United States
Environmental Protection
Agency

This document is one chapter from the EPA "Water Quality Trading Assessment Handbook," published in November 2004. The reference number is EPA 841-B-04-001. You can find the entire document at http://www.epa.gov/owow/watershed/trading/handbook/index.html.

WATER QUALITY TRADING ASSESSMENT HANDBOOK

Can Water Quality Trading Advance Your Watershed's Goals?

November 2004

IV. Market Infrastructure

Purpose

The previous chapters of this Handbook addressed the viability of trading based on pollutant suitability, watershed and discharger characteristics, and the financial attractiveness of likely trades. This chapter considers the infrastructure required to enable trading. This chapter will help answer the following questions:

- What functions must a water quality trading market perform?
- Why is each function important to the success of water quality trading?
- What mechanisms have been used to perform these functions in demonstration trading projects?
- What are the considerations in selecting appropriate mechanisms and integrating them into a market?

After reading this chapter, considering the examples provided, and reflecting on what you have learned in the previous chapters, you will better understand the watershed's unique market infrastructure needs, market mechanisms best suited for the watershed, and the commitment that may be needed to create a market. This Handbook does not provide a specific blueprint for creating a market, but does highlight features of different market designs that you will want to consider as you proceed. With this information you will be better able to tailor a market to your watershed's unique needs.

Approach

All viable markets, whether trading water pollutant reductions or widgets, must efficiently create benefits for its participants. "Markets" are social constructs facilitating interactions among parties interested in exchanging goods or services. Research indicates that successful markets evolve to reduce costs associated with:

- identifying others willing to purchase or supply goods or services;
- comparing the goods or services offered by other parties;
- negotiating the terms of an exchange of goods and services; and
- enforcing the terms of the exchange.

A market is more likely to be successful if it has rules, procedures, and norms allowing parties to participate at a cost acceptable to everyone involved. Viable water quality trading (WQT) markets are no different from conventional markets in this regard. However, WQT markets are unconventional in the sense that they exchange goods (pollutant loading reductions) that are created primarily by (i.e., have value because of) regulatory obligations by at least some participants. As such, WQT markets may require different and/or additional infrastructure to ensure practical enforceability, water quality equivalence, avoidance of localized impacts, and sufficient progress towards water quality goals. In WQT the "products" exchanged have an

essential purpose in meeting CWA goals that serve the public good. The challenge is to design a market that meets these essential needs in a way that is cost-efficient and minimizes program costs.

Market development and transaction costs, as well as risks associated with various uncertainties, play an ongoing role in encouraging or suppressing market activity. These considerations, which collectively represent the degree of "friction" individual transactions face in the marketplace, should remain central to all infrastructure design decisions. Failure to manage market friction effectively will substantially constrain and may entirely stifle otherwise environmentally equivalent and financially attractive trades.

As discussed in the previous chapter, potential WQT market participants may be challenged by a variety of ***market development costs***, including those associated with analyzing the viability of trading in the watershed, developing and selecting options for market infrastructure, convening interested parties to discuss trading perspectives and options, and creating the infrastructure. ***Market development uncertainty***—the risk that a market may not emerge—compounds these challenges.

In addition to market development costs, ***transaction costs*** include information gathering, trade execution, and any additional monitoring undertaken as part of the trading program. These transaction costs will be driven largely by the procedures, trade execution methods, and tracking infrastructure established in the watershed. ***Transaction uncertainty*** due, for example, to an unclear basis or time-frame for regulatory approvals will compound these costs. A market that needs trade-by-trade regulatory approval, for example, will be relatively costly and uncertain. There will be a constant risk that any particular trade will not materialize or will not receive regulatory approval in time to satisfy a source's capital budgeting and/or compliance deadline constraints.

WQT markets are intended to meet water quality goals at a lower societal cost. The choice of trading program infrastructure will substantially impact the costs associated with implementing trading. High market development costs and uncertainty combined with high transaction costs/uncertainty produce substantial overall market "friction." High market friction will limit activity to only very, very financially attractive trades. Therefore, the infrastructure designer's goal is to create the smoothest transaction path consistent with regulatory requirements and water quality improvement goals.

This chapter of the Handbook suggests ways to manage market and regulatory imperatives to encourage efficiency and increase the likelihood that trading will occur. To this end, three WQT models will be discussed based on how each model performs particular functions. Building on the information and analysis you developed in the previous chapters, this additional information will help you design an appropriate market infrastructure to perform the essential functions in your watershed. No particular approach is prescribed, but this chapter offers options and criteria to evaluate them.

Considerations: Market Sizing

This section is intended to help you find ways to substantially reduce market friction by appropriately sizing market infrastructure to your watershed's unique trading characteristics. The

chapters on Pollutant Suitability and Financial Attractiveness are intended to help you develop a solid understanding of where your watershed might be positioned along the water quality trading spectrum. At one end of the spectrum is a watershed with a single viable trade between two point sources who will experience modest financial benefits and are expected to sustain the trading relationship for the foreseeable future. At the other end of the spectrum is a watershed with a potentially large number of viable trades among both point and nonpoint sources. This potentially large number of trades would involve numerous transactions among diverse parties, potentially saving millions of dollars.

For the watershed with only one viable trade, an overly large market infrastructure consisting of a web-based trading platform linked to state agency permit databases would be unnecessary and so expensive that, if it were required, would likely make the trade unattractive. On the other hand, if participants in the large, dynamic market didn't have sufficient market access and infrastructure support and were required to manually record trades and revise their NPDES permits to reflect each individual trade, the costs and uncertainty in the market would diminish or eliminate the value of trading to many if not all of them. In practice, the geographic size and number of point sources in a watershed will be a strong consideration to determine the market infrastructure. The following information and examples illustrate ways to tailor your market infrastructure and associated "overhead" costs to the potential size of the market in your watershed.

What Is Driving the Market?

All markets evolve to help fulfill the demands of consumers. Consumers provide producers an opportunity to earn a profit for altering their behavior and attending to the market's constantly changing demands for goods and services. Until a consumer decides they "need" a soda, and is willing to pay someone to produce it, there is no market for sodas.

Total Maximum Daily Loads (TMDLs) are the leading market drivers for WQT markets today because they typically create the "need" to alter behavior by identifying pollutant reductions needed to meet water quality standards. TMDLs and similar frameworks are sometimes described as "budgets" for the introduction of pollutants into watersheds. Scientific studies estimate the pollutant loading that a specific watershed or segment can assimilate without exceeding the water quality standards enacted to protect the watershed's designated beneficial use(s). This "pollutant budget" is then allocated across point sources through wasteload allocations and nonpoint sources through load allocations and incorporates a federally mandated "margin of safety." TMDL wasteload allocations for point sources are reflected in NPDES permit limits that often will require greater levels of pollutant control. For nonpoint sources, the TMDL load allocation is not translated into a binding requirement. However, WQT can provide an incentive for nonpoint sources to reduce their pollutant loadings by providing financial incentives (i.e., ability to sell pollutant reduction credits) for controlling pollutant loadings beyond the TMDL load allocation.

EPA's 2003 Water Quality Trading Policy supports trading to meet TMDLs (or similar analytical framework) for certain pollutants. The policy also supports pre-TMDL trading in certain circumstances and trading to maintain existing high water quality. This chapter assumes that

your watershed has a TMDL, or similar framework, driving your interest in creating a WQT market.

What Are the Essential Functions of a Water Quality Trading Market?

Based on a review of the academic literature and the water quality trading projects conducted to date, a WQT market has at least eight essential functions. Various mechanisms can perform these functions. Market mechanisms are limited only by participants' creativity, regulatory imperatives, and the characteristics of the watershed. In some cases, specific mechanisms may perform more than one function, potentially increasing market efficiency. It is important to note that these market functions do not cover all essential *activities* involved in implementation of trading such as soliciting public input, crafting NPDES permits that incorporate trading, and assessing progress towards water quality standards as would be done with any watershed management approach. The functions do encompass essential functions central to market-based approaches for water quality management.

The eight essential functions are:

1. Assuring compliance with the Clean Water Act and relevant state and local requirements;
2. Defining and executing the trading process;
3. Defining marketable reductions;
4. Ensuring water quality equivalence of trades and avoiding hotspots;
5. Communicating among buyers and sellers;
6. Tracking trades;
7. Managing risk among parties to trades; and
8. Providing information to the public and other stakeholders.

The following discussions review briefly why these functions may be necessary for conventional markets and why they are essential for WQT. How well a mechanism may perform its function is discussed in light of market friction.

1. Assuring Compliance with Clean Water Act and State/Local Requirements

Conventional Market Function—In some conventional markets, buyers and sellers have regulatory obligations to entities outside the transaction. These obligations derive from a variety of public policy goals including protecting the parties directly involved in the trade and/or those with an indirect interest in the transaction's outcome. For example, the Securities and Exchange Commission requires publicly traded companies to conduct third-party audits of financial statements and report specific information annually to the public. This reduces the opportunity to commit fraud and lowers investors' market risk.

Regulatory Obligations in WQT Markets—WQT processes must involve various watershed participants, including important non-discharging stakeholders like regulatory agencies. EPA's

Water Quality Trading Policy states that trading programs must be developed in the context of regulatory and enforcement mechanisms, which predominantly rely on NPDES discharge permits. Thus, the market, federal, state and local regulations, and the agencies responsible for their enforcement are closely connected. EPA's Water Quality Trading Policy says that "mechanisms for determining and ensuring compliance are essential for all trades and trading programs… States and tribes should establish clear, enforceable mechanisms consistent with NPDES regulations that ensure legal accountability for the generation of (pollutant reductions) that are traded." The appropriate regulatory agency(s) therefore will need a process to authorize, evaluate, permit, verify, and evaluate trading programs or even individual trades. Demonstration projects have performed this function in a variety of ways.

A good regulatory compliance assurance mechanism minimizes the transaction costs and transaction uncertainties associated with any potential trade by achieving consistent approval decisions—in both outcome and timing—based on the data needed to ensure achievement of the required pollutant reductions, water quality equivalence, and avoidance of hotspots. A poor mechanism increases transaction costs and transaction uncertainty by sending incorrect signals to the market regarding what is expected of participants and then inconsistently processing the provided information.

2. Defining and Executing the Trading Process

Conventional Market Function—Each conventional market has its own unique trading process. The types of trading processes depend on the types of products and participants involved. For example, in a simple retail exchange at the local convenience store, a customer chooses a loaf of bread based on personal taste and posted prices, pays the proprietor at the cash register, and leaves the store free to eat the bread or feed it to the pigeons. A more complex trading process occurs when a party seeks to purchase goods and services for construction of a new skyscraper. This process may involve a request for proposals, bidding by several interested firms, financing the project, selecting a general contractor, purchasing materials, arranging for all necessary permits and inspections, overseeing and inspecting physical construction, and agreeing on the level of completion. Friction in conventional markets can be minimized if participants have a solid understanding of the steps involved in a transaction, the order in which they need to be completed, and each step's likely cost.

The Trade Process in WQT Markets—EPA's Water Quality Trading Policy supports trading under different conditions (i.e., both within the context of a TMDL and prior to its approval.) The policy does not prescribe specific processes that each market must employ to complete a trade. Each WQT market may develop its own trading process.

The "Trading Process" includes the steps all parties must take to complete a proposed trading transaction that ensures full CWA practical enforceability and fully supports TMDL requirements. These steps could include, but are not limited to:

- Negotiating a transaction;
- Accounting for water quality equivalence and avoiding hotspots;
- Completing and conveying appropriate paperwork;
- Reviewing and approving trades;
- Installing control technologies or adopting pollutant management methods;

- Monitoring and verifying reductions;
- Reporting to appropriate regulatory agencies and stakeholders;
- Auditing reported information against regulatory obligations; and
- Taking enforcement actions, if necessary.

A good trading process covers these steps in the appropriate order while minimizing uncertainty and costs associated with the trading transaction. A poor mechanism is incomplete and adds to uncertainty and costs associated with the transaction so that trading is potentially suppressed. This can happen if the steps don't generate enough momentum towards trade completion. In addition, redundancies in the process (i.e., steps that are revisited without adding sufficient value) add to transaction costs and will erode the value of trading.

Some states considering trading and/or with demonstration projects underway have developed documents that describe the process the state will use to formally recognize water quality trades. These documents usually do not prescribe exacting protocols for individual trades, but provide general guidelines. Care should be taken to review your state's document (if it has one) and design the market consistent with its guidelines and in consultation with appropriate state agencies.

3. Defining Marketable Reductions

Conventional Market Function—In conventional markets, a "marketable" product or service is anything that one individual is willing to compensate another individual to produce. The marketability of a product or service may be influenced by personal need, taste, and economic conditions. For example, a person may need shelter, may prefer to live in a townhouse, and may find it financially advantageous to pay someone to build the house rather than foregoing salaried employment to build it alone. A product may be marketable to one person but not another. For example, a second person may share the need for shelter but prefer to live in an apartment. Such a person may have no interest in purchasing a townhouse.

Marketable Products in WQT Markets—In WQT markets, "overcontrol" of pollutant loadings is the marketable product. The product is produced when the reduction of pollutant loadings goes beyond a source's regulatory obligation or a nonpoint source's TMDL load allocation (or other baseline). A WQT market must do two things to create a marketable product. First, the market must identify the relevant pollutant reduction expectations; overcontrol cannot exist until a TMDL or other framework sets the reduction expectations. Second, the market must transform overcontrol into a marketable product by allowing that behavior to acquire value. Value is acquired when a regulatory framework allows one source to offset its discharge reduction obligations with overcontrol by other sources. As described in the Financial Attractiveness chapter of this Handbook, the value of overcontrol is highly dependent upon differences in incremental control costs. Minor control cost differences will create little, if any, value even if the regulatory framework allows offsets.

4. Ensuring Water Quality Equivalence of Trades and Avoiding Hotspots

Conventional Market Function—Some market mechanisms allow consumers to compare the characteristics and quality of products targeting similar needs. For example, over the counter drug packaging must inform consumers of the drug's chemical contents—including the relative amount of active ingredients. This allows consumers to compare the likely effectiveness of various painkillers and cold remedies so they can select the product that best meets their needs.

Equivalence in WQT Markets—As emphasized earlier, trading requires that the impact of the purchased pollutant reduction is (at least) equivalent to the reduction that would have occurred without trading. Market participants and regulatory agencies must be able to evaluate the water quality equivalence of reducing pollutants at the points of credit creation and use. For example, hydrologic conditions in the stream between the two trading points must be evaluated because they can have a profound impact on water quality equivalence.

Demonstration WQT projects have used various mechanisms to perform the essential market function of facilitating water quality equivalence assessments. One important consideration is the higher cost of developing an accurate model versus setting ratios based on a rule of thumb (i.e., 3 to 1). Although establishing ratios based on accurate modeling and a wealth of ambient data may be the most precise approach, a WQT program may not be viable unless less costly approaches can be found. The potential participants may be willing to make a tradeoff in such a case. For example, a rule of thumb ratio that is less expensive to develop can be set at a high level to provide a margin of safety with each trade, even though this might drive up the cost per unit of needed reductions. A good mechanism will ensure equivalence while keeping the total cost of a specific trade (i.e., costs to develop the ratio and the cost of needed equivalent reductions) to a minimum. A poor mechanism will fail to control total costs.

Various approaches exist for avoiding localized hotspots including: retaining individual (non-tradeable) permit limits on pollutant forms that can exert an acute effect, e.g., ammonia nitrogen; limiting the portion of a facility's discharge limit that may be met through the purchase of credits; and not permitting trades beyond a certain size. State regulatory agencies will have a primary voice in how water quality equivalence is established and localized impacts avoided.

5. Communicating Among Buyers and Sellers

Conventional Market Function—All conventional markets are communication systems. They provide participants with information on product availability, variety, quality, quantity, and price. This information is used to:

- Identify parties willing to produce or consume goods;
- Compare the merits of similar offers; and
- Negotiate mutually beneficial terms of exchange.

Without a means to acquire the needed information, potential market participants would be unable to benefit from each other's ability and willingness to produce goods and services.

Communication's Unique Role in WQT Markets—A WQT market gives dischargers who face pollutant control costs a forum for communicating with other sources to identify environmentally equivalent excess reductions that can be attained at a lower cost. Because pollutant suitability and financial attractiveness are specific to the pollutant's chemical properties, the watershed's physical characteristics, and the relevant economic conditions, WQT markets must facilitate sharing information regarding a relatively complex product—a certain type/form of pollutant reduction, at a specific time and place, for a predetermined duration, in a particular quantity, for a certain cost.

A good WQT market allows parties to learn what quantity of excess reductions are being offered and demanded, when they can/will be delivered, their duration, their likely impact on water quality at all relevant points, and how much they will potentially cost to acquire. A WQT market is more likely to succeed if it allows participants to efficiently survey the details of all potential offers to buy or sell overcontrol and identify those most beneficial to their unique needs. It is less likely to succeed if it fails to disseminate the pertinent information and/or requires participants to expend an inordinate amount of time, energy, and money to do so.

6. Tracking Trades

Conventional Market Function—Most conventional markets track transactions. How much information is gathered, who stores it, and its future use depend on the types of transactions and the purposes for tracking. For example, when an individual purchases a loaf of bread at the local convenience store, the store may track the amount paid, when the transaction was completed, and what was purchased. This information may be saved by the register or transmitted to a large database for all transactions completed in the region. The information may be used to justify keeping that store open until 2 a.m., to document sales tax collection, or to manage inventory. The customer receives a receipt that can help reconcile their budget, obtain reimbursement from housemates, or enable a return of damaged goods.

Why Trades Need to be Tracked in WQT Markets—Tracking trades in a WQT market is necessary to ensure that pollutant reductions credited to a source are actually made, all relevant discounts are applied to credits, trades are not double counted (i.e., one source does not sell the same reductions to more than one buyer) and to provide a clear audit trail for compliance assurance purposes. Crucial pieces of information a water quality trade tracking mechanism must include are amount of excess reduction and chain of custody. In this context, chain of custody refers to the possession of the right to use the pollutant reduction for regulatory compliance purposes. Keeping track of this information is essential to ensuring that the goal of the TMDL, meeting water quality standards, is being advanced and that practical enforceability is maintained. In addition, this information makes the creation and ownership of individual reductions clear and traceable in the context of determining if sources are complying with NPDES or other relevant permits.

A good trade tracking mechanism minimizes market friction by keeping transaction costs for chain of custody low, while providing regulators with easy and prompt access to appropriate levels of transaction detail. Transaction costs can be kept low by setting clear and consistent expectations for what information is required and limiting the administrative burden on trading partners. Sizing the tracking system to the market will also help limit transaction costs. A poor trade tracking mechanism will drive up the cost of administering individual trades to the point where it erodes

the value of trading. It may require trading partners or regulatory agencies to perform non- value-added administrative tasks (e.g., reconstructing market activity from inconsistent transaction statements).

7. Managing Transaction Risk Among Parties to a Trade

Conventional Market Function—During the exchange of goods or services, a chance always exists that the specific terms or the intent of a negotiated deal will not be fulfilled. Conventional markets allow parties to identify this transaction risk, assign the burden of the risk to the appropriate party, and provide the opportunity for recourse if it is needed. Escrow deposits and performance bonds are examples of such risk mitigation mechanisms.

Managing Transaction Risk in WQT Markets—WQT markets involve three facets of transaction risk:

- The risk that regulators will find that the discharge reductions negotiated under the agreement do not conform to market rules;
- The risk that the specific discharge reductions negotiated under the agreement (for a pollutant type/form, at a specific time, for a predetermined duration, in a particular quantity) will not be produced; and
- The risk that reductions will fail to have the intended impact on water quality.

The chapter on Financial Attractiveness explained the detrimental effects transaction risk can have on trading. Insufficiently managed risk will induce participants to steeply discount the price they are willing to pay for discharge overcontrol. This erodes the financial benefits associated with trading and can potentially suppress market activity.

Risk management transaction costs (identifying and assigning risk) increase when remedies for nonperformance of discharge reduction obligations are less certain. A good mechanism for managing transaction risk identifies and assigns the three types of transaction risks to specific parties, and sets reasonable expectations about how failure to fulfill terms of the agreement will be handled, including the size of the remedy. As always, good mechanisms minimize transaction costs. A poor mechanism will create high transaction costs and fail to account for all three transaction risks, assign the risk to an inappropriate party, and/or create ambiguity over how a transaction “gone bad” will be handled.

8. Providing Information to the Public

Conventional Market Function—Some conventional markets recognize that commercial activity can directly or indirectly affect parties other than the traders. For example, the Securities and Exchange Commission requires corporate officers to notify the public when they purchase or sell stock in the companies they manage. Public dissemination of this information provides investors and securities regulators with information relevant to investment decisions and public policy.

Public Information in WQT Markets—The CWA and federal, state, and local water quality regulations require provision of opportunities for public participation, including public notice and

opportunity for comment. WQT markets must therefore perform this essential function. WQT viability often depends on the public participation process to generate understanding and trust among watershed participants. Failure to do so could influence stakeholders to challenge the market system or specific trades, potentially introducing uncertainty and eroding the value of trading.

EPA's Water Quality Trading Policy supports, "public participation at the earliest stages and throughout the development of water quality trading programs to strengthen program effectiveness and credibility." Both early and on-going public participation are important to market development. Easy and timely public access to transaction information may increase market efficiency. Improving water quality takes sustained effort. An uninformed public may lose interest in a trading program, threatening its long-term viability. Informed watershed participants are more likely to discover and/or support new forms of trading. Some trading markets may produce trading opportunities that do not conform to the market design's original vision of trading, but do provide real water quality and economic benefits. Such opportunities evolve as watershed participants learn more about each other's needs and the needs of the watershed's ecosystem.

A good public information mechanism is transparent, easy to engage, and available to all interested parties while controlling transaction costs. The EPA Water Quality Trading Policy encourages electronic publication of information on:

- Boundaries of the watershed and trading areas;
- Discharge sources involved;
- Quantity of credits generated and used; and
- Market prices where available.

Other information may be important to participants in your watershed. The value of satisfying all interests will need to be balanced with the cost of collecting, managing, and distributing data. A poor public information mechanism will be resource intensive for both the information distributors and its consumers. As watershed participants must work harder to get information, their level of trust may diminish, threatening the market's stability.

Current Market Models

The remaining market infrastructure discussion focuses on three market models that are in various stages of implementation in the United States. Each of these market models responds to the unique needs of its watershed and market participants while handling the essential WQT market functions discussed above. Each market model is discussed in terms of the basic premise underlying the market, important mechanisms used to support the system, and how the model performs certain WQT market functions. These models illustrate significantly different approaches. The examples run from a predominantly urban and point source focused estuary (Connecticut) to a strong agricultural and nonpoint source influenced river (Idaho). The examples provided are ones that have been established with varying degrees of success. After reviewing them, you will have a better understanding of approaches potentially suitable for your watershed. However, note that any market will be tailored to local conditions; other models not mentioned here may have aspects that are more suitable for your watershed.

A Private, Non-profit Co-operative Facilitating Pre-Approved, "Dynamic" Trading

In 1998, the Lower Boise River Water Quality Trading Pilot Project undertook design of a WQT system for approximately 64 miles of river from Lucky Peak Dam to the mouth of the Boise River. Market participants agreed they could make trading more robust, flexible, and cost-effective by focusing on minimizing market friction. Participants identified design principles they felt were crucial to a viable market in their watershed, including the following:

- Avoid trade-by-trade changes to the TMDL;
- Avoid trade-by-trade changes to NPDES permits; and
- Acquire advance agency approval for specified trading to minimize trade-by-trade review.

To support these three design principles, watershed participants and regulatory stakeholders worked together to design clear guidelines and requirements for trades that would preclude the need for trade-by-trade review of most transactions. Public notice, review, comment, and agency approval of these trading guidelines and requirements were pivotal to this approach and created a model for dynamic trading. The key element of the Lower Boise market that allows market participants to trade in this fashion is the pre-approval of trade transactions through the issuance of a single new or modified NPDES permit enabling trading.[8]

The Idaho Clean Water Cooperative, a private, nonprofit association of various watershed participants, is charged with the day-to-day management of trading in the Lower Boise River. The Co-op will rely on language in the TMDL, language in NPDES permits, and a State Trading Document establishing the ground rules for creating and verifying trade transactions to facilitate trading. The Co-op will be responsible for helping connect buyers and sellers, developing and maintaining a trade tracking database, and preparing monthly watershed-wide trade summaries. The Cooperative will provide an important link among trading parties, the environmental agencies ensuring Clean Water Act compliance, and the public. By maintaining the trade tracking database and regularly disseminating transaction details, the association will also ensure that timely information about trades is available to the public and the environmental agencies. As a non-governmental organization, the Cooperative will be dedicated to supporting the trading system as agreed to by its members and in accordance with established rules.

Water Quality Market Functions in the Lower Boise River

Defining marketable reductions—The Lower Boise market uses a common definition of overcontrol (control below a source's TMDL defined allocation) to classify the reductions that sources may sell. To enable nonpoint source market participation, market stakeholders (including state and federal regulators as well as agricultural and technical assistance agencies) created a list of Best Management Practices and construction management, monitoring, and verification protocols that pre-qualify resulting reductions for sale. The BMP List provides the basis for the straight-forward verification of the nonpoint source generated reductions. This was done to eliminate the need for an intermediary in any transaction and create the opportunity for

[8] As of the publication of this document, trading in the Lower Boise market has not been initiated for reasons unrelated to the market design issues discussed here. Several steps and mechanisms have been created to enable trading, including the creation of the Idaho Clean Water Co-operative, reporting forms, model NPDES permit language, model TMDL language, and the State Trading Document.

direct participation of nonpoint sources in dynamic trading. Nonpoint sources that can demonstrate they follow the appropriate protocols have reductions recognized as valid and tradeable.

Communicating among buyers and sellers—Although the Co-op is charged with connecting buyers and sellers, the mechanisms used to fulfill that role are currently undefined. As the market manager, to which all sources must report certain information if they choose to trade, the Co-op is uniquely situated to act as a "broker". This may entail providing an electronic or physical bulletin board of bids and offers for reductions or may evolve into a more formal matchmaking role where the Co-op introduces sources with reduction needs to dischargers capable of addressing them. Both methods can help participants identify trades that may meet their needs. The costs of communication in the Lower Boise will be borne by both the Co-op and market participants.

Ensuring water quality equivalence and avoiding hotspots—One factor that is particularly important to address in dynamic, pre-approved trading is the potential for adverse environment impact resulting from individual trades. To lower the total cost of developing a ratio and the needed equivalent reductions, the Lower Boise market will rely on the water quality model developed for formulating the TMDL. This model provided each major discharger with an individual index, allowing a source to relate their discharge's effect on water quality to discharges by other sources. Use of an existing model keeps development costs to a minimum. In addition, this model ensures that trading ratios used are consistent with the TMDL. Relative to ratios based on a rule of thumb set artificially high to ensure equivalence, this minimizes the number of reductions a source must purchase. To preclude localized impacts, modified NPDES permits will include caps limiting the downstream trading capacity of individual sources. This will ensure that individual trades do not produce discharges in excess of the local assimilative capacity of the river segment between trading sources.

Assuring compliance with the CWA and regulations in the Lower Boise—In this market, the pertinent TMDLs will contain initial phosphorus wasteload allocations (WLAs) for point sources and a provision for trade-dependent WLA variability. Sources will then receive a new or modified NPDES permit incorporating their WLA as a limit and, if desired, a provision enabling a trade-dependent variable limit. In all point-source to point-source trades, the enabling provision automatically adjusts the buyer's NPDES discharge limit up and the seller's NPDES discharge limit down, based on the volume of reductions traded and their water quality equivalence ratio. If a source exceeds its adjusted discharge limit during a reporting period, it is in violation of the CWA and potentially subject to regulatory enforcement.

In nonpoint source to point source trades, the enabling provision gives the point source a credit that can be applied against the point source's NPDES permit limit during that reporting period. The credit is based on the amount of environmentally equivalent reductions that have been traded from the nonpoint source(s) to the point source. A point source violates the CWA if its actual discharge, adjusted for all reduction credits acquired through trading during that period, exceeds its discharge limit. In this market, EPA or the Idaho Department of Environmental Quality (DEQ) may invalidate credits established by the nonpoint source reductions if they fail to meet BMP protocols and retain full authority to enforce the corresponding point source's effluent limit without applying the invalid credits.

Point sources involved in a trade will use modified *Discharge Monitoring Reports (DMRs)* to report to the EPA. Along with the modified DMR, each source will submit an individual *Monthly*

Trade Report created by the Co-op. DMRs and Trade Reports include actual discharge, point source trades lowering or increasing their discharge limit, and nonpoint source credits reducing their recognized loadings. This information will be used by EPA to assure CWA compliance.

Defining and executing the trading process—The Lower Boise stakeholders developed a trading framework clearly defining the roles and responsibilities of all parties involved in a transaction (the buyer, the seller, the Co-op, and the regulatory agencies) and the steps needed to "complete" a transaction. Two steps common to water quality trades are handled automatically by certain mechanisms: 1) accounting for water quality equivalence and avoiding hotspots; and 2) reviewing and approving trades.

The framework allows market participants to negotiate trades on their own and provides clear guidelines for paperwork submission, control technology or process installation, and reporting protocols. Reduction monitoring and/or verification is generally assigned to point sources, while the Co-op, Idaho DEQ, and EPA will work together to audit trades and assure regulatory compliance. EPA will be responsible for regulatory enforcement actions.

With pre-approved trading, mechanisms are incorporated upfront to ensure that each trade meets water quality requirements. The Lower Boise market uses two mechanisms to prevent the need for trade-by-trade review without increasing the chance for adverse environmental effects: the use of known, published ratios for any given trade which lowers transaction costs by eliminating the need to negotiate ratios for each trade; and a pre-qualified set of BMPs which provides participants a clear understanding of what pollutant reduction practices will be recognized, minimizing transaction uncertainty.

How the Idaho Clean Water Co-operative tracks trades—In the Lower Boise, the tracking system was designed to establish chain of custody, maintain accountability, and provide the public with a means of readily tracking all reductions bought and sold. Key elements of the trade tracking system are 1) a record keeping and reporting protocol, and 2) a trade tracking database. The system strives to minimize transaction costs by setting clear and reasonable expectations for reporting. Market friction is managed by providing reasonably direct communication channels between participants, the Co-op, and the regulatory agencies.

Trading parties will be required to gather documentation and retain specific information pertaining to trades and then report selected information to the Co-op using standardized forms. For each point-source to point-source trade, a *Trade Notification Form* is required to officially register the trade, transfer reductions from seller to buyer, and trigger the enabling NPDES permit provision(s) to adjust allowable discharge limits. For trades involving nonpoint sources, both a *Trade Notification Form* and a *Reduction Credit Certificate* must be submitted by the point source to certify the nonpoint source reduction and generate a credit against the point source's discharge amount. The Co-op will maintain a trade tracking database as well as individual trade and account information and produce a *Monthly Trade Report* for each source.

Managing transaction and market risk in the Lower Boise market—The Lower Boise market will manage the transaction and market risks associated with WQT through its trading framework and private contracts. The market mitigates the risk that specific transactions will not be recognized by regulatory authorities by including in the market driver (applicable TMDLs and implementation plans), as well as the regulatory mechanism (NPDES permits), and the state trading document, the explicit requirements for defining marketable reductions and their proper

conveyance to other sources. This information is publicly available, so buyers and sellers of reductions jointly assume the risk that the paperwork documenting their transaction is proper and filed with the required entities.

A defining feature of the Lower Boise market is how it manages the risk that an agreed upon reduction will not be achieved. Water quality regulatory agencies in the Lower Boise have limited or no authority over nonpoint sources' discharge behavior. Although nonpoint sources are issued load allocations by the TMDL, they are not issued NPDES (or state equivalent) permits that create CWA regulatory liability. Nonpoint sources involved in creating the market wanted to maintain their independence from CWA regulatory liability and still be allowed to participate in the market. Faced with supporting point source trading while maintaining regulatory independence for nonpoint sources, market designers decided that CWA liability would reside with NPDES permit holders, while the liability for failing to produce purchased credits would be handled, particularly in the case of nonpoint source trades, through private contracts between sources.

In the Lower Boise WQT market, trading parties agree on the specific terms of a trade by entering into a private contract that identifies the trading parties, reduction measures to be undertaken, reduction amounts to be achieved, effective date, responsibilities of each party, price and payment provisions, and remedies for failure to deliver reductions. Although private contracts cannot shift regulatory liability from one source to another, they can assign the financial liability of regulatory non-compliance to the seller of pollutant reductions. Subject to applicable contract law, the parties to the trade can decide between them who will pay for damages in the event reductions are not delivered and the purchasing source is consequently found to be violating its NPDES permit.

Private contracts in the Lower Boise allow parties to the trade to decide how great they believe the risks of the trade are and who will bear them. Writing the contract may require legal assistance, which may be relatively expensive for some nonpoint sources. It is important to remember that the contract terms used to manage risk will be based on the buyer's and seller's ***perceived*** risk. High perceived risk may result in large price discounts and erode the financial attractiveness of trading.

Providing information to the public and facilitating their participation—The public participation mechanism in the Lower Boise relies on transparency in the Co-op's activities and in the issuance of relevant NPDES permits. This is extremely important because pre-approved, dynamic trading in the Lower Boise requires market designers to generate and maintain trust from non-discharging stakeholders and also satisfy CWA public notice and comment procedures. A point source wanting to trade remains subject to the standard NPDES permitting process. The usual CWA public notice and comment procedures will give stakeholders the opportunity to learn about and participate in the consideration of issues surrounding market participation by a specific source.

The Co-op will be responsible for making transaction information accessible to the public. The marginal cost of providing the information—whether on demand or published at regular intervals—will be minimal, as the trade tracking database already manages the information likely to be requested. In the Lower Boise, non-discharging stakeholders have a forum to question and influence the permitted discharge limits and then easy access to information keeping them informed of actual discharge behavior.

A Public Authority Banking and Managing Phosphorus Credits with Case-By-Case Approval of Credit Use

In 1985, the Cherry Creek Basin Water Quality Master Plan was created to manage development's environmental impact on the Cherry Creek Reservoir in Colorado. In the basin, point source and nonpoint source nutrient discharges cause eutrophication problems that preclude attainment of the reservoir's designated uses. Rapid economic development in the area was forecasted to strain the ability of local POTWs to serve the burgeoning population without further degrading water quality in Cherry Creek Reservoir. As dischargers of predominantly soluble phosphorus, which is readily available biologically and promotes rapid algal growth, seven utility districts operating POTWs were challenged to limit their phosphorus contribution to the Cherry Creek Reservoir. A Total Maximum Daily Load was developed for phosphorus discharged into the reservoir, and the wastewater facilities received a total allocation of 2,310 pounds per year.

Two counties, four cities, and the seven utility districts reached an intergovernmental agreement chartering a state empowered government entity, the Cherry Creek Basin Water Quality Authority (the Authority), to develop and administer a water quality trading program facilitating continued economic growth while minimizing adverse impact on water quality in the reservoir. Although a pilot trading program has been in place for several years, few trades have been completed. Recently, an effort has been made to elicit more market activity. The Authority has been charged with designing a market in which POTWs and other point source dischargers would be able to purchase credits included in the POTWs' 2,310 pound phosphorus allocation while funding new phosphorus reduction projects. These credits may increase an individual point source's wasteload allocation and allow it to expand its services to new developments, which would otherwise cause the POTW to exceed its wasteload allocation. The trading market requires POTWs to fund phosphorus removal projects in exchange for an allocation of additional phosphorus discharge.

In the Cherry Creek market, the Authority manages two sources of credits for use by POTWs, a Phosphorus Bank and a Reserve Pool. The Authority functions as a phosphorus reduction bank by owning and allocating purchasable phosphorus credits associated with four nonpoint source phosphorus control projects built by the Authority in the 1990s. These projects have reduced the net amount of phosphorus discharged, creating additional loading capacity in the reservoir. The credits from these projects have been placed in the Phosphorus Bank from which POTWs may draw credits to meet their regulatory obligations. A total of 216 annual pounds of phosphorus credits were allocated to the Phosphorus Bank by the TMDL.

The control technologies used in the Phosphorus Bank nonpoint source projects include retention/detention ponds, constructed wetlands, and shoreline stabilization above and beyond required BMPs, leading to phosphorus discharge reductions that can offset discharges from a POTW. The Authority has control over these credits and decides who may purchase them. Funds raised from the sale of the credits will be used by the Authority to fund additional projects to further improve water quality.

The Authority also manages an additional 216 pounds of phosphorus credits generated by other parties. These allowances give POTWs the right to purchase reductions from non-Authority phosphorus reduction projects and receive an increased WLA. The TMDL allocated these credits to a Reserve Pool. POTWs wanting to increase their phosphorus allocation may construct

projects and/or compensate third-party landowners, local governments, or other POTWs to do so for them.[9] Credits tied to these reductions enable the Authority to transfer a portion of the Reserve Pool phosphorus allocation to POTWs. A phosphorus reduction project will be evaluated by the Authority before a specific agreement is reached to use the credits. The total number of credit allowances third-party projects may generate for redistribution to the POTWs is currently capped at 216 pounds annually.

Important Market Functions in the Cherry Creek Basin

Defining marketable reductions—Marketable reductions in the Cherry Creek market are defined as reductions accruing from the implementation of control technologies in excess of those expected from the Mandatory Best Management Practices identified in the Cherry Creek Reservoir Control Regulations. Mandatory BMPs include temporary measures implemented to mitigate construction runoff (e.g., filter fences, re-vegetation, and hay bales) and/or permanent water quality improvements required by drainage criteria and land use regulations for all new development (i.e., detention ponds, swales, and constructed wetlands).[10]

The Reserve Pool marketable reductions evolve from one of six different types of projects.

- **BMPs added to Existing Development**—Phosphorus removals from BMPs not completed during land development prior to January 1, 2000 are eligible for trading.
- **Expanded or Retrofitted BMPs**—Phosphorus removals from BMPs that are added to land development undertaken prior to January 1, 2000 that result in additional reductions are eligible for trading.
- **Projects Beyond Required BMPs**—Phosphorus removals from BMPs that result in reductions in excess of the removals from required BMPs are eligible for trading.
- **Cooperative Authority Projects**—Phosphorus removals from Authority and third party co-development projects are eligible for trading. Credits placed in the Reserve Pool will be limited to the proportion constructed or funded by the third party.
- **Engineered Authority Projects**—Phosphorus removals from any nonpoint source project for which the Authority completes preliminary engineering and design and which the Authority agrees to third party construction of that project are eligible for trading.
- **Water Supply Operations**—Phosphorus removals beyond the incidental reductions from regular, normal operations are eligible for trading.

Not every pound of phosphorus overcontrol from a project may be associated with credit allowances in the Reserve Pool. A project specific "Trade Ratio" is applied to calculate the proportion of phosphorus reduction that results in credit allowances recognized by the Authority and the regulatory agencies.

Defining and executing the trading process—Similar to other trading programs, the Cherry Creek Authority and stakeholders have developed a trading framework clearly defining the roles and responsibilities of all parties (the buyer, the seller, and the Authority) in reviewing reduction projects and trades and administering the allocations of credits. Program evaluations have identified the following five steps for executing trades.

[9] A more detailed description of these projects is provided below.
[10] *Phosphorus Credit Trading in the Cherry Creek Basin: An Innovative Approach to Achieving Water Quality Benefits.* Water Environment Research Foundation. Project 97-IRM-5A. 2000.

1. **Project Evaluation and Approval**—Authority constructed phosphorus reduction projects have already been evaluated and their credits placed in the Phosphorus Bank. Interested parties may nominate other projects for consideration by the Authority for inclusion in the Reserve Pool. The technical specifications of the project, the estimated pollutant reductions, reliability of the project operations, comments from Colorado's Water Quality Control Division, consistency with the Master Plan, trading guidelines, and control regulations, and the effect on water quality are all considered by the Authority. Other stakeholders may contribute input at a public meeting. The Authority's Board of Directors votes to recognize the validity of the phosphorus reductions.
2. **Credit Calculation**—After voting to include reductions in the Reserve Pool, the Authority's Board of Directors determines the amount of credit allowances that will be associated with the project based on projected reductions and a project-specific trading ratio.
3. **Credit Allocation**—Point sources seeking to adjust their permitted discharge limits may apply to acquire phosphorus credits from the Phosphorus Bank or credit allowances from the Reserve Pool. Trades are reviewed based on the buyer's history of regulatory compliance and operating abilities, as well as the trade's conformance to the Master Plan and control regulations. Potential Sale Credit applicants are also reviewed based on their "need" as defined by the Authority. A Technical Advisory Team reviews all trades and makes recommendations to the Authority Board of Directors. The Board then approves or disapproves each specific trade.
4. **Trade Review**—After a transaction is completed, the Authority retains the right and obligation to review reduction performance and periodically adjust the number of credits or credit allowances awarded to point sources based on actual reduction performance.
5. **NPDES Permitting**—Prior to discharging phosphorus in excess of its existing NPDES permit, the credit or credit allowance purchaser must be issued a new or modified permit.

The trading guidelines used in the Cherry Creek market provide all participants with a clear understanding of what's expected of market participants. Transaction costs are likely to be relatively known prior to initiating a trade, as the information needed and the process used to evaluate a trade are well defined. Market participants are also likely to understand the transaction costs associated with the permitting process.

Ensuring water quality equivalence and avoiding hotspots—The focus of water quality trading in this market is to maintain the condition of the Cherry Creek Reservoir, not to address water quality within specific stretches of rivers or tributaries. Water quality equivalence is therefore confined to the effect each sources' individual discharge has on the concentration of phosphorus in the reservoir.

Each Reserve Pool transaction receives a trade ratio, which translates phosphorus reductions into credit allowances, set between a minimum of 2-to-1 and a maximum of 3-to-1. The trade ratio varies based on the relative load of soluble and non-soluble phosphorus between the two parties and/or the attenuation of discharged phosphorus as it moves through the watershed. For example, the ratio may be increased when the credit allowance buyer is closer to the reservoir than the credit producer to avoid localized impacts in the intervening reach and ensure an equivalent reduction in the reservoir. Ratios are based on site-specific monitoring data, empirical modeling, and/or best available scientific evidence

Communicating between buyers and sellers—Use of this market model influences the transaction costs associated with trading partner identification, product comparison, and deal negotiation and their effect on market efficiency. All available credits or credit allowances are held or managed by the Authority. Buyers do not have to contact several potential trading partners to find a mutually beneficial deal. This market model can limit interactions between certain buyers and sellers. The Authority explicitly identifies and selects trading partners allowed into the market by placing reductions from specific projects into the Phosphorus Bank and allowing certain buyers, based on Authority-defined "need," to apply for the right to buy the credits. For the Reserve Pool, the Authority only approves or disapproves the transfer of credit allowances for individual transactions. The Authority has limited justifications for stopping a transaction. As such, participation in the Reserve Pool segment of the market is not limited.

The Authority manages product comparison for Phosphorus Bank reductions by quantifying them, applying a project-specific trade ratio, and establishing the price of credits. For these reductions, the authority sets the terms of the trade based on the Authority's costs of building, operating, and monitoring current and future phosphorus reduction projects, as well as the costs of establishing and administering the trading market. The Authority also manages product comparison for Reserve Pool trades by quantifying available credit allowances based on the trade ratio. However, the Authority does not price these allowances; price is negotiated by the parties to the trade.

Tracking Trades—The Authority is in a unique position to track trading activity because it plays an active role in all transactions. In addition, trades are considered to last in perpetuity, limiting the number of actual transactions that will take place during any given period. It is anticipated that the Authority will develop a trade tracking system as trading activity increases. Most likely, a spreadsheet managed by the Authority will be used to ensure that reductions and their associated credits or credit allowances are traded to other sources only once. Trades approved by the Authority are documented in Appendix A of the Cherry Creek Water Quality Authority Trading Program Guidelines.

Assuring compliance with the CWA and regulations in Cherry Creek Basin—Although the Authority administers the transfer of credits and credit allowances in the Cherry Creek water quality market, transactions do not *automatically* alter a source's obligations to federal, state, or local water quality regulations. In this watershed, Colorado's Water Quality Control Division (WQCD) is responsible for administering NPDES permits. The WQCD does not acknowledge Phosphorus Bank or Reserve Pool credits as immediately off-setting the phosphorus discharge limit in the source's NPDES permit limit.

As stated in the Trading Guidelines, "It shall be the sole responsibility of the (credit buyer) to obtain any approvals or modifications to their discharge permits necessary to allow increased or modified phosphorus discharges." Therefore, a source wishing to use 10 pounds of credits must go through the normal permit modification process. Sources purchasing credits must work with the WQCD to amend their NPDES permit limits prior to discharging phosphorus at increased levels. Monitoring and reporting protocols are detailed in their individual NPDES permits.

Managing transaction and market risk in the Cherry Creek Market—As is typical of water quality banks, Phosphorus Bank credits are made up of credits from various projects co-mingled together. A quantity of credits sold out of the Phosphorus Bank likely includes reductions from several projects that have different risks associated with them. The Cherry Creek market model

both actively and passively manages the risk that reductions do not conform to market rules, the risk that specific reductions fail to materialize, and the risk that reductions fail to have the required impact on water quality.

The Cherry Creek Authority is delegated the responsibility of evaluating and allocating credits by the regulatory and administrative agencies responsible for watershed oversight. The Authority, a water quality bank operated as a quasi-government entity, plays an active role in defining marketable reductions. For both Phosphorus Bank and Reserve Pool transactions, the Authority is only allowed to allocate credits if reductions conform to market rules. Therefore, the Authority manages the buyer's risk of purchasing non-marketable reductions by acting as a certifier of credits.

The Authority's certification role also helps manage the risk that the credits purchased by the buyer do not reflect actual phosphorus overcontrol. The rigorous certification of reductions during project approval coupled with the trade ratio creates a safety margin for each credit. In addition, if phosphorus reduction projects begin to perform poorly, the Authority may revoke or adjust the number of credits downward. For Phosphorus Bank credits, if re-evaluation results in lowering the reductions achieved (and therefore the credits), the Authority relies on surplus credits in the trading pool that have not been allocated and sold to other sources to make up the difference. If there are insufficient surplus credits in the Phosphorus Bank, the Authority notifies all Phosphorus Bank credit holders that their credits have been reduced on a pro-rata basis for three years. If additional credits become available from the Phosphorus Bank during those three years, credits will be restored. After three years, the credit reductions are permanent.

Transaction risk for Reserve Pool transactions, where the credit allowances are merely "warehoused" by the Authority until a private deal is struck, is not as actively managed by the Authority. The Authority also certifies these credit allowances. However, purchasers of Reserve Pool credits cannot be awarded the credits if negotiated reductions fail to materialize. They must negotiate another trade and pay for additional credits.

Providing information to the public and other stakeholders—The ongoing public participation mechanism in Cherry Creek relies on standard public notice and comment procedures used for NPDES permits. In the Cherry Creek market, non-discharging stakeholders have opportunities to play an active role in trading activity, including open forums to question and influence project evaluation, credit allocation, and permit modification. For project evaluation and allocation, the Authority is required to issue a public notice of its intent to review specific proposals and hold a public hearing. A similar procedure is used during permit modification.

The Authority is responsible for making transaction information accessible to the public. The marginal cost of providing the information—whether on demand or published at regular intervals—will likely be minimal as the Authority already possesses or generates all the pertinent information. Trades approved by the Authority are documented in Appendix A of the Cherry Creek Water Quality Authority Trading Program Guidelines.

A State-Managed Nitrogen Credit Exchange

In 1990, Connecticut, the State of New York, and EPA adopted a Comprehensive Conservation and Management Plan (CCMP) for the Long Island Sound. The CCMP calls for the reduction of

nitrogen to increase dissolved oxygen in Long Island Sound and mitigate hypoxia damaging the Sound's ecosystem. The CCMP was designed to reduce the total enriched nitrogen load coming from point and nonpoint sources by 58.5 percent between 2000 and 2015. A TMDL, approved in April 2001, includes wasteload allocations for point sources and load allocations for nonpoint sources in the watershed. Connecticut chose to develop a trading program for contributing point sources within its borders to lower the cost of implementing the CCMP and the TMDL.

The main mechanism facilitating trading in Connecticut is a general, or watershed, permit. Connecticut's program uses both its general state authority and its NPDES permitting authority to issue a single general permit for the total nitrogen discharges of 79 wastewater treatment plants (most of which are POTWs). Facilities can opt out of the general permit and receive a traditional NPDES permit and implementation schedule. However, all facilities have chosen to take advantage of trading under the general permit. The general permit sets a cap for total annual nitrogen discharges from all facilities at 2000 levels, and reduces the total nitrogen discharges allowed in each year between 2000 and 2015 on a percentage basis. Individual point sources under the permit (called sub-dischargers) are required to lower their proportional share of the annual percentage reduction based on their discharge in 2000.

Market designers faced a number of challenges. The Connecticut market area is predominantly urban, with few opportunities for low-cost nonpoint source controls. To achieve the 58.5 percent nitrogen reduction from all identifiable sources, 79 wastewater treatment plants (WWTPs) located within the watershed were tasked with lowering their nitrogen discharge by 64 percent from 2000 baseline levels. Other challenges involved the proximity to the hypoxia zone of certain dischargers in western Connecticut compared to their eastern counterparts, and the state's previous efforts to fund nutrient removal projects at WWTPs near Long Island Sound. Western Connecticut had been the focus of pre-trading nitrogen removal grants. Market designers felt that market models used in other pilot projects might lead to inequities across the regulated communities, as affluent western communities would likely be able to generate marketable reductions by relying on previously installed control technology.

The trading program that evolved is described as a "Nitrogen Credit Exchange." Sources discharging less than their annual limit receive credits for overcontrol. The Connecticut Department of Environmental Protection (CTDEP) is obligated by state law, enacted specifically to implement the Exchange, to purchase all nitrogen credits from these sources. Facilities that exceed their limit must purchase nitrogen credits from CTDEP to meet compliance obligations. CTDEP is obligated by state law to sell the credits it purchases from overcontollers to facilities that under-control their discharge.

Important Market Functions of the Connecticut Nitrogen Credit Exchange

Defining marketable reductions—Marketable reductions in the Nitrogen Credit Exchange are defined as reductions in excess of a facility's total nitrogen permit obligations for each calendar year. As described in the February 2003 *General Permit for Nitrogen Discharges and Nitrogen Credit Exchange Program*, by March 31 of each year, the Nitrogen Credit Exchange (NCE) and the CTDEP compile the calendar year monitoring data for each individual source. The average nitrogen discharge for each month is calculated and the end-of-pipe surplus or deficit is reported as a yearly average. Credits are generated when the actual, sampled yearly average load of total nitrogen is less than the annual discharge limit. A Nitrogen Equivalency Factor, based on a source's contribution of nitrogen to the hypoxia zone in Long Island Sound, is then applied to

calculate the number of credits that the NCE buys from that source. Appendix 1 of the general permit provides a schedule of each sub-discharger's individual Annual Discharge Limit for total nitrogen as well as a Nitrogen Equivalency Factor.

Defining and executing the trading process—Unlike the other two models discussed in this section, Connecticut's trading process is stipulated in state law. Public Act No. 01-180 describes the processes used to transfer marketable reductions from WWTPs achieving overcontrol to WWTPs out of compliance with their NPDES permit.

Trading in this market is executed through a multi-step process completed on an annual basis. The first step is the setting of the annual discharge limits in the general permit. These limits, set by the Nitrogen Credit Exchange Board, are based on a 2000 baseline for each WWTP, reduction goals ensuring consistency with the TMDL by 2015, and the projected nitrogen reductions to be achieved by control projects likely to be operating during the year. The annual limits require each WWTP to attain an equal percentage reduction from its 2000 baseline. WWTPs monitor and report their discharge throughout the ensuing year pursuant to language in the general permit.

WWTPs unable to meet their new limits may elect to install nitrogen control technology. Grant and loan funding for control projects is available on a competitive basis through the Connecticut Clean Water Fund. WWTPs that do not directly reduce their discharges must purchase credits from the NCE at the end of the year.

At the end of the year, the Nitrogen Credit Exchange Board, in conjunction with the CTDEP, analyzes the discharge for individual WWTPs for compliance with the annual permit limit. This analysis includes the calculation of credits produced by dischargers able to overcontrol and the number of credits needed by WWTPs failing to meet their limits. The Equivalency Factor translates the overcontrol into credits automatically purchased by the NCE, and the under-control into credits that a WWTP must buy from the NCE.

The NCE Board then calculates the price of credits for both buyers and sellers. The dollar value of credits is determined annually, based on the average capital and operating costs of all nitrogen removal projects operating during that year and the total reductions achieved by those projects during that year. This is the uniform price (per pound of total nitrogen) that buyers of credits are charged or sellers of credits receive. Those WWTPs exceeding compliance with their annual limit receive a check for their credits. Those WWTPs that have not met their annual limit receive a bill for the total cost of all credits that would bring them into alignment with the general permit.

Ensuring water quality equivalence and avoiding hotspots—The focus of water quality trading in this market is to attain the designated uses of Long Island Sound. Thus, water quality equivalence factors were established to equate the impacts on the Long Island Sound hypoxia zone from discharges (and load reductions) at different locations throughout the state. A peer-reviewed water quality model was developed to delineate the impact that nitrogen discharges in the large area covered by the TMDL have on oxygen concentrations in the hypoxia zone. The model identified six different impact zones closely aligned with the major watersheds or basins in the state. Some zones were further broken down into tiers to account for attenuation in rivers flowing into the Sound. Based on this analysis each WWTP was assigned an equivalency factor that could be used to relate their impact to the impact of any other facility and to the zone of concern in Long Island Sound. For example, a WWTP located on the Sound close to the hypoxia zone would have a factor of 1.0 (no pollutant attenuation) while a WWTP located far up river in

the eastern part of the state would have a factor of .18 (only about 18% of nitrogen loads or reductions reach the zone of concern).

To avoid localized impacts, each WWTP continues to retain an individual permit limit for all pollutants other than total nitrogen. This includes individual permit limits for ammonia nitrogen designed to protect local receiving waters from ammonia toxicity. Regardless of the number of total nitrogen credits a plant uses from the Exchange, it must meet its individual ammonia limits and all other individual pollutant limits.

Communicating between buyers and sellers—The Connecticut water quality trading model does not promote contact between individual dischargers. The NCE manages the transaction costs that would otherwise be associated with trading partner identification, product comparison, and deal negotiation because redistribution of the cost of nitrogen control is handled exclusively by the NCE as it carries out its statutory responsibilities. As previously discussed, the NCE gathers information from regulated dischargers, rewards WWTPs for overcontrolling, and charges others that have not achieved their annual limits. This results in redistributing the cost of overcontrolling nitrogen between the two groups.

Tracking Trades—NCE administrators need three sets of information to facilitate and track trades—discharge loadings from each WWTP, nitrogen reductions achieved by control projects, and the cost of those control projects. In this program, trading is an annual process. By March 31 of each year, the NCEP notifies each individual facility regarding their credit balance. After the credit checks and bills are paid or redeemed, the books are "closed" for that year and the process begins again.

Assuring compliance with the CWA and regulations in the Connecticut Market—Trading in the Connecticut NCE takes place within the framework of the general permit, which regulates the annual discharge of total nitrogen. The aggregated general permit discharge limit is lowered each year to ensure steady progress towards full implementation of the TMDL in 2015 as well as providing a buffer in case total reductions achieved fall below those anticipated in the annual allocation. Each individual discharger is issued a permit limit incorporating the annual reduction of the aggregated general permit.

Trades are based on actual, sampled discharge performance. Monitoring and reporting protocols for point source discharge are set out in the general permit and follow standard NPDES monitoring and reporting mechanisms. Sampling frequency and procedures are based on the volume treated by the WWTP on a daily basis. The collected chemical analysis samples are entered into a Nitrogen Analysis Report and Monthly Operating Report and submitted to the CTDEP. In addition, each WWTP calculates a monthly mass loading of total nitrogen and submits it to the CTDEP in a Discharge Monitoring Report. Each WWTP is also responsible for retaining a copy of all reports submitted to CTDEP as well as the data used to generate those reports for at least five years.

WWTPs failing to meet their permit limits must purchase credits from the NCE by July 31st of each year for their previous year's discharge. Failure to purchase credits by this date results in non-compliance and opens the WWTP to enforcement actions by the CTDEP.

Managing transaction and market risk among parties in the Nitrogen Credit Exchange— Credits are based on the level of nitrogen discharged during the year compared with the permit

limit and can only be generated by WWTPs subject to the general permit. The authorizing legislation (Public Act No. 01-180), the general permit, and CTDEP publications clearly describe the process used to create the annual permitted limit, calculate discharge, and the analysis used to compute the surplus or deficit of credits. Nitrogen credits are only available from the NCE, making the program the de facto certifier of credits and eliminating the risk of purchasing non-marketable reductions.

The Connecticut Nitrogen Exchange executes trading at the end of the year, when actual discharge volumes and amount of over- or under-control are known. The NCE is obligated by state law to sell all the credits needed by all sources to meet their regulatory obligation under the general permit. This statutory requirement eliminates the risk to individual dischargers that specific credits will fail to materialize, regardless of the actual supply that year.

There are two market risks inherent in this model. The first is the risk that during the year the WWTPs, in aggregate, will create more credits than are needed to offset the WWTPs that fail to meet their annual limits. Since the NCE is obligated by law to purchase all credits and is unable to sell them to other sources, the NCE annually runs the risk of subsidizing the surplus overcontrol. For example in 2002, the NCE purchased $2,757,323 worth of credits from 39 dischargers. The program sold $1,317,233 worth of credits. The $1,440,110 difference was paid for by NCE funds.

The second market risk is that during the year the WWTPs, in aggregate, may fail to create the number of credits needed by other WWTPs. In years when the demand for credits is larger than the supply, the NCE receives a net infusion of cash because all sources must purchase the necessary credits. This infusion of cash is intended to pay off any deficits from previous years when there is a credit surplus. In either case, the aggregate annual limit may be adjusted in light of the previous year's deficit or surplus and the projected control to be completed during the year. This helps manage the annual deficits and surpluses, both in terms of nitrogen control and funding, while continuing to implement reductions under the TMDL.

Finally, the market manages the risk that reductions generated and traded in the market will not achieve the designated uses of the waterbody by providing for periodic review of both the TMDL and the general permit allocations. The TMDL includes a periodic review schedule, during which the TMDL allocations may be modified up or down. In turn, a change in the TMDL allocation could result in a modification of the annual allocations in the general permit.

Providing information to the public and other stakeholders—The on-going public participation mechanism in Connecticut relies on traditional public notice and comment procedures used for NPDES permits. The NCE is operated within the framework of the general permit, providing the opportunity for public comment for the permit when it was issued and when it is renewed.

In addition, the NCE annually produces a publication listing the price of nitrogen credits as calculated by the NCE Board. Included with the report is a *Long Island Sound Total Nitrogen Credit Exchange Final Balance* detailing the dollar value of the credits bought by the NCEP from WWTPs discharging less than their annual limit as well as the dollar value of credits to be purchased by facilities exceeding their annual limit.

Summary

This section illustrates the core functions that water quality trading markets must serve and reviews different approaches employed by three different market models. This range of approaches is presented to stimulate your thinking on possible market infrastructures that could be adapted to your watershed. All water quality trading markets share a common set of necessary functions. At the same time, the market examples make it clear that how these functions are addressed can vary substantially. Developing your market may involve borrowing approaches from one or more existing market models but will also be heavily influenced by the state regulatory agency and consultation with affected stakeholders. Assessing stakeholder readiness for water quality trading, and engaging stakeholder interests, is the subject of the next chapter