NWQEP NOTES

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PROJECT SPOTLIGHT

Lake Champlain Basin Agricultural Watersheds Section 319 NMP Project: Measuring Success

Donald W. Meals
New England Interstate Water Pollution Control Commission/
Vermont Dept. of Environmental Conservation

Introduction

Lake Champlain, the nation's sixth largest freshwater lake, is undergoing cultural eutrophication due to excessive phosphorus (P) load from its 20,800 km^2 drainage basin, which spans portions of Vermont, New York, and Quebec, Canada. About 71% of the average 647 t/yr P load comes from nonpoint sources (NPS) (VT DEC and NY DEC, 1997) and up to 66% of the nonpoint source P load to Lake Champlain has been attributed to agricultural land in the basin (Meals and Budd, 1998). The management strategy for Lake Champlain calls for reductions of P loading from both point and nonpoint sources. In addition, many Vermont streams fail to meet bacteriological water quality criteria due to agricultural NPS pollution. Vermont's NPS management strategy for Lake Champlain and its tributaries will thus rely heavily on implementation of effective controls for agricultural NPS pollution to meet state water quality standards.

Efforts to reduce agricultural NPS pollution in Vermont since 1980 have targeted animal waste management in the state's predominantly dairy agriculture. Construction of manure storage structures, barnyard runoff management, and adoption of improved waste management to avoid winter spreading of manure have been encouraged under federal and state incentive programs. Grazing impacts on water quality have not been addressed, despite the fact that dairy cows in Vermont traditionally spend half of the year on pasture with free access to streams. Direct waste deposit into streams, destruction of riparian vegetation, and trampling of streambanks and streambeds are all potential problems associated with unrestricted livestock grazing. Livestock grazing is widely recognized to contribute increased nutrients, sediment, and microorganisms to surface waters in the USA (Correll et al., 1995; Belsky et al., 1999).

The goal of the *Lake Champlain Basin Agricultural Watersheds Section 319 NMP Project* was to quantify the effectiveness of livestock exclusion, streambank protection, and riparian restoration practices as tools for reducing sediment, nutrient, and bacteria runoff from agricultural land to surface waters. The project sought to document changes in pollutant concentrations and loads at the watershed level in response to implementation of practical, low-technology measures to protect stream corridors from livestock grazing. Treatment effectiveness was evaluated through water quality monitoring at watershed outlets using a paired-watershed design. The project was one of twenty-three special NPS control projects in the National Monitoring Program, funded in part by the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act.

EDITOR'S NOTE

The National Nonpoint Source Monitoring Program (NMP) was created in 1991 with funding authorized by Section 319 of the Clean Water Act. Its purpose is to increase the scientific knowledge of nonpoint source pollution and to evaluate nonpoint source pollution control technologies. Twenty-three projects are currently part of the NMP. These projects are unique among nonpoint source control watershed projects in that their focus is on long-term monitoring. Projects typically range from 6-10 years, and include monitoring prior to, and after, land treatment implementation. A number of projects are near completion or have been completed, and many have documented success. As nonpoint source pollution continues to be the leading source of water quality impairment in the U.S., it is imperative to share the knowledge gained from the NMP projects for the benefit of the numerous water quality protection and restoration efforts underway in the U.S. and around the world.

In this, and upcoming issues of *NWQEP NOTES*, we feature NMP projects that have come to completion and were successful in documenting water quality improvements due to land treatment. This issue presents the Lake Champlain Basin NMP project in Vermont, where significant reductions in phosphorus, nitrogen, suspended solids, and indicator bacteria were document from implementation of livestock exclusion and riparian zone protection.

As always, please feel free to contact me regarding your ideas, suggestions, and possible contributions to this newsletter.

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Methods

Study Area

The project was conducted within the Missisquoi River drainage of the Lake Champlain Basin in Vermont (Fig. 1). The study streams are tributaries to the Missisquoi River, which drains the most intensively agricultural region of the Basin, contributing the greatest nonpoint source P load (approximately 82 t/yr) to Lake Champlain among its tributaries. Typical of the region, water quality in the study streams is impaired by phosphorus, bacteria, and organic matter originating from animal wastes generated from dairy farms, crop production, and livestock activity within streams and riparian areas (VT ANR, 1996).

The 690 ha Samsonville Brook watershed (WS1) and the 1422 ha Godin Brook watershed (WS 2) received riparian restoration treatment. The 954 ha Berry Brook watershed (WS 3) was the control. The climate of the area is of the cool, continental type with cold winters, warm summers, a short growing season, and pronounced seasonal variations in temperature and precipitation. The watersheds are similar with respect to major land use/land cover categories. About 60% of land area is covered by mixed coniferous/deciduous forest. Just 2 to 3% of each watershed is in residential use. One-third of the watershed area is in dairy agriculture, although some beef and sheep production exists. More than a quarter of each watershed is in hay or mixed hay/pasture. In 2000, farms in the study watersheds reported 864, 2306, and 379 A.U. (Animal Units, 1 A.U. = ~450 kg) in WS 1, WS 2, and WS 3, respectively.

Study Design

The project followed a paired watershed design (USEPA, 1993), using two watersheds – treatment and control, and two periods of monitoring – calibration and post-treatment. The purpose of the control (untreated) watershed is to account for year-to-year variations in climate/hydrologic inputs.

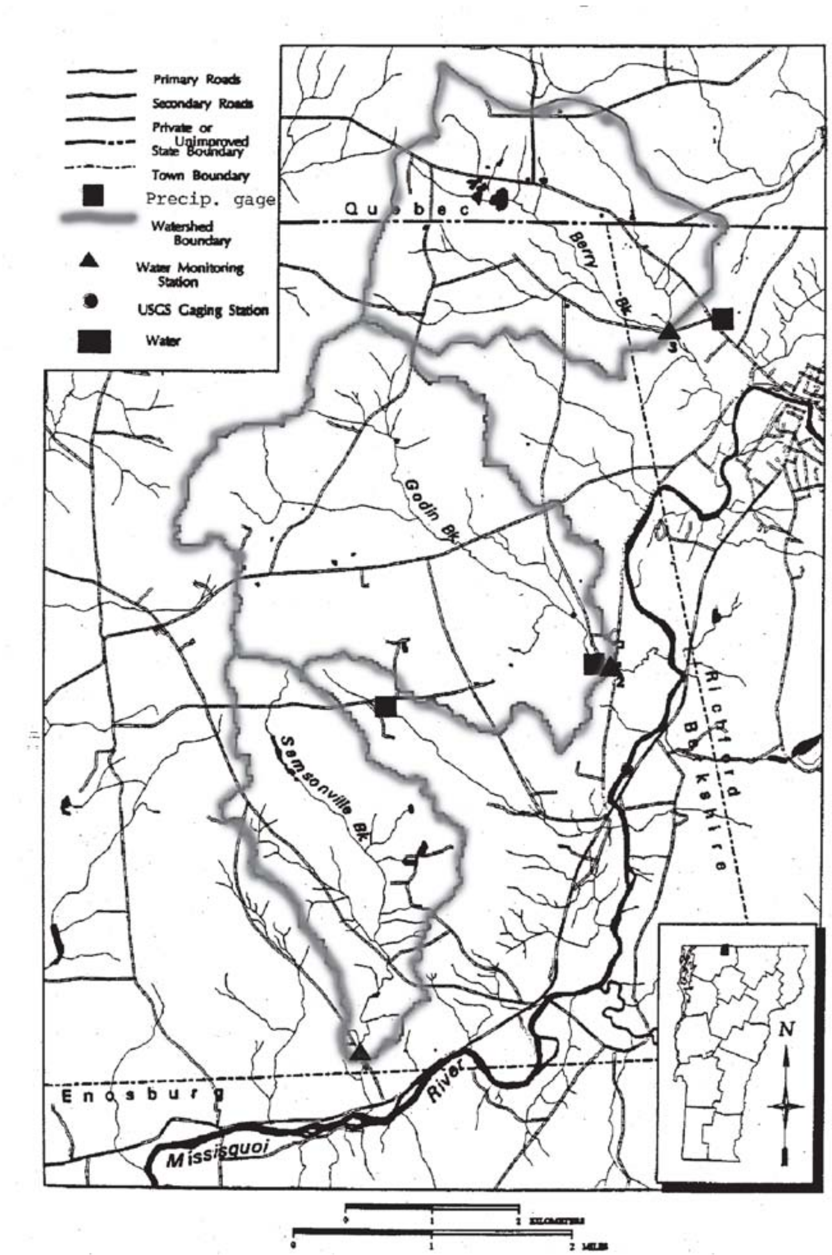

Fig. 1. Project location map.

During the *calibration period*, the watersheds receive no treatment and water quality data are collected similarly at each watershed outlet. The treatment watershed has a change in management implemented at the end of the calibration period, whereas management in the control watershed remains unchanged. During the *post-treatment period,* management changes are active in the treatment watershed, while the control watershed remains under original conditions. Monitoring continues according to the original design throughout the treatment period.

Chemical/physical water quality and streamflow were monitored at the outlet of each watershed preceding land treatment in order to achieve satisfactory calibration relationships (i.e., by linear regression) between the two watersheds. Land treatments were then applied and monitoring continued during the treatment period. The effect of treatment was measured by the difference between the calibration and treatment relationships. Two treatment watersheds (WS 1 and WS 2) were monitored to assess different levels of treatment. The principal hypothesis to be tested was that treatment in WS 1 and WS 2 would yield significant improvements in water quality compared to the control.

The monitoring system has been described in detail elsewhere (Lombardo et al., 2000; Meals, 2001a,b). Precipitation was recorded continuously by gages located in each watershed. Streamflow was recorded continuously at monitoring stations located at each watershed outlet; flow-proportional water samples for total P (TP), total Kjeldahl N (TKN), and total suspended solids (TSS) were collected in refrigerated automatic samplers composited into a weekly sample from each watershed. Grab samples for *E. coli*, fecal coliform and fecal streptococcus bacteria were collected twice weekly; dissolved oxygen, specific conductance, and water temperature were measured concurrently. All sample handling and analytical procedures followed U.S. EPA methods (USEPA, 1983). Macroinvertebrate and fish communities were assessed annually in several representative habitats in each study stream and in a regional reference station.

Baseline data on soils, topography, land ownership, and agricultural land use and management were collected at the beginning of the project. Changes in land use and agricultural activity were monitored and updated annually through farmer record-keeping, interviews with each owner and/or operator of agricultural land, and review of USDA aerial photography. Land ownership and land use/land cover were compiled and mapped in a GIS.

Land Treatment Plan

During the calibration period, critical areas needing treatment in WS 1 and WS 2 were identified through baseline farm inventories, inspection of stream corridors, and interpretation of aerial video imagery. Treatment plans were developed for individual farms in cooperation with landowners, who participated voluntarily. Landowners signed agreements to ensure operation and preservation of the treatments for the duration of the project, and to provide for joint maintenance of treatments by the project and the landowner.

Land treatment was designed to treat and protect streams and riparian zones and included exclusion of livestock from selected areas of streams, creation of protected riparian zones, improvement or elimination of heavily used livestock stream crossings, and revegetation of degraded streambanks. The treatment required fencing, watering systems, reducing the number and size of livestock crossing areas, bridging or armoring crossing areas, and streambank erosion control through bioengineering techniques. Personnel from U.S. Dept. of Agriculture Natural Resources Conservation Service and from the U.S. Fish and Wildlife Service provided technical assistance in treatment design. The project budget, other conservation programs, the landowners themselves, and local volunteer groups provided funds and labor for treatment implementation.

Results

The calibration period began in May, 1994 and continued through May, 1997. Except for small differences due to variations in precipitation and stream discharge, water quality was fairly consistent through the calibration period in each of the monitored streams, with few statistically significant differences between project year means. Satisfactory calibration was achieved for all water quality variables between both treatment watersheds and the control. Calibration period water quality data have been reported fully elsewhere (Meals, 1998; Meals, 2001a,b).

Land treatment was fully implemented in WS 1 and WS 2 from May - November, 1997. Eight landowners signed treatment agreements; additional work was done on four other properties in the watersheds. In WS 1, treatment included livestock exclusion fencing, creating a protected riparian zone, and elimination of three livestock crossing areas. Treatment along Godin Brook in WS 2 included protection of both sides of 2300 m of stream and wetland with a livestock bridge (see Fig. 2), livestock exclusion fencing (see Fig. 3), a 300 m stabilized livestock travel lane, and three culvert and two armored stream crossings for livestock. The width of the fenced riparian zones created varied from about 2 - 8 m, depending on topography and the extent of land area the landowner was willing to set aside. Livestock watering systems were installed on two farms to replace stream access as a drinking water supply.

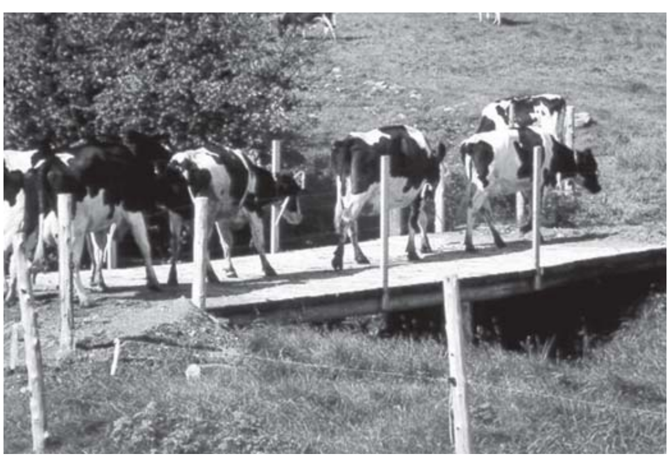

Figure 2. New stream crossing on Godin Brook.

Figure 3. Riparian zone in Godin Brook after 1.5 years of livestock exclusion by fencing.

Within all protected riparian zones, streambank stabilization was done through bioengineering techniques, including planting willows as cuttings, live stakes and fascines, and installation of tree revetments and brushrolls. No other deliberate plantings were made in riparian zones; natural regrowth of native grasses, shrubs, and other vegetation following removal of grazing pressure was ample. Treatment installation was done by project staff, landowners, volunteers from a local river basin association, and a Youth Conservation Corps work crew. Total treatment costs were: WS 1 - $3,789 and WS 2 - $34,565. The extent of land treatment achieved in the project is shown in Table 1. WS 1 received a higher level of treatment relative to need than did WS 2, although the absolute extent of treatment was greater in WS 2.

Post-treatment monitoring was conducted from 1997 through 2000; three years of post-treatment data were evaluated for evidence of response to treatment. Direct comparisons of calibration and post-treatment data suggested that TP concentrations declined slightly in both WS 1 and WS 2 following treatment, but increased in WS 3 (control watershed) over the same period. Both stream discharge and TP export from all three watersheds tended to be higher in the post-treatment period. This was not surprising, given extreme discharge events that occurred during the treatment period. However, the utility of the paired-watershed design is in the ability to account for such expected variability by using data from the control watershed through Analysis of Covariance (ANCOVA).

Variable	WS 1	WS 2	WS 3
Total stream length(m)	10,382	24,776	18,051
Pasture stream length (m)	1,481	8,150	2,085
Treated stream length (m)	726	2,283	0
Stream length treated (%)	7%	9%	---
Pasture stream length treated (%)	49%	28%	---
Livestock grazing on treated pasture (%)	96 - 97%	15 – 23%	---
Pasture area draining to treated stream (%)	42%	32%	---

Table 1. Extent of land treatment, from GIS

An example of ANCOVA results is shown in Figure 4. In this plot, the treatment period regression line relating the control watershed (WS3) *E. coli* counts to the treatment watershed (WS1) *E. coli* counts is shifted downward from the regression line for the calibration period. This indicates that *E. coli* counts dropped after BMPs were established in the treatment watershed. The magnitude of the decline can be found by taking the difference in *E. coli* values predicted by the treatment and calibration period regression equations for any given *E. coli* level in the control watershed. For the log-log relationship depicted in Figure 4., the percentage decline in *E. coli* is constant over the entire range of WS3 *E. coli* values. Changes in other water quality variables between Calibration and Treatment periods were analyzed similarly.

	WS 1 % change in mean	WS 2 % change in mean
[TP]	-15%	+18%
[TKN]	-12%	0
[TSS]	-34%	+40%
E. coli	-29%	-44%
Fecal coliform	-38%	-46%
Fecal strep.	-40%	-20% (n.s.)
Conductance	-11%	+1%
Temperature	-6%	+3%
	WS 1 change in annual export	WS 2 change in annual export
TP export	-49% (-830 kg/yr)	+80% (+1,200 kg/yr)
TKN export	-38% (-2,200 kg/yr)	+44% (+ 23,500 kg/yr)
TSS export	-28% (-114,900 kg/yr)	+104% (+ 392,200 kg/yr)

Table 2. Summary of water quality response to treatment. Differences are statistically significant, P≤0.10, except Fecal strep. in WS 2.

To estimate the reduction in annual export, measured weekly loads for WS1 and WS2 for the treatment period were summed and compared to the loads that would have occurred without treatment. To estimate loads that would have occurred in WS1 and WS2 without treatment, the treatment period loads for the control watershed were used with the respective calibration period regression equation. Export reduction estimates are shown in Table 2. These reductions are similar to those reported by Williamson et al. (1996) and Eghball et al. (2000) following riparian zone enhancement.

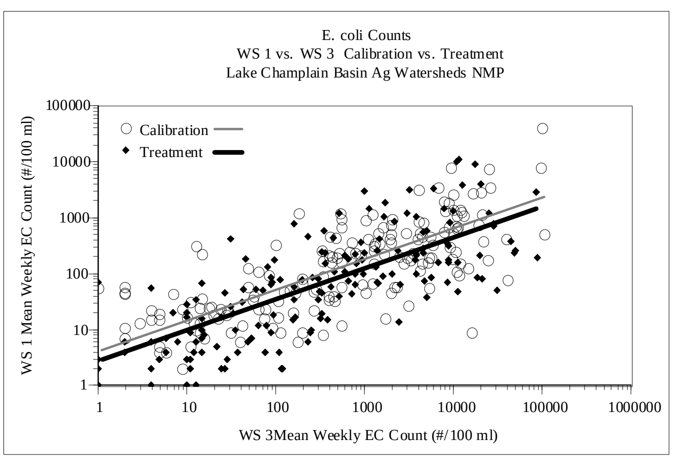

Figure 4. Paired regression plot for weekly *E. coli* counts, WS 1 vs. WS 3. Points and line labeled "Calibration" represent data pairs May 1994 - May 1997; "Treatment" points and line represent data pairs October 1997 - October 2000. Regression lines differ significantly, P<0.001.

The deterioration in water quality in WS 2 (increases in sediment and nutrient concentration and load in the Treatment period) was due to severe erosion and manure runoff events beginning in 1999 from mismanagement on land upstream of installed treatment. Improvements in water quality in Godin Brook over the first two years of treatment were overwhelmed by these catastrophic events in the third treatment year.

In both treated streams, macroinvertebrate communities responded significantly to treatment while community metrics remained unchanged in local control streams. Improvements in biological integrity were indicated by significant changes in the Bio Index and EPT/EPT+chiro. Ratio values. In the second and third years after treatment, Bio Index values met or approached Vermont Class B water quality biocriteria. Improvements noted in Godin Brook after two years of treatment were reversed in the final year due to the catastrophic sedimentation events noted above. No changes in the fish communities were noted in the treatment streams.

Conclusions

Land treatments were implemented that addressed a significant portion of grazing-related water quality problems in each treatment watershed. This success was due in large measure to technical assistance from USDA-NRCS and US Fish & Wildlife personnel, to local volunteer labor, and to voluntary participation of landowners. Fencing livestock away from streams and protection of riparian zones did not appear to impair normal farm operation or grazing management on participating farms. Land treatment costs were very low; the approximate $40,000 expended in the two treatment watersheds can easily be spent on structural practices on a single farm in traditional land treatment programs.

The project successfully documented significant reductions in phosphorus, nitrogen, suspended solids, and indicator bacteria in response to livestock exclusion and riparian zone protection. Modest positive effects on stream biota were also noted. The project also clearly demonstrated the ability of a single extreme case of poor farm management to overwhelm the effects of land treatment in a small watershed.

Riparian zone protection/restoration is a cost-effective tool for reducing nonpoint source pollutant concentrations and loads from livestock grazing lands in the Lake Champlain Basin.

For More Information

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Additional project information can be found at the following website: **www.anr.state.vt.us/dec/waterq/VT319Watershed.htm.** In addition, copies of the final project report (Meals, 2001b) can be obtained from Rick Hopkins at the address above.

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Conference Report

The 9th National Nonpoint Source Monitoring Workshop was held on August 27-30, 2001, in Indianapolis, Indiana. The focus of the workshop was monitoring and modeling nonpoint source pollution in agricultural landscapes. The workshop presented progress made and lessons learned from Section 319 National Monitoring Program projects as well as other nonpoint source control watershed projects. Over 170 people participated in the conference, which included two pre-conference workshops on TMDL development and public outreach, and an all-day field trip. Conference session topics included innovative monitoring, BMP implementation, animal operations, land use and fisheries, modeling, and volunteer monitoring. The field trip featured visits to Purdue University's Water Quality Field Station; a constructed wetland to treat golf course and urban runoff; and a constructed wetland within a tiled agricultural watershed receiving spray irrigation from animal waste lagoons.

Workshop sponsors include Conservation Technology Information Center (CTIC), E.S.E.I. Purdue University, University of Illinois - State Water Survey, and U.S. Environmental Protection Agency. Thanks to Lyn Kirschner of CTIC, Chair of the conference planning committee, and to all the planning committee members, workshop sponsors and hosts for organizing a successful, informative and enjoyable conference. Stay tuned for the location and date of next year's annual event.

Section 319 NMP Project personnel, Indianapolis, IN.
(Photo by Knowles Photography, Indianapolis, IN)

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Information

National Monitoring Program Successes and Recommendations

The NCSU Water Quality Group is pleased to release the report titled *Section 319 Nonpoint Source National Monitoring Program Successes and Recommendations*.

The report highlights the contributions of the National Monitoring Program in furthering our understanding and advancing the science of nonpoint source pollution control and water quality monitoring. Results of the 23 National Monitoring Program projects fully support the need for long-term water quality monitoring in order to: (1) quantify improvements in water quality due to best management practice implementation; and (2) determine the most cost effective land management options to best meet water quality goals.

Copies of the report are available for free. Please contact Cathy Smith at 919-515-3723 or *wq_puborder@ncsu.edu*. The publication is also available online in Adobe pdf format at: **www.ncsu.edu/waterquality/**.

New Online BMP Manual

The Metropolitan Council of the St. Paul - Minneapolis area plus several local cities and watershed districts have developed a new BMP manual for sites of less than 5 acres in cold climate environments. The manual includes guidelines for selecting BMPs, design guidelines for pollution prevention and stormwater runoff BMPs, stormwater model ordinances, list of project examples in the Twin Cities area, and an annotated bibliography. The manual can be used online (see link below) but is easier to use from a CD on your own system. Ordering information for CD version and paper version is also available on the website. For more information, contact Karen Jensen, Metropolitan Council St. Paul, Minnesota, at the following email address: *karen.jensen@metc.state.mn.us*. **http://www.metrocouncil.org/environment/Watershed/bmp/manual.htm**

Center for Watershed Protection Completes NY Stormwater Manual

The Center for Watershed Protection announces the completion of the "New York State Stormwater Management Design Manual." The Manual provides designers with a general overview on how to size, design, select, and locate stormwater management practices at a development site to comply with NY State stormwater performance standards.

This manual is a key component of the Phase II State Pollution Discharge Elimination System(SPDES) general permit for stormwater runoff from construction activities from all sizes of disturbance. The manual can be found at **http://www.dec.state.ny.us/website/dow/swmanual/swmanual.html** and can be downloaded for free.

To learn more about this and other projects, visit the Center online at **http://www.cwp.org** and **http://www.stormwatercenter.net.**

EPA Requesting Comments on Draft Guidance for Wetland and Riparian Area Protection

EPA has put up a draft guidance which is intended to provide technical assistance to State, local, and tribal program managers and others on the best available, economically achievable means of reducing nonpoint source pollution of surface and ground water through the protection and restoration of wetlands and riparian areas, as well as through the implementation of vegetated treatment systems. The deadline for comments is **February 4, 2002**. Comments may be sent to Christopher Solloway of EPA's Nonpoint Source Control Branch at *solloway.chris@epa.gov*. The guidance document can be viewed at the following web site: **http://www.epa.gov/owow/nps/wetmeasures/.**

New Guide for Lake Residents

The Terrene Institute announces the availability of a citizen's guide, *Managing Lakes and Reservoirs*, written for people who live around lakes and answers questions on how to protect lakes and reservoirs. Some questions answered include: how to control algae; why the watershed must be managed along with the lake; why you might or might not want plants growing in the lake; what phosphorus does to the lake; how barley straw may help the lake; how to use models to predict how water quality may change; and why people are the most important part of lake management.

Managing Lakes and Reservoirs is the third edition of the book originally published in 1998 as *The Lake and Reservoir Guidance Manual*, and was written and published by the Terrene Institute and the North American Lake Management Society in cooperation with the U.S. Environmental Protection Agency.

Copies sell for $33.95 plus shipping, with special discounts available. For more information or to order a copy, phone (800) 726-4853. Copies are also available from the North American Lake Management Society at **www.nalms.org**.

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MEETINGS

Call For Papers

Illinois Lake Management Association 17th Annual Conference: Lakesheds - Go with the Flow: April 18-20, 2002, Rockford, Illinois. For general conference information, contact Dick Hilton, ILMA 2002 Conference Coordinator; Tel: 800-338-6976 access code 01; Fax: 815-653-5097; Email: wildick@mc.net.

The conference encourages presentations on innovative and/or creative watershed and lake management techniques, watershed and in-lake efforts to reduce erosion and runoff, and improve water quality or habitat, and case studies and reports of ongoing lake and watershed efforts relevant to the conference theme *Lakesheds - Go with the Flow.* **Submit abstracts by email to jenkins.david@uis.edu. Abstracts must be received by December 15, 2001.**

Ninth International Conference on Hydraulic Information Management: HYDROSOFT 2002: May 29-31, 2002, Montreal, Canada. Organized by Wessex Institute of Technology. Web site: www.wessex.ac.uk/conferences/2002/hy02/.

The conference encourages presentations on all aspects of Hydraulic Information Management. The main areas covered include ground water, open channel and pressure flow, and presentations on water quality and decision support systems. **Abstracts due as soon as possible.**

AWRA's Annual Summer Conference: Ground Water/Surface Water Interactions: July 1-3, 2002, Keystone, Colorado. Papers (oral or poster) are invited in the following and related topics: Stream-Aquifer Interactions; evapotranspiration from riparian vegetation; infiltration and percolation to ground water; conjunctive use of ground water and surface water; aquifer recharge technology; legal/regulatory aspects of surface water and ground water interaction; water quality and source water protection; planning and management of integrated surface water and ground water systems; environmental impacts; computer modeling and GIS technology. Contact Patricia A. Reid, AWRA, 4 West Federal St., P.O. Box 1626, Middleburg, VA 20118-1626; Ph: 540-687-8390; Fax: 540-687-8395; Email: pat@awra.org. Website: www.awra.org. **Abstracts must be received by January 31, 2002.**

6th International Conference on Precision Agriculture and Other Precision Resources Management: July 14-17, 2002, Minneapolis, Minnesota. Conference web site: www.precision.agri.umn.edu/2002. **Abstracts due by December 14, 2001.**

6th International Conference on Diffuse Pollution: September 30-October 4, 2002, Amsterdam, Netherlands. Contact Conference Secretariat, Buerweg 51, 1861 CH Bergen, Netherlands. Tel: +31-20-4602466; Fax +31-20-4602475; Email: r.r.kruize@inter.nl.net. **Abstracts due January 1, 2002.**

Hydrologic Extremes: Challenges for Science and Management. American Institute of Hydrology 2002 Annual Meeting and Conference: October 13-17, 2002, Portland, OR. The themes are riparian processes, climate change, droughts and floods, stream temperature standards and modeling, endangered species, managing forest health, ground water variability, water quality variability, and channel and watershed morphology. Visit the website: www.aihydro.org/call_2002.htm/. **Abstracts are due before Febuary 28, 2002.**

Meeting Announcements - 2002

February

33rd Annual Conference and Expo: Adventures in Erosion Education: February 25 - March 1, 2002, Orlando, FL. Contact IECA, P.O. Box 774904, Steamboat Springs, CO 80477-4904. Tel: 970-879-3010; Fax: 970-879-8563; Email: ecinfo@ieca.org; or register on-line at www.ieca.org.

5th National Mitigation Banking Conference: February 27 - March 1, 2002, Washington, D.C. Contact Carlene Bahler at 703-548-5473 or email cbahler@erols.com. Visit website: www.terrene.org.

March

Agriculture and the Environment: The Challenge of Change: March 4 - 6, 2002, Ames, IA. Contact: Richard Larson, AEP Coordinator, Iowa State University, Ames, IA 50011. Tel: 515-294-6429; Fax 515-294-1311. Website: http://extension.agron.iastate.edu/aged/water_quality/MainWQ/wqm.htm.

Fourth Biennial Conference on University Education in Natural Resources. March 14 - 17, 2002. Raleigh, NC. Web site: www.ces.ncsu.edu/nreos/forest/feop/uenr2002.html.

May

AWRA's Annual Spring Conference: Coastal Water Resources: May 13 - 15, 2002, New Orleans, LA. Contact Michael J. Kowalski, 4 West Federal Street, P.O. Box 1626, Middleburg, VA 20118-1626; Tel: 540-687-8390; Email: mike@awra.org; Website: www.awra.org.

NWQMC 3rd National Monitoring Conference 2002: May 21 - 23, 2002, Madison, WI. Visit website: www.nwqmc.org. Email: dan@nwqmc.org; Tel: 405-516-4972.

7th Biennial Conference on Stormwater Research & Watershed Management: May 22-23, 2002, Tampa, Florida. Contact Amy Dolsom, McRae & Company, Inc., P.O. Box 12187, Tallahassee, Florida 32317-2187. Tel: 850-906-0099; Fax: 850-906-0077; Email: AmyF@mcraeco.com.

12th International Soil Conservation Organization Conference. May 26-31, 2002. Beijing, China. Address: Fuxinglu Jia 1, Haidian District, Beijing, 100038, P. R. China. Tel: 86-10-63204363; Fax: 86-10-63204359; Email: isco2002@swcc.org.cn; Website: http://www.swcc.org.cn/isco2002.

August

StormCon 2002, The North American Surface Water Quality Conference & Exposition: August 12-15, 2002, Marco Island, FL. Contact Forester Communications, P.O. Box 3100, Santa Barbara, CA 93130. Visit the website: www.stormcon.com.

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