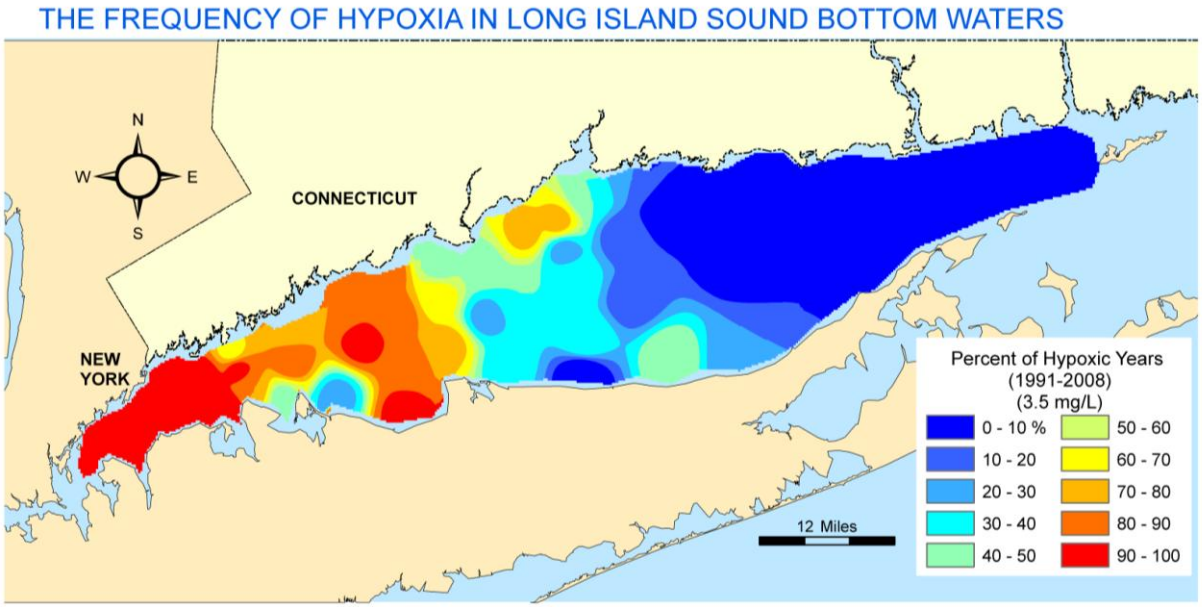
Connecticut's Nitrogen Credit Exchange – An Incentive-based Water Quality Trading Program



The Connecticut Department of Environmental Protection
Bureau of Water Protection and Land Reuse
Hartford, CT

Connecticut's Nitrogen Credit Exchange

A. Introduction

The Connecticut Department of Environmental Protection (CTDEP) has been actively involved in the operation of Connecticut's Nitrogen Credit Exchange (NCE) since 2002. During the 2002-2009 period the total value of credits bought and sold was $45.9 million, representing 15.5 million nitrogen credits exchanged. It is one of the few expansive water quality credit trading programs successfully implemented in the United States. The program has provided an alternative compliance mechanism for publicly owned treatment works (POTW) to meet the nitrogen wasteload allocation (WLA) for the Total Maximum Daily Load (TMDL) adopted for Long Island Sound.

The program provides an alternative compliance mechanism for 79 POTWs located throughout the state, and is completing its eighth annual credit exchange based on 2009 operations. The program is an incentive-based approach, enabled through legislation passed by the Connecticut General Assembly in 2001, organized under the authority of a State Of Connecticut general permit for nitrogen (NGP), and overseen by an independent Nitrogen Credit Advisory Board (NCAB), which represents both state agencies and the participating municipal interests.

The NCE has proven to be a flexible, cost-effective approach for meeting the WLA under an accelerated schedule, and its structure has demonstrated capability with minimal administrative burden. It provides one of the few mature examples of water quality credit trading with a successful track record. Further, it has promoted economic, policy and regulatory understanding of how water quality trading can work, serving as a model for EPA policy and other water quality trading programs. In recognition of the NCE success, EPA awarded its first Blue Ribbon for Water Quality Trading to the Connecticut program in 2007.

B. Environmental Improvement

The Long Island Sound Study (LISS) through its Comprehensive Conservation and Management Plan (CCMP) identified Long Island Sound's most pressing environmental problems as: 1) low dissolved oxygen or "hypoxia", 2) toxic contamination, 3) pathogen contamination, 4) floatable debris, 5) the impact of those water quality problems and habitat degradation on the health of living resources, and 6) land use and development resulting in habitat loss and degradation of water quality.

Hypoxia is a problem whose significance had not been previously recognized in Long Island Sound. As a result, little management attention had been directed towards its control. Large areas, often more than half, of the Sound's 1300 mi^2 of bottom waters are impacted during the late summer hypoxic period, rendering them unsuitable for healthy fish and other living resources. Monitoring over the past 20 years has shown that the most severe hypoxic conditions of less than 3 mg of dissolved oxygen per liter affect 200 mi^2 of bottom waters for an average period of almost two months.

LISS research and computer modeling efforts have linked the problem to excess loading of a nutrient - nitrogen - to the system. Nitrogen stimulates the growth of microscopic algae that are either consumed, passing through larger zooplankton and fish, or die, ultimately sinking to the bottom of Long Island Sound as animal waste and dead algae, where they undergo microbial decay. During decay, oxygen is consumed. Because Long Island Sound is stratified during the summer, bottom water oxygen replenishment is limited. The oxygen consumption from microbial respiration far exceeds oxygen replenishment from photosynthesis and wave action resulting in the severe hypoxic conditions.

A large share of the anthropogenic nitrogen entering LIS is discharged by the many POTWs located along the coast and throughout the drainage basin, which extends north into Canada. In the joint total maximum daily load analysis (TMDL) approved in 2001 Connecticut and New York agreed to reduce their collective load of nitrogen to Long Island Sound by 58.5% by the year 2014. The Connecticut Department of Environmental Protection (CTDEP) has a strong commitment to implement the plan adopted in the TMDL. The plan builds upon the programs and longstanding commitments Connecticut has to clean up and protect Long Island Sound. Full implementation of the TMDL is expected to achieve compliance with state water quality standards for dissolved oxygen, restoring the sound to a healthy condition.

C. Anticipated Economic Benefits

To facilitate nitrogen control from point sources, primarily POTWs, Connecticut evaluated the use of water pollutant trading through a Nitrogen Credit Exchange (NCE). The LISS had invested considerable effort scoping the potential for trading as a means to accelerate nitrogen removal and to save money. There have also been studies specific to Long Island Sound that have identified significant potential for cost savings while reducing the regulatory oversight that would be required if each POTW were permitted individually. Further, trading gives each member municipality the ability to make fiscally responsible decisions about whether to upgrade and market credits or to buy credits to meet their permit limit based on estimated incremental costs for credits compared to treatment.

The economic record of the NCE demonstrates the vigor of trading over the seven years of completed trades from 2002-2009 (Table 1). In sum, 15.5 million credits have been traded on the NCE representing $45.9 million in economic activity.

Table 1. Performance of the NCE, 2002-2009.

Trading Year	Credit Price (Dollars)	Purchased (Dollars)	Sold (Dollars)	Purchased (1000 Credits)	Sold (1000 Credits)
2002	$1.65	$1,317,223	$2,357,323	798	1,429
2003	$2.14	$2,116,875	$2,428,636	989	1,135
2004	$1.90	$1,786,736	$2,659,804	940	1,400
2005	$2.11	$2,467,757	$1,315,392	1,170	623
2006	$3.40	$3,828,114	$2,394,956	1,126	704
2007	$4.36	$5,159,019	$2,072,001	1,183	475
2008	$4.50	$6,148,327	$2,660,688	1,366	591
2009	$4.54	$4,390,023	$2,835,447	967	625
Total		$27,214,074	$18,724,247	8,539	6,982

The use of geographically-based trading ratios is instrumental to the relative cost of meeting nitrogen reduction limits at the 79 treatment plants, which are scattered throughout the state (Figure 1). Because nitrogen is non-conservative as it travels down rivers into the Sound, and the Sound's currents further affect relative impacts as they transport nitrogen, and the resulting algal blooms, to the hypoxic areas at varying efficiencies, location of each treatment plant makes a difference in relative impact on dissolved oxygen per pound of nitrogen discharged at end of pipe.

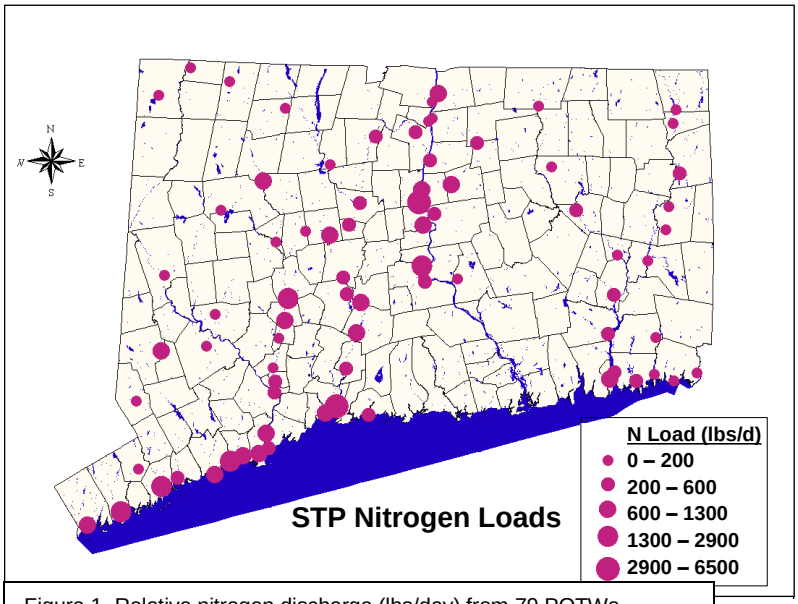


Figure 1. Relative nitrogen discharge (lbs/day) from 79 POTWs.

Generally, the closer a POTW is to the edge of the Sound, and the closer to the hypoxic zone, the higher the trading ratio (Figure 2). For plants with high trading ratios, economics often favor treatment, while those with lower ratios may find the purchase of credits economically advantageous over treatment.

Further, there are economies of scale, i.e., larger POTWs (Figure 1) often can remove nitrogen at a lower per pound cost than smaller facilities. Municipal Water Pollution Control Authorities (WPCA) can fully consider both location and cost when planning, and scheduling, potential nitrogen removal projects. The prices of nitrogen credits have been low (ranging from $1.65 - $4.50 per equalized credit (Table 1)) but are expected to continue to increase over time as the lowest-cost projects are completed first. Because of the inevitable increase in credit costs, decisions on treating vs. trading are re-evaluated on an annual basis by WPCAs.

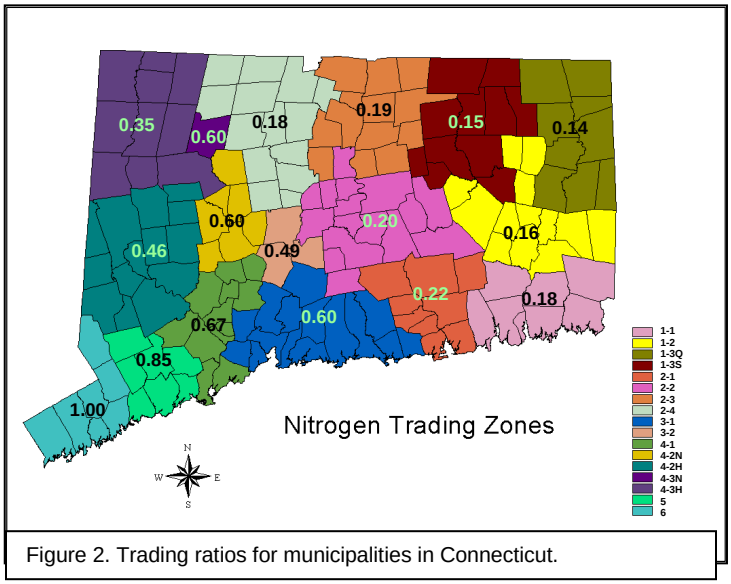


Figure 2. Trading ratios for municipalities in Connecticut.

A considerable amount of public financing goes into reconstruction and upgrades of municipal facilities by a combination of grants and low-interest loans. All the facilities are on equal terms regarding financing from Connecticut's state and federally funded revolving loan program, the Clean Water Fund (CWF). However, competition for the funds through a priority-setting process is often high. Willingness to institute nitrogen removal does add points to the scoring process and can move a POTW's project higher on the priority list.

Since 1993, the CWF has financed more than $300 million for the nitrogen removal portion of facility improvements at more than 40 POTWs. These projects represent about 8.5 million pounds of nitrogen removed from the aggregate wastestream annually as of 2009. It is anticipated that total nitrogen removal project costs will be in the area of $800 million to meet the 2014 wasteload allocation specified in the TMDL for Connecticut. While estimates of cost savings vary and are affected by a range of environmental and operational cost conditions that will not be fully known until the job is completed, it is estimated that trading through the NCE will have saved $300 - $400 million over the alternative of implementing nitrogen removal projects at all 79 facilities listed in the NGP.

While some savings are clearly an accidental result of POTW distribution and the effect of trading ratios, the nitrogen trading program also allows flexibility in meeting permit limits as an alternative form of compliance. If all 79 POTWs were required to design their facilities to meet their individual wasteload allocation at all times, there would be a tendency to over engineer to meet those limits under the most extreme conditions. With trading, they can decide upon a level of treatment appropriate to their facility, which could range from a low-cost retrofit to a state of the art biological nitrogen removal facility. They are also able to design towards average operational goals and optimal costs. Should an individual plant undergo short-term operational problems and under perform with respect to nitrogen removal, the combined benefit of the reductions from the other 78 facilities would compensate, providing a safety buffer. The aggregate, statewide wasteload allocation would still be met because an individual plant's performance does not dominate the statewide performance statistics in aggregate, virtually eliminating the risk of permit non-compliance. This helps keep both capital and operational costs optimal.

D. Operations of the Nitrogen Credit Exchange

The state is required to purchase all equivalent nitrogen credits created by at the annually established value. When there is a surplus of credits, i.e., the aggregate performance of the 79 POTWs is better than the aggregate nitrogen limit in the NGP, excess payments are drawn from Connecticut's Clean Water Fund. Those credits become the property of the State. Although the enabling legislation for the NCE allows for their sale to alternative markets such as Connecticut industries or facilities in New York, that option has not been used to date. During the first three years of nitrogen trading (2002-2004), there were combined surpluses of about $2 million that were written off to environmental benefit. Those payments went to POTWs that are required to use the funds to maintain and enhance their nitrogen removal processes and capacity.

For a variety of reasons, partially related to weather and construction schedules, but primarily caused by the ramping down of permit limits for nitrogen each year to keep performance moving ahead, the aggregate performance from 2005 through 2009 did not meet aggregate permit limits, i.e., the NCE took in more money from sale of credits than was disbursed for purchases (Table 1 and Figure 3). The implementation structure of the NCE anticipated that performance would fluctuate around the annual permit limits (which become more stringent each year) because of weather and project implementation (e.g., funding stream) problems that could not be predicted when the permit limits were established. However, to assure the schedule agreed upon in the TMDL wasteload allocation is met, the aggregate permit limits are set well below the TMDL

schedule, which increases the number and cost of credits that must be purchased, thus incentivizing progress. This approach also helps ensure that the TMDL schedule will be met.

For those years when the NCE takes in more money than it disburses, the NCAB is charged with establishing accounts to be used for administration of the nitrogen credit exchange program and which may be used for nitrogen removal projects, habitat restoration projects and research. Among those activities the NCAB funded with surplus were technical assistance activities to educate and assist municipalities in implementing nitrogen removal at their POTWs.

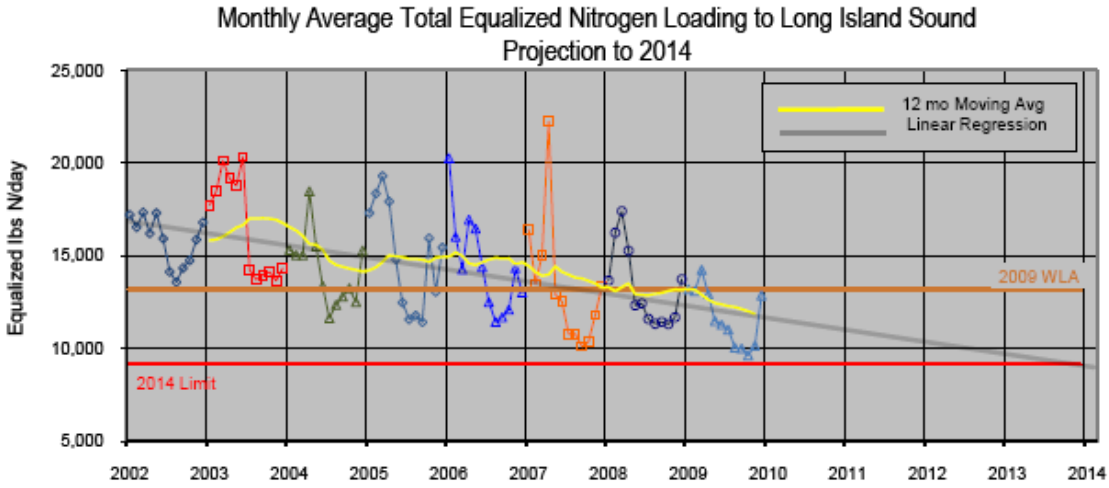


Figure 3. Performance of the NCE, 2002 – 2009.

E. Accountability of Meeting Permit Limits

The NCE is anchored by, and regulated under, a state-issued Nitrogen General Permit (NGP). No new regulations had to be written and adopted to institute the NCE, adding both practicality and simplicity to the process. Nevertheless, trading is a regulated process under existing authorities and there are options for enforcement should the need ever arise. The NGP is issued for a five-year period, as per EPA requirements, but also includes the final 2014 wasteload allocations for each of the 79 participating facilities. The current NGP, which was reissued for 2006 (one year early to make some adjustments in annual permit limits) is in effect until 2010. The NGP requires full accountability for each permittee to monitor, report, operate nitrogen removal equipment, and meet the permit limits, either by performance or by purchase of the requisite number of credits to come into compliance with their individual nitrogen load limit for that year.

Further, the permit provides, "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."

Within the NGP, the Commissioner maintains the full enforcement authority that the law allows, "The Commissioner may take any action provided by law to abate a violation of this general permit, including the commencement of proceedings to collect penalties for such violation. The Commissioner may, by summary proceedings or otherwise and for any reason provided by law, including violation of this general permit, revoke a permittee's authorization hereunder in accordance with … Regulations of Connecticut State Agencies. Nothing herein shall be construed to affect any remedy available to the Commissioner by law."

The Commissioner may also revise or revoke the permit if it is not working to meet the obligations of the State of Connecticut under the TMDL, "The Commissioner may, for any reason provided by law, by summary proceedings or otherwise, revoke or suspend this general permit or modify it to establish any appropriate conditions, schedules of compliance, or other provisions which may be necessary to protect human health or the environment or to implement the 15 year TMDL."

F. Nonpoint and Stormwater Source Trading

The NCE does not currently include either stormwater (another point source) or nonpoint sources (NPS) in its nitrogen trading program. However, the enabling legislation does allow the NCAB to consider the potential and viability of including other nitrogen sources. CTDEP has conducted an evaluation of stormwater/NPS potential for trading and has found the costs to generate a nitrogen credit far exceed those applicable to POTWs. Further, there would be accountability constraints because of the difficulty of tracking and monitoring diffuse sources within Connecticut's 169 municipalities.

Despite these obvious challenges, the potential for stormwater/NPS will continue to be explored, especially as the price of credits within the NCE continue to rise over time. Connecticut and New York are also obligated to meet a stormwater/NPS load allocation under the TMDL, and are using Phase II (MS4) permitting programs, CWA Section 319 Nonpoint Source programs, and CZARA Section 6217 Coastal Nonpoint Source programs as the mechanisms to meet the load allocation.

If a stormwater/NPS trading component were to be added in the future, it would most likely also be an incentive-based program rather than a free-market approach. Nitrogen is difficult and costly to control in Connecticut's urban/suburban setting, and reductions are unlikely to be cost competitive with POTW credits in a free market system. However, because municipalities are required to implement the Phase II stormwater permit, and various federal, state and local programs that require or emphasize stormwater/NPS management, there may be benefits of an incentive-based approach to offset some of those costs. For example, payment for stormwater/NPS reductions at the same credit prices paid to POTWs under the NCE would help defray costs, and encourage additional nitrogen reductions from stormwater/NPS sources. Connecticut and the NCAB will continue to evaluate and explore the viability of these options.

G. Stakeholder Involvement

Although the municipalities and their resident populations are the primary stakeholders in this effort, the LISS and the CTDEP have provided ample opportunity, both formally and informally, for stakeholder and public involvement. Both have a strong tradition of public outreach, and have involved groups such as the LISS Citizens Advisory Committee in the development and institution of the trading program.

Adoption of the TMDL required a formal public comment period, and many questions were raised regarding nitrogen trading and whether the environmental benefits would be equivalent under the variety of scenarios that might transpire. After the TMDL was submitted and approved by EPA, CTDEP held a similar formal comment period on the wasteload allocation, and its implementation through a nitrogen credit exchange. There was strong interest, especially on the part of the municipalities, regarding cost, enforcement, and benefits of trading over conventional permitting approaches. Issuance of the Nitrogen General Permit is also a public process with opportunities for a public comment period and formal hearing.

Although CTDEP appeared to have all the authorities required to develop and enforce a nitrogen trading program, it drafted enabling legislation to ensure full public understanding, and confirmation of authority. Passage of that legislation by the Connecticut General Assembly, and signing by the Governor, provided another public process, and opportunity for public input.

Finally, the continuing NCE process is a public process, largely controlled by a Nitrogen Credit Advisory Board. While the NCAB includes state agencies, including CTDEP, the Connecticut Office of Policy and Management, and the Connecticut Treasurer's Office, the other nine members are appointees of the Governor's Office and state legislators, representing a range of municipal interests. These appointees include citizens and POTW principals from a distribution of small to large municipalities, including those that are likely to be sellers of credits, and those that are likely to be buyers, to provide balance to the NCAB. All meetings of the NCAB are open, and an opportunity for public comment is included at each meeting.

H. Evaluation of the Nitrogen Credit Exchange

By statute, the NCE is continually under evaluation and modification, when warranted. On annual basis, the NCAB must report to the Connecticut General Assembly's (CGA) Environment Committee, on performance of the NCE and identification of any operational issues requiring change or other resolution. This also includes, "Recommendations for changes to the program including, but not limited to: (A) Exchanging nitrogen credits with entities outside the state; (B) expanding the general permit for nitrogen discharges and the nitrogen credit exchange program to include additional point and nonpoint sources; and (C) exchange transactions executed outside of the nitrogen credit exchange program."

The annual reports to the CGA are public reports, posted on the CTDEP website. More important, they are generally a call to act upon issues relevant to the NCE operations. Recent cuts in the Clean Water Fund were discussed in the most recent report, and how those reductions could affect Connecticut's ability to meet the requirements of the TMDL by the 2014 deadline.

Connecticut's ability to meet the nitrogen wasteload allocation is continually reviewed when the priority lists for Clean Water Funding are updated each year. The process helps identify individual POTW readiness to move forward and is a check on the likely progress in nitrogen removal goal attainment.

In general, the municipalities have been ready to move forward with nitrogen removal projects at a pace that exceeds the ability of the Clean Water Fund to finance. CWF financing, however, does enjoy strong public support from municipalities and environmental groups, as well as the public. A summit was sponsored by several municipal and environmental associations in December 2006, where the message to legislators was to increase CWF funding to meet the many clean water needs in the state, including nitrogen removal. This type of "external" evaluation of the NCE demonstrates the high level of public and private engagement in the process.

In another area, in December 2006 the NCAB recommended to the Commissioner that the program be expanded to include private entities with nitrogen discharges. A final procedure was approved by the Commissioner for incorporation into the NCE for the 2007 trading year.

I. Summary

- Nitrogen trading is proving to be a viable alternative for improving dissolved oxygen conditions in Long Island Sound.
- Connecticut's Nitrogen Credit Exchange has demonstrated success since 2002.
- Trades from 2002-2009 have a cumulative value of about $45.9 million representing the exchange of nearly 14 million equalized credits.
- Trading has allowed the state to more cost-effectively implement nitrogen removal under the TMDL for nitrogen control to Long Island Sound.
- With enabling legislation, existing regulatory authorities proved to be available and adequate to implement the program.
- A Nitrogen General Permit is the fundamental regulatory authority underlying the program, and provides a necessary enforcement mechanism.
- The program has focused state Clean Water Fund financing towards the effort, about $300 million for nitrogen removal since 1993.
- The use of trading ratios provides an economic engine, forcing action towards the most cost-effective and environmentally beneficial projects.
- Prices of credits have remained fairly low to date, but continue to rise as the most cost effective projects are completed first.
- Nitrogen trading has accelerated the schedule to meet the TMDL wasteload allocation.
- Potential savings with nitrogen trading are in the $300-400 million range over individual permitting approaches.
- Managed by a Nitrogen Credit Advisory Board, the Nitrogen Credit Exchange is a public process that allows for public input.
- The NCE serves as a working model for incentive-based trading in other states.