Integrating Ambient and Compliance Monitoring in the Kennebec River Basin, Maine

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Abstract

One of the recommendations of the national Interagency Task Force on Water-Quality Monitoring (ITFM) is to better integrate ambient (stream monitoring to assess general water-quality conditions) and compliance (effluent-quality monitoring for regulatory purposes) monitoring. An integrated monitoring program can improve the understanding of stream-water-quality conditions, while still tracking effluent as required by discharge-permit limitations. Over the past 2 years, the U.S. Geological Survey, Maine Department of Environmental Protection, U.S. Environmental Protection Agency, New England Interstate Water Pollution Control Commission, and a number of permitted wastewater dischargers in the Kennebec River Basin have been developing an integrated monitoring strategy for the Basin. Participating wastewater dischargers include a number of pulp and paper mills, municipal wastewater treatment facilities, and hydropower facilities.

Activities included an inventory of current and past ambient and discharge-permit related water-quality monitoring in the Basin, a survey of resources and expenditures for current ambient and compliance-monitoring activities, and identification of the important water-quality issues in the Basin. During the summer of 1997, the first coordinated water-quality sampling of the Kennebec River took place. A long-term, integrated ambient-compliance monitoring plan is under development with the goal of redirecting monitoring activities to areas where gaps in knowledge exist, without increasing the resources spent on monitoring. A creative working environment has developed between the participants so that resources are shared among the Federal and State agencies and dischargers to accomplish mutual goals of the plan. Overall, participants are genuinely interested in improving the understanding of river-water quality and its management.

Introduction

In 1992, the Intergovernmental Task Force on Monitoring Water Quality (ITFM) was created to develop a national integrated monitoring strategy that would assist in facilitating defensible water-quality programs and decision making (Intergovernmental Task Force on Monitoring Water Quality, 1994). The ITFM recognized that there are limited resources available for environmental-monitoring programs and that these programs need to be conducted as effectively and efficiently as possible. A number of recommendations were made by the ITFM in 1995 to enhance the effectiveness of water-quality-monitoring programs across the Nation (Intergovernmental Task Force on Monitoring Water Quality, 1995). One recommendation was to better integrate ambient and compliance monitoring activities in watersheds. Ambient monitoring activities of streams assess general water-quality conditions. This monitoring typically is performed by government

agencies and citizen groups and is often a discretionary activity. On the other hand, the regulated community, which includes public water suppliers, wastewater-treatment facilities, and industrial facilities, conducts compliance monitoring. Compliance monitoring is subject to regulatory directions.

The ITFM recognized that the regulated community conducts more water-quality monitoring for compliance purposes than government agencies do to assess general water-quality conditions (Intergovernmental Task Force on Monitoring Water Quality, 1995). As a result, water-resource managers have a more thorough understanding of regulated activities than they do of the water resources being affected. The ITFM felt that partnerships between the ambient and compliance monitors would make the data from both activities more usable and accessible. If such partnerships are established, more thorough assessments of stream water-quality conditions can be done without increasing overall monitoring costs. In return, environmental protection agencies would offer the regulated community adjustments to their compliance monitoring as compensation for the overall benefits from the partnership.

To test the concept of integrating ambient and compliance monitoring, the U.S. Geological Survey (USGS) proposed pilot studies in conjunction with National Water-Quality Assessment (NAWQA) Program study units in 1995. Three of these pilot studies were ultimately established. One of these pilot studies was in the Kennebec River Basin in central Maine; the Kennebec River is part of the New England Coastal Basins (NECB) NAWQA study (figure 1). This paper describes the results to date of efforts to develop an integrated ambient and compliance monitoring framework for the Kennebec River.

The Kennebec River ambient-compliance-monitoring integration study initially began in 1995 when the Maine Department of Environmental Protection (MEDEP) expressed interested in working with USGS to develop the pilot study. This was followed in 1995 with a series of meetings between State and Federal monitoring and water pollution control agencies and wastewater permittees in the basin. Currently (1998), the process is still on-going. The goal of the study is to increase knowledge of water quality in the Kennebec River Basin by integrating ambient and compliance monitoring in a comprehensive manner without an increase in resources allocated to monitoring. Only compliance monitoring performed by wastewater treatment facilities on their influent and effluent is included in the study. Other compliance monitoring in the basin, such as that related to public water supplies or waste disposal sites, was not considered. The study area includes the part of the Kennebec River Basin from Madison, Maine to Richmond, Maine (figure 1). The study focuses on the mainstem of the Kennebec River and not on tributaries; tributaries are considered as point-source contributors to the mainstem.

Description of the Study Area

The 145-mile-long Kennebec River in central Maine drains an area of 5,890 square mile (mi^2), the second largest drainage basin in the State. The basin is 82 percent forested, 10 percent water, 6 percent agriculture, and 2 percent urban. The Kennebec River drains into Merrymeeting Bay before flowing into the Atlantic Ocean. Timber harvesting is prevalent in the northern half of the basin, whereas agriculture, industries, and scattered population centers are found in the southern half of the basin. Pulp and paper mills and impoundments are found along the Kennebec River and tributaries. Below Augusta, the river is a freshwater tidal estuary.

Approximately 50 miles of the Kennebec River are within in the study area. Major tributaries to the Kennebec in this section include Sandy River, Wesserunsett Stream, Sebasticook River, Messalonskee Stream, and Cobbosseecontee Stream (figure 1). Six dams are located along the Kennebec River in the study area; these dams are used primarily for generation of hydropower. Population centers in the study area include Madison, Skowhegan, Fairfield, Waterville, Augusta, and Gardiner. Eight major wastewater treatment operations or industrial facilities discharge directly to the Kennebec River in the study area; of these discharges, three are municipal, three are industrial, and two are municipal with industrial contributions comprising a majority of the total wastewater flows (table 1).

Water quality in the Kennebec River has improved over the past 30 years. Before the mid-1970s, untreated and incompletely treated wastewaters from cities and industries resulted in a highly degraded river. In the 1960s and early 1970s, a pulp and paper facility at Winslow discharged organic-enriched wastewaters that were equal to a city of 2 million people (New England River Basins Commission, 1979). Since the mid-1970s, however, water quality has steadily improved as a result of improved wastewater treatment. In 1994, MEDEP classified the Kennebec River between Madison and Fairfield as Class B waters, and between Fairfield and the Edwards Dam as Class C waters (Maine Department of Environmental Protection, 1994). Class B waters are suitable for recreation in and on the water, fishing, drinking and industrial water supplies, navigation, and unimpaired habitat for fish and other aquatic life; Class C waters have similar designated uses except that these waters only support habitat for fish and other aquatic life and have lower water-quality criteria than Class B waters (Maine Department of Environmental Protection, 1994). Below Fairfield, the water in the Kennebec River has been classified as Class C because of reduced dissolved oxygen as a result of industrial wastewater discharges and impoundments used for hydropower. In addition, this section of the river is under a fish consumption advisory because of the presence of dioxin in fish tissues. The dioxin is a consequence of past wastewater discharges from pulp and paper facilities in the basin. A part of the river between Waterville and Augusta is Class B as a result of recovery from upstream wastewater discharges. The freshwater tidal estuary is Class C.

Agencies and Organizations Involved in the Study

USGS and the MEDEP- Bureau of Land and Water initiated the study in 1995 and have taken the lead in arranging meetings and setting goals for the study. Representatives of the major wastewater treatment facilities (permittees), the U.S. Environmental Protection Agency (USEPA) – Region 1, and New England Interstate Water Pollution Control Commission were invited to participate in the study in 1995. Since then, the number of participants has increased and currently (1998) totals about 15 individuals representing 12 different agencies and organizations. Agencies and organizations currently participating in the study are shown in table 2.

All operators of major and minor wastewater treatment facilities were invited to participate; major facilities are distinguished from minor facilities on the basis of flows and amounts of chemicals discharged. All major and a few of the minor permittees participated, either by attending meetings or requesting to be on the mailing list, at sometime during the 3 years of the study. Although there are no citizen watershed groups specific to the Kennebec River, two citizen/environmental advice groups have requested to be informed about the progress of the study.

Progress Towards Integrating Ambient and Compliance Monitoring in the Kennebec River Basin

MEDEP operates a program of revolving studies of the major river basins in the State. These revolving studies are conducted on 5-year intervals and include monitoring of water quality, wasteload allocation modeling, and re-issuance of wastewater discharge permits and licenses. (MEDEP issues licenses for all wastewater discharges in the State; these licenses are in addition to the National Pollutant Discharge Elimination System permits issued by the USEPA.) Watershed studies for the Kennebec River Basin were planned for 1997-98 with revised wastewater discharge licenses/permits issued in 1998. Initially, the plans for integrating ambient and compliance monitoring were to be completed by 1997 so that the plans could be incorporated into license/permit re-issuance in 1998. However, MEDEP is currently about 1 year behind in their schedule for completing the Kennebec River Basin watershed study and re-issuance of licenses. USEPA has completed its re-issuance of discharge permits. Plans for fully integrating ambient and compliance monitoring were not completed in 1997 and are still under development. Despite delays in completing an integrated monitoring strategy, progress has been made; this progress is presented in the following sections.

The government agencies and permittees involved in this study have been participating because they feel it is a worthwhile activity. No special funding has been obtained to pay for the work involved in the study. As a

result, the work has occasionally become a low priority, which has delayed the completion of the 3-year study.

The Process

The following six-step process was developed for integrating ambient and compliance monitoring:

- Identify and describe ongoing and historical monitoring activities in the study area.
- Identify the existing resources that various organizations apply to monitoring.
- Identify, assess, and prioritize water-quality problems and data needs for the study area.
- Develop an `idealized' integrated monitoring approach for the study area of the Kennebec River based on the water-quality issues and priorities.
- Identify how existing monitoring programs/requirements can be modified to support an integrated monitoring plan.
- Develop action plan and necessary logistics for implementing program changes needed to achieve an integrated monitoring program.

The first three steps were completed in the first 2 years of the study. These steps included an inventory of current and past ambient and discharge-permit related water-quality monitoring in the basin, a survey of resources and expenditures for current ambient and compliance-monitoring activities, identification of the important water-quality issues in the basin, and the use of existing data for various river-management activities. The results of these activities are described in the following paragraphs.

During the summer of 1997, the first integrated water-quality sampling of the Kennebec River took place; a second integrated sampling is planned for 1998. Subsequent to this sampling activity, a long-term, integrated ambient-compliance-monitoring plan will be developed with the goal of redirecting monitoring activities to areas where gaps in knowledge exist without increasing the resources spent on monitoring. A creative working environment has developed between the participants so that resources are shared among the Federal and State agencies and permittees to accomplish mutual goals of the plan.

Ambient and Compliance Monitoring

Descriptions of the ambient- and compliance-monitoring activities in Kennebec River were gathered early in the study. Information on the types and frequency of monitoring and the annual costs associated with the monitoring were collected. A review of ambient monitoring of the Kennebec River from 1980 to the present (1998) found that there is no current on-going, continuous monitoring underway (table 3). Both MEDEP and the USGS formerly performed routine water-quality monitoring of the Kennebec River; MEDEP's routine water-quality monitoring was discontinued in 1989 and USGS's routine monitoring ended in 1994. MEDEP currently focuses their monitoring on toxic substances and benthic invertebrates. The toxic monitoring consists of annual collections of fish tissue and bed sediments at two locations on the Kennebec River. Dioxins, polychlorinated biphenyl's, pesticides, trace metals, and polyaromatic hydrocarbons are monitored. In addition, MEDEP monitors water quality of the Kennebec River once every 5 years to collect data necessary for the re-issuance of discharge permits; these data are collected under low-flow conditions. USGS does not currently (1998) monitor water quality in the study area. The only other in-stream water-quality monitoring that was identified is that done by the Kennebec Sanitary Treatment District (KSTD). River samples are analyzed for E. coli bacteria because the District has combined sewer overflows; this monitoring is required as part of their discharge permit.

Information on the compliance-monitoring activities of the four largest permitted discharges in the study area was compiled. The remaining discharges did not provide information but comprise a small fraction of the total waste discharged to the Kennebec River. The compliance-monitoring requirements for all permittees can be obtained from the NPDES permit or state license issued to the facility. (The costs associated with the

compliance monitoring, however, could not be obtained from the permit/ license.) Most of the major permittees contain multiple discharges and typically include separate process wastewaters and stormwater discharges. Compliance monitoring of the process wastewaters of major facilities generally includes bioassay tests and the analysis of chemical constituents and flow.

The annual costs associated with ambient- and compliance-monitoring activities vary by activity and agency/organization. In addition, some of the costs are only estimates. This is especially true for costs associated with the discontinued ambient-monitoring activities; these estimates are based on costs during the last year of monitoring, and as such, are outdated. In 1996, the year this information was collected, about $35,000 was spent annually by the MEDEP to monitor the Kennebec River in the study area. Of this amount, $20,000 was from fees collected by MEDEP associated with the licenses of 3 permittees in the basin—KSTD and 2 pulp-and-paper mills (SD Warren Co. and Kimberly-Clark)—to assess dioxin effects. Estimates of the costs of compliance monitoring by permittees are difficult to compare to one another because of the variability of the information provided by each. One permittee estimated annual costs to be near $150,000; this figure includes all staff salaries. Other permittees included only direct laboratory costs—these varied from approximately $9,000 per year to $25,000 per year. If one assumes that annual laboratory costs average $15,000 per year per major permittee, then approximately $120,000 is spent for direct laboratory costs associated with compliance monitoring. This compares to $35,000 annually spent on ambient monitoring by the State.

Water-Quality Issues in the Kennebec River and Utility of the Ambient and Compliance Data for River Assessments

In 1996, participants in the study developed a matrix that defined the uses of past and present ambient- and compliance-data-collection activities in terms of the water-quality issues affecting the Kennebec River (table 4). Types of monitoring, uses of the data, and water-quality issues are included in table 4. The purpose of compiling this information was to determine which forms of ambient and compliance monitoring were most valuable for assessing a variety of water-quality issues and management programs. This information would then to used to identify those monitoring activities that should be part of a long-term monitoring plan for the Kennebec River.

The water-quality issues found to be affecting the Kennebec River include a variety of chemical constituents and pollutants and contributing sources of the pollutants. Important water-quality issues identified included an understanding of the general water-quality characteristics of the Kennebec River, such as color, odor, bacterial quality, and nutrients, knowledge of the sources of contaminants, and how the river assimilates and transports contaminants.

Three types of monitoring were identified as generating the most useful data to assess water-quality issues and resources in the study area: (1) fixed-site river monitoring of chemical constituents that occurs throughout the year, (similar to monitoring by the former USGS National Stream Quality Accounting Program); (2) monitoring of toxic substances in fish tissues and sediments; and (3) effluent data from the major permittees. All three of these monitoring efforts provide data necessary for determining the status of water-quality conditions and trends in conditions over time. Currently (1998), toxics and effluent discharges are being monitored, but year-round, fixed-site chemical monitoring of the Kennebec River is not being done.

Integrating Ambient and Compliance Monitoring – An Initial Test

In the summer of 1997, MEDEP and USGS conducted a 3-day intensive monitoring program for the Kennebec River to collect water-quality data necessary for a wasteload-allocation model developed by MEDEP. This monitoring consisted of the collection of samples at multiple sites along the river itself and at the outlet of major tributaries, and collection of effluent samples from permittees. Samples were analyzed for dissolved oxygen, nutrients, biological oxygen demand, and E. coli bacteria. Participants in the ambient-

compliance-integration study felt that this 3-day monitoring effort would be a reliable test to see if monitoring agencies and permittees could work together to monitor the river. The monitoring plan prepared by MEDEP with the assistance of USGS had the following integrated components (Miller, 1997):

- Personnel from the permittees would participate in river monitoring with MEDEP and USGS staff;
- The KSTD would analyze all E. coli bacteria samples, thus reducing laboratory analysis costs for MEDEP; and
- The USEPA and MEDEP would waive effluent compliance monitoring requirements for permittees participating in the river monitoring.

Personnel from the four major permittees in the study area participated in the monitoring effort along with staff from MEDEP and USGS. Overall, this arrangement worked well and saved MEDEP resources that would have been needed to monitor the river. MEDEP felt that without the support from the permittees, the monitoring could not have been done in 1997 because of other work commitments. MEDEP also joined into a cooperative agreement with the local office of the USGS to coordinate the operation of the monitoring program.

MEDEP and USEPA informed all the permittees in the study area that compliance-monitoring requirements would be waived if the facility participated in the monitoring, although none of the permittees requested the waiver. The permittees felt that it would be easier to maintain their monitoring schedule since they already had the staff and equipment than to stop monitoring altogether, some of which was necessary for plant operation.

MEDEP is planning to conduct a second 3-day intensive monitoring program for the Kennebec River in the summer of 1998 to gather additional data for their wasteload-allocation model. Based on the overall success of the monitoring in 1997, permittees will be participating again. Offers to waive compliance monitoring will once again be made.

Developing a Long-term Integrated Monitoring Plan for the Kennebec River

Progress has been slow on the development of a long-term integrated monitoring plan for the Kennebec River. Reasons for this include (1) resources allocated to develop a long-term plan are minimal within the agencies participating and work on the plan must be done in addition to day-to-day assignments; (2) the focus of the participants over the past year has been on completing the summer intensive monitoring; and (3) existing data on water-quality, compliance monitoring, and the watershed have not been fully analyzed. In May 1998, MEDEP, USGS, and USEPA agreed that if a long-term integrated monitoring plan is to be developed and implemented, then reliable resources need to be allocated for its development. Special funding will be pursued for 1999 to complete the plan. Activities that will need to be conducted include the following:

- Determine the distribution of nonpoint sources of pollution in the study area,
- Determine the spatial and temporal degradation in the river water quality based on all existing data,
- Identify gaps in our knowledge exist, for instance, nutrient loadings,
- Assess State dioxin monitoring for trends and variations from year to year,
- Examine results of existing water-quality models for timing and causes of degraded water quality,
- Complete assessment other water-quality studies conducted in the basin,
- Compare known point-source loadings with ambient loads in the river,
- Gather information on watershed characteristics, such as nutrient and pesticide loading estimates, water use, flow modifications, known nonpoint-source locations,
- Work with permittees and enforcement agencies to review compliance monitoring strategies and make a final determination if compliance monitoring can be altered, and

- Determine how ambient and compliance monitoring can be integrated while maintaining or reducing the

total resources spent on these activities.

Since 1995, some of these activities have been started, but are not fully completed and need to be completed as part of the development of the long-term integrated monitoring plan.

Conclusions

Currently (1998), all participating agencies and permittees continue their interest in achieving the long-term goal of an integrated monitoring program for the Kennebec River. The past 3 years have shown that sensitive issues related to compliance monitoring and private-sector resources can be tabled when the goal is better environmental data and decisionmaking. In addition, a creative working environment has developed between the participants so that resources are shared among agencies and permittees to accomplish these mutual goals.

It remains to be seen, however, if substantial revisions to compliance-monitoring requirements will be implemented. Regulatory staff appear somewhat reluctant to reduce the monitoring frequency and coverage over an extended time period, even if it means improved river monitoring. At the same time, permittees feel their wastewater operations are vulnerable to public scrutiny if their monitoring is not perceived by the public to be adequate.

As these issues are addressed and resolved, an increased understanding of the quality of the Kennebec River will be reached. This long-term monitoring study is evolutionary in design, not only in identifying the monitoring needs for the river, but also in developing the relationships among the parties to address the monitoring needs. At the same time, the quality of the river is changing as the relative effect of different stressors and sources of pollutants also are changing. All these factors must be incorporated long-term monitoring programs for the Kennebec River.

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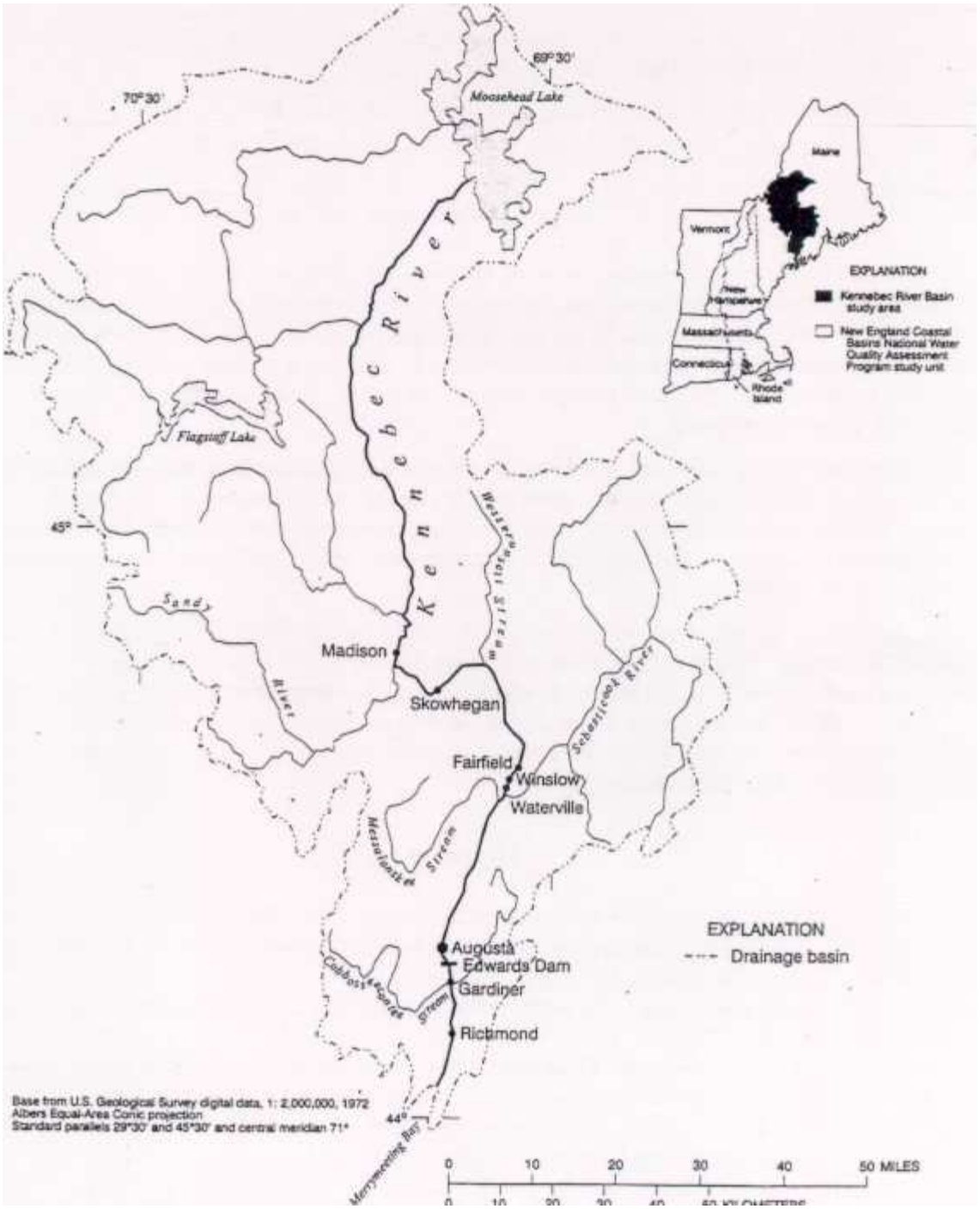

Figure 1. Map of the Kennebec River Basin.

Table 1. Wastewater Permittees Discharging to the Kennebec River Study Area, Maine

Facility	Type of facility/wastewater	Permitted flows (million gallons per day)	Major or minor facility
Anson-Madison Sanitary District	Municipal-industrial	7.8	Major

Kennebec Sanitary Treatment District	Municipal-industrial	12.7	Major
Augusta Sanitary District	Municipal	8.0	Major
Gardiner Wastewater Treatment Facility	Municipal	1.7	Major
Skowhegan Wastewater Treatment Facility	Municipal	1.4	Major
S.D. Warren Co. (Sappi)	Industrial process and stormwater	47	Major
Kimberly Clark (discontinued operation in 1998)	Industrial process and stormwater	11	Major
Statler Industries (discontinued operation in 1998)	Industrial process	6.0	Major
Norridgewock Wastewater Treatment Facility	Municipal	0.2	Minor
Skowhegan Package Plant	Municipal	—	Minor
Richmond Utilities District	Municipal	0.3	Minor
Central Maine Power Co – Merimel Hydroelectric	Industrial stormwater	—	Minor
Central Maine Power Co – Weston Hydropower	Industrial stormwater	—	Minor
Central Maine Power Co – Shawmut Station	Industrial stormwater	—	Minor
Madison Paper Industries	Industrial stormwater	—	Minor

— = No data available.

Table 2. Organizations and Agencies Participating in the Kennebec River Ambient-Compliance-Monitoring Integration Study

Organization/Agency
Maine Department of Environmental Protection
U.S. Geological Survey

U.S. Environmental Protection Agency
New England Interstate Water Pollution Control Commission
Kennebec Sanitary Treatment District
Kimberly Clark
Madison Paper Industries
Central Maine Power Co.
S.D. Warren Co. (Sappi)
Anson-Madison Sanitary District
Somerset County Soil and Water Conservation District
Friends of Merrymeeting Bay

Table 3. Ambient River Monitoring Activities in the Kennebec River Study Area, Maine, 1980-1998

Monitoring program and agency	Period of data collection	Number of sites on the Kennebec River	Constituents monitored	Purpose of monitoring
National Stream Quality Accounting Network/USGS	1978-93	1	Water column: nutrients, trace elements, field parameters, bacteria, suspended sediment	National water-quality network
Continuous Monitor/USGS	1979-94	1	Water column: specific conductance, pH, temperature, dissolved oxygen	Assess wastewater discharge impacts
Primary Monitoring Network/MEDEP	1974-89	3	Water column: DO., temp., fecal coliform, pH, color, priority pollutants	Establish baseline conditions, assess trends, and assess use attainment
Dioxin Monitoring/MEDEP	1988-present	2	TCDD, TCDF in fish tissue	Assess classification/ designated use attainment
Biomonitoring/MEDEP	1988-present	4	Benthic invertebrate community	Assess designated use attainment
Surface Water Ambient Toxics/MEDEP	1994-present	2	Fish tissue: metals, PCBs, pesticides, polyaromatic hydrocarbons (PAHs)	Assess designated use attainment

USGS, United States Geological Survey

MEDEP, Maine Department of Environmental Protection

Table 4. Components of the Matrix Relating Monitoring Activities to Use of the Monitoring Data and Water-Quality Issues for the Kennebec River Study Area, Maine

Type of monitoring activity	Uses of the monitoring data	Water-quality issues in the study area
• Ambient • Compliance • Streamflow measurements	• Enforcement/compliance • Water-quality conditions assessment • Models/predictive studies • Wasteload allocations • Public health advisories • Time trends • Planning water uses/water management decisions (both public and private) • Resource assessment • Time trends • Planning water uses/water management decisions (both public and private) • Planning water uses/water management decisions (both public and private) • Resource management • Fisheries management • Wastewater treatment process controls • Third party legal actions	• Chronic toxicity of aquatic life and bioaccumulation (esp. chlorine and metals) • Assimilative capacity and background concentrations for toxics, conservative pollutants, and nutrients • Pathogens/E. coli bacteria • Understanding background conditions in the river • Understanding the relative contribution of point and nonpoint sources to total loads in the river • Contaminated sediments • How flow regulation affects water quality and aquatic habitat • Color/odor/foam/total suspended solids • Health of aquatic life/biomonitoring • Fate and transport of metals. nutrients, sediments, and constituents of concern