not contain language that specifies the details of the trading program (Environomics 1999). An agreement between the Wisconsin Department of Natural Resources (WDNR) and the city contains the details of the trading program, including implementation milestones (Environomics 1999).

How Are Credits Generated for Trading?

The phosphorus reduction credits associated with a BMP were estimated using phosphorus loading models developed for and used by many Priority Watershed projects. All the trades have involved nutrient management planning or no-tillage, which are well-established and well-understood practices. Dischargers may trade only to meet phosphorus requirements and farmers may receive payment for a BMP for 3 years (Breetz et al. 2004).

What Are the Trading Mechanisms?

The Barren County Land Conservation Department serves as a third-party facilitator, negotiating with farmers and establishing contracts between participating farmers and Cumberland (Breetz et al. 2004).

What Is the Pollutant Trading Ratio?

Initially, the WDNR proposed a trading ratio of 20:1, expecting the city of Cumberland to negotiate for a smaller ratio. Eventually a trading ratio of 2:1 was agreed upon by WDNR and the city (Prusak 2004).

What Type of Monitoring Is Performed?

The Barron County Land Conservation Department and Cumberland evaluated landowners according to the trading area criteria. Soil testing of each field was done to calculate the phosphorus delivery to the stream from the field where the BMP was used (Breetz et al. 2004). Additional monitoring is taking place to help calibrate the SWAT model (WDNR 2002).

What Are the Incentives for Trading?

The city of Cumberland believed that participating in a trading program to promote nonpoint source phosphorus reductions would be beneficial to the watershed and would not require an investment for phosphorus controls at the POTW. However, the WDNR's fourth progress report on the trading of water pollution credits stated that the effluent limit of 1 mg/L was not an adequate driver for a trading program; a total maximum daily load (TMDL) is needed to generate interest (WDNR 2002).

What Water Quality Improvements Have Been Achieved?

Water quality improvements are unknown. However, in 2001 the city of Cumberland paid 22 landowners a total of $14,526, primarily for reduced tillage on lands showing excessive phosphorus in soil tests. These trades resulted in 5,000 pounds of phosphorus credits, although Cumberland was required to reduce phosphorus by only 4,400 pounds. Approximately the same number of farmers participated in 2002, 2003, and 2004. The number of acres enrolled in the program increased from 720 in 2003 to 891 in 2004. In 2004 Cumberland paid 21 landowners a total of $17,659.45 for no-till planting and reduced conservation tillage that resulted in 9,584 lbs of phosphorus saved. As of 2004, Cumberland has paid a total of $58,000 to remove a total of 31,500 lbs of phosphorus (WDNR 2006). It is anticipated that the city will continue trading until it becomes impossible to secure enough nonpoint source credits (Breetz et al. 2004).

What Are the Potential Challenges in Using This Trading Approach?

One challenge associated with the Red Cedar River Trading Pilot Program is determining a precise phosphorus credit for BMPs. Other challenges cited by the WDNR include developing an agreed-upon set of tools for quantifying phosphorus reduction loads from BMPs and generating an incentive for participation without a TMDL in place (WDNR 2002).

What Are the Potential Benefits?

Through the Red Cedar River Trading Pilot Program, the watershed could benefit in the long term from the installation of BMPs. The city of Cumberland will pay for only one BMP for 3 years, and after that will find different landowners to generate credits through new BMPs. The hope is that the original BMPs will remain up and running in the watershed after the 3-year, credit-generating period (WDNR 2002). The BMPs installed through the program reduce phosphorus loads in part by reducing sediment loads to the watershed; therefore, the Red Cedar River watershed is receiving an additional water quality benefit (Prusak 2004).

Applicable NPDES Permit Language

4.0 Schedules of Compliance

4.1 Phosphorus

> Pursuant to s. 283.84, Stats., the 1.0 mg/L phosphorus limitation is held in abeyance as long as the permittee is active in the Red Cedar River Watershed Pilot Project. If the permittee stops participating or the pilot terminates, the permittee shall take steps to achieve total phosphorus limits.

Required Action

Letter of Intent: The permittee must submit a letter of intent to the Department regarding pollutant trading. The letter of intent shall indicate whether the permittee intends to continue the Red Cedar River Watershed Pilot Project or proceed with adjustments/modifications to the facility to achieve compliance with the phosphorus limitation. If the letter of intent states that the permittee does not intend to continue trading, then the permittee shall proceed with modifications to the plant (or adjust plant operations) to achieve compliance with phosphorus limitation by a deadline established by the Department.

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