COCHECO RIVER WATERSHED ENVIRONMENTAL QUALITY REPORT

Prepared by

Thomas R. Fargo
and
Danna B. Truslow

D. B. Truslow Associates
Rye, NH

Prepared for

Cocheco River Watershed Coalition
Dover, NH

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Cocheco River Watershed
ENVIRONMENTAL QUALITY REPORT

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COCHECO RIVER WATERSHED - ENVIRONMENTAL QUALITY REPORT

1.0 PROJECT OVERVIEW

Since 1998, the Cocheco River Watershed Coalition (CWRC) has been working with the NH Department of Environmental Services (DES) to monitor the water quality of the river. In 1999, the Cocheco River Watch was established with three monitoring teams under the direction of the DES Volunteer River Assessment Program. In an effort to better understand a broad range of technical issues relating to the health of the watershed, the CWRC applied for a grant from the DES funded through their Section 319 Clean Water Act program. In 2003 the DES awarded the CRWC funds to support a project titled, *Environmental Quality Characterization and Recommended Monitoring and Restoration for the Cocheco River*. According to the DES:

> This project aims to establish a baseline of existing conditions, identify sources of contaminants and determine impacts on the Cocheco River ecosystem as a whole. This will be accomplished through the compilation and analysis of existing information, creation of watershed and site descriptions and land use cover maps, to determine recommendations for future monitoring programs and restoration activities within the Cocheco River Watershed.

D.B. Truslow Associates was contracted by the Cocheco River Watershed Coalition to write three documents:

1. An Environmental Quality Report that describes the pollution issues, pollution sources and the resulting human and biological impacts, if known. The report identifies gaps in information for both spatial coverage and measured parameters.
2. A draft and final Monitoring Plan that addresses issues and pollutants that have been identified as important in previous studies.
3. A draft and final Restoration and Implementation Plan that describes actions to address the environmental quality problems, the steps needed to complete the restorative action, measures for success, community interest, an estimated budget for each restoration action, and an organizational structure for implementation.

These documents provide a comprehensive compilation of existing data and information, an interpretation of the conditions in the watershed, and a plan for future monitoring and restoration activities for the CWRC and others.

This report represents the first of these three documents.

Reproduced below is the “Statement of Purpose” for the Cocheco River Watershed Coalition.

Cocheco River Watershed Coalition
STATEMENT OF PURPOSE
May 27,1999

The Coalition wants watershed communities to regard the river as an asset, to foster the environmental health of the river and to derive benefits from the river.

Watershed communities that recognize the value of the river will protect the economic value of the water resources, including groundwater, with resulting increase in quality of life, property values, recreational opportunities, and resource management. Citizens of the watershed communities will have an increased capacity to make informed decisions regarding management of the river and other natural resources of the watershed. Informally citizens will act to protect and enhance the environmental values of the river. They will celebrate the river as a cornerstone of their sense of place.

The Coalition wants healthy fish populations in the watershed as indications of ecological well-being and for recreation and consumption.

Healthy fish populations depend on a healthy watershed, river corridors, river and estuary. Fish need habitat that provides food, water, shelter and space for each species with suitable physical, chemical and biological characteristics of the river and tributaries. Pollution, including sedimentation, impedes stream flow, habitat availability and quality. For recreation, people need access to the river and free navigation of the stream. Inventory and assessment of the condition of the river are essential to improving and maintaining healthy fish populations and recreational activities.

The Coalition wants citizens of the watershed to have access to a clean, healthy river and to develop a stewardship ethic regarding the watershed.

The Cocheco River will meet Class B standards set by the state. People should expect to be able to fish and swim in the river. Citizens who become familiar with the watershed, take part in assessment of the river and its improvement will develop a stewardship ethic.

2.0 GEOGRAPHIC AND PHYSICAL SETTING

Some facts and figures on the Cocheco River Watershed Study area are included in Table 1. These statistics help to illustrate the importance of the river to the area and the impacts that the human population has and will continue to have on the watershed. Details on these statistics are included throughout the report. For a glossary of hydrologic terms used in the report, please refer to the web address http://www.crh.noaa.gov/hsd/hydefd-f.html#d.

Table 1
Facts and Figures - Cocheco River Watershed

Area of Cocheco River Watershed	185.2 square miles
Number of designated Subwatersheds	8
Elevation Change Along River	700 feet
Median Daily Discharge (at Rochester)	71 cubic feet per second
Maximum Recorded Discharge (at Rochester)	2980 cubic feet per second
Minimum Recorded Discharge (at Rochester)	2 cubic feet per second
Total Discharge to Estuary	9.01 billion cubic feet per year
Human Population of Watershed – 2000	68,689
Projected Human Population – 2020	83,370
Population Change 2000 to 2020	14,681 (21.4%)
Change in Impervious Surface Area – 1990 to 2000	5.9 %
Number of CRWC Sampling Points Used in Study	28

2.1 Geographic Limits of the CRWC Study Area

The Cocheco River watershed encompasses approximately 185.2 square miles. This watershed makes up one portion of the larger Piscataqua/Salmon Falls watershed area recognized by the United States Geological Survey, the US Environmental Protection Agency, and other federal and New Hampshire state agencies. Other major

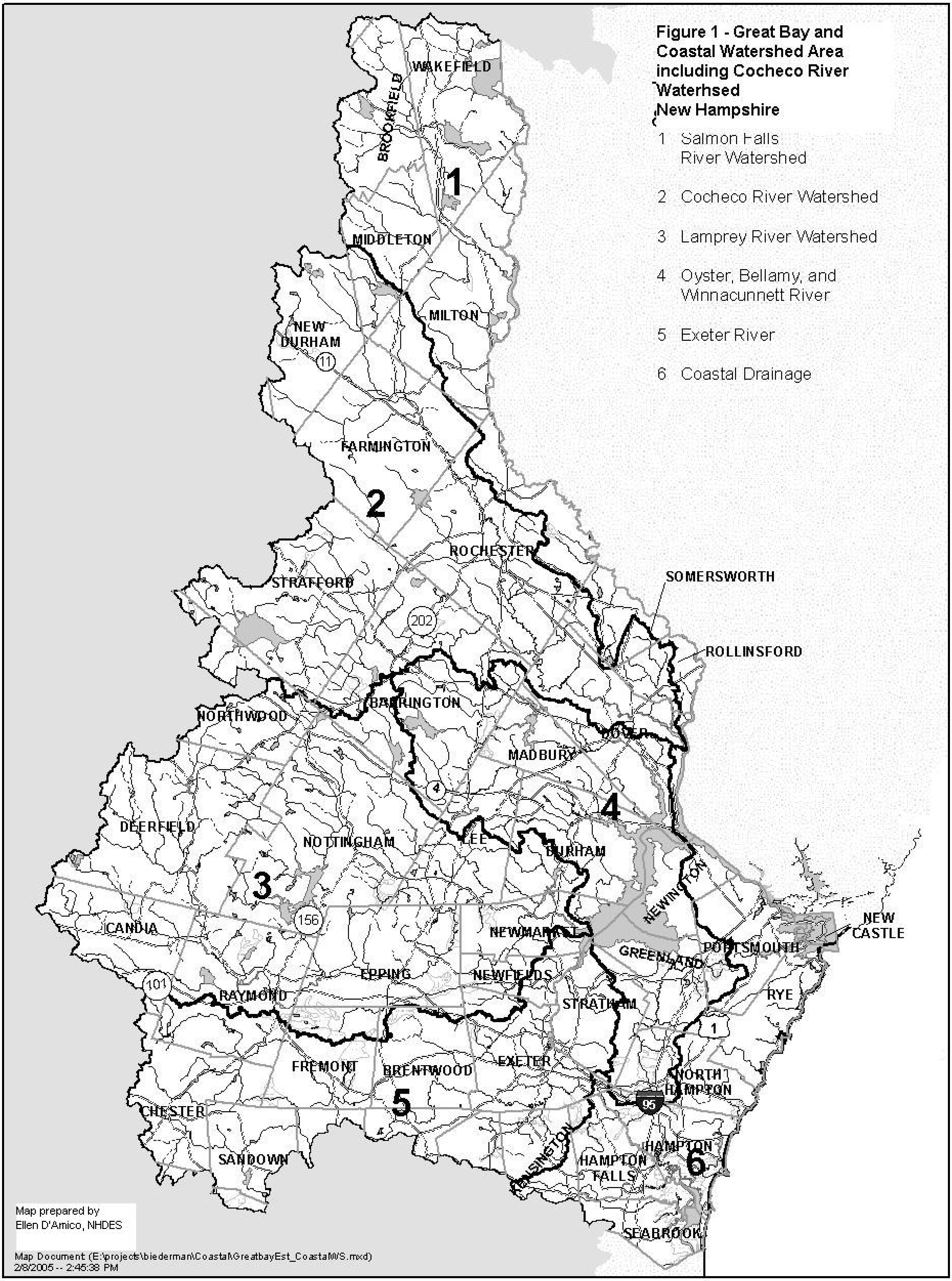


Figure 1 - Great Bay and Coastal Watershed Area including Cocheco River Waterhsed New Hampshire

rivers/watersheds within the Piscataqua watershed include the Exeter, Lamprey, Oyster, Bellamy, and Salmon Falls as shown in Figure 1.

The NHDES has divided the Cocheco River Watershed into eight sub-watersheds for assessments and reporting related to the requirements of the Clean Water Act, Sections 303d and 305b. These sub-watersheds are denoted by the NHDES by their 12-digit Hydrologic Unit Codes (HUC-12). The names, HUCs, and areas of these sub-watersheds are listed below in Table 2.

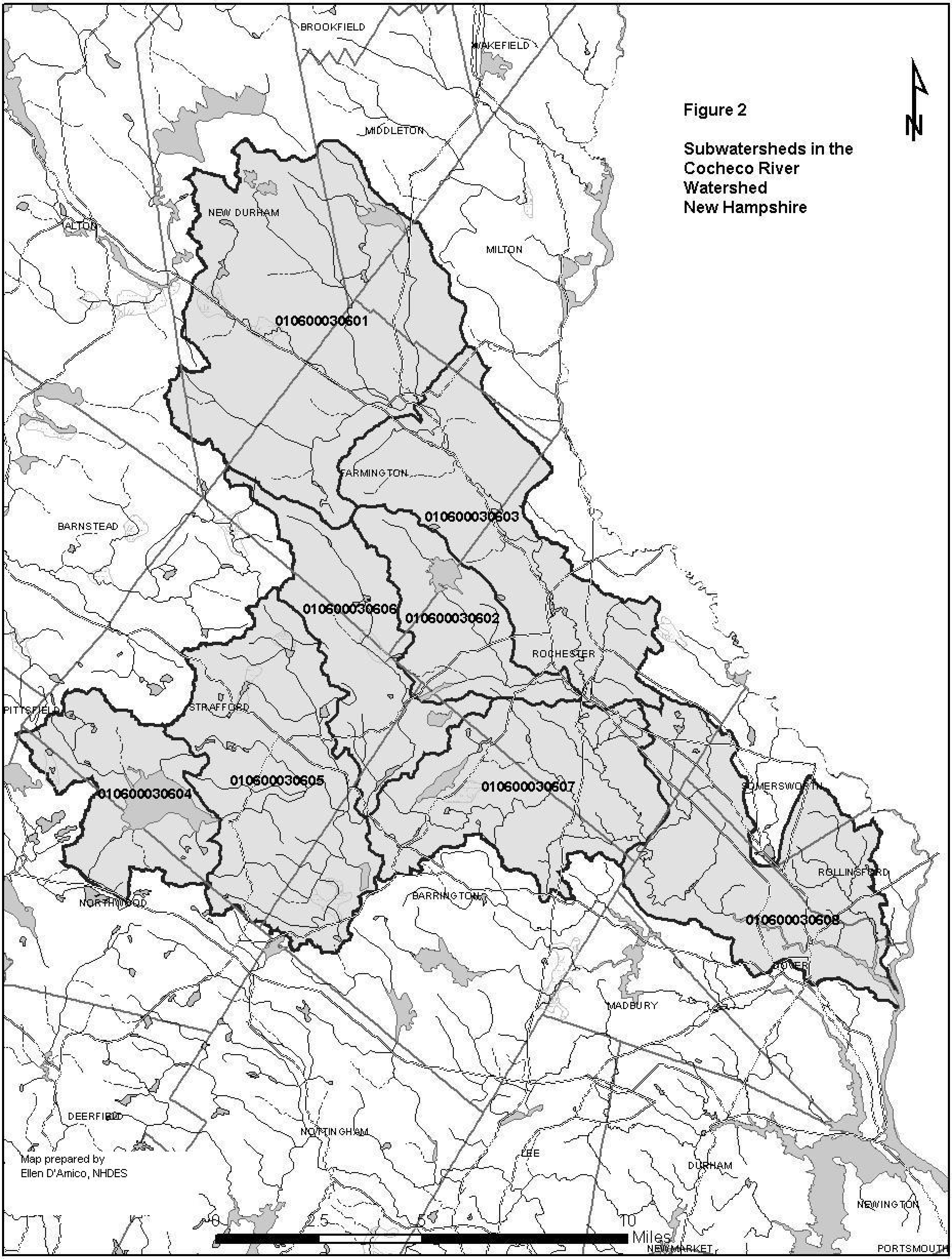
Table 2
NHDES "HUC 12" Sub-Watersheds Within the Cocheco River Watershed

Sub-Watershed Name	12-Digit Hydrologic Unit Code Number	Sub-Watershed Area (square miles)
Upper Cocheco	010600030601	43.2
Axe Handle Brook	010600030602	11.6
Middle Cocheco River	010600030603	24.9
Bow Lake	010600030604	14.3
Nippo Brook – Isinglass River	010600030605	27.2
Long Pond	010600030606	15.9
Lower Isinglass	010600030607	22.8
Lower Cocheco	010600030608	25.3
Total Cocheco Watershed	**Not Applicable**	**185.2**

Figure 2 depicts the areal extent of the eight sub-watersheds within the overall Cocheco River watershed area.

It is recognized that the activities of the Cocheco River Watershed Coalition have concentrated primarily on assessing the main stem of the river from its upper reaches in Farmington, through Rochester, to its merging with tidal waters in Dover. In an effort to condense this project to a manageable scope, certain portions of the watershed were recognized as being out of the extent of this assessment.

Those portions of the watershed draining to the Isinglass River (above its confluence with the Cocheco River main stem near the Dover-Rochester municipal boundary) have not been included in this environmental quality assessment. In June of 2002, the Isinglass River became what is known as a "designated river" within the NHDES Rivers Management Program. An Isinglass River Local Advisory Committee (LAC) was appointed in December 2002 to advise federal, state, and local municipal officials regarding the management of the river and its corridor area in accordance with NH State Laws RSA 483:8 and RSA 483:8-a. The Bow Lake, Nippo Brook – Isinglass River, Long Pond, and western portions of the Lower Isinglass sub-watersheds (listed in Table 1) are considered to be within the purview of the Isinglass River LAC. Over the years, the CRWC has conducted limited water quality assessments within the Isinglass watershed. For this reason, members of the Isinglass River LAC are being interviewed regarding



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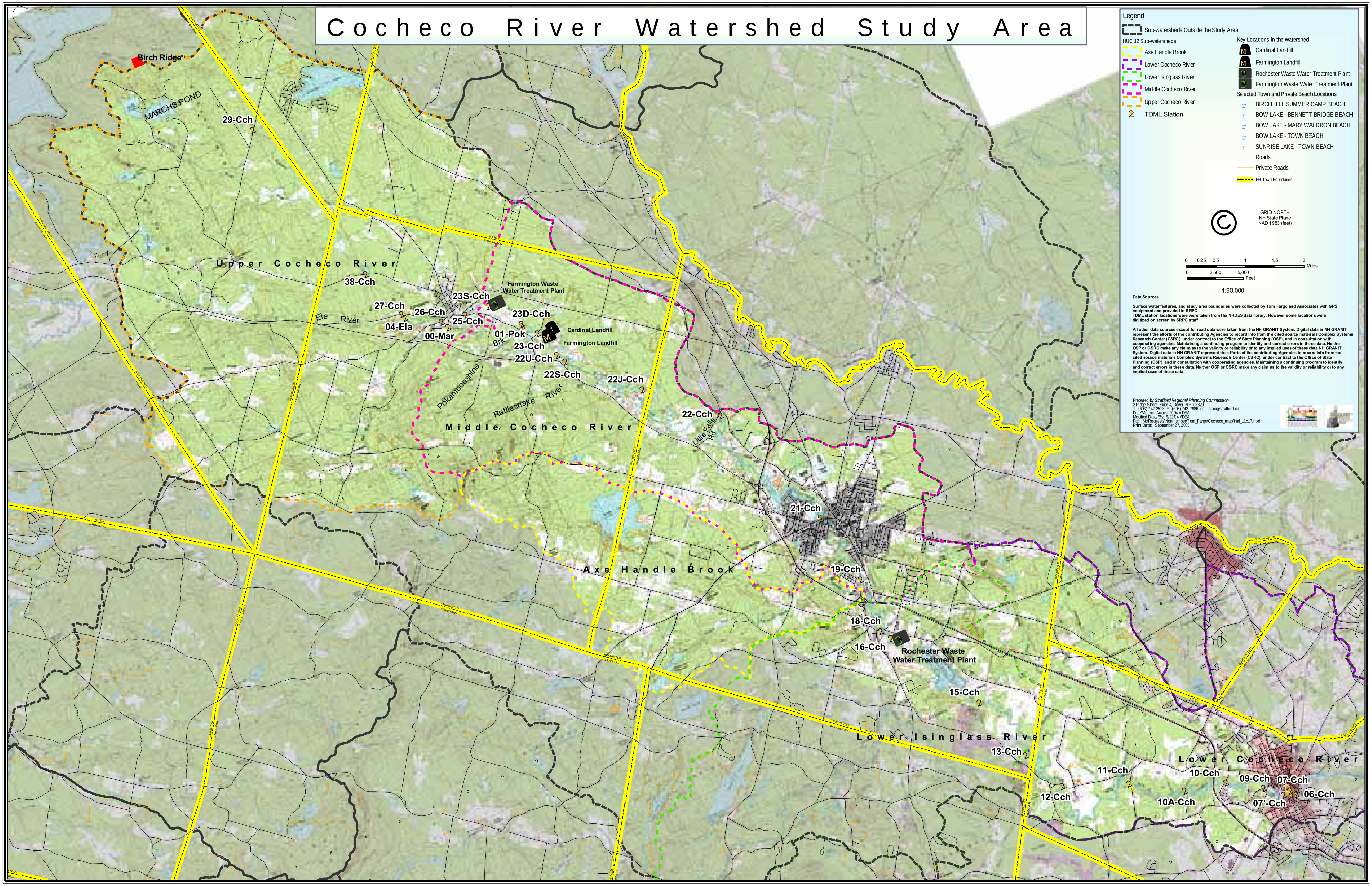
their opinions about managing water resources within the Cocheco River watershed as a whole.

The CRWC has also conducted only limited water quality assessments in the tidal portions of the Cocheco River. Extensive studies of this portion of the river system have been completed by the Great Bay Coast Watch organization in cooperation with the New Hampshire Estuaries Project (NHEP) and New Hampshire Coastal Program. The NHEP has completed both “A Technical Characterization of Estuary and Coastal New Hampshire” (Jones, 2000) and a “Management Plan” (NHEP, 2000) that cover the tidal portions of the Cocheco River in much more detail than could be offered herein. This project, therefore, does not attempt to incorporate assessing tidal Cocheco River, including those portions of the tidal Cocheco River watershed that are drained by first-order streams and the Fresh Creek drainage that discharges directly to tidal waters.

The area of the Cocheco River watershed investigated and reported herein is shown as the CRWC Study Area in Figure 3. This area has been calculated to encompass 101.7 square miles.


Cocheco River Watershed Study Area
Legend
Sub-watersheds Outside the Study Area
HUC 12 Sub-watersheds
Axe Handle Brook
Lower Cocheco River
Lower Isinglass River
Middle Cocheco River
Upper Cocheco River
TDML Station
Key Locations in the Watershed
Cardinal Landfill
Farmington Landfill
Rochester Waste Water Treatment Plant
Farmington Waste Water Treatment Plant
Selected Town and Private Beach Locations
BIRCH HILL SUMMER CAMP BEACH
BOW LAKE - BENNETT BRIDGE BEACH
BOW LAKE - MARY WALDRON BEACH
BOW LAKE - TOWN BEACH
SUNRISE LAKE - TOWN BEACH
Roads
Private Roads
NH Town Boundaries
GRID NORTH
NH State Plane
NAD 1983 (feet)
0 0.25 0.5 1 1.5 2 Miles
0 2,500 5,000 Feet
1:90,000
Data Sources
Surface water features, and study area boundaries were collected by Tom Fargo and Associates with GPS equipment and provided to SRPC.
TDML station locations were were taken from the NHDES data library. However some locations were digitized on screen by SRPC staff.
All other data sources except for road data were taken from the NH GRANIT System. Digital data in NH GRANIT represent the efforts of the contributing Agencies to record info from the cited source materials Complex Systems Research Center (CSRC), under contract to the Office of State Planning (OSP), and in consultation with cooperating agencies. Maintaining a continuing program to identify and correct errors in these data. Neither OSP or CSRC make any claim as to the validity or reliability or to any implied uses of these data NH GRANIT System. Digital data in NH GRANIT represent the efforts of the contributing Agencies to record info from the cited source materials Complex Systems Research Center (CSRC), under contract to the Office of State Planning (OSP), and in consultation with cooperating agencies. Maintaining a continuing program to identify and correct errors in these data. Neither OSP or CSRC make any claim as to the validity or reliability or to any implied uses of these data.
Prepared by Strafford Regional Planning Commission
2 Ridge Street, Suite 4, Dover, NH 03820
T: (603) 742-2523 F: (603) 742-7986 em: srpc@strafford.org
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Print Date: September 27, 2005
Birch Ridge
MARCHS POND
29-Cch
Upper Cocheco River
38-Cch
27-Cch
26-Cch
04-Ela
00-Mar
25-Cch
23S-Cch
Farmington Waste Water Treatment Plant
23D-Cch
01-Pok
Brk
Cardinal Landfill
Farmington Landfill
23-Cch
22U-Cch
22S-Cch
22J-Cch
Ela River
Pokamoonshine
Rattlesnake River
Middle Cocheco River
22-Cch
Little Falls Rd
21-Cch
Axe Handle Brook
19-Cch
18-Cch
16-Cch
Rochester Waste Water Treatment Plant
15-Cch
Lower Isinglass River
13-Cch
12-Cch
11-Cch
Lower Cocheco River
10-Cch
10A-Cch
09-Cch
07-Cch
07'-Cch
06-Cch

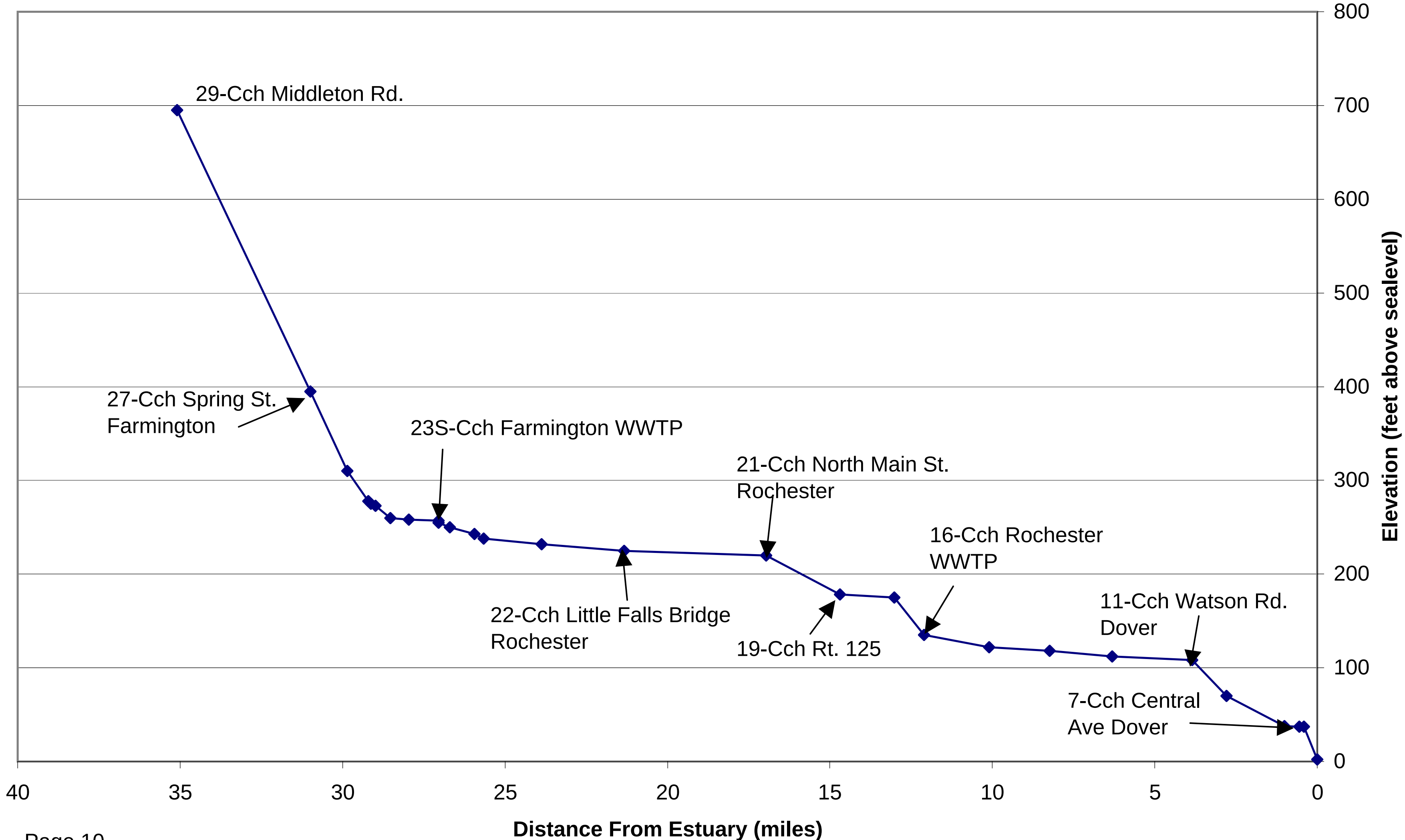
2.2 Description of the Study Area

The following description of the Cocheco River is excerpted from two descriptions prepared by the NH Department of Environmental Services (DES, 1990 and 1992). The tributaries and landmarks listed below are shown in Figure 3. An elevation profile of the Cocheco River, reproduced from the DES reports cited above, is included as Figure 4.

> "The Cocheco River flows southeast from its headwaters, a distance of approximately 33 miles to the tidal dam in downtown Dover. The river has its headwaters on the southeast side of Birch Ridge in New Durham, approximately 7 miles above downtown Farmington. This uppermost reach has the greatest drop in elevation of the entire watershed (610 feet). It is characterized by shallow, fast-flowing water with a sand or gravel streambed. Two significant tributaries, the Ela and Mad Rivers, enter from the west in the downtown area of Farmington. The drainage area of the Cocheco River above the Farmington wastewater treatment plant is 43.8 square miles.
>
> Below Farmington, the Cocheco River meanders along a small swampy area, then through large (glacial) outwash areas where sand and gravel operations have capitalized on these natural deposits. The Pokamoonshine Brook and Rattlesnake River enter the Cocheco River downstream of the Farmington outfall and upstream of Rochester. Two landfills, the Farmington landfill and the Cardinal (private) landfill are located between these two tributaries. Between Farmington and northern Rochester, the river drop is minimal. From above Farmington to the bridge on Little Falls Road in Rochester, the Cocheco Rover drops approximately 15 feet in 6.6 miles. Its width averages about 25 feet while the average depth increases from about two feet to approximately five feet.
>
> Below Little Falls Bridge to the Rochester wastewater treatment plant outfall, there are five dams and the river drops approximately 85 feet in 4.9 miles. This segment is characterized by alternating sections of flat, slow-moving water with sediment deposits behind the dams, and rapid areas of fast moving water over scoured rocky substrate. The segment from the Rochester outfall to Watson Road dam in Dover is a typical meandering, mature river basin with varying depth and occasional deep pools. River width averages 60 feet with a range from 30 to 100 feet. Near the middle of this segment a major tributary, the Isinglass River, joins the Cocheco River from the west. The Isinglass River originates at the outlet of Bow Lake and joins the Cocheco River near the southern border of Rochester and drains about 73 square miles. The Watson Road dam is currently the only impoundment in this segment. The last 3.3-mile segment from Watson Road dam to the tidal dam in Dover has fewer meanders and backwater areas than the previous segment. Below Dover the river flows under tidal influence to the confluence with the Salmon Falls and Piscataqua Rivers."

Based on digital Geographic Information Systems (GIS) data the CRWC study area, included in this investigation, encompasses approximately 106 square miles. The measured length of the main stem of the Cocheco River, in this area, is 37.1 miles. As can be seen on Figure 3, the CRWC study area includes significant portions of the municipalities of New Durham, Middleton, Milton, Farmington, Rochester, Somersworth, and Dover. There are only minor portions of the towns of Alton, Strafford, and Barrington within the CRWC study area. As discussed above, that portion of the

Figure 4 - Elevation Profile of Cocheco River



Cocheco River watershed lying within the Isinglass River sub-watershed is considered outside the current CRWC study area.

2.3 Hydrologic Data Analysis

The United States Geological Survey (USGS) maintains two gauging stations within the Cocheco River watershed. One gauging station records stage height in the Isinglass River immediately upstream from the confluence with the Cocheco River. The other gauging station (USGS ID# 01072800) is located in Rochester near that city's wastewater treatment plant. The USGS estimates that there are 85.7 square miles of drainage basin upstream of this discharge monitoring point. The Rochester gage has been collecting daily discharge measurements since March 1, 1995. Discharge data from March 1995 through September 30, 2003 are available for downloading from the USGS web site. (http://nh.water.usgs.gov/WaterData/station_map.htm)

2.3 a Stream-Flow Statistics

Based on the roughly nine-year period of USGS monitoring, the average daily discharge measured near the Rochester wastewater treatment plant is 132 cubic feet per second (cfs). Figure 5 depicts the average discharge measured on a monthly basis over the entire monitoring period.

Since averages tend to be skewed by large flood discharges, a more accurate statistical indicator of "normal" discharge conditions would be the median value (i.e. 50% of the measurements are greater, 50% are lower). The median daily discharge for the Cocheco River measured at Rochester, between March 1, 1995 and September 30, 2003 was 71 cfs.

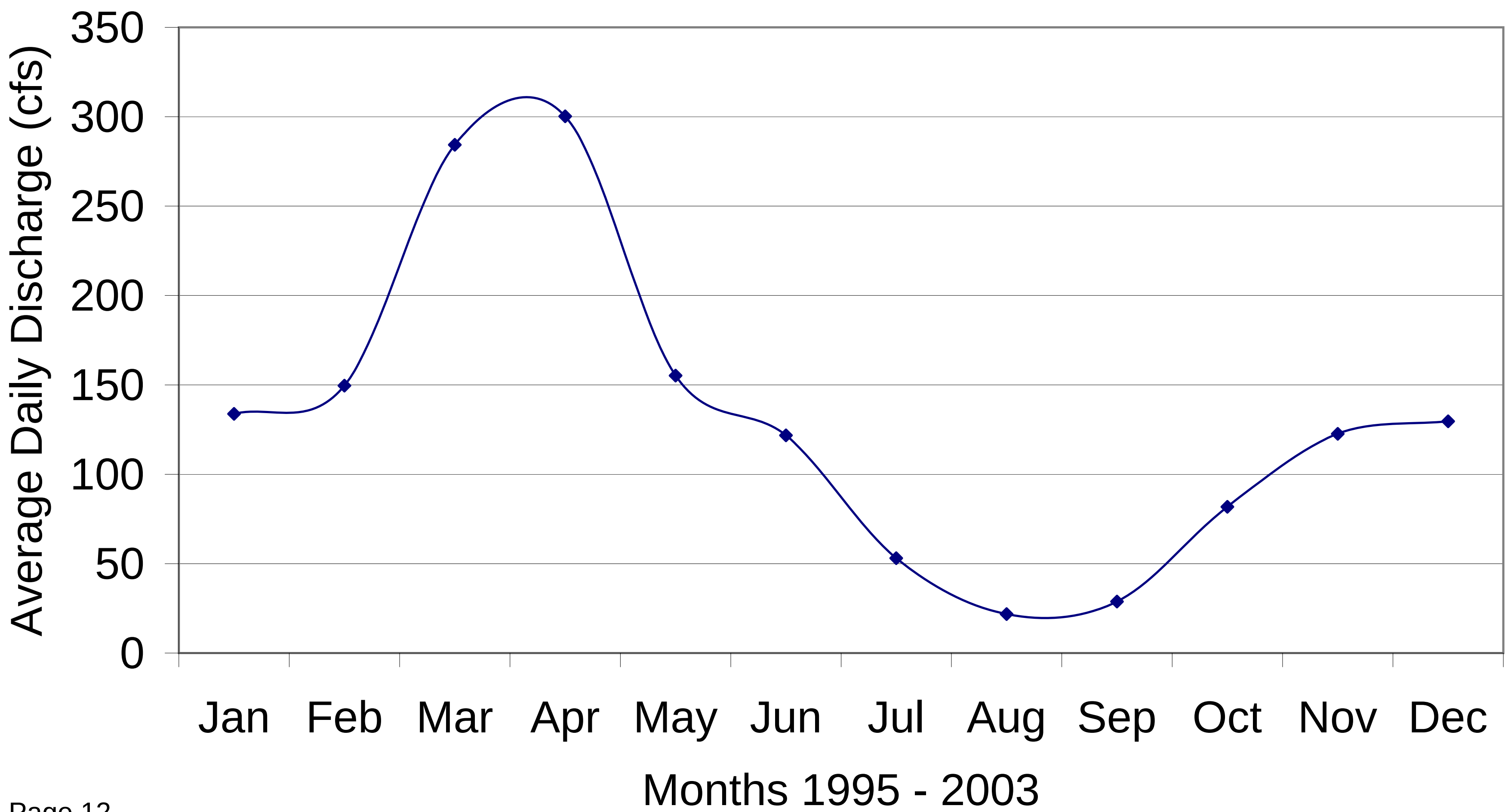
The maximum discharge measured at the Rochester gauging station was 2,940 cfs, recorded on June 15, 1998. Other high flows occurred on April 17, 1996 (2,530 cfs), October 22, 1996 (2,730 cfs), April 19, 1997 (2,240 cfs), and June 14, 1998 (2,880 cfs).

Generally, the seasonal low flows occur during early to mid-September. The lowest measured flows occurred on September 14 and 15, 2002 when the average daily discharge was measured at 2.0 cfs. Comparable low flows were recorded on September 4, 1995 (2.2 cfs) and September 5 and 6, 1999 (2.5 cfs). Based on flow data from 1995 through 2003, it is considered unusual to have river flows less than 10 cfs.

2.3 b Hydrologic Budget Considerations

The total annual runoff for the Cocheco River watershed, estimated from the Rochester gauging station data, is estimated to be approximately 9.0 billion cubic feet per year. (USGS website data). This is based on the total drainage basin area of 185 square miles, and an average discharge of 1.54 cubic feet per square mile of drainage area. This total discharge equals a runoff value of 20.93 inches per square foot per year. Annual precipitation across the Cocheco River watershed is approximately 42 inches per square

Figure 5
Average Monthly Discharge
of Cocheco River at Rochester, NH



foot per year (UNH Weather Station Data). A widely accepted rule-of-thumb is that approximately one-half of the annual precipitation that falls in this area is lost through evaporation and/or transpiration from plants. The remaining half of the precipitation eventually runs off as stream drainage. The Rochester gauging data supports this rule-of-thumb estimate.

2.3 c Low Flow Conditions

The DES assesses the allowable levels of treated wastewater discharge on the river's water quality by estimating the potential impact the discharge would have under low flow conditions. The discharge statistic used in this determination is the "7Q10" flow. The 7Q10 is an estimated discharge that represents the anticipated 7-day low flow, which occurs on the average of once every ten years. In 1990, prior to the establishment of the USGS gauging station, the DES estimated the 7Q10 at the Rochester wastewater treatment plant at 2.2 cfs (DES, 1990). This flow compares well to the low flows measured in early September between 1995 and 2003. According to George Berlandi, of the State's Wastewater Engineering Bureau, the DES will likely be revising downward the 7Q10 values, for several segments of the Cocheco River, based on the USGS data that is now available.

2.3 d Time of Travel Estimates

Another river flow characteristic that influences the quality of the Cocheco River water is the time of travel. As part of their Rochester and Farmington waste load allocation studies (DES 1990 & 1992), the DES has calculated estimates of the amount of time it would take for a slug of water to travel across various river segments, at various flow conditions. Time of travel estimates from these calculations, as well as extrapolations for reaches not evaluated by the DES, are listed in Table 3. These data reflect "normal" or approximate median flow conditions (reflective of a 70 cfs discharge at the Rochester gage) and low-flow conditions (reflective of 7Q10 discharge at the Rochester gage). As can be seen in Table 3, under median flow conditions the total time it would take a slug of water entering the Cocheco River in Farmington to travel to the tidal dam in Dover is approximately 8.6 days. Under low flow (7Q10) conditions, the time required to flow the same distance might be on the order of 40 days. Variations in the Cocheco River's flow velocity and retention time can have a profound effect on its water quality.

2.4 Land Use Trends Within the Watershed

One of the principal concerns regarding maintaining and improving the water quality of the Cocheco River is the influence of land use changes on point and non-point pollution sources. The CRWC has expressed an interest in monitoring areas where baseline water quality data may be obtained to assess the effects of development. The former New Hampshire Office of State Planning (now incorporated into the Office of Energy and Planning) projects that the population living within the watershed area will increase by at least 20 percent over the next 20 years. The following chart, Table 4, describes the

Table 3 -Time of Travel Estimates

Cocheco River

		Median Flow Conditions (70 cfs*)		7Q10 Flow Conditions (2.2 cfs*) (Low Flow)	
Reach	**Length of Reach (miles)**	**Approximate Velocity (ft/sec)**	**Time of Travel for Reach (days)**	**Approximate Velocity (ft/sec)**	**Time of Travel for Reach (days)**
Farmington WWTP to Rattlesnake River	2.0	0.26	0.47	0.6	0.20
Rattlesnake River to Little Falls Road**	4.3	0.16	1.64	0.04	6.57
Little Falls Road to Downtown Rochester **	4.4	0.16	1.68	0.04	6.72
Downtown Rochester to Rochester WWTP**	4.8	0.5	0.59	0.4	0.73
Rochester WWTP to Isinglass River	3.7	0.26	0.87	0.06	3.77
Isinglass River to Watson Road Dam	4.4	0.14	1.92	0.02	13.45
Watson Road Dam to Dover Tidal Dam	3.3	0.14	1.44	0.02	10.09
Total River Length - Farmington WWTP to Dover Tidal Dam	**26.9**		**8.6**		**41.5**
* - Approximate Flow at USGS Gaging Station					
** - Estimated - not in NHDES reports					
WWTP - Wastewater Treatment Plant					

anticipated growth in the population of key communities within the Cocheco River watershed over the next 16 years (OEP website data).

Table 4
Population Growth Within the Cocheco River Watershed

City or Town	Census 2000 Population	Estimated 2020 Population	Percent Change
Dover	26,884	30,150	+12%
Rochester	28,461	35,070	+23%
Farmington	5,774	7,500	+30%
New Durham	2,220	3,500	+58%
Middleton	1,440	1,980	+38%
Milton	3,910	5,170	+32%
Total Watershed	**68,689**	**83,370**	**+21.4%**

It is widely recognized that the amount of land used to accommodate increased population is much greater that the actual increase in population. This phenomenon is known as urban or suburban sprawl. For example, the USEPA reported that the amount of urban area growth (the increase in land use consumption) in the Boston metropolitan area between 1950 and 1990 was 158% while the population increased only 24.3% over the same period (USEPA, 2001). This pattern of growth reflects the opportunities provided by and also dependence on automobile transportation. The same EPA report showed that Americans are continuing to rely even more on their automobiles. Between 1980 and 1996 the rate of vehicle miles traveled in the US increased by 3.1% annually while the associated increase in population was only 1%. This has resulted in an approximate 60% increase in vehicle miles traveled during the 16-year study period. If these growth statistics hold true for the Cocheco River watershed area, we may see the doubling of the amount of developed land within the watershed in the next 20 years. Most of this development would happen by way of a conversion from undeveloped fields and forests to residential and commercial uses.

These anticipated changes in population and the associated increases in development will have a profound effect on the Cocheco River watershed. Discharge volumes from point sources, such as municipal wastewater treatment plants, will increase as the population served by these facilities increases. The demand for water supplies will also increase dramatically. Recent trends have shown that a rise in affluence (increased personal income) can dramatically increase, perhaps tenfold, the per capita demand for water supplies (USGS). One significant factor here appears to be increased outdoor water use such as lawn irrigation, landscaping, and auto washing. In addition, as more areas are placed on municipal sewer and stormwater conveyance services, infiltration and groundwater recharge will decrease. This will ultimately result in decreases in stream base flow and increases in storm flow.

Development, particularly the installation of impervious surfaces, increases the rapidity with which precipitation or stormwater runs off the developed areas. Development also increases the likelihood that pollutants will be discharged to the river's tributaries and the rivers main stem by that runoff. This latter type of pollution is known as non-point source pollution.

3.0 OBSERVED RIVER CONDITIONS

During the fall of 2003, representatives of D.B. Truslow Associates and the CRWC toured the Cocheco River watershed areas in the Town of Farmington, and the Cities of Rochester and Dover. The purpose of these tours was to gain an insight into issues affecting the water quality of the Cocheco River and it tributaries in the aforementioned municipalities. In each of the communities, the effects of increased development were apparent. Copies of the meeting notes are attached as Appendices A-C of this report. Salient points noted during the watershed tours are summarized below:

3.1 Farmington

Most all of the Cocheco River watershed upstream of Farmington village is not heavily influenced by man-induced activities. As the river and its tributaries enter the more heavily developed Farmington village, water quality impacts become more apparent.

Hydrogeologic observations suggest that upstream of Farmington Village tributaries flow across uplands underlain by relatively thin glacial till deposits covering bedrock. As these tributaries enter the village area, the underlying geology changes to glacially derived sand and gravel deposits. It appears that a significant portion of stream flow is exchanged between the groundwater and surface water systems. This has two influences on the water quality of surface water. First, the infiltration of stream flow through the river profile decreases the amount of surface water moving through the drainage courses thereby reducing the dilution potential along these reaches. Second, a large proportion of the water flowing through this area of the watershed passes through the groundwater flow system. As this groundwater flows through the extensive sand and gravel deposits that underlie Farmington, it can pick up contaminants introduced by dumping, and possible spills, that have impacted these aquifers.

Observations made at the Pike Industries Bridge suggest that a large portion of the groundwater component of flow discharges to the Cocheco River in this vicinity. There is a measurable increase in the Cocheco River's flow as well as evidence that groundwater constituents are entering the stream. Water quality data (persistent low dissolved oxygen values) and prevalent iron staining of the bed materials suggests that some chemical constituents dissolved in groundwater are being oxidized upon entering the Cocheco River in this area. This area may be influenced by discharge of contaminated groundwater from the Cardinal landfill, Farmington town landfill and its associated septage lagoons. Section 5.3 of this report discusses what is understood regarding groundwater contamination, in the vicinity of the Town of Farmington and Cardinal landfills, that impacts the Cocheco River. During this tour we learned that the City of Rochester is currently pursuing the development of a municipal water-supply well 2.5 miles downstream of the Farmington landfill.

The Farmington wastewater treatment plant meets current treatment requirements. The Town is aware of the existing plant's limitations to handle increased wastewater loads due to development. The plant is working with the DES on a Total Maximum Daily Load (TMDL) study to assess treatment capabilities into the future. Section 5.2 of this report discusses issues related to operations and planned upgrades of the wastewater treatment plant. The town is not prepared to extend sewer lines beyond currently serviced areas (Ed Mullen, personal communication, 2003).

Also during the tour, some concern was expressed for apparent failing septic systems in several locations. The Spring Street area represents one section of Farmington where septic failure or overflows to Ela River are known and/or suspected. Other areas of town also appear to have similar conditions. This will be discussed in Section 4.5 b (Bacterial Contamination), later in this report.

Concern was expressed about sprawl and increasing residential and commercial development in outlying portions of the town where there could be water quality impacts resulting from on-site wastewater disposal systems. Large-scale residential subdivision developments are also seen as a growing threat to natural resources within the Farmington portion of the Cocheco River watershed. Encroachment of housing developments into ecologically sensitive riparian areas is recognized as being detrimental to the maintenance of the existing water quality (DES, 2004).

3.2 Rochester

A significant area of concern regarding the Cocheco River waterfront in Rochester could be described as lack of river corridor stewardship. The dumping of trash and fill materials was observed along the river and its several in-town tributaries. Debris has evidently been, and continues to be dumped over the steep embankments that characterize the riparian area through the central portion of the city. Significant portions of the Cocheco River's edge are difficult to access due to topographic relief and/or private property ownership restrictions. This has resulted in neglected stretches of the river corridor and its tributary areas in the downtown Rochester area. Seasonal use of the Rochester Fairgrounds has led to haphazard waste disposal practices, including human and animal waste. The portion of the fairgrounds used as seasonal camps are not serviced by a properly constructed septic system, or by the City's sewer system. The City is currently working with the fairground association to upgrade the sewer system.

The water quality in the main stem of the Cocheco River is generally very good as it passes through downtown Rochester. Downstream of the confluences with Hurd and Willow Brooks the water quality impacts become more apparent. These tributaries have shown intermittent high bacterial (*E. coli*) contamination through the historical sampling period.

Outside the densely developed portion of the city, tributaries are generally not heavily influenced by man-influenced activities. According to river monitors, Axe Handle Brook has generally exhibited good water quality. However, an ongoing residential development in the Route 202 – Dry Hill Road area poses a potential threat to this tributary because this development will not be serviced by the city sewer system. Water quality monitoring on this reach also indicates that levels of pH and *E.coli*. exceed water quality standards.

Section 5.4 of this report discusses issues related to operations and the recent upgrade of the Rochester wastewater treatment plant. Former wastewater treatment lagoons, located off Pickering Road, were taken out of service may years ago due to pond bottom failures. These ponds now serve as wildlife habitat and a recreational area that was visited during the tour. Pickering Ponds are home to a large population of gulls that also frequent the nearby Waste Management, Inc. landfill complex.

Several known or suspected uncontrolled waste sites were noted in proximity to the Cocheco River. Some of these sites have on-going remedial investigations, as required by the DES; others may pose unknown threats to the Cocheco River water quality.

A concern was expressed about excelerating residential and commercial development in outlying portions of the town where there could be water quality impacts resulting from on-site wastewater disposal systems. The recent approvals of several large Planned Unit Developments (PUDs) in areas not presently serviced by the city's wastewater collection and treatment system were noted. The Rochester Planning Board recently issued a moratorium on the acceptance of new applications for PUDs so that their impact on the City's infrastructure could be fully assessed.

Waste Management, Inc. operates a 1,200-acre landfill facility in Rochester. According to Steve Poggi, WMI's Environmental Engineer, the permitted footprint of the landfill area is approximately 200 acres. All of the solid waste landfills are lined and have leachate collection systems. WMI operates an on-site wastewater treatment facility for industrial pre-treatment of the collected landfill leachate. Following on-site treatment, WMI's wastewater is discharged to the City of Rochester wastewater treatment facility for additional treatment prior to discharge into the Cocheco River. By City permit, WMI's discharge is not to exceed 70,000 gallons per day.

The City of Rochester is currently conducting hydrogeological studies required to develop a new water-supply well field located adjacent to the Cocheco River near the Rochester-Farmington municipal boundary. Rochester's current water source is the Berry River portion of the Isinglass watershed. Water is stored in both the Rochester Reservoir (in the Axe Handle Brook sub-watershed) and in Round Pond (in the Isinglass River Watershed). The City has the ability to transfer water between these impoundments, across the watersheds' boundary. This source supplies an average daily volume of 2.1 million gallons per day (GPD), which varies seasonally from 1.8 million GPD in the winter to approximately 3.0 million GPD in the summer.

3.3 Dover

The Cocheco River watershed area of northwest Dover is undergoing rapid commercial and residential development. A light industrial and technology business park, located on Sixth Street near Exit 9 of the Spaulding Turnpike, is approaching full development. Outer Sixth Street is also the locus of large-scale residential development. Only a few of these recently completed residential developments are serviced by the city's sewer system. Many residential developments in this area are serviced by the municipal water supply but rely on individual or community septic systems. Dover's 2000 Master Plan established a policy that the city will not extend sewer service into outlying areas unless there is a need to address existing septic system failures. This policy reflects an effort to avoid premature development and sprawl.

Development is taking place along the Cocheco tributaries of Reyners Brook and Indian Brook. There are known septic system failures in the Cherokee and Apache Drive area located in the Reyners Brook drainage (Dean Peschel, Dover Environmental Program Director, personal communication, 2003). The city is pursuing funding to extend sewer service to this area. The Blackwater Brook area has not experienced large-scale development and is relatively intact ecologically. Ongoing efforts by the Dover Conservation Commission and Water Department have led to the preservation of over 100 acres of the Blackwater Brook drainage to protect a future water supply source area. However, upstream areas along Clark and Blackwater Brooks in Rochester and Somersworth are being developed.

The City of Dover wastewater treatment facility discharges to the tidal portion of the Cocheco River (considered to be the Piscataqua River) and is therefore considered outside of this study. The city is aware that illicit discharges of sewerage have been a source of bacterial contamination of the Cocheco River. These discharges are usually associated with sanitary and storm sewer cross-connections. Prior to 1970, Dover had a combined sanitary and storm water sewer collection system. This system was reconstructed in the early 1970's as separate collection systems in an effort to avoid combined sewerage overflows. During construction of the sanitary sewer collection system, some service connections were apparently missed. For the past seven years, Dover has an ongoing program to stop all illicit sanitary sewer discharges to the Cocheco River and its tributaries. This work continues as part of the City's EPA Phase II Stormwater Management Plan. This program has been effective in reducing bacterial (Escherichia coli or *E. coli*) contamination in the Cocheco River, particularly in the tidal section (data not presented in this report). Section 4.3 b of this report presents the results of *E. coli* monitoring in the freshwater portion of the Cocheco River.

The largest uncontrolled landfill in Dover is the former municipal landfill on Tolend Road. A portion of the Dover Municipal landfill lies within the Cocheco River watershed. Contaminated groundwater flows in a northeasterly direction toward the Cocheco River. This region of subsurface contamination is known as the "eastern plume". Pollutants in the "eastern plume" will eventually be controlled by limiting the migration of contaminants near the boundary of the landfill. Groundwater seeps along the bank of the Cocheco River, associated with the "eastern plume", have been evaluated. Federal and State environmental agencies have concluded that the river's water quality is impacted by the groundwater seeps, but the level of impact is below the threshold for remedial action. Further evaluations are anticipated (USEPA, 2004)

4.0 ENVIRONMENTAL QUALITY

4.1 Introduction

The Statement of Purpose for the Cocheco River Watershed Coalition includes the following reference to environmental quality and water quality standards:

The Coalition wants citizens of the watershed to have access to a clean, healthy river and to develop a stewardship ethic regarding the watershed.

The Cocheco River will meet Class B standards set by the state._ People should expect to be able to fish and swim in the river. Citizens who become familiar with the watershed, take part in assessment of the river and its improvement will develop a stewardship ethic.

New Hampshire State Law RSA 485-A:8 outlines the water quality standards for Class A and Class B waters. This law is reproduced in Appendix D. Class A represents the highest level of quality standards reflecting water bodies where there is no discharge of sewage or wastes and suitability for supporting aquatic life, swimming, and drinking with adequate treatment. Class B represents a secondary level of quality standards reflecting water bodies where there may be a discharge of adequately treated sewage or wastes and suitability for supporting aquatic life, swimming, and drinking with adequate treatment.

By New Hampshire law, all rivers and streams within the state are classified as either Class A or Class B. This does not mean that at all rivers and streams currently meet the standards set forth in RSA 485-A:8, but rather expresses the goal that all waters will achieve at least the level of quality specified in both the NH State regulations and the Federal Clean Water Act requirements.

The New Hampshire Code of Administrative Rules has rules for surface water known as the Surface Water Quality Regulations, Chapter 1700 also known as Env-Ws 1700. The purpose of these rules is to establish water quality standards for the state's surface water uses as set forth in RSA 485-A:8, I, II, III and V. These standareds are intended to protect public health and welfare, enhance the quality of water and serve the purposes of the Clean Water Act and RSA 485-A. These standards provide for the protection and propagation of fish, shellfish, and wildlife, and provide for such uses as recreational activities in and on the surface waters, public water supplies, agricultural and industrial uses, and navigation in accord with RSA 485-A:8, I and II.

Segments of streams and rivers meeting the water quality criteria explained in the rules are known as "**fully supporting**" the classification. River or stream segments that test outside the water quality standards are known as "**non-supporting**", "**impaired**", or "**threatened**" segments. The New Hampshire DES has inventoried all surface water bodies (rivers, streams, lakes, ponds, impoundments, and estuaries) and has subdivided these bodies into segments known as "assessment units". Currently there are approximately 5000 assessment units that have been delineated statewide.

4.2 Cocheco River Water Quality Assessment

Within the CRWC study area, the DES has delineated assessment units according to the sub-watersheds listed in Table 5, below:

Table 5
DES Assessment Units (AUs) Within the Cocheco River Watershed Study Area

Sub-Watershed Name	River & Stream Segments	Impoundments	Lakes & Ponds	Estuary Segments
Upper Cocheco	9	2	7	0
Axe Handle Brook	4	2	3	0
Middle Cocheco River	10	3	0	0
Lower Isinglass	4	2	0	0
Lower Cocheco	14	6	1	1
Total CRWC Study Area	**41**	**15**	**11**	**1**

The DES has assigned 68 assessment units within the CRWC study area. The DES has indicated that they may be willing to modify the assessment units to be more consistent with the CRWC's monitoring programs. At the end of the 2003 monitoring period, the DES had enough data to assess whether 22 of the 68 assessment units (AUs) were supporting or not supporting at least some of their designated uses. In the remaining 46 assessment units, there was either insufficient data (5 AUs) or no data available (41 AUs). Table 6 is a DES compilation of the existing water quality data and designated use support based on these data.

The water quality standards outlined in RSA 485-A:8 and Env-Ws 1700 can be grouped into quantitative standards and qualitative standards.

4.3 Quantitative Class B Standards

Quantitative standards are those for which a specific numerical value has been assigned reflecting minimum analytical results that must be met to achieve the classification.

Dissolved Oxygen:
RSA 485-A:8 establishes the standard for dissolved oxygen to be at least 75% saturation. Oxygen saturation depends on the temperature of the water. The warmer the water is, the less dissolved gasses (including oxygen) it can contain. Concentrations of dissolved oxygen above a level of 5.0 mg/L are critical to fish

Table 6

Cocheco River Assessment Units*

	Assessment Unit ID#	Name	Associated Sampling Point(s)	Assessment Unit Size	Support Status/Cause of Impairment: Aquatic Life		Drinking Water After Adequate Treatment		Fish Consumption		Primary Contact Recreation		Secondary Contact Recreation		Wildlife	
	Upper Cocheco	**USDA HUC 010600030601**														
1	NHRIV600030601-01	Unnamed Brook to Club Pond	None	0.98 miles	NA		NA		NS	Hg	NA		NA		NA	
2	NHRIV600030601-02	Cocheco River	26-Cch/Ela River	9.33 miles	NS	pH	NA		NS	Hg	NS	E. coli	FS		NA	
3	NHRIV600030601-03	Cocheco River	None	5.1 miles	NS	pH	NA		NS	Hg	Insuff.		Insuff.		NA	
4	NHRIV600030601-04	Cocheco River	None	1.36 miles	NA		NA		NS	Hg	NA		NA		NA	
5	NHRIV600030601-05	Cocheco River-Hayes Brook	None	9.97 miles	NA		NA		NS	Hg	NA		NA		NA	
6	NHRIV600030601-06	Unnamed Brook-Branch of Mad River	None	2.59 miles	NA		NA		NS	Hg	NA		NA		NA	
7	NHRIV600030601-07	Dames Brook	01-DMS	6.73 miles	Insuff.		NA		NS	Hg	NA		NA		NA	
8	NHRIV600030601-08	Mad River	5 Stations (MAR)	8.84 miles	NS	pH	NA		NS	Hg	NA		NA		NA	
9	NHRIV600030601-09	Cocheco River	25-Cch	0.77 miles	NS	pH	NA		NS	Hg	NS	E. coli	FS		NA	
10	NHIMP600030601-01	Branch Mad River	None	8 acres	NA		NA		NS	Hg	NA		NA		NA	
11	NHIMP600030601-02	Cocheco River- Cocheco Dam 1	None	4 acres	NA		NA		NS	Hg	NA		NA		NA	
12	NHLAK600030601-01	Chalk Pond		44 acres	Insuff.		NA		NS	Hg	Insuff.		Insuff.		NA	
13	NHLAK600030601-02	Club Pond		32.5 acres	Insuff.		NA		NS	Hg	Insuff.		Insuff.		NA	
14	NHLAK600030601-03	Coldrain Pond		27.2 acres	Insuff.		NA		NS	Hg	Insuff.		Insuff.		NA	
15	NHLAK600030601-04	Marchs Pond		70.2 acres	Insuff.		NA		NS	Hg	Insuff.		Insuff.		NA	
16	NHLAK600030601-04-02	Birch Hill Summer Camp Beach		1.38 acres	NA		NA		NS	Hg	NA		NA		NA	
17	NHLAK600030601-05-01	Sunrise Lake		246.88 acres	NS	NNAP	NA		NS	Hg	FS		FS		NA	
18	NHLAK600030601-05-02	Sunrise Lake-Town Beach		0.533 acres	Insuff.		NA		NS	Hg	FS		FS		NA	
19	NHLAK600030601-06	Currier Pond		17.99 acres	NA		NA		NS	Hg	NA		NA		NA	
	Axe Handle Brook	**USDA HUC 010600030602**														
1	NHRIV600030602-01	Unnamed Brook-Upper Reach to Baxter Lake	None	0.24 miles	NA		NA		NS	Hg	NA		NA		NA	
2	NHRIV600030602-02	Unnamed Brook-to Baxter Lake	None	1.35 miles	NA		NA		NS	Hg	NA		NA		NA	
3	NHRIV600030602-03	Axe Handle Brook-Howard Brook	None	7.01 miles	NS	pH	NA		NS	Hg	NS	E. coli	NS	E.coli	NA	
4	NHRIV600030602-04	Howard Brook	AH-1	2.44 miles	NA		NA		NS	Hg	NA		NA		NA	
5	NHIMP600030602-01	Unknown River-Bouchard Pond	None	0.25 acres	NA		NA		NS	Hg	NA		NA		NA	
6	NHIMP600030602-02	Howard Brook-Witcher Pond	None	2 acres	NA		NA		NS	Hg	NA		NA		NA	
7	NHLAK600030602-01	Baxter Lake	VLAP	294.9 acres	NS	pH	NA		NS	Hg	FS		Insuff.		NA	
8	NHLAK600030602-02	Nubble Pond		10.01 acres	NA		NA		NS	Hg	NA		NA		NA	
9	NHLAK600030602-03	Rochester Reservoir		56 acres	Insuff.		FS		NS	Hg	Insuff.		Insuff.		NA	
	Middle Cocheco	**USDA HUC 010600030603**														
1	NHRIV600030603-01	Cocheco River	23-Cch & 22U-Cch	5.12 miles	NS	Al, DO, pH	NA		NS	Hg	NS	E. coli	NS	E.coli	NA	
2	NHRIV600030603-02	Pokamoonshine Brook	01-Pok & 00A-Pok	2.92 miles	NS	DO, pH	NA		NS	Hg	NS	E. coli	FS		NA	
3	NHRIV600030603-03	Howard Brook-Axe Handle Brook-Rickers Brook-Unnamed Brook	None	1.03 miles	NA		NA		NS	Hg	NA		NA		NA	
4	NHRIV600030603-04	Rattlesnake River	01-Rat	2.89 miles	NS	pH	NA		NS	Hg	Insuff.		Insuff.		NA	
5	NHRIV600030603-05	Unnamed Brook-to Cocheco River	None	1.51 miles	NA		NA		NS	Hg	NA		NA		NA	
6	NHRIV600030603-06	Cocheco River	22-Cch	3.17 miles	NS	Al, pH	NA		NS	Hg	NS	E. coli	FS		NA	
7	NHRIV600030603-07	Cocheco River	None	0.05 miles	NA		NA		NS	Hg	NA		NA		NA	
8	NHRIV600030603-08	Cocheco River	19-Cch	2.36 miles	NS	Ben, Bio, Hab, pH	NA		NS	Hg	NS	E. coli	FS		NA	
9	NHRIV600030603-09	Unnamed Brook-to Franklin Heights Detebtion Pond	None	0.57 miles	NA		NA		NS	Hg	NA		NA		NA	
10	NHRIV600030603-10	Wordley (Willow) Brook-Unnamed Brooks	None	5.17 miles	NA		NA		NS	Hg	NA		NA		NA	
11	NHIMP600030603-01	Cocheco River-City Dam1	21-Cch	50 acres	NS	DO, NNAP, pH	NA		NS	Hg	FS		FS		NA	
12	NHIMP600030603-02	Cocheco River-Hatfield Dam	None	1 acre	NA		NA		NS	Hg	NA		NA		NA	
13	NHIMP600030603-03	Unknown River-Franklin Heights Detention Pond II	None	1.75 acres	NA		NA		NS	Hg	NA		NA		NA	

Table 6

Cocheco River Assessment Units*

#	Assessment Unit ID#	Name	Associated Sampling Point(s)	Assessment Unit Size	Aquatic Life		Drinking Water After Adequate Treatment		Fish Consumption		Primary Contact Recreation		Secondary Contact Recreation		Wildlife	
	Lower Isinglass	**USDA HUC 010600030607**														
1	NHRIV600030607-12	Unnamed Tributary-to Cocheco River	None	3.84 miles	NA		NA		NS	Hg	NA		NA		NA	
2	NHRIV600030607-13	Unnamed Brook-to Cocheco River	None	2.43 miles	NA		NA		NS	Hg	NA		NA		NA	
3	NHRIV600030607-14	Cocheco River	None	0.55 miles	NA		NA		NS	Hg	NA		NA		NA	
4	NHRIV600030607-15	Cocheco River	16-Cch & 15-Cch	4.26 miles	NS	DO	NA		NS	Hg	FS		FS		NA	
5	NHIMP600030607-02	Cocheco River-Gonic Pond Dam	18-Cch	18 acres	Insuff.		NA		NS	Hg	NS	E.coli	FS		NA	
6	NHIMP600030607-03	Cocheco River-Mill Pond Dam	None	4 acres	NA		NA		NS	Hg	NA		NA		NA	
	Lower Cocheco	**USDA HUC 010600030608**														
1	NHRIV600030608-01	Unnamed Brook-Champlin Pond to Farm Pond	None	0.33 miles	NA		NA		NS	Hg	NA		NA		NA	
2	NHRIV600030608-02	Blackwater Brook	None	8.12 miles	NA		NA		NS	Hg	NA		NA		NA	
3	NHRIV600030608-03	Cocheco River	12-Cch	3.77 miles	NS	pH	NA		NS	Hg	FS		FS		NA	
4	NHRIV600030608-04	Reyners Brook	None	1.71 miles	NA		NA		NS	Hg	NA		NA		NA	
5	NHRIV600030608-05	Cocheco River	10-Cch	1.94 miles	NS	pH	NA		NS	Hg	NS	E.coli	FS		NA	
6	NHRIV600030608-06	Indian Brook	None	1.11 miles	NA		NA		NS	Hg	NA		NA		NA	
7	NHRIV600030608-07	Emerson Brook	None	1.23 miles	NA		NA		NS	Hg	NA		NA		NA	
8	NHRIV600030608-08	Fresh Creek-Twombly Brook	None	4.07 miles	NA		NA		NS	Hg	NA		NA		NA	
9	NHRIV600030608-09	Unnamed Brook-Rollins Brook	None	0.99 miles	NA		NA		NS	Hg	NA		NA		NA	
10	NHRIV600030608-10	Rollins Brook	None	2.75 miles	NA		NA		NS	Hg	NA		NA		NA	
11	NHRIV600030608-11	Fresh Creek	None	1.03 miles	NA		NA		NS	Hg	NA		NA		NA	
12	NHRIV600030608-12	Unnamed Trib. to Cocheco River, Dover (downstream of Portland Ave)	None	0.3 miles	NA		NA		NS	Hg	NA		NA		NA	
13	NHRIV600030608-13	Unnamed Trib. to Cocheco River, Dover (upstream of Atlantic Ave)	None	0.4 miles	NA		NA		NS	Hg	FS		NA		NA	
14	NHRIV600030608-14	Unnamed Trib. to Cocheco River, Dover (from landfill)	None	0.15 miles	NA		NA		NS	Hg	NA		NA		NA	
15	NHIMP600030608-01	Unknown River-Champlin Pond	None	9 acres	NA		NA		NS	Hg	NA		NA		NA	
16	NHIMP600030608-02	Cocheco River-Watson-Waldron Dam Pond	11-Cch	54 acres	NS	pH	NA		NS	Hg	FS		FS		NA	
17	NHIMP600030608-03	Blackwater Brook Farm Pond	None	17 acres	NA		NA		NS	Hg	NA		NA		NA	
18	NHIMP600030608-04	Cocheco River-Central Ave Dam	7-Cch & 7'-Cch	20 acres	NS	pH	NA		NS	Hg	NS	E.coli	FS		NA	
19	NHIMP600030608-05	Unknown River-Conservation Pond	None	0.33 acres	NA		NA		NS	Hg	NA		NA		NA	
20	NHIMP600030608-06	Fresh Creek Farm Pond	None	0.5 acres	NA		NA		NS	Hg	NA		NA		NA	
21	NHLAK600030608-01	Fresh Creek Pond														

Support Status Abbreviations:

NS - Not Supporting
NA- Not Assessed
Insuff. - Insufficient Information
FS - Fully Supporting

Cause of Impairment Abbreviations:

pH = pH <6.5 or >8.0
NNAP - Non-Native Aquatic Plants
Al - Aluminum concentration < X mg/L
DO - Dissolved oxygen < 5 mg/L or <90%
Ben - Benthic Macroinvertibrate
Bio - Bioassessment (Streams)
Hab - Nabitat Assessment (Streams)
Hg - Mercury (Statewide Consumption Advisory)

* Data included in 2004 NHDES 305b report

survival (USGS, 2004). The 5.0 mg/L dissolved oxygen concentration is widely used as an indicator of the ability of a stream or river to support life and has been adopted as a water quality standard by the DES (Env-Ws 1703.07)

Escherichia coli Bacterial Contamination:

State Law (RSA 485-A:8) establishes the following standards for Class B waters:

- *Escherichia coli* geometric mean based on at least 3 samples obtained over a 60-day period of less than 126 *Escherichia coli* per 100 milliliters, or;
- Less than 406 *Escherichia coli* per 100 milliliters in any one sample.

Escherichia coli, or *E. coli*, is one type of fecal coliform bacteria. It is a common bacteria that is specific to the intestines of warm-blooded animals and is used as an indicator of the possible presence of other more harmful disease-causing or pathogenic bacteria. *E. coli* contamination is not indicative of just human waste discharges, since the feces of many warm-blooded animals (birds, mammals), and especially pets, can also pollute surface water. The New Hampshire Estuaries Project has identified pet waste as a principal cause of bacterial contamination (NHEP, 2000). The presence and amount of *E. coli* in a water sample must be analyzed under controlled conditions in a laboratory. When there is a need to distinguish between sources of bacterial contamination, the DNA of the *E. coli* bacteria can be analyzed through a method called ribotyping. Ribotyping matches DNA fingerprints of bacteria in surface water to a library of fingerprints from known source species in a reference database (Morin et al., 2003).

pH:

RSA 485-A:8 establishes the standard for hydrogen ion concentration or pH within a range between 6.5 and 8.0, except when due to natural causes. The pH within a stream or river is a measure of the water's acidity or alkalinity. Aquatic plants and animals (vertebrates & invertebrates) have individual ranges of the acidity or alkalinity that they can tolerate or survive. Many factors can affect the pH of streams or rivers. The decay of organic materials, particularly in wetlands, can release naturally occurring organic acids (such as tannin and lignin) that can lower the pH or acidify a stream below the established range. Air pollution, usually in the form of oxides of nitrogen and sulfur, can cause acid precipitation or acid rain that impacts stream and river pH. Variations in bedrock and soil mineral assemblages can also influence stream pH. Sulfide minerals in soil and bedrock can release inorganic acids. Carbonate minerals can create alkaline conditions. For this reason, the DES recognizes that variations outside the pH range of 6.5 to 8.0 may be due to natural causes. In most areas of New Hampshire, air pollution and other natural causes tends to lower the pH below the neutral level of 7, resulting in acidic conditions

4.4 Qualitative Class B Standards

Qualitative standards reflect the physical characteristics or aesthetic condition of the water and/or stream or river segment. Such standards include:

Temperature Change:
RSA 485-A:8 establishes a standard for temperature change so that: “Any stream temperature increase associated with the discharge of treated sewage, waste or cooling water, water diversions, or releases shall not be such as to appreciably interfere with the uses assigned to this class.” Temperature change is a quantifiable measure but is based on existing or ambient conditions. The primary concern regarding higher temperature discharges is that they can cause a lowering of dissolved oxygen, because warm water can’t hold as much dissolved gasses as cooler water. Wastewater discharge permits may specify acceptable quantitative temperature differentials between the discharge and the receiving water. DES rule Env-Ws 1708 specifies only a qualitative provision for antidegradation “where a potential water quality impairment is associated with a thermal discharge”.

No Objectionable Physical Characteristics:
RSA 485-A:8 specifies that: “Class B waters shall be of the second highest quality and shall have no objectionable physical characteristics”. The issue is: What would or should be considered objectionable physical characteristics? The statute later states that waters “shall be free from slicks, odors, turbidity, sludge deposits, and surface-floating solids of unreasonable kind or quantity”.

The value of setting these qualitative standards is to provide a framework for the discovery and elimination of pollution sources. Observations of slicks, odors, turbidity, etc. should be investigated further so that their sources are identified and corrected.

Field or laboratory instruments can measure some of the potential objectionable physical characteristics. However, they can also be discerned by simple observations. For example, turbidity (or cloudiness in water) can be quantitatively analyzed as the ability of a sample to transmit light. Turbidity can also simply be noted as the observer’s ability to see the bottom of a stream. One problem is that the potential sources of turbidity in a stream are numerous, and can include both natural and man-made causes.

Turbidity is an analytical parameter normally instrumentally analyzed during water quality monitoring. Such turbidity measurements are often used as a surrogate for the more complicated total suspended solids (TSS) laboratory analysis. Wastewater discharge permits may specify acceptable quantitative levels for turbidity. DES rule Env-Ws 1703.11 specifies that the turbidity of Class B waters shall not exceed naturally occurring conditions by more that 10 NTUs. (NTU = “Nephelometric Turbidity Unit” and is the standard unit of measure for light transmitted through a water sample.)

The value of making turbidity measurements is in how the data can be used for locating and eliminating sources of sediment runoff. Such runoff can impact a water body’s ability to meet qualitative water quality standards, such as dissolved oxygen levels and bacterial contamination. This will be discussed further in Section 4.5 a and 4.5 b of this report, respectively.

Oil and grease, the substances that that might cause slicks, can also be quantified in laboratory. It is generally not necessary to quantify the amount of oil and grease in a sample from a slick. Once introduced into water, oil slicks can persist for a long time enabling them to travel great distances, depending on flow conditions. This can make it difficult to locate a transient or intermittent source. DES rule Env-Ws 1703.09 specifies that: “Class B waters shall contain no oil or grease in such concentrations that would impair any existing or designated uses”. Petroleum contains numerous substances that can be toxic to aquatic organisms. One key to eliminating oil and grease discharges is through public education. Several Cocheco watershed communities have had storm drain labeling programs intended to raise awareness about the potential damage that can be caused by the dumping of oil. Lubricating oil recycling and reuse programs have also been implemented within the watershed.

Odors represent a very subjective qualitative physical characteristic. Despite the inherent variability in people’s ability to detect and describe odors, most observers can agree on what they perceive as objectionable odors. DES rule Env-Ws 1703.12 specifies that: “Class B waters shall contain no slicks, odors, or surface-floating solids that would impair any existing or designated use, unless naturally occurring”. Other DES surface water quality rules limit the use of “tainting substances” that might impart an objectionable taste, odor, or color to the flesh of fish or other edible aquatic organisms. The CRWC routinely makes observations regarding odor during water quality sampling. Again, the value of the observations is there use in tracking down and correcting the source of the offensive odor.

<u>No Disposal of Sewage or Waste Inimical to Aquatic Life:</u>
This last qualitative standard set fourth in RSA 485-A:8 prohibits the disposal of sewage or other wastes that would be harmful to or have adverse effects on aquatic life. This is the least specific of the requirements of the NH water quality standards, yet it has the broadest applicability for limiting waste disposal to surface waters. This portion of the statute forms the basis for all of the DES rules regarding controlling toxic substances in surface water (Env-Ws 1703.21).

<u>This law also has applicability for limiting disposal of trash, yard waste, litter, demolition debris, etc. in waterways and adjacent land areas where these materials may be washed into the river.</u>

4.5 Cocheco River Water Quality

In subsequent sections of this report the results of water quality monitoring will be discussed. The DES has assembled a database of water quality testing results for the Cocheco River that includes monitoring data from the CRWC, as well as DES testing related to assessing wastewater discharges from the Farmington and Rochester treatment plants. These data have been quality checked by the DES prior to incorporation into their database. For the purposes of this study, these datasets were edited to remove data obtained prior to 1999. This results in a data analysis spanning five years, 1999 through 2003, inclusive. The truncation of the data sets is consistent with the DES’s “Consolidated Assessment and Listing Methodology” (CALM) that forms the basis for reporting water quality improvements to the USEPA, as required by the Clean Water Act. Limiting the data analysis to the latest five years makes sense because significant improvements have been made in limiting pollutant discharges to the Cocheco River over the past decade.

The Cocheco River water quality data analysis includes data from as many as 28 monitoring points. These water-quality monitoring locations are depicted on Figure 6. These monitoring locations are described in Table 7. Table 7 also presents a summary of the dissolved oxygen and pH analytical results discussed below.

Emphasis is placed on the main stem of the freshwater portion of the river, with some data from significant tributaries included only when data from the tributary is collected at the point of confluence with the main stem. Some monitoring points were only sampled for one or two analytical parameters once or twice over the five-year period included in the data analysis. Some monitoring locations had over 70 analyses for specific analytical parameters over the five-year period. Some analytical results are reported in the DES database as being less than the laboratory's detection limit. Following USEPA guidance, these results were treated statistically by assigning a value of one-half the detection limit as the analytical result.

4.5 a Dissolved Oxygen

Dissolved oxygen within a stream or river is a measure of the water's ability to support aquatic life. Oxygen is necessary for aquatic animals (vertebrates& invertebrates) to survive.

Sources and Influences
There are many factors that influence the dissolved oxygen level in a stream or river. Oxygen can be absorbed directly from the atmosphere. Riffles at rapids and turbulence at waterfalls can raise the dissolved oxygen in a stream through a process known as aeration. Photosynthesis can also raise dissolved oxygen levels. During the day, algae and aquatic plants produce oxygen while sunlight is present. This daily production of oxygen by plants is mirrored by a reduction in oxygen caused by the respiration of both plants and animals during the night. Figure 7 depicts the diurnal variations of dissolved oxygen measured by the DES at four locations in the Cocheco and Isinglass Rivers during July 30-31, 2003 (16-Cch, 15-Cch, 12-Cch, and 02-Isg). This graph shows that dissolved oxygen usually reaches a daily low between 4:00 and 8:00 AM, and a daily high between 4:00 and 8:00 PM. Dissolved oxygen levels were measured to vary by as much as 3.0 mg/L throughout the day.

There are several factors that lower the dissolved oxygen levels. One has already been mentioned. Respiration is the taking in of oxygen by living organisms, both plants and

Figure 6
Dissolved Oxygen Monitored by the NHDES, Isinglass and Cocheco Rivers, July 2003

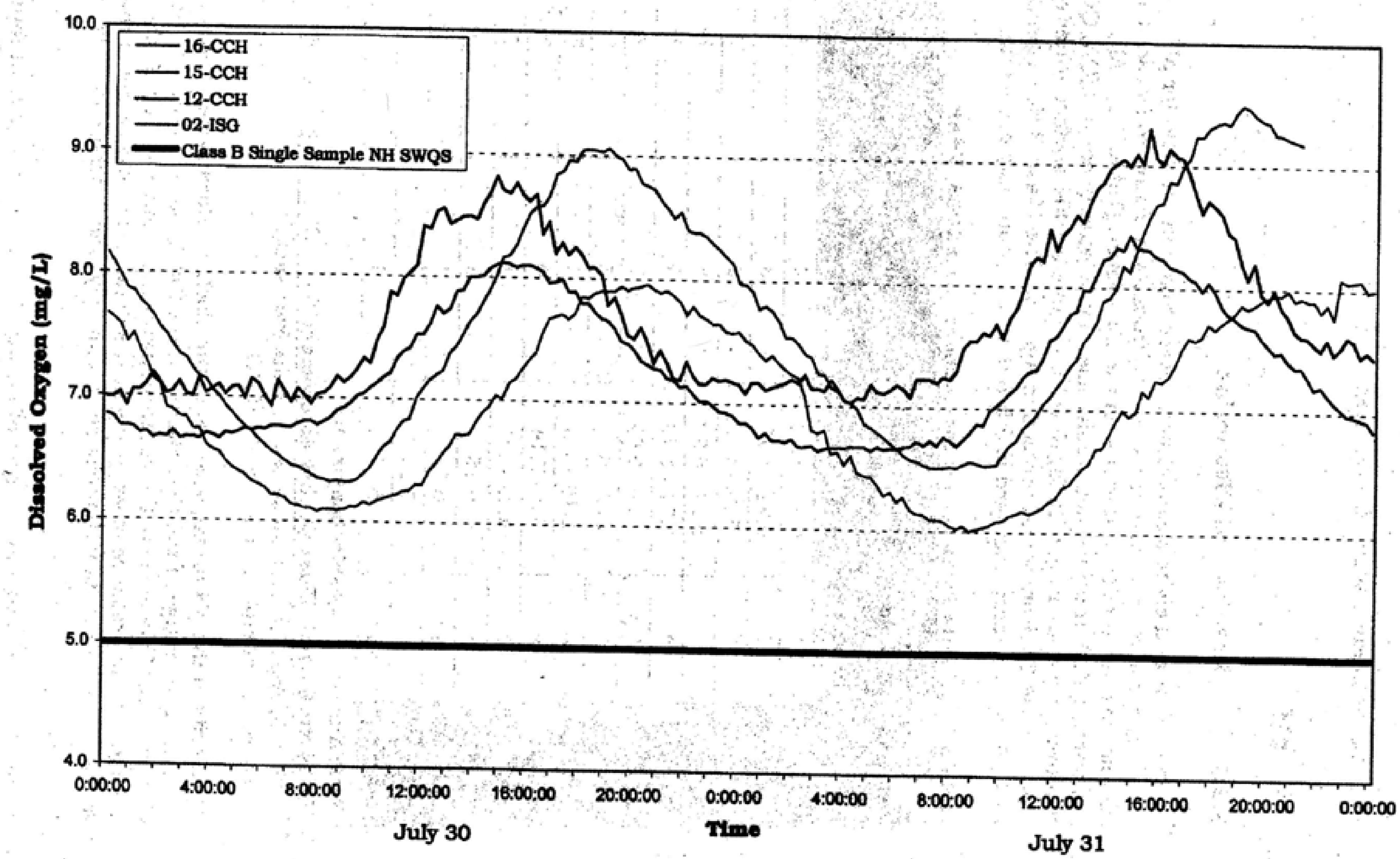
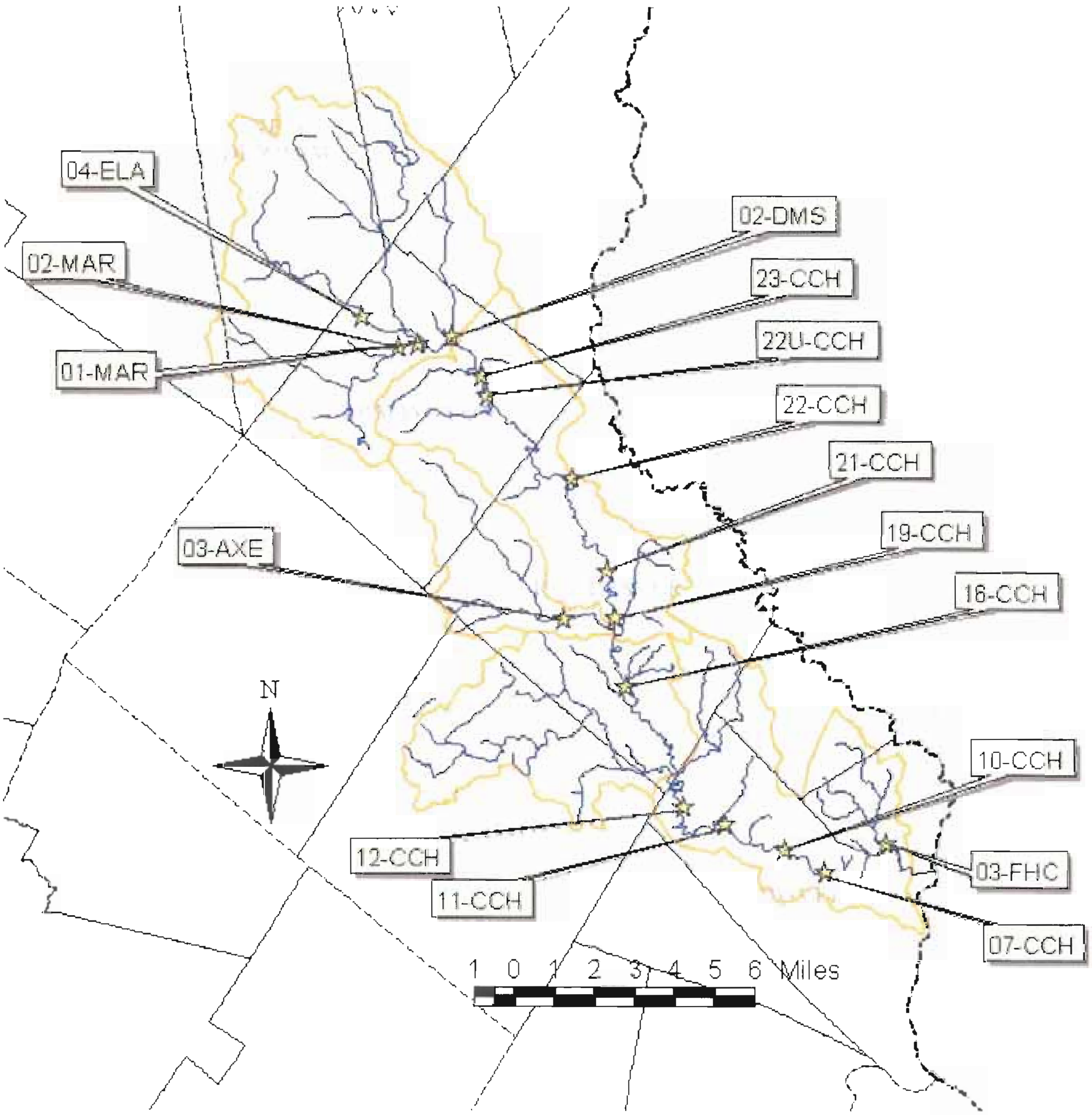


Table 7
Cocheco River Monitoring Locations and Data Summary

Sample Location	Site Description	Distance from Estuary	Sample Point Elevation (ft. MSL)	Dissolved Oxygen Saturation		Dissolved Oxygen Concentration		pH Value	
				Average (%)	# of Analyses	Average (mg/L)	# of Analyses	Average	# of Analyses
06-CCH	WASHINGTON ST BRIDGE, DOVER	0.00	2	95.6	9	10.40	9	6.75	9
07-CCH	CENTRAL AVE BRIDGE, DOVER	0.41	37	95.7	39	8.97	40	6.85	40
07'-CCH	CHESTNUT ST BRIDGE, DOVER	0.55	37	93.7	17	8.31	17	6.91	17
09-CCH	FOURTH ST BRIDGE, DOVER	1.01	38	85.9	7	7.41	7	7.16	7
10A-CCH	UPPER FACTORY RD, DOVER	2.78	70	85.8	31	7.81	32	6.75	32
11-CCH	WATSON RD BRIDGE, DOVER	3.85	108	95.0	42	8.48	43	6.94	43
12-CCH	STRAFFORD COUNTY FARM, DOVER	6.31	112	80.3	37	7.43	37	6.68	38
13-CCH	BELOW CONFLUENCE WITH ISINGLASS, ROCHESTER	8.24	118	***71.9***	1	7.52	1	6.83	1
15-CCH	WASTE MANAGEMENT ABANDONED ROAD, ROCHESTER	10.10	122	78.7	1	8.19	1		
16-CCH	ROCHESTER WASTEWATER TREATMENT FACILITY	12.10	135		0		0		
18-CCH	MAPLE ST BRIDGE, ROCHESTER	13.02	175	84.8	2	7.28	3	6.79	4
19-CCH	RTE 125 BRIDGE, ROCHESTER	14.68	178	79.6	46	7.37	48	6.56	48
21-CCH	NORTH MAIN ST. BRIDGE (RTE 202A), ROCHESTER	16.96	220	78.1	56	6.85	71	6.50	55
22-CCH	LITTLE FALLS BRIDGE, ROCHESTER	21.33	225	77.2	51	7.50	60	***6.41***	53
22J-CCH	ABANDONED BRIDGE BEHIND CMC	23.87	232	***74.1***	4	6.41	12	***6.24***	6
22S-CCH	D.S. OF CONFLUENCE W/ RATTLESNAKE R., FARMINGTON	25.65	238	***54.7***	2	5.54	7	***6.41***	3
22U-CCH	PIKE INDUSTRIES BRIDGE, FARMINGTON	25.93	243	***59.3***	32	5.65	40	***6.25***	31
23-CCH	WATSON CORNER RD BRIDGE, FARMINGTON	26.69	250	81.3	37	7.58	45	***6.29***	34
01-POK	POKAMOONSHINE BK AT CONFLUENCE	27.05	255		0		3	***5.95***	3
23D-CCH	U.S. CONFLUENCE W/ POKAMOONSHINE BK	27.05	257	***73.7***	3	6.63	12		
23S-CCH	U.S. OF FARMINGTON WWTF OUTFALL	27.96	258	87.5	3	7.68	7		
25-CCH	NEAR INTERSECTION OF FARMINGTON BUSINESS DISTRICT	28.53	260	101.5	6	8.83	19	6.52	10
00-MAR	MAD RIVER AT CONFLUENCE	28.98	273	93.3	3	9.21	3	***6.37***	14
26-CCH	CENTRAL ST BRIDGE (RTE 75), FARMINGTON	29.13	275	89.7	48	8.32	57	***6.44***	45
04-ELA	ELA RIVER AT CONFLUENCE	29.21	278	91.6	0	8.48	1	6.82	1
27-CCH	CROSSING AT SPRING ST BR., FARMINGTON	29.85	310		0		0		
28-CCH	CROSSING AT MAIN STREET/OLD BAY RD., FARMINGTON	30.99	395		0		0		
29-CCH	CROSSING AT MIDDLETON RD., FARMINGTON	35.10	695	79.9	1	7.89	1		
	Maximum Value			**149.6**		**35.0**		**9.74**	
	Minimum Value			**22.5**		**0.03**		**5.15**	
	Mean Value			**83.37**		**7.62**		**6.58**	
	Median Value			**85.85**		**7.73**		**6.53**	
	Total Analyses				**478**		**576**		**494**
	Notes:								
	Values denoted in ***bold italics*** fall outside of Class B standards								


04-ELA
02-DMS
02-MAR
23-CCH
01-MAR
22U-CCH
22-CCH
21-CCH
03-AXE
19-CCH
16-CCH
N
10-CCH
12-CCH
03-FHC
11-CCH
07-CCH
1 0 1 2 3 4 5 6 Miles

animals. Respiration takes place both day and night; but is offset by oxygen-producing photosynthesis only during daylight hours.

Microorganisms play a significant role in depleting oxygen. Within the water column there are various constituents that make up what is known as biological oxygen demand or BOD. The two principal components of BOD are nitrogenous oxygen demand and carbonaceous oxygen demand. Nitrogenous oxygen demand is related to the transformation of ammonia (a wastewater constituent) to nitrite and nitrate. Carbonaceous oxygen demand is related to the transformation of organic carbon, to carbon dioxide. Both of these transformations are oxidation processes brought about by various types of microorganisms. These processes take time to complete so that, in moving water, there is often a decrease in the dissolved oxygen for some distance downstream from the source of the BOD. Where the rate of transformation of BOD peaks, the dissolved oxygen will experience a minimum level.

Figure 8 depicts a theoretical dissolved oxygen (DO) sag or depletion curve prepared by the DES. This figure shows that after a source of BOD is added, the dissolved oxygen will decrease rapidly until a minimum is reached (Dc). Dissolved oxygen will slowly increase as the BOD is oxidized and a new equilibrium DO level is achieved. Time on this graph can also be interpreted as distance downstream from the source of BOD because in a river the water is moving.

Sediment also plays an important role in the oxygen level in a river. Sediment runoff can bring nutrients and carbonaceous BOD into a stream in much the same manner as a wastewater discharge. Sediments settle to the bottom and, depending on the local conditions, may remove oxygen through several organic and inorganic processes. The oxidation of carbon and other materials trapped in the bottom sediment can remove oxygen from the water. This process can be significant, especially when the water depth is shallow and the water velocity is low.

Excess nutrients (principally phosphate and nitrate) can cause the rapid growth of algae and other aquatic plants. Following the rapid growth these plants, they often die and settle to the bottom of the water body to decompose. These cyclic periods of rapid growth and death of aquatic flora can lead to the build up of organic sediment through a process known as eutrophication. This process can cause seasonal or other temporal variations in the dissolved oxygen of a river.

Cocheco River Dissolved Oxygen Data

The DES Cocheco River database for dissolved oxygen includes both percent saturation and mg/L values (Figure 9 and Table 7). There are 492 values for dissolved oxygen, expressed in percent saturation, measured at 23 of the 28 monitoring locations included in the database. The mean and median dissolved oxygen values were 83.4 % and 85.9%, respectively. The minimum value measured was 22.5% at 21-CCH. A total of 121 values (roughly one quarter of the analyses) were less than the state’s Class B water quality standard of 75% dissolved oxygen saturation.

Figure 8
Theoretical Dissolved Oxygen Depletion Curve from NHDES

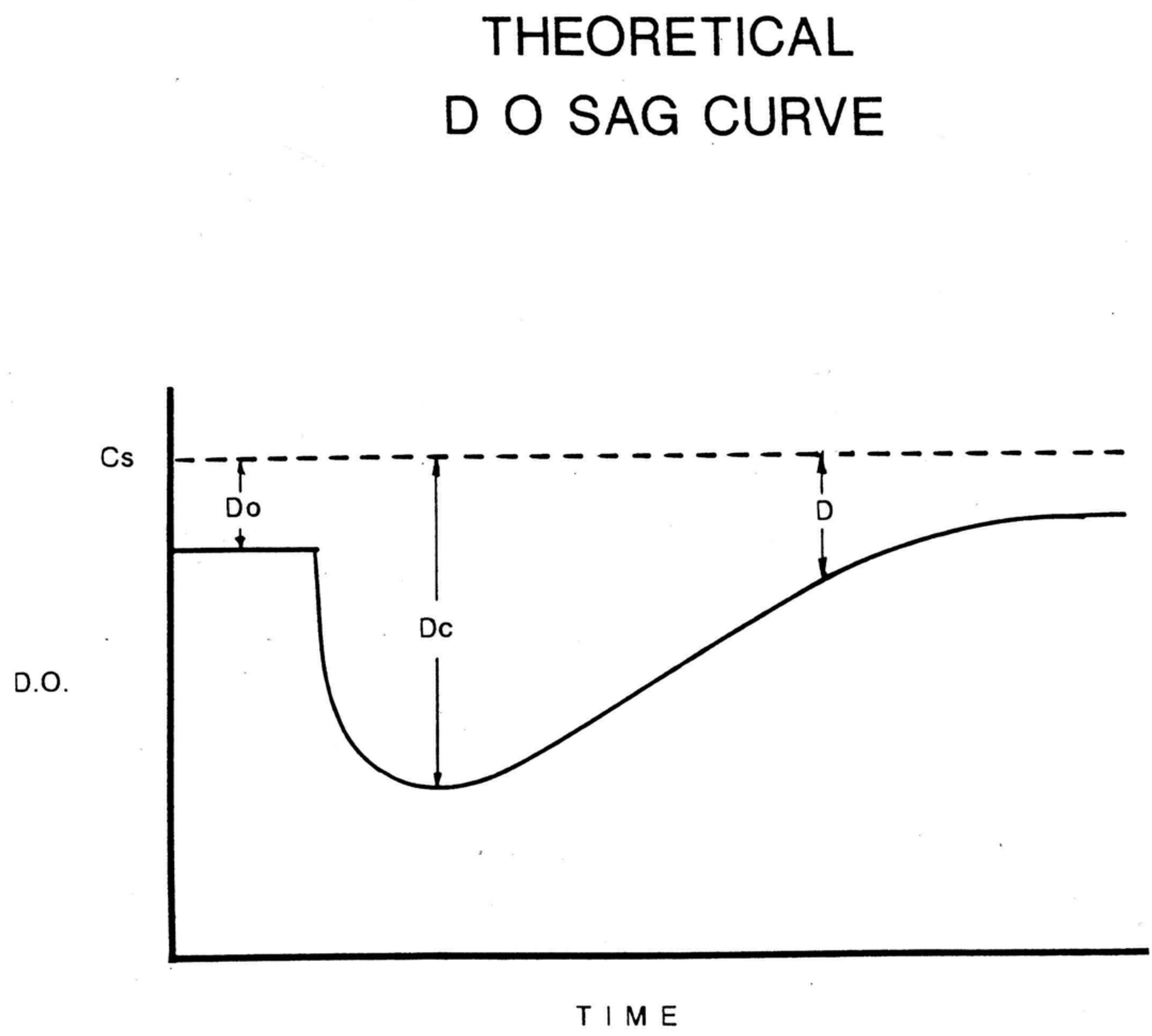


Figure 9
Average Dissolved Oxygen, 1999-2003
in Percent Saturation, Cocheco River

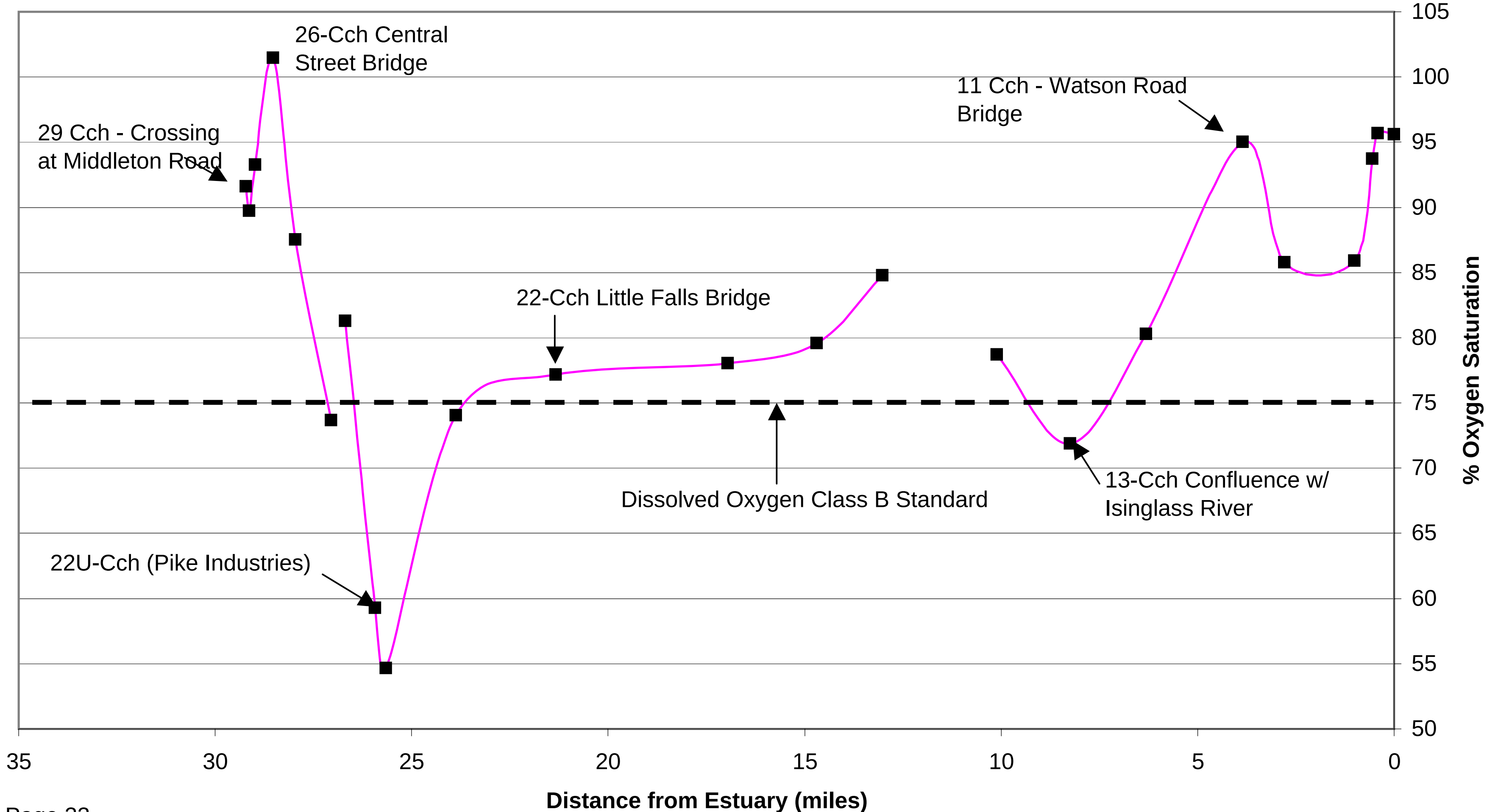


Figure 9 depicts the distribution of the average dissolved oxygen saturation at each monitoring location plotted vs. the distance from the tidal estuary. The graph also hows the 75% saturation Class B standard. There are two dips in dissolved oxygen levels, below the 75% standard, apparent on this graph. The largest DO sag occurs between monitoring locations 23D-Cch and 22J-Cch. Dissolved oxygen in this reach is influenced by groundwater discharge to the river in the vicinity of the Farmington and Cardinal landfills. The second DO sag, below 75% saturation, is seen at 13-Cch which is located just downstream of the confluence with the Isinglass River. (The possible source of the DO sags will be discussed in Sections 5.2 and 5.3 of this report.)

The DES database also includes dissolved oxygen expressed in mg/L. There are 593 values for dissolved oxygen, expressed in mg/L, measured at 25 of the 28 monitoring locations included in the database (Table 7). The mean and median dissolved oxygen values were 7.62 mg/L and 7.73 mg/L, respectively. The maximum value was recorded as 35 mg/L at monitoring station 22-CCH. The minimum value measured was 0.03 mg/L also recorded at 22-CCH. A total of 51 values (roughly 9% of the analyses) were less than the state's water quality standard of 5 mg/L dissolved oxygen concentration.

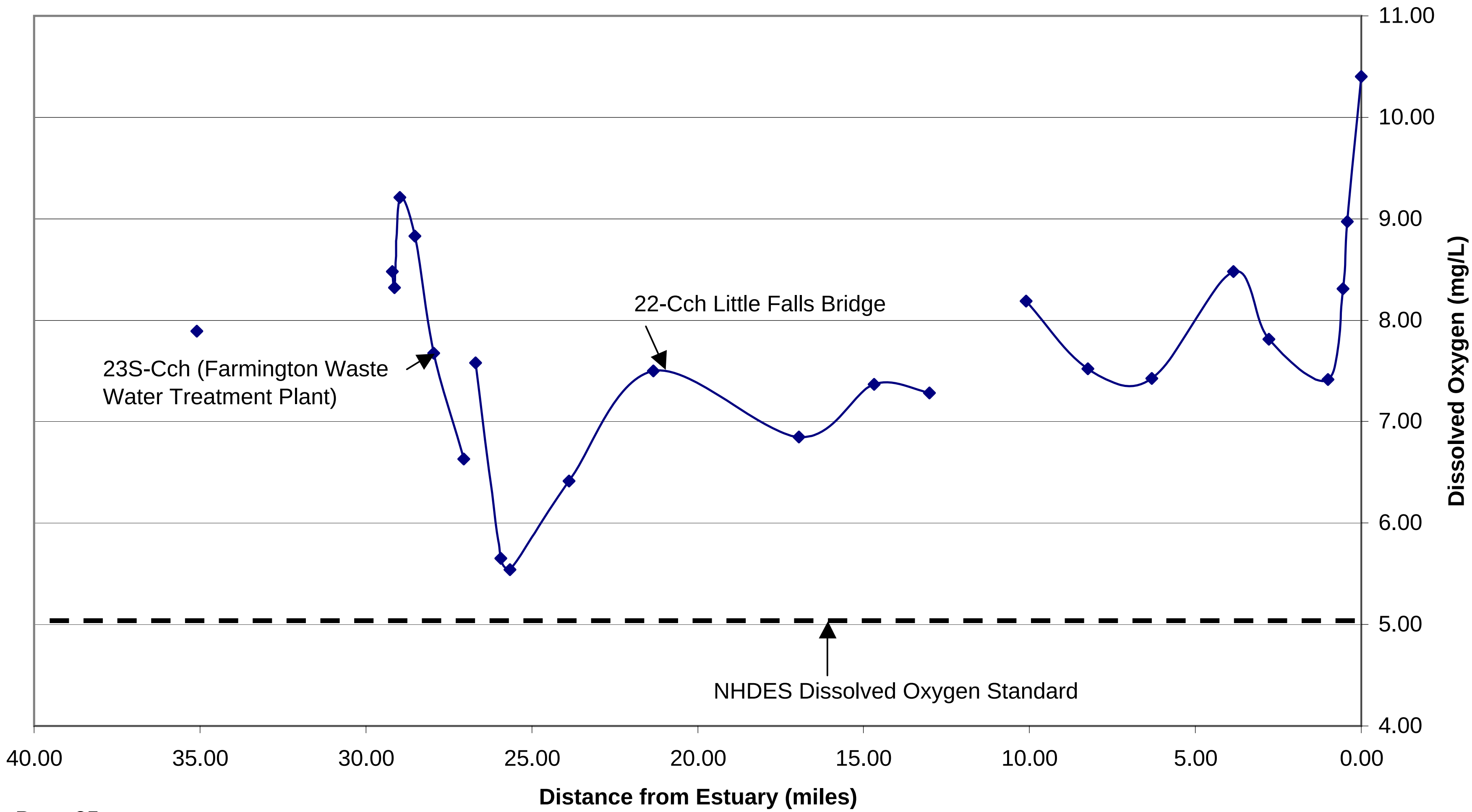
A plot of dissolved oxygen, expressed in concentration (mg/L) is depicted in Figure 10. In this figure, like Figure 9, the X-axis is sampling location as distance from the tidal estuary. This figure shows the same primary DO depletion or sag (as does Figure 9) located between 23D-Cch and 22J-Cch. None of the five-year averages for dissolved oxygen, expressed in mg/L concentration, fell below the 5.0 mg/L DES water quality standard, although individual values did.

As depicted in Figures 9 and 10, the 1999 through 2003 monitoring data indicated that there are two problem areas for dissolved oxygen along the main stem of the Cocheco River. The lesser of these problem areas appears to be associated with low dissolved oxygen emanating from the confluence with the Isinglass River. Low dissolved oxygen measured at this location may be associated with the Isinglass River's portion of the flow, or could result from BOD constituents introduced into the Cocheco by the Isinglass. There may also be some influence from the Turnkey Landfill, due to decreased groundwater discharge in this area.

The main problem area for dissolved oxygen, in the Cocheco's main stem, is located between 23D-Cch and 22J-Cch, between the Farmington wastewater treatment plant and the DES sampling station midway between the confluence with the Rattlesnake River and Little Falls Bridge (Figure 11). The DES evaluated the cause of this DO sag in its waste load allocation study (DES, 1992). Only a portion of the BOD responsible for this sag in the dissolved oxygen levels comes from the discharge of Farmington's treated effluent. According to the DES:

> "In sampling for the waste load allocation study, it was discovered that the Class B dissolved oxygen standard was violated from an area near the landfills through the remainder of the study area. This violation occurred even when the

Figure 10
Average Dissolved Oxygen, 1999-2003
Concentration (mg/L)



Farmington discharge was stopped, indicating that no level of treatment at Farmington would cause the Cocheco River to meet standards below the landfills. The source of these pollutants will be investigated under the Nonpoint Source Program and the Solid Waste Program."

The DES report went on to estimate the magnitude of the discharge from the landfills. According to water balance calculations contained within the waste load allocation study, approximately 27% of the flow within the Cocheco River, measured near 22U-Cch (the Pike Industries bridge), enters as groundwater discharge. Based on BOD measurements made at this point, the groundwater discharging to the river contributes approximately 32 mg/L of BOD (25 mg/L of carbonaceous oxygen demand and 7 mg/L of nitrogenous oxygen demand). According to the 1992 DES report: "The water quality downstream of the two landfills was poor and had marked effects on downstream water quality".

Discussion
The DES is in the process of conducting a Total Maximum Daily Load (TMDL) analysis for the Farmington wastewater treatment plant. The DES has completed most of their data collection and it is expected that the Wastewater Engineering Bureau will prepare a revised discharge permit, based on the TMDL data analysis, before the existing discharge permit expires in December 2005. The Town of Farmington will then have the design criteria necessary to plan and construct upgrades to the wastewater treatment plant.

The infiltration of BOD-laden groundwater into the Cocheco River, downgradient of the Cardinal and Farmington landfills, is being addressed by several bureaus within the DES. These activities are discussed in Section 5.3 of this report.

Detection and correction of illicit sewer/stormwater cross connections and illicit discharges will also help to correct some of the negative impacts on dissolved oxygen especially in the older downtown sections where infrastructure is aging. The Phase II Stormwater regulations have also been designed to address the sources of BOD that result from stormwater runoff.

4.5 b Bacterial Contamination

NH State Law (RSA 485-A:8) establishes the following bacterial standards for Class B waters:

- Escherichia coli (*E. coli*) geometric mean based on at least 3 samples obtained over a 60-day period of less than 126 Escherichia coli per 100 milliliters, or;
- less than 406 Escherichia coli per 100 milliliters in any one sample.

Sources and Influences
Escherichia coli, or *E. coli*, is one type of fecal coliform bacteria. It is a common bacteria that is specific to the intestines of warm-blooded animals and is used as an indicator of the possible presence of other more harmful disease-causing or pathogenic bacteria. *E. coli* data in the DES database for the Cocheco River was analyzed primarily by the DES laboratories or by the state-certified laboratory at the City of Rochester wastewater treatment plant.

The presence or absence of *E. coli* in water samples from the Cocheco River and its tributaries is used as an indicator of sewage discharges to these water bodies. State law prohibits such discharges. When found, these illicit discharges can usually be traced to two sources: 1) improperly built or failed on-site wastewater disposal (or septic) systems; or 2) cross-connection of sanitary and storm sewers in municipal service areas. The two of the three municipal sewer service areas, within the Cocheco River watershed (Rochester and Dover) have separate storm water and sanitary wastewater collection systems. Historically, each municipality had a combined storm water and sewage collection system that piped all wastewater to the wastewater treatment plants. This approach presented a problem during periods of heavy rainfall because the plants couldn't process the wastewater fast enough.

This stormflow load resulted in what is known as combined sewerage overflows, where untreated sewage was periodically discharged to the river. In the 1970s Dover's combined wastewater collection systems were reconstructed into separate sanitary and storm water collection systems. In some instances the sanitary sewers for homes and businesses were not disconnected from the storm water collection systems and the discharge of untreated wastewater continued. Evidence of these illicit discharges was discovered through the monitoring of the DES and watershed groups such as the CRWC. Over the past decade, Dover and Rochester have been actively seeking sewerage system cross connections and other illicit discharges needing correction. This is a requirement of the USEPA Phase II Stormwater Management Program (see Section 6.1 below). The *E. coli* monitoring data suggests that additional work needs to be completed.

Cocheco River E.coli Data
The DES database for the Cocheco River includes 304 analyses for *E. coli* (Table 8). The mean and median *E. coli* analytical results were 204 and 100 counts per 100 ml, respectively. The maximum value was recorded as >2000 counts per 100 ml. at monitoring stations 22J-Cch (Little Falls Bridge, Rochester), 23- Cch (Downstream of Confluence with Pokamoonshine Brook, and 26-Cch (Central Street Bridge, Farmington). These extremely high values essentially represent the presence of *E. coli* bacteria too plentiful to count. The minimum value listed in the database was 0 counts per 100 ml. This value represents samples in which no *E. coli* bacteria were present, essentially a non-detect value. The number of analyses that exceeded the 406 per 100 ml. Class B single sample standard was 42, or approximately 14% of the samples analyzed.

A total of 133 values (roughly 44%) of the analytical results were greater than the state's Class B water quality standard of 126 Escherichia coli per 100 ml. This standard is to be applied to the geometric mean of at least three samples collected over a 60-day period. The database was analyzed statistically to determine the geometric mean of samples collected and analyzed over each monitoring season. Non-detected values were entered as 2.5 counts per 100 ml., or one-half the lowest detection limit in the database. During some monitoring seasons, less than three samples were collected. No geometric mean value was calculated for such instances. There was sufficient data to compute seasonal geometric means at 21 sampling locations. Table 8 (below) lists the 21 sampling points for which sufficient data are available to statistically analyze the *E. coli* monitoring data.

Table 8
***Escherichia coli* Monitoring Summary**

Monitoring Location - Listed from Upstream to Downstream	**Number of Samples (1999-2003)**	**Number of Sample Values Exceeding 406 counts/100 ml**	**Number of Monitoring Seasons w/ >3 Samples per Season**	**Number of Seasonal Geometric Means Exceeding 126 counts/100 ml**
Farmington				
27-Cch	3	0	1	0
Ela	12	0	1	0
26A-Cch	4	0	1	0
26-Cch	36	8 (22%)	4	3 (75%)
25-Cch	5	1	1	1
23D-Cch	3	2	1	1
Pokamoonshine	7	1	2	1
23-Cch	29	6 (21%)	4	2 (50%)
22U-Cch	18	3	3	1
22J-Cch	3	2	1	1
Rochester				
22-Cch	24	2	3	2
21-Cch	22	1	2	0
20-Cch	5	2	1	1
19-Cch	24	8 (33%)	3	2 (66%)
Dover				
12-Cch	17	1	2	0
11-Cch	22	1	3	0
10A-Cch	18	0	3	0
09-Cch	3	1	1	0
07'-Cch	5	0	1	0
07-Cch	24	1	4	1
06-Cch	10	2	1	0
Total No of Samples	294	42	43	9

Based on the above tabulation, at least three potential problem areas along the Cocheco River's main stem were noted (denoted with bold font). For each of these problem areas there appeared to be sufficient *E. coli* monitoring data to characterize the water quality as impaired. The values in parentheses represent the percentage of monitoring results that exceeded the regulatory thresholds of 406 counts/100 ml and 126 counts/100ml for single samples and geometric means, respectively. The *E. coli* problem areas noted were:

- 26-Cch – the Central Street Bridge (Route 75) in Farmington;
- 23-Cch – the formerly Watson Corners Road Bridge (now Cocheco Road) in Farmington; and
- 19-Cch – the Route 125 Bridge in Rochester.

Discussion
The 26-Cch monitoring location is in the Cocheco River, just downstream of the confluence with the Ela River. The next upriver monitoring point is 27-Cch located at the Spring Street Bridge over the Cocheco (Figure 11). There has been limited *E. coli* monitoring at the Spring Street Bridge, three samples in May-June 2000. These samples have a geometric mean of 30 counts/ 100 ml. suggesting that a significant source of bacterial contamination is not located upstream of 27-Cch. Twelve samples taken from four locations on the Ela River during May-June 2000 also showed low levels of *E. coli* (an average geometric mean of 69.6 counts/100 ml). The *E. coli* contamination monitored at 26-Cch appears to originate along Spring Street. This is an area of Farmington where there are known or suspected septic system failures. A new pumping station would be needed to provide sewer service to this section of town. The Town has unsuccessfully attempted to secure funds for this project.

The 23-Cch monitoring location is in the Cocheco River downstream of the Farmington wastewater treatment plant and also downstream of the confluence with Pokamoonshine Brook (Figure 11). The *E. coli* database includes 7 samples from Pokamoonshine Brook collected in 2000 and 2003. Two of the samples collected in 2000 exceeded 126 counts/100 ml. There are two upstream monitoring points between Pokamoonshine Brook and the wastewater treatment plant (23D-Cch and 23M-Cch; see Figure 10). There are only three analyses for *E. coli*, completed at location 23D-Cch in 2000, in the database. Two of these three samples exceeded 406 counts/100 ml. There is also an un-sampled, unnamed tributary that enters the Cocheco from the east, near the confluence with Pokamoonshine Brook. The source of the persistent *E. coli* contamination, monitored at 23-Cch, appears to be from Farmington wastewater treatment plant area. Pokamoonshine Brook and the unnamed tributary could also play a role. A campground near the Farmington/Rochester boundary may also reprepresent a source of *E. coli*. Further testing is suggested to narrow the possibilities in delineating this problem area.

The 19-Cch monitoring location is in the Cocheco River, approximately 1,500 feet upstream of the confluence with the Axe Handle Brook (Figure 12). The next routinely monitoring point upstream is 21-Cch located at the North Main Street Bridge in downtown Rochester. There has been a good amount of *E. coli* monitoring at the North Main Street Bridge, twenty-two samples over the five-year 1999-2003 period. These samples have a geometric mean of 60.9 counts/ 100 ml. suggesting that a significant source of bacterial contamination is not located upstream of 21-Cch. Five *E. coli* samples were taken by DES staff from 20-Cch, located near the Rochester Fairgrounds between 21-Cch and 19-Cch, during July-September 2001. This sampling showed elevated levels of *E. coli* (a geometric mean of 276 counts/ 100 ml). CRWC sampling has revealed some *E. coli* contamination in Hurd Brook, a tributary that enters the Cocheco near the National Guard facility on Brock Street. Some of the *E. coli* contamination monitored at

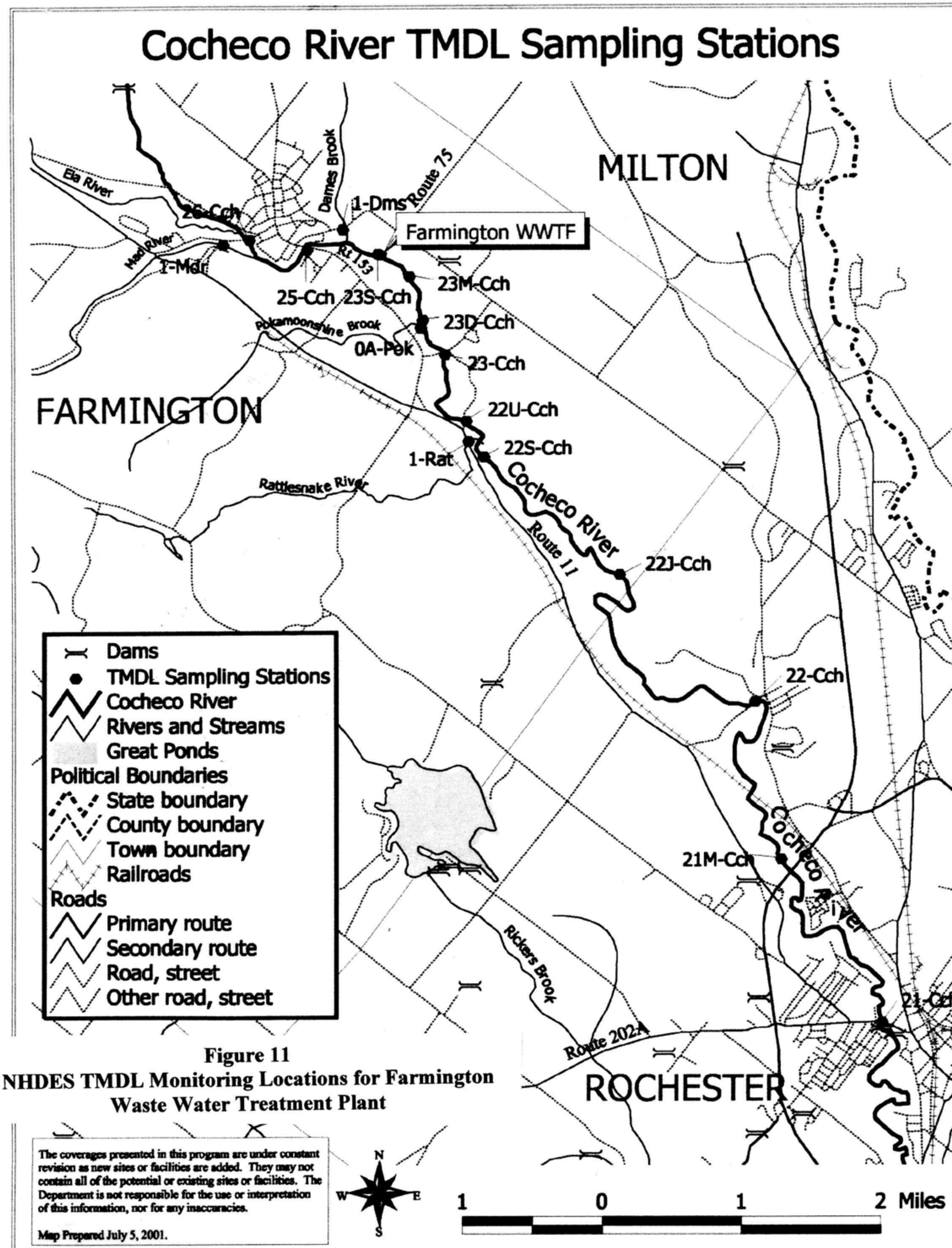
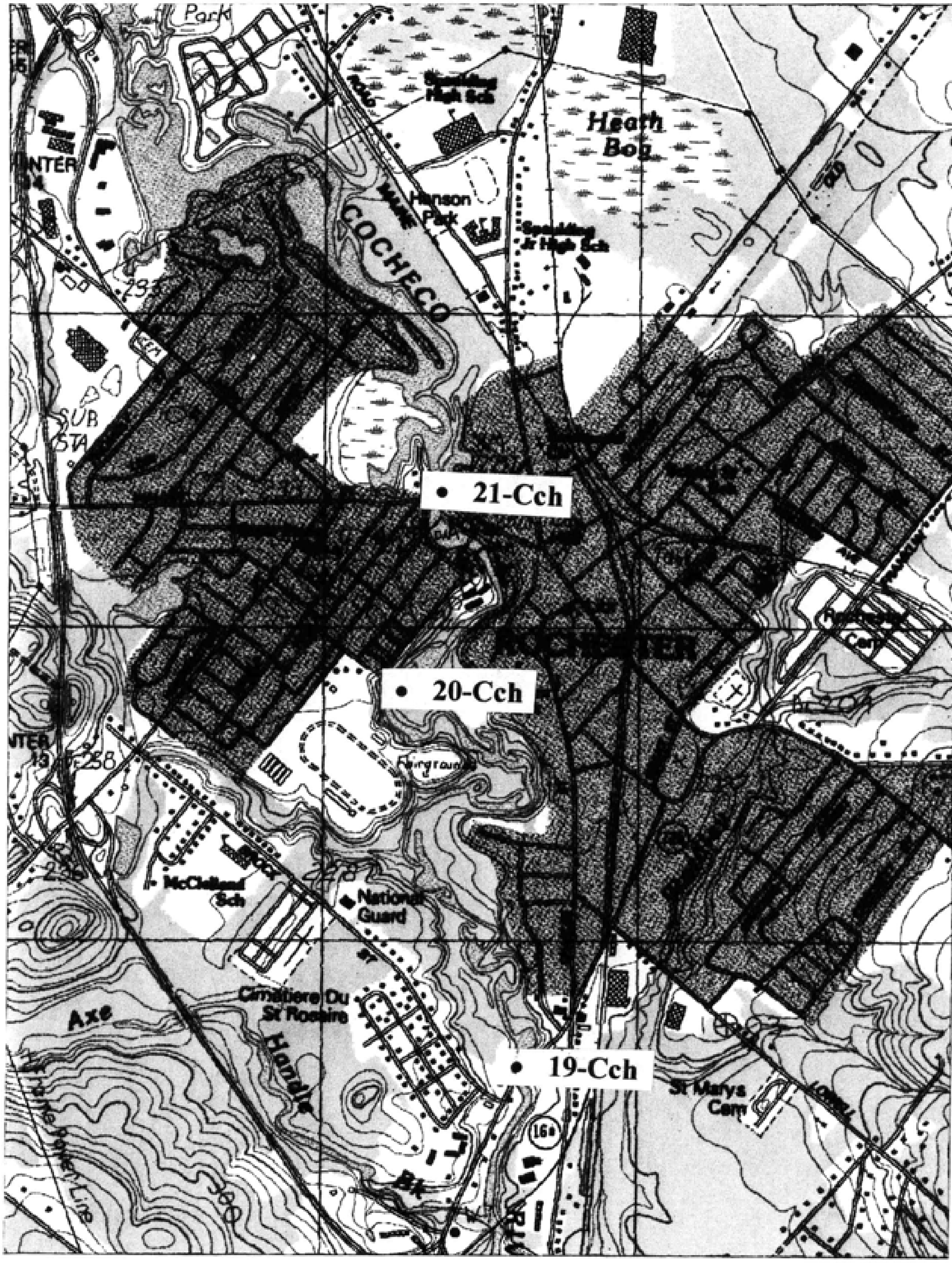


Figure 11
NHDES TMDL Monitoring Locations for Farmington Waste Water Treatment Plant

Figure 12
CRWC Monitoring Locations in Rochester



19-Cch may be associated with non-point source livestock waste and horse manure disposed at the Rochester Fairgrounds. The City of Rochester is currently looking for illicit discharges and is mapping stormwater outfalls throughout the City.

4.5 c pH Changes

The pH within a stream or river is a measure of the water's acidity or alkalinity. Aquatic plants and animals (vertebrates& invertebrates) have individual ranges of the acidity or alkalinity that they can tolerate or survive. RSA 485-A:8 sets a standard for a range of pH to be maintained between 6.5 and 8.0, except when water is outside this range due to natural causes.

Sources and Influences
As discussed above, many factors can affect the pH of streams or rivers. The interaction of water with organic materials can release naturally occurring organic acids. Air pollution can cause acid precipitation or acid rain that impacts stream and river pH. Variations in bedrock and soil mineral assemblages can also influence stream pH.

During July 30-31, 2003, the DES completed continuous pH measurements at the same monitoring locations as the dissolved oxygen analyses noted in Section 4.5a, above (16-Cch, 15-Cch, 12-Cch, and 02-Isg). The results of these analyses are presented in Figure 13. There is a striking similarity between the diurnal variations of dissolved oxygen and pH (Figures 6 and 13, respectively). The measured pH levels showed daily minimum values usually in the early morning hours. Daily maximum pH values peak in late afternoon - early evening. The daily variation in pH was measured to be as much as 0.4 pH units. The river water was most acidic in the early morning and least acidic in the early evening.

The similarity between the diurnal variations of both dissolved oxygen and pH suggests that there is a causal relationship between the two parameters. To test this hypothesis dissolved oxygen and pH data from the Cocheco River monitoring, from 1999 through 2003 were compared for the 28 monitoring locations in the DES database. There was sufficient data to plot 21 five-year average values in this analysis. This analysis included data from 494 pH measurements and 576 dissolved oxygen measurements. Figure 14 depicts a plot of the average dissolved oxygen value (in mg/L), verses the average pH value. Although there is some scatter in the plot, there is a positive correlation between dissolved oxygen and pH. Also plotted on this graph is a best-fit, linear regression line showing the proportional relationship between the two parameters.

What are the Figures 7, 13 and 14 telling us about pH and dissolved oxygen in the Cocheco River? It is clear that when dissolved oxygen is higher, the acidity is lower. Conversely, when dissolved oxygen is lower, acidity is higher. If we think in terms of what other dissolved gas is present in the water that can influence pH, and is also present in variable concentrations throughout the day, the answer is carbon dioxide. We have already discussed the influence of photosynthesis and respiration on dissolved oxygen

Figure 13
pH Monitored by the NHDES, Isinglass and Cocheco Rivers, July 2003

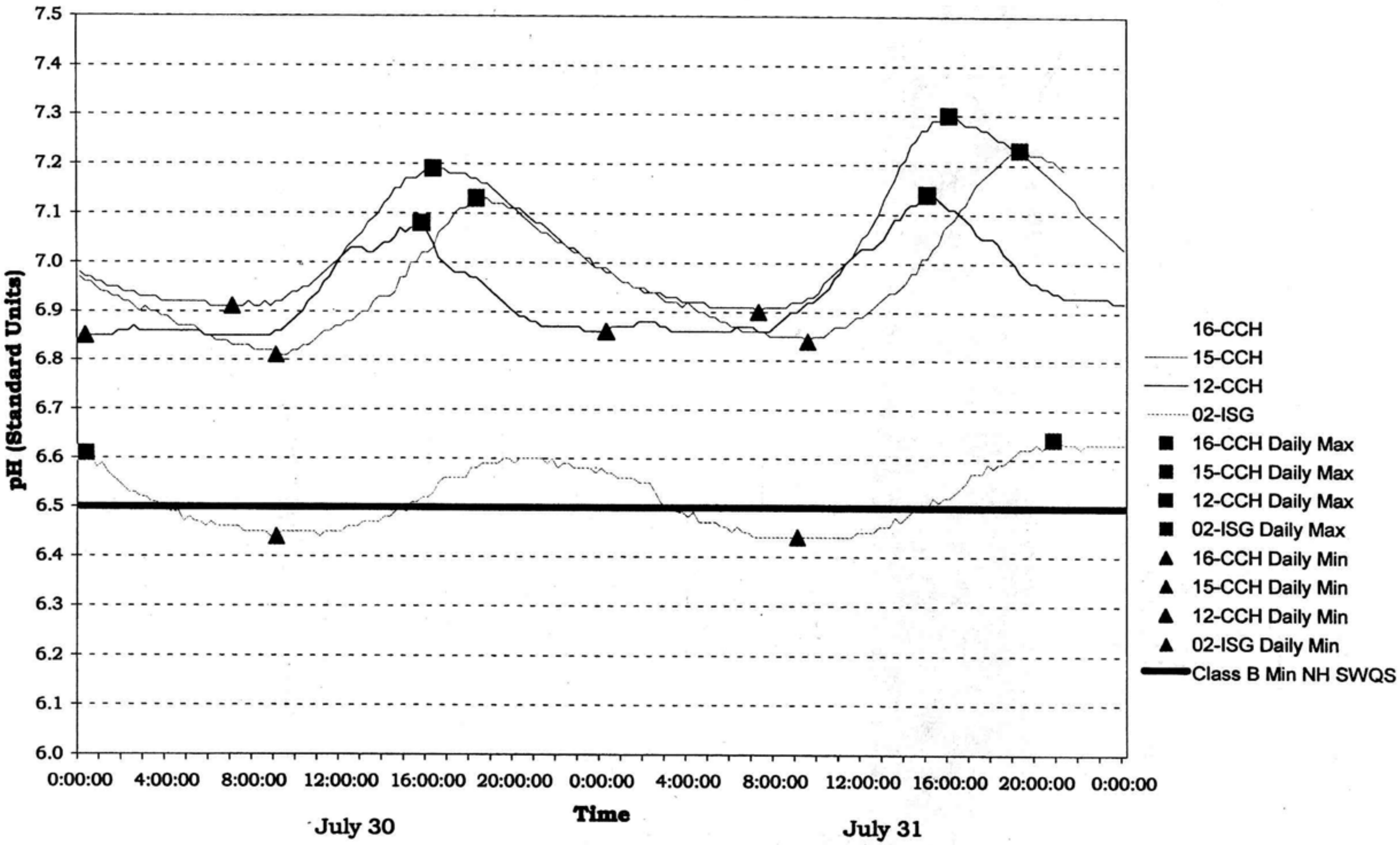
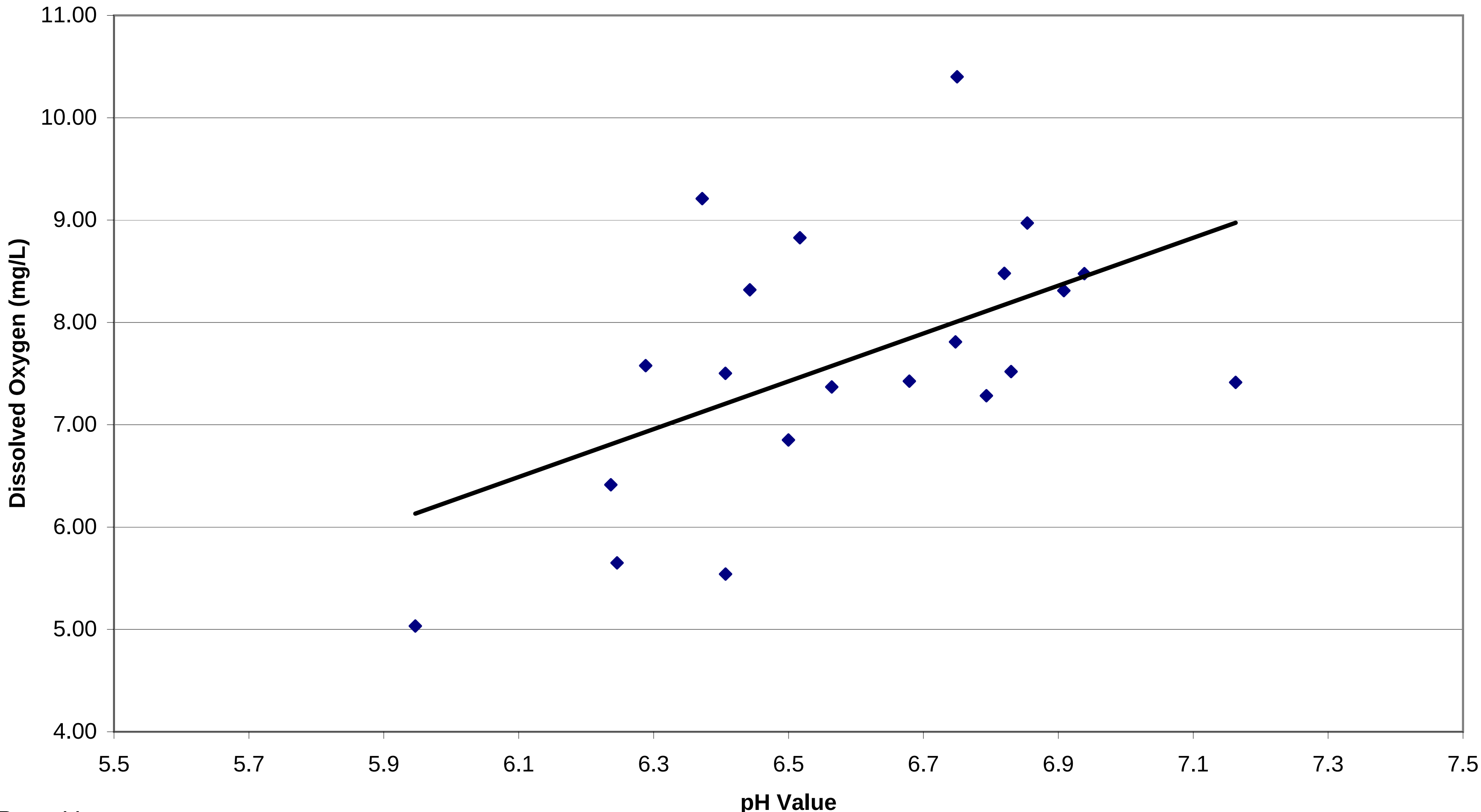


Figure 14
COCHECO RIVER DATA 1999-2003
AVERAGE DO (MG/L) vs. AVERAGE pH



(Section 4.5 a, above). The interaction between photosynthesis and respiration also influences the carbon dioxide concentration in the water as well, thus effecting pH also.

Cocheco River pH Data
Figure 15 depicts the distribution of the average pH measurements at each monitoring location plotted vs. the distance from the tidal estuary. The graph also shows the acceptable Class B pH range (6.5 to 8.0). Data for this plot are listed in Table 8. There seems to be a systematic increase in pH along the river. The pH values measured from 26-Cch in Farmington to 22-Cch at Little Falls Bridge in Rochester fell below the 6.5 pH lower-end of the Class B pH range. Downstream of North Main Street Bridge in Rochester, the pH values were variable, but remained within the Class B range of 6.5 to 8.0.

Discussion
There is a striking similarity between the plot of pH (Figure 15) and the plot of dissolved oxygen (Figures 9 & 10) along the length of the Cocheco River. All three plots show problematic low water quality in the vicinity of the Farmington wastewater treatment plant and landfills. This is further evidence of the relationship between dissolved oxygen and pH. This suggests that those pH measurements that fall outside the Class B range (between 26-Cch through 22-Cch) do not represent enhanced acidity associated with natural causes alone. The same biochemical processes that cause the lowering of dissolved oxygen below 75% saturation (Figure 9), also appear to be a possible cause for the pH to fall below the 6.5 pH lower Class B standard (Figure 15). This suggests that correcting the problems that are manifested in impaired dissolved oxygen levels should also improve what appears to be a problem with pH levels in the upper Cocheco River.

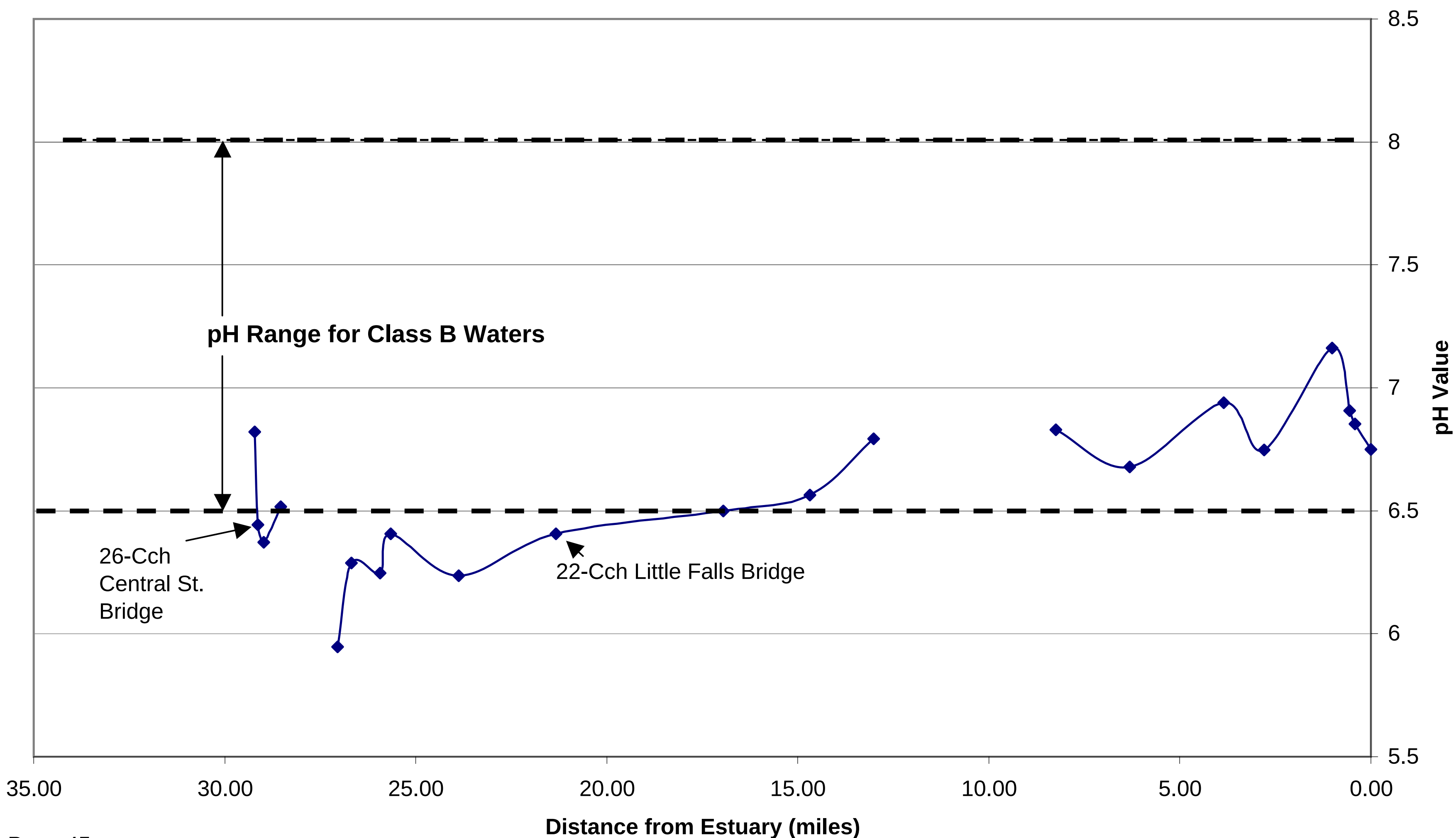
4.5 d Toxic Metals

Certain naturally occurring metals can become toxic to aquatic plants and animals if they are present in elevated concentrations. Other non-toxic metals such as iron and manganese have also been tested in Cocheco waters but are not covered in this narrative. The NHDES surface water quality standards (Env-Ws 1703.21) set maximum concentrations at which certain metals can be present in river water without having an adverse effect on aquatic organisms.

Sources and Influences
The sources of dissolved metals that can become toxic are numerous. Like pH, the metals that are dissolved in surface waters can be derived from the interaction of water and the geologic materials it passes through. Some soils and bedrock units have natural enrichments of certain minerals that can leach metals into the environment. Arsenic is a good example of a naturally occurring toxic metal that is associated with enrichment in certain bedrock geologic units in the New Hampshire seacoast area (Ayotte et al., 1999). Toxic metals can become enriched in surface waters due to changes in the pH of precipitation infiltrating to groundwater that ultimately discharges to rivers.

Cocheco River Toxic Metals Data
The NHDES database includes analyses for as many as nine potentially toxic metals in water samples collected between 1990 and 2000. These analyses were completed for a variety of

Figure 15
Average pH Value, Cocheco River 1999-2003



monitoring programs including the NHDES's Ambient River Monitoring Program (ARMP) and Volunteer River Assessment Program (VRAP). The maximum number of potentially toxic metal analyses in the database was 87. The minimum number of analyses was 22. Nine potentially toxic metals are included in the NHDES database. These metals are:

- Aluminum
- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Selenium
- Zinc

Some analytical parameters (arsenic, selenium, and nickel) were only tested in 1990 and 1991. These metals were found to occur at only low concentrations and were apparently dropped from further analyses.

Table 9 below summarizes the regulatory-significant statistics of the toxic metal data for the Cocheco River samples included in the NHDES database. Included in this table is the NHDES concentration threshold (standard) for the protection of freshwater aquatic life from chronic effects of exposure to the metal. This standard is the lowest concentration value, listed in Env-Ws 1703.21 that is applicable to freshwater portions of the Cocheco River.

Table 9
Potentially Toxic Metal Data from Cocheco River Water Quality Monitoring

Parameter	Aquatic Life Protection Chronic Criteria (Env-Ws 1703.21)	Number of Samples Analyzed	Number of Detects (Concentrations above Analytical Detection Limit)	Number of Analytical Results above Criteria	Percent of Analyses Exceeding Criteria
Aluminum	**0.087 mg/L**	**87**	**78**	**50**	**57%**
Arsenic	0.150 mg/L	23	5	0	0%
Cadmium	0.080 mg/L	43	28	0	0%
Chromium	0.024 mg/L	43	20	0	0%
Copper	**0.0027 mg/L**	**87**	**46**	**16**	**18%**
Lead	**0.00054 mg/L**	**87**	**65**	**82**	**94%**
Nickel	0.0161 mg/L	23	4	0	0%
Selenium	0.005 mg/L	22	3	0	0%
Zinc	0.0365 mg/L	87	60	5	5%

Discussion

The NHDES rules that establish the maximum concentrations for potentially toxic metals exempt those concentrations that are naturally occurring. In evaluating the data for the Cocheco River, listed above, three metals appear to show problematic concentrations; aluminum, copper, and lead (denoted in **bold**).

Aluminum is the third most abundant element on the surface of the earth. Aluminum is a primary component of many rock-forming minerals, including common feldspars and clay. It is not uncommon to detect elevated concentrations of aluminum in surface water samples. It is believed that much of the elevated aluminum levels are associated with suspended sediment or turbidity in the sample that was analyzed. The analytical techniques often used do not filter out the minute clay particles. This suggests that the elevated aluminum may derive from a combination of natural causes and analytical techniques.

Copper and lead are other potentially toxic metals that appear to occur at elevated concentrations. Elevated lead and copper in drinking water is often attributable to corrosion of household plumbing fixtures, especially in regions where slightly acidic sources of water are used. Drinking water suppliers often have to adjust the water's pH, prior to distribution, to avoid corrosion of pipes that can lead to elevated copper and lead at the faucet. It is possible that a portion of the elevated lead and copper measured in Cocheco River water is due to lead and copper in the discharge from wastewater treatment plants. Wastewater treatment plant operators will need to meet increasing stringent discharge standards in the coming years. Lead and copper have been identified as potential contaminants of concern in treated wastewater (or effluent) discharges. In the 2003 legislative session, New Hampshire passed Senate Bill 70 that authorized $1,000,000 to complete a feasibility study for combining treated wastewater effluent and conveying it to a regional treatment and/or discharge facility. Details of this project are available through the website: http://www.coastalclear.org.

4.5 e Nutrients

Excess nutrients (nitrogen compounds and phosphorus) in water bodies can cause excessive growth of aquatic plants that can, in turn, lead to eutrophication of the water body. This process was discussed briefly in Section 4.5a of this report, as related to depletion of dissolved oxygen. The NHDES water quality standards for nutrients are listed in Env-Ws 1703.14. For Class B water bodies the following standards apply:

- Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring.
- Existing discharges containing either phosphorus or nitrogen which encourage cultural eutrophication shall be treated to remove phosphorus or nitrogen to ensure attainment and maintenance of water quality standards.
- There shall be no new or increased discharge of phosphorus into lakes or ponds.
- There shall be no new or increased discharge(s) containing phosphorus or nitrogen to tributaries of lakes or ponds that would contribute to cultural eutrophication or growth of weeds or algae in such lakes and ponds.

Sources and Influences

Sources of excessive nutrients in surface water bodies are well known. Principal among these sources are point-source discharges from municipal wastewater treatment plants. Tertiary level treatment is required to effectively remove nutrients from the wastewater. Typical non-point sources of nutrients include runoff from agricultural operations, excessive residential fertilizer use and septic system discharges that impact groundwater.

Until recently, there was only limited data on what concentrations of nutrients that would cause the adverse effects. In 1997 the United States Geological Survey (USGS) initiated a multi-component assessment of the New England Coastal (watershed) Basins (NECB) as part of the National Water-Quality Assessment Program (NAWQA). Robinson and others (2003, USGS Circular 1226) presents a summary report for initial phases of the NECB portion of the NAWGA program.

Riskin and others (2003) completed a study intended to determine what level of nutrients would cause unwanted growth of aquatic plants in representative NECB watersheds. Although this study did not include the Cocheco River watershed, the thirteen watersheds included in the study were considered to representative of moderately developed watersheds with primarily forested riparian zones. The study analyzed water samples for chlorophyll A concentrations in periphyton samples along with total nitrogen (nitrate + nitrite + ammonia + organic & inorganic nitrogen) and total phosphorus. The study quantified the relationships between excessive algal growth (measured as chlorophyll A) and nutrients (total nitrogen and phosphorus). The study revealed there was a degradation of water quality (excessive algal growth) when total nitrogen exceeded concentrations in the range of 0.64 to 0.73 mg/L and when total phosphorus exceeded concentrations in the range of 0.030 to 0.036 mg/L.

Excess Nutrients in the Cocheco River

The NHDES database includes analyses for a variety of the forms nutrients including:

- Ammonia Nitrogen
- Total Kjeldahl Nitrogen
- Nitrate Nitrogen
- Nitrate & Nitrite Nitrogen
- Nitrite Nitrogen
- Organic Nitrogen
- Total Phosphorus
- Orthophosphate
- Organic Phosphorus

The analytical results that can be used to evaluate the nutrient levels in the Cocheco River, relative to the thresholds determined by Riskin and others (2003) are apparently Total Kjeldahl Nitrogen (TKN) and Total Phosphorus. Table 10 summarizes the statistical qualities of these analytical results.

Table 10
Statistical Values of Selected Nutrients in the Cocheco River

Parameter	Number of Samples	Average Concentration	Median Concentration	Number of Analyses Exceeding Threshold *	Percent of Analyses Exceeding Threshold *
Total Kjeldahl Nitrogen	247	0.494 mg/L	0.440 mg/L	29	11%
Total Phosphorus	316	0.107 mg/L	0.047 mg/L	192	60%

* Threshold concentrations of 0.70 mg/L for total nitrogen and 0.033 mg/L for total phosphorus were used as an indicator of excess nutrients.

Table 10 clearly shows that total phosphorus is the nutrient that is likely to cause excessive growth of aquatic plants in the Cocheco River.

<u>Discussion</u>
It is suggested by the work of Riskin and others that aquatic ecosystems can tolerate greater loading rates for nitrogen nutrients than they can assimilate excess phosphorus.
Runoff from agricultural operations and runoff of excess residential fertilizer usually represents sources of nitrogen nutrients to aquatic ecosystems. Septic system discharges that impact groundwater also tend to have higher concentrations of nitrogen nutrients, such as ammonia and nitrate. It is apparently more important to identify sources of phosphorus runoff to address excessive aquatic plant growth and the causes of eutrophication. A discharge limitation for phosphorus from wastewater treatment plants appears to be where efforts for limiting nutrients should be directed. It is obviously expensive to provide tertiary treatment to achieve significant reductions in phosphorus loading. Sediment runoff from construction sites is often implicated as a source of phosphorus to aquatic ecosystems. These sources are being addressed by the USEPA's Phase II stormwater program (see Section 5 of this report).

4.6 Cocheco River Habitat

The Cocheco River Watershed Coalition makes healthy fish habitat one of its primary goals as stated below.

The Coalition wants healthy fish populations in the watershed as indications of ecological well-being and for recreation and consumption.

The following section summarizes data on habitat analysis, anadromous fish populations, and captured mammals.

The in-stream and terrestrial habitat of the Cocheco River have not been extensively studied. For the purposes of this report, several sources were reviewed in order to provide a general picture of the current habitat conditions in the watershed. The sources of data include results of the Wadeable Stream Project evaluation conducted by the USEPA in 2001 near the Little Falls Bridge in Rochester, a compilation of fish species found at the Cocheco Fish Ladder in Dover, and fall deer kill counts and trapped fur-bearing mammal counts reported to the New Hampshire Fish and Game Department.

4.6 a Wadeable Stream Study Results, USEPA

In 2001, the USEPA chose sites on wadeable streams in New England in order to determine overall water quality and habitat quality of New England streams and rivers. Included in each evaluation was water quality testing, in-stream and riparian habitat assessments, fish community assessments, macro-invertebrate sampling, physical chemistry measurements, and photo documentation. One of the randomly selected sites for evaluation was the Cocheco River. The sampling took place near Little Falls Bridge in Rochester in September 2001. The location of the sampling point is shown in Figure 16 (USEPA, 2004). Results of the New England Wadeable Stream project, and more details on the Cocheco River sampling can be found at http://www.epa.gov/boston/lab/reportsdocuments/wadeable/index.html.

A summary of the results of in-stream and riparian habitat assessment is shown in Table 11. This location was evaluated using low gradient stream habitat criteria. Out of a possible score of 200, the Cocheco River sampling point scored 128. Each factor listed in the table had a possible total score of 20. Most characteristics evaluated received a score below 10. The low scores were largely due to poor riparian vegetative cover or poor bank stability at the tested location. In summary, lack of vegetative cover, bank erosion, and sedimentation were the major factors in ranking this sampling location as having a sub-optimal in-stream and riparian habitat.

During this same sampling event, a survey of the fish species in this location was made using electro-shock sampling. A 546-foot stretch of river was evaluated to see what species were present in the riffle, run and pool segments of the river. Northern pike, Notropis, Creek Chub, Common White Sucker, Common Shiner, and American Eel were detected in this reach. There were generally fewer numbers and fewer species detected in the Cocheco River compared to the other streams sampled.

Figure 16
Wadeable Streams Sampling Point, between Little Falls Bridge and Spaulding Turnpike

Source: USEPA, 2001, Wadeable Streams Project

Table 11
Cocheco River – Habitat Assessment

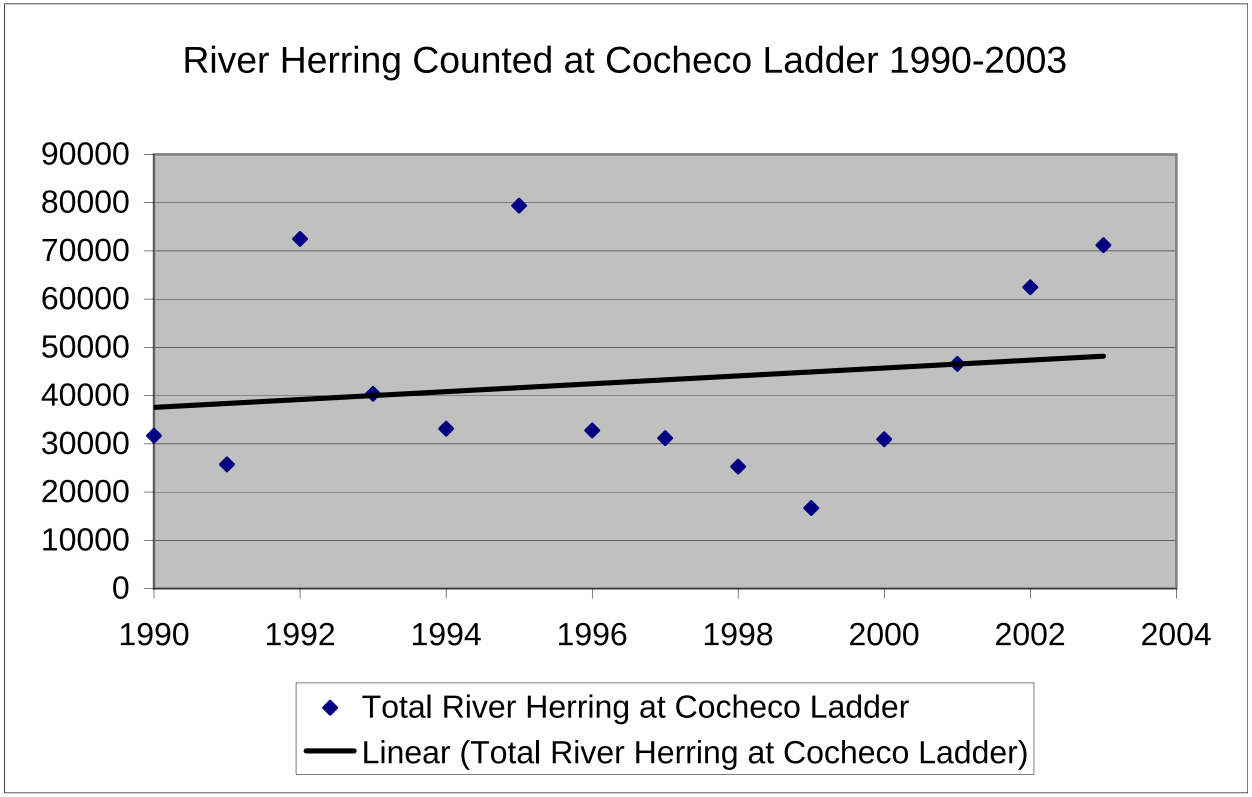
Habitat Parameter – Low Gradient Stream *	Score**
Epifaunal Substrate/Available Cover	11
Pool Substrate Characterization	9
Pool Variability	13
Sediment Deposition	6
Channel Flow Status	16
Channel Alteration	17
Channel Sinuosity	7
Bank Stability – Left Bank	9
Bank Stability – Right Bank	8
Vegetative Protection – Left Bank	9
Vegetative Protection – Right Bank	9
Riparian Vegetative Zone Width – Left Bank	6
Riparian Vegetative Zone Width – Right Bank	8
Total Score (out of a possible 200 points)	**128**

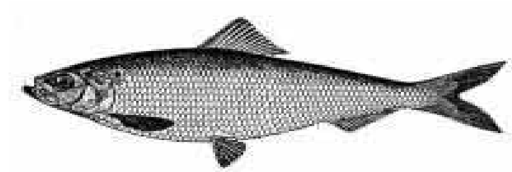
** Score per parameter out of a total score of 20

Invertebrates were also sampled at this location. Of the six wadeable streams sampled in NH as part of this study, the Cocheco ranked second overall indicating a good number and diversity of invertebrates at this location.

4.6b Anadromous Fish Counts – Cocheco River Ladder Records of anadromous fish returns have been kept at the Cocheco River Fish ladder since 1976. Anadromous means, "running upward" and refers to fish that are hatched in freshwater streams, swim to the ocean to mature, and return to the same stream to spawn. Evaluation of the overall numbers indicates that the Cocheco River has a diverse and healthy population of returning anadromous fish (Trowbridge, 2003). Table 12 shows the fish species that have been identified at the Cocheco River fish ladder. The returning population of river herring, which includes alewives and blue-black herring, is shown in Figure 17. The highest number counted since 1990 was in 1995 when nearly 80,000 individual fish were counted at the ladder. Biologist Mike Dionne from New Hampshire Fish and Game Department (NHFG) feels that the fish diversity and population represented at the Cocheco fish ladder is superior to that found at the other fish ladders in coastal

Figure 17





Source - New Hampshire Fish and Game Department, 2004

Table 12
Fish Species Found at Cocheco Ladder,
NH Fish and Game

Common Name	Species Name
Alewife	*Alosa pseudoharengus*
Blueback Herring	*Alosa aestivalis*
American Shad	*Alosa sapidissima*
Sea Lamprey	*Petromyzon marinus*
American Eel	*Anguilla rostrata*
Atlantic Salmon	*Salmo salar*
Brown Trout	*Salmo trutta*
Rainbow Trout	*Oncorhynchus mykiss*
Eastern Brook Trout	*Salvelinus fontinalis*
Fallfish	*Semotilus corporalis*
White Sucker	*Catostomus commersoni*
Smallmouth Bass	*Micropterus dolomieui*
Largemouth Bass	*Micropterus salmoides*
Striped Bass	*Morone saxatilis*

New Hampshire. Little study has been done by NHFG on freshwater spawning habitat, according to Mr. Dionne. He believes that low water levels may be the largest threat to spawning habitat as fish need a certain depth of water in order to spawn successfully (Dionne, personal communication, 2004). Dissolved oxygen and temperature, which can be related to water depth, are also major factors in habitat quality for fish populations.

4.6c Fish and Game Mammal Population Data

New Hampshire Fish and Game was also consulted regarding mammal species and relative health of populations in the watershed. Eric Orff, NHFG, provided data on fur bearing mammal catches reported to NHFG by licensed trappers and deer kill reported by licensed hunters. Table 13 summarizes captured deer, beaver, muskrat, fisher cat, mink and otter in Dover, Rochester, Barrington, Farmington and New Durham from 1997 to 2003. In general, Barrington and Rochester appear to have the largest populations of these species based on trapping and hunting records.

Discussion In summary, relatively little investigation of in-stream or terrestrial habitat has been conducted on the non-tidal portion of the Cocheco River. The data that are available point to impaired habitat in some reaches, however, mammal populations and anadromous fish populations appear to remain robust. Recent mapping by the NHFG to define overall habitat quality based on natural resource characteristics will provide greater information about terrestrial habitat, but more detailed in-stream and riparian buffer analysis is clearly needed to understand impacts on aquatic species and species that are dependent on high quality riparian corridors.

Table 13
Captured Mammal Populations in Cocheco River Area - 1997 to 2003

Animal	New Durham	Farmington	Barrington	Rochester	Dover
Deer	50 to 67	53 to 85	103 to 128	88 to 118	44 to 66
Beaver	11 to 19	3 to 37	2 to 42	51 to 138	17 to 54
Muskrat	4 to 12	3 to 12	12 to 28	9 to 29	4 to 63
Fisher	3 to 7	1 to 7	2 to 10	4 to 23	0 to 15
Mink	2 to 8	0 to 8	0 to 5	0 to 23	1 to 2
Otter	1 to 2	1 to 3	3 to 6	2 to 9	2 to 7

5.0 POTENTIAL POLLUTION SOURCES

5.1 Point Source Pollution

Point sources of pollution are generally regarded as direct discharges to a water body through a pipe or outfall. The 1972 amendments to the Federal Water Pollution Control Act (FWPCA, also referred to as the Clean Water Act or CWA) prohibit the discharge of any pollutant to waters of the United Stares from a point source unless the discharge is authorized by a National Pollutant Discharge Elimination System (NPDES) permit. Efforts to improve water quality under the NPDES program traditionally have focused on reducing pollutants in discharges of industrial process wastewater and from municipal sewage treatment plants (USEPA, 1996). Some states have applied to the USEPA for the authority to manage and enforce NPDES regulations. New

Hampshire is one of eleven states that chose not to administer such a program. The USEPA Region 1 holds regulatory authority over point source discharges from industrial and municipal wastewater treatment systems.

Table 14 lists the registered NPDES point source discharges to the Cocheco River. Some of the known pollution discharges to the Cocheco River do not come from outfalls subject to permit requirements of the NPDES program. These discharges are known as non-point source pollutants. In some cases non-point source pollution can come from pipes or outfalls, such as storm water runoff or discharges. These pollution sources will be discussed in Section 6, below. In other times, non-point pollution discharges may enter the river through broad areas of groundwater discharge. We have briefly discussed, in previous sections, how the discharge of contaminated groundwater from landfills and septage lagoons is degrading the water quality in the Cocheco River. In this section, we provide some more detail regarding areas along the river that may impact the water quality of the river. Some of the potential sources discussed below meet water quality standards at the point of discharge, however, can still have water quality impacts to the river due to the content and volume of discharge.

Table 14 – NPDES Discharges in the Cocheco River Watershed

Facility	Permit Number	Location	Receiving Stream
Dover Water Treatment Plant	NHG640003	Dover	Berry Brook
Farmington WWTF	NH0100854	Farmington	Cocheco River
Rochester WWTF	NH0100668	Gonic	Cocheco River

5.2 Town of Farmington Wastewater Treatment Plant

The following overview of the Farmington wastewater treatment plant is based on brief conversations with Dale Sprague, Director of Water and Waste Management for the Town. It also includes data that Dale provided to staff of the Strafford Regional Planning Commission, in the summer of 2003, during collection of background information related to the 2003 Senate Bill 70 "Regional Outfall" project.

The Farmington wastewater treatment plant was built in 1975-1976. It has a capacity of 350,000 gallons per day, and an "overflow" capacity of 225,000 gallons. The plant is considered to have secondary treatment and has separated storm water and sanitary wastewater collection systems. (Like many communities, some cross-connections may exist.) In the springtime, flow to the plant can reach 500,000 gallons per day and Dale reported that the plant could manage this discharge volume for a few weeks. The plant has had some upgrades to its clarifiers, but the Town is looking to upgrade the entire plant. In the late 1980's the Town replaced sewer lines on Main Street to reduce infiltration and inflow. The plant serves 2,500 to 3,000 people with 850 service connections.

The plant is not at service capacity. The DES is collecting data for a Total Maximum Daily Loading (TMDL) study that will set effluent limits. The plant's existing discharge permit will expire in 2005. It is anticipated that the TMDL study will be completed and the renewed permit will have the revised discharge standards. The DES is looking at dissolved oxygen as the limiting factor. Dale reported that discharge standards would be likely be stringent because there is low dilution rate in the Cocheco River at the outfall location (3.4:1 to 5.1:1). Once the DES sets the effluent limits, the Town will need to upgrade the plant to meet the limits and also prepare for increasing development in the sewer service area.

5.3 Town of Farmington and Cardinal Landfills

The following is a summary is based, in part, on discussions with DES personnel completed on June 15, 2004 regarding the Town of Farmington and Cardinal Landfills. There are known groundwater contamination problems associated with both the Farmington town landfill and the adjacent Cardinal landfill. The landfills are so close that it has been difficult for the DES to clearly delineate the contamination as being from one or the other. The Cardinal landfill is a CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Act or Superfund) site and an EPA-approved remediation program is underway (Tetra Tech NUS, Inc., 2003). Both the landfills are potential sources of groundwater pollutants to the nearby main stem of the Cocheco River. As discussed in Section 4.5 a, significant depletion of dissolved oxygen occurs downstream of the landfills.

The Cardinal landfill is generally regarded as presenting the largest problem to the environment. The landfill was used to dispose of industrial wastes that included chlorinated solvents. The solvents are toxic and therefore are subject to regulation at very low concentrations. The DES Hazardous Waste Remediation Bureau is managing the clean up of the Cardinal Landfill. There is an on-going pilot program to address groundwater contamination.

The Farmington town landfill is located adjacent to the Cardinal landfill. The DES Solid Waste Engineering Bureau is working with the Town of Farmington to close the unlined town landfill. The Town is exploring several options including construction of a new lined landfill and the capping and/or reclaiming of the existing landfill. The town landfill is currently accepting municipal waste, and accepting septage for disposal in on-site lagoons. Some of the ongoing waste disposal practices at the landfill raise concerns about their potential impact on the Cocheco River water quality. The town still allows septage haulers to dump wastes into open, unlined lagoons at the landfill. During a site visit in September 2003, some overflows from the septage lagoons were observed. Air-dried sewage sludge from the Farmington wastewater treatment plant is also disposed near the septage lagoons. In July 2000, the DES issued a Groundwater Management Permit (#198401085) covering the area between the landfills and the Cocheco River. Groundwater monitoring, conducted as required by the permit, has revealed elevated nitrate and BOD downgradient of the septage lagoons. Concentrations of these contaminants have been observed to increase during dryer seasons and decrease during wetter seasons. The Groundwater Management Permit will need to be renewed and/or updated in 2005.

Approximately 2.5 miles downstream of the landfills, the City of Rochester is conducting hydrogeological testing required to develop new groundwater supply wells in proximity to the Cocheco River. This location is near where the effects of the dissolved oxygen sag associated with the landfills starts to wane. Discussions with the DES have pointed out the need for active dialog regarding coordinating the potential permitting of both a new water supply source in Rochester and expansion of a municipal landfill in Farmington.

5.4 Rochester Wastewater Treatment Plant

The City of Rochester wastewater treatment facility completed a $16.1 million upgrade in August 2000. The facility has a treatment capacity of five million gallons of wastewater per day. Average daily load is 2.6 million gallons per day (GPD), representing approximately 2.1 million GPD from Rochester's water supply users, 400,000 GPD from Lindall Manufacturing's on-site wells, and some collection system infiltration and inflow. The wastewater treatment includes tertiary treatment to meet advanced limits for the removal of Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), and ammonia. Treated effluent is also disinfected with ultraviolet light and aeration. The plant meets or exceeds current wastewater treatment standards.

5.5 Dover Municipal Landfill

An overview of the groundwater contamination and remediation issues associated with the Dover Municipal Landfill was presented in Section 3.3, and is also expanded on in Appendix C to this document. On September 30, 2004 the USEPA and the NHDES agreed to an amended proposed clean-up plan for the landfill. A summary of this proposed plan is available at the following EPA website: http://www.epa.gov/region01/superfund/sites/dover

Groundwater pollutants from the Dover landfill impact the Cocheco River primarily in two seepage areas along the riverbank. These seepage areas mark the northern end of what is known as the eastern contaminated groundwater plume. Contaminants of concern within the eastern plume include arsenic and vinyl chloride. The EPA's amended proposed plan to address this contamination is as follows:

> "The Eastern Plume remedy will remain as monitored natural attenuation, MM-2 (the same remedy proposed in the 1991 Record of Decision). Monitored natural attenuation has specific protocol by which EPA ensures that natural processes are reducing contaminants to concentrations protective of human health and the environment.
>
> Currently, ground water in the Eastern Plume is discharging to the Cocheco River, however it does not pose a current risk to human health because all residents have been supplied with municipal water. Risk to future users of groundwater is controlled through restrictions that prohibit the use of groundwater for drinking water. These restrictions will remain in place until the aquifer is restored to drinking water status. Groundwater discharge to the Cocheco River does cause sediment concentration levels to exceed screening levels for an ecologic risk; therefore, further assessment and monitoring will be performed to clearly characterize any risk and, if necessary, sediment will be excavated. It is believed that once contamination emanating from the landfill is cutoff, conditions will improve in the Eastern Plume and Cocheco River sediment within a reasonable amount of time. An assessment of the remedy will be conducted five years after the source control remedy has been implemented to verify that monitored natural attenuation is functioning as expected."

The EPA plan estimates that the estimated time for design and construction of the remedy for the entire landfill is 1.5 to 2.5 years with an estimated cost of $19.4 million dollars. The time required for the remedy to clean up the eastern plume, and its impact on the Cocheco River, is estimated to be less than 20 years from completion of the construction of the remedy.

5.6 Illicit Discharges and Sewer Cross-Connections

The cities of Dover and Rochester are actively investigating and correcting cross connections between storm sewers and sanitary sewers and illicit sewer discharges to surface water and storm water systems. This is being done as part of Phase II stormwater work, but due to the complexity and age of these sewer lines, it is a long and involved process. The Town of Farmington will also be investigating these discharges as the wastewater treatment plant is upgraded. Regular review of these efforts may be helpful in determining sources for some of the high bacterial and nutrient results along the river. In areas where no sanitary sewer infrastructure exists, detection and correction of these septic system failures and illicit discharges will be more difficult but will be aided by close evaluation of sampling results.

6.0 IMPACTS OF DEVELOPMENT

Section 2.4 describes the anticipated growth of population within the Cocheco River watershed and the potential change of land use that may take place to accommodate this growth. Communities within the Cocheco River watershed are trying to deal with the rapid pace of land development. This development will ultimately have a significant effect on the water quality of the Cocheco River and its tributaries. It was decided that this report should include an introduction to natural resource based planning and current environmental protection programs intended to lessen the impact of development. It is hoped that stakeholders in the Cocheco River Watershed Coalition can use this information to accomplish goals set forth in its Statement of Purpose:

> *"The Coalition wants watershed communities to regard the river as an asset, to foster the environmental health of the river and to derive benefit from the river.*
>
> Watershed communities that recognize the value of the river will protect the economic value of the water resources, including groundwater, with resulting increase in quality of life, property values, recreational opportunities, and resource management. Citizens of the watershed communities will have an increased capacity to make informed decisions regarding management of the river and other natural resources of the watershed. Informally citizens will act to protect and enhance the environmental values of the river. They will celebrate the river as a cornerstone of their sense of place."

6.1 Non-Point Source Pollution

As discussed above, non-point source pollution can be regarded as any source of pollution that is not generally subject to discharge limitations. During the 1980's there was a growing realization that the non-regulated storm water runoff and discharges were a significant source of surface water impairment. According to the 1996 National Water Quality Inventory, 13 percent of impaired rivers, 21 percent of impaired lakes acres and 45 percent of impaired estuaries are affected by urban/suburban storm water runoff. In addition 6 percent of impaired rivers, 11 percent of impaired lake acres, and 11 percent of impaired estuaries are affected by construction site discharges. (USEPA, 2000)

6.2 Impervious Surfaces – Storm Water Management

Hard surfaces where water cannot readily absorb into the soil are termed impervious surfaces. In urban areas this includes roadways, parking lots, sidewalks, and buildings. Figure 18 depicts the changes in land cover, impervious surface estimated between 1990 and 2000 for communities within the Strafford Regional Planning area. The communities of New Durham, Middleton, Milton, Farmington, Rochester, Somersworth and Dover are within the CRWC study area.

Rainfall and snowmelt (collectively termed as stormwater) can penetrate into the ground in pervious areas allowing for groundwater recharge and slow discharge to surface waters. In addition, the quality of the water flowing through a groundwater system or wetland can be improved as it passes through these subsurface areas and is filtered and contaminants are modified in transport.

On impervious surfaces that same water flows over hard surfaces and finds its way to storm drains or drainage ditches before flowing to a stream or other water body. The water washes over the material that has collected on these surfaces – leaks from automobiles, sand, silt, excess lawn/road treatment chemicals, pet wastes and solid waste causing many of the pollution problems discussed in the previous section. Storm runoff across impervious surfaces is not slowed down by absorption or interception by vegetation so it flows rapidly to drains, often exceeding the capacity for drains and ditches and causing flooding. This water also does not receive any water quality filtration as it passes through ditches and pipes and can often transport sediment and contaminated materials that have collected in these storm drains. Water quality impacts become apparent when the amount of impervious land cover increases above ten percent.

Figure 18 shows that the communities of Dover, Rochester and Somersworth exceed the ten percent threshold. Table 15 summarizes the change in impervious surface cover between 1990 and 2000 by subwatershed. The Lower Cocheco has the highest percentage of impervious surfaces (12.9% in 2000) with the Middle Cocheco close behind at 10.6% in 2000. The Upper Cocheco and Axe Handle still have the lowest percentage of impervious cover at 3.6 and 4.1 percent respectively.

Table 15
Changes in Impervious Surface Cover, Cocheco River Watershed
1990 to 2000

Sub-Watershed	1990 - % Impervious Cover	2000 - % Impervious Cover
Upper Cocheco	2.6	3.5
Axe Handle Brook	3.0	4.1
Middle Cocheco	8.0	10.6
Lower Isinglass	5.6	8.3
Lower Cocheco	9.3	12.0

Source – EOS, UNH, 2003

The Strafford Regional Planning Commission recently developed two sections of its Regional Master Plan that address limiting non-point pollution sources through land use and water quality policies and implementation strategies. Copies of these draft sections of the Regional Master Plan are included in Appendix F. These documents will form the basis of storm water management model ordinances that the Strafford Regional Planning Commission developed in 2004. Municipalities within the Cocheco River watershed can adopt these model ordinances. The DES recently published a reference manual for communities to use in implementing programs designed to control non-point source pollution (see DES, 2004 listed references). This guide is also available from the DES on-line.

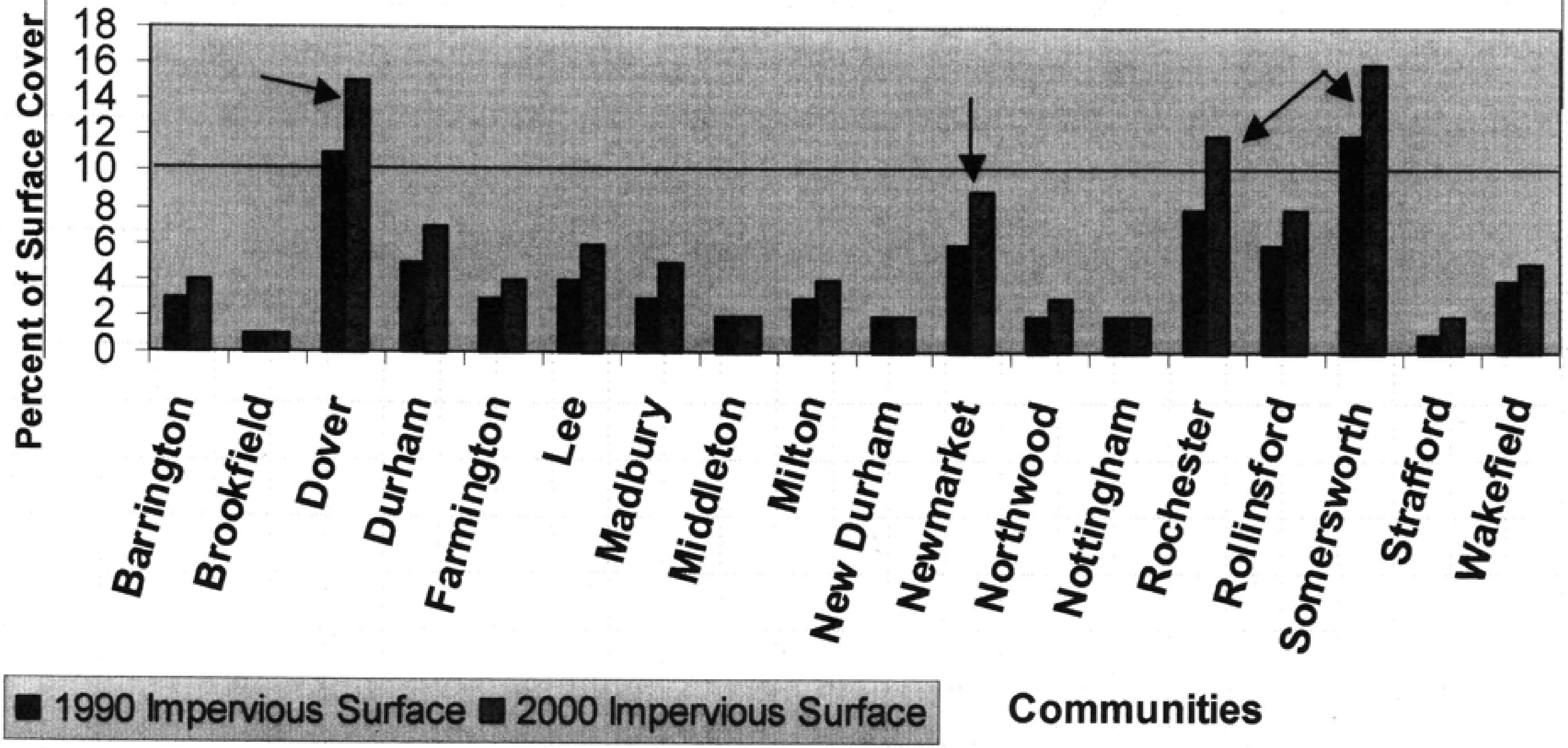
6.3 USEPA Phase II Storm Water Management Program

The Federal Water Quality Act of 1987 recognized that runoff from urban areas and industrial sites pollute surface waters. It required the USEPA to address storm water discharges with National Pollutant Discharge Elimination System (NPDES) permits using a two-phased approach. The Phase I and Phase II regulations were published in 1990 and 1999, respectively. In Phase I, EPA required medium and large municipal separate storm sewer system (MS4) operators to obtain permit coverage. These MS4s, none of which are located in New Hampshire, generally served areas with populations of 100,000 or more. Dischargers of "storm water associated with industrial activity" were also required to apply for permits. Phase II regulates "Small MS4" discharges in urbanized areas located in 45 municipalities in New Hampshire; Storm Water Discharge Associated with Small Construction Activity; and the Municipally Owned Industrial Activities that were exempted from regulation during Phase I.

On May 1, 2003 the USEPA implemented the “Small MS4” portion of storm water regulations set fourth in the Phase II requirements. These regulations set multi-component requirements for managing discharges from small municipal separate storm sewer systems (MS4) communities. Small MS4s are certain municipalities with separate storm and sanitary sewer systems that have populations under 100,000 people and that also meet criteria to be designated as urbanized areas. Five communities within the Cocheco River watershed met the criteria and were designated MS4 communities; Dover, Milton, Rochester, Rollinsford and Somersworth.

The following is an overview of the requirements for MS4 communities, adapted from DES Fact Sheet on “Federal Storm Water Permits (WD-WEB-8)”.

Growth: Land Coverage: Impervious Surfaces



The State's MS4 General Permit requires MS4 operators to develop a storm water management program that controls pollutants from all of the MS4 discharge points to the "Maximum Extent Practicable." The MS4 General Permit requires that the storm water program include the six minimum control measures listed below as well as an annual report to EPA summarizing progress toward achieving specific measurable goals:

1. Public education and outreach on storm water impacts.
2. Public involvement/participation during program development.
3. Illicit discharge detection and elimination.
4. Construction site storm water runoff control.
5. Post-construction storm water management in new development and redevelopment.
6. Pollution prevention/good housekeeping for municipal operations.

Another component of the EPA Phase II program is the management of runoff from construction sites. The EPA reissued New Hampshire's Construction General Permit (CGP) on July 1, 2003. The reissued CGP now covers both the Phase I large construction sites greater than five acres and "Storm water associated with small construction activity," which includes construction sites from one to five acres (or smaller than one acre if part of a larger "common plan of development or sale" that totals one acre). The permit contains conditions to protect endangered species and historic properties and requires the owner and operator of the construction site to, among other things:

1. Submit a Notice of Intent (NOI) application to USEPA
2. Develop and implement a storm water pollution prevention plan (SWPPP).
3. Post a visible public notice at the main entrance of the construction site (or if infeasible, at a local public building) containing confirmation of permit coverage and details on where the SWPPP may be viewed.
4. As part of the SWPPP, develop a site map showing surface waters, disturbed areas, best management practices (BMPs), etc.
5. Have "qualified personnel" inspect all erosion and sediment control BMPs, maintain BMPs after storm events and keep records in the SWPPP of all inspections and maintenance performed.
6. Control wastes, such as discarded building materials, concrete truck washout, and sanitary wastes.
7. File a Notice of Termination (NOT) form when the construction site is stabilized/revegetated.

The USEPA maintains an extensive library of fact sheets intended to assist communities with implementing the water quality protections of their Phase II program. These materials may be accessed through the USEPA Stormwater Best Management Practices Home Page: http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/menu.cfm.

6.4 Dumping and Debris Along the Cocheco River

The Cocheco River Watershed Coalition has emphasized the need for individual stewardship of the river corridor to maintain water quality and recreational opportunities on the river. Part of this effort included cleanups along the river in Dover, Rochester and Farmington. Nearly 200 people have participated in these cleanups along 10 miles of River. In this time 5,745 pounds of trash and debris were removed from the river corridor between 1997 and 2003. During water quality montiroing activities along the River and its tributaries, volunteers have consistently identified the presence of trash and debris at most of the water quality sampling sites.

7.0 Summary and Conclusions

This report provides a snapshot of the water quality, habitat quality, and growth impacts from 1998 to 2003. Impacts from the rapidly growing human population in the watershed will undoubtedly be felt in the next five-year period. The period from 1998 to 2003 represents a time when impacts from point source discharges in several areas were being reduced, but more diffuse impacts were being felt.

The major indicators used to evaluate water quality were dissolved oxygen, *E. coli* bacteria, pH, toxic metals, and nutrients. Results of sampling were compared to Class B water quality standards as described in previous sections. Dissolved oxygen levels (percent saturation) met Class B standards at the majority of sampling points, but repeatedly fell below the standard at two locations in Farmington and at the confluence of the Isinglass River in Rochester (high dissolved oxygen indicates good water quality). The Farmington impacts are below the municipal and Cardinal landfill and the Farmington Wastewater Treatment Plant. The depressed level of dissolved oxygen from the incoming Isinglass River results in the lower than normal reading at the Cocheco in this area. More investigation as to the cause of these lower levels is needed.

Values for *E. coli* provides an overall picture of bacterial contamination of a water body. This indicator exceeded Class B standards at the Central Street Bridge in Farmington, at the Watson Road Bridge in Farmington and at the Route 125 Bridge in Rochester. Contamination from the Spring Street area in Farmington may be the cause for the elevated levels at the Central Street Bridge and the Farmington Wastewater Treatment Plant is the likely source for elevated readings at the Watson Road Bridge. Contamination from Hurd Brook appears to be a source of bacterial contamination at the Route 125 bridge sampling point.

Measured pH values were within a normal range for Class B waters downstream of Little Falls Bridge, but above that, most of the average values fell below the 6.5 pH level. Discharge from the Farmington WWTP and the seepage from the municipal and Cardinal Landfills are the likely causes of this pH drop. There appears to be a direct relationship between depressed dissolved oxygen and lower pH. Reducing the biological oxygen demand should allow both dissolved oxygen and pH to return to healthier levels.

Three metals, aluminum, copper and lead, were found to be elevated above aquatic criteria. The causes of these elevated metals concentration are not clear. However, aluminum is a major component of rock forming minerals so elevated levels of this metal may be a result of inclusion of silt and small sediment grains in sampled water. The copper and lead may come from wastewater treatment plant discharge. These metals are commonly used in plumbing and can be dissolved as waters become acidic. Since WWTP's are a collection point for household and industrial water that has passes through pipes containing metals, this is a plausible source for elevated lead and copper levels. Further evaluation of these occurrences will be required.

Elevated levels of nutrients found in the Cocheco can be from fertilizers, runoff from animal wastes and from stormwater and septic discharge. The presence of elevated nutrients in surface water, especially phosphorus, can lead to algal blooms which can further impact water quality by reducing oxygen levels in surface waters. Phosphorus exceeds Class B standards somewhat at the Pokamoonshine confluence in Farmington, but increases substantially between the Rochester WWTP and the Watson Road Bridge in Dover. The impacts to the water quality along the main stem of the Cocheco are from known and suspected point and diffuse sources. Discharge of treated and untreated sewage appears to be having a major impact to water quality in some reaches. Impacts from more diffuse sources such as landfills and septic systems are also still evident.

Perhaps the most difficult influence to measure is that of stormwater. Untreated stormwater brings sediment and contaminants to the river that is washed from pavement, lawns, fields and roadways. The 5% overall increase in impervious surfaces between 1990 and 2000 demonstrates the increasing impact that stormwater runoff will have to the quality of the Cocheco River. While concerted efforts are being made to limit these point discharges and diffuse impacts in some areas, sources still remain in other areas.

The in-stream and riparian habitat along the Cocheco has not been extensively studied, but a recent EPA sampling program found degradation in the in-stream habitat primarily from erosion, siltation and insufficient vegetation on stream banks. Counts of anadromous fish at the Cocheco fish ladder are encouraging, but little is known about the quality of the upstream breeding habitat for these fish. Mammal populations appear to be healthy at this time but impacts from habitat fragmentation and destruction of wetland habitat may begin to erode the rebound these animals have enjoyed in the past century.

Dumping and debris remain a problem along the Cocheco as well. Annual cleanups and outreach programs have emphasized the need for individual stewardship along the river corridor, but dumping is still occurring, especially along tributaries and the main stem in the Rochester and Farmington areas.

The focus of this investigation was on the main stem and major tributaries of the Cocheco from Farmington to the bridge in downtown Dover where the tidal portion of the Cocheco begins. The importance of the wetland complexes and small streams and tributaries in the upper reaches of the Cocheco cannot be overlooked however. It is here that the habitat remains the richest and where the important recharge to headwater streams occurs. Maintaining the water quality of these systems is essential to the overall health of the Cocheco River. These headwaters areas should be a focus of further monitoring and evaluation for the Cocheco River Watershed Coalition.

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Appendix A

Town of Farmington – Cocheco River Watershed
Tour Report - September 25, 2003

Notes from Meeting with Cocheco River Watershed Coalition (CRWC) Stakeholders

Meeting Date: September 25, 2003
Location: Farmington, NH
Attendees: Danna Truslow
Thomas Fargo
Ed Mullen
Joe Gaudette

Purpose: To gain an insight into issues affecting the water quality of the Cocheco River and it tributaries in the vicinity of Farmington, NH.

Itinerary: Attendees gathered at Route 16 parking area near intersection with Route 153. A map of the watershed was reviewed by the attendees and a plan for a tour was formulated. The stops were as follows:

1. Bridge over Cocheco River at Pike Industries facility
2. Town of Farmington Landfill with view of adjacent Cardinal landfill
3. Windshield survey of various locations along Route 153 and within Farmington village, including Kicking Horse and Dick Dame Brook
4. Town of Farmington wastewater treatment facility
5. Former Pike gravel pit on Route 16 now a composting facility
6. Crossings of Mad River and Rattlesnake Brooks at Route 16
7. Farmington Town Forest area
8. Ela River near Spring Street

Issues Identified Through Tour and Interviews:

Potential Sources Identified:

- Cardinal Landfill – Industrial and solid waste
- Farmington Landfill – Municipal Solid Waste
- Farmington Landfill – Septage Lagoons
- Farmington Sewage Treatment Plant Discharge
- Non-point source runoff and solid waste dumping in "urbanized" stream channel within heavily settled areas of Farmington
- Pike Industries gravel pits – sediment, non-point source pollution
- Areas with no public sewer hook-up in heavily settled areas – possible failed or insufficient septic system discharge
- Farmington Country Club – pesticide/herbicide/fertilizer use

Overview of the Watershed:

The purpose of this trip was to view and better understand the known and possible impacts on water quality and water quantity along the Cocheco River and immediate tributaries in Farmington, NH. Emphasis was placed on the heavily settled areas in town and the commercial/industrial districts close to Route 11.

According to Ed Mullen, most all of the Cocheco River watershed upstream from Farmington is not heavily influenced by man-induced activities. As the river and its tributaries enter the more heavily developed Farmington village water quality impacts become more apparent. Historical and some more recent developments are located within riparian buffer areas and in some places within floodplain areas (Spring Street). The Dick Dame and Kicking Horse tributaries can be considered urbanized streams within Farmington village.

Hydrogeologic observations suggest that upstream of Farmington Village several tributaries flow across uplands underlain by relatively thin glacial till deposits covering bedrock. These streams appear to respond rapidly to precipitation events. As these tributaries enter the village area, the surficial geology changes to glacially derived sand and gravel deposits. It appears that significant portions of stream flow is exchanged between the groundwater and surface water systems, depending on recent precipitation events and season. The tour took place only a day after a very short duration, high precipitation event occurred. Joe and Ed described this area as nearly dry during most fall sampling periods, but on our observation, substantial stream flow was still apparent. Surface water may infiltrate into the groundwater regime due to this high permeability stratified drift that underlies much of the lower valley areas. This has two significant influences on the water quality of surface water. First, the infiltration of stream flow through the river profile may decrease the amount of surface water moving through the drainage courses thereby reducing the dilution potential along these reaches. Second, a larger proportion of the water flowing through this area of the watershed passes through the groundwater flow system. As this groundwater flows through the extensive sand and gravel deposits that underlie Farmington, it can (and apparently does) pick up contaminants or dissolve other naturally occurring constituents.

Observations made at the Pike Industries bridge suggest that a large portion of the groundwater component of flow discharges to the Cocheco River in this vicinity. Water quality data (persistent low dissolved oxygen values) and prevalent iron staining of the bed materials suggests that some chemical constituents dissolved in groundwater are being oxidized upon entering the Cocheco River in this area. This area may be influenced by discharge of contaminated groundwater from the Cardinal landfill, Farmington town landfill and its associated septage lagoons.

<u>Point Source Contaminants</u>

The Town of Farmington wastewater treatment facility was toured. Attendees spoke briefly with the plant supervisor Dale Sprague (?) about the treatment process and the plant's capabilities and limitations. The process is apparently enhanced secondary treatment. Sludge from the treatment plant is disposed at the Farmington Landfill.

Farmington has separate sanitary and storm water collection systems. Combined sewer outflows are not a problem. Sanitary sewer infiltration and inflow (I&I) volumes are not significant (less than 20%) and are manageable. Addressing the I&I component of plant influent is not a priority. In the winter, facility operations are impacted by sludge management considerations. The facilities have not been upgraded in over 20 years. According to the operator and also a review of a 1992 DES wasteload allocation study[1], the plant meets current treatment requirements. However, at the maximum design flow, some discharge violations are likely. There is some concern about the plant's capabilities to handle increased wastewater loads due to development. The supervisor felt that this plan was at or near capacity with the existing load. The plant is working with the DES on a Total Maximum Daily Load (TMDL) study to assess treatment capabilities into the future. The town is not prepared to extend sewer lines to unserviced areas.

No other permitted direct discharges to the Cocheco River or its tributaries were viewed or discussed.

<u>Non-Point Source Pollution Sources</u>

Numerous non-point source pollution source types were viewed and discussed.

<u>Septic systems</u>:
Some concern was expressed for apparent failing septic systems in several locations. The Spring Street area represents one section of Farmington where septic overflows to Ela Brook are known and/or suspected. The age of septic systems, proximity to the stream, and shallow water table all suggest that this area may be a source for observed (?) bacterial contamination in Ela Brook. There may be some homes (unconfirmed) where sewage and gray water are discharged directly to the brook. Other areas of town also appear to have similar conditions. As noted above, the town is not yet prepared to extend sewer service to Spring Street area.

Attendees expressed concern about premature residential and commercial development in outlying portions of the town where there could be water quality impacts resulting from widely distributed on-site wastewater disposal systems. Much of the area being proposed (zoned) for development is located within depleted gravel pits. These areas tend to be underlain by excessively well-drained soils close to the water table that may not adequately treat septic system effluent. The Town of Farmington reportedly does not have a groundwater protection ordinance or a gravel extraction regulation that establishes a minimum separation distance between the seasonal high water table and the bottom of gravel pits. <u>Such an ordinance could be developed under the authority of NH RSA 155E:11 II</u>.

Large-scale residential subdivision developments are also seen as a growing threat to natural resources within the Farmington portion of the Cocheco River watershed. Encroachment of

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[1] Cocheco River Wasteload Allocation Study, Farmington, NH, New Hampshire Department of Environmental Services, prepared by Robert Baczynski, March 1992.

housing developments into ecologically sensitive riparian areas is recognized as being detrimental to the maintenance of the existing water quality. The Town reportedly has not adopted local zoning ordinances consistent with the requirements of the State's Shoreland Protection Act. The Cocheco River in Farmington is not classified as a Class IV river and is therefore not subject to the riparian buffer protection regulations of the Shoreland Protection Act. <u>The Town could, however, adopt an overlay district ordinance to protect riparian buffers under the authority of NH RSA 674:2 III. (d).</u> Land protection efforts are underway to establish perpetual conservation easements on critical headwater areas. These efforts will likely require funding at the local level. This may be addressed in the next election cycle.

Some concern was expressed about "transient" sources of septic system effluent. Within Farmington there are campgrounds located adjacent to streams that are tributaries to the Cocheco River. These campgrounds are generally expanding their operations and extending the time period over which people reside in the campgrounds. There is a concern about upgrading the on-site wastewater facilities to meet the increasing wastewater loads.

<u>Uncontrolled landfills</u>:

There are known groundwater contamination problems associated with both the Farmington town landfill and the adjacent Cardinal landfill. The Cardinal landfill is a CERCLIS (Superfund) site and an EPA-approved remediation program is underway at this site[2]. There are ongoing waste disposal practices at the Farmington town landfill that raise concerns about their potential impact on the Cocheco River water quality. The town still allows septage haulers to dump wastes into lagoons at the landfill. This operation is not well managed and lagoon overflows were apparent. Air-dried sewage sludge from the Farmington wastewater treatment plant is also stockpiled (disposed) near the septage lagoons. Both the sludge and septage are potential sources of nutrient (BOD), metals and pathogen pollutants to the nearby main stem of the Cocheco River. There are currently at least two proposals from waste management companies to contract with the Town of Farmington to operate the landfill and possibly expand its operations.

The City of Rochester is currently pursuing the development of a municipal water-supply well 2.5 miles downstream of the Farmington landfill[3].

<u>Other Non-Point Source Pollution Sources</u>:

Some concern was expressed regarding the landscaping practices of the Farmington Country Club. Potential nutrient and pesticide runoff were cited as a concern due to the proximity of the golf course to the Cocheco River and the improbable mid-summer lush condition of the greens and fairways. Though not directly applicable to this instance, the state's Shoreland Protection Act prohibits application of pesticides and fertilizer within 25 feet of the water's edge. This law

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[2] Final Expanded Site Inspection Report for Cardinal Landfill, Farmington, NH; CERCLIS NO. NHD980913321, Site Inspection Response Action Contract (RAC), Region 1, prepared by Tetra Tech NUS, Inc, Wilmington, MA, for USEPA Region 1, March 2003.
[3] Preliminary Hydrogeological Investigation, The City of Rochester, Groundwater Development Wells RCH-1C and RCH-2A1, Rochester NH; prepared by: Emery and Garrett Groundwater, Inc., August 2002.

is regarded as applicable guidance for management of water pollution sources outside its jurisdictional areas.

Appendix B

City of Rochester – Cocheco River Watershed
Tour Report - November 7, 2003

Notes from Meeting with Cocheco River Watershed Coalition (CRWC) Stakeholders

Meeting Date: November 7, 2003
Location: Rochester, NH
Attendees: Danna Truslow
Thomas Fargo
Lorie Chase, Director CRWC
George Bailey, Rochester Cons. Comm. Chair

Purpose: To gain an insight into issues affecting the water quality of the Cocheco River and it tributaries in the vicinity of Rochester, NH.

Itinerary: Attendees gathered at downtown parking area near the Cocheco River at Wyandott Falls. A map of the watershed was reviewed by the attendees, and a plan for a tour was formulated. Also providing input of potential points of interest was Rochester resident and conservationist, Bill Sammis. The stops were as follows:

1. Area immediately upstream of Wyandott Mills dam
2. Wyandott mill area and old box factory across river
3. Windshield survey of Hansen Pines area adjacent to Spaulding High School- a City-owned protected area
4. Windshield survey of Heath bog area adjacent to Lilac Mall - a unique and partially protected area
5. Former gravel pit proposed to be a NHDOT wetland impact mitigation site off Chestnut Hill Road
6. Little Falls bridge (a.k.a. sampling station #22CCH)
7. Area of "old" Granite Ford dealership (Peirce Ford site, DES ID # 13868) on Farmington Road
8. Overview of cove in Cocheco River at end of Beauview Street
9. Rochester Fairgrounds and "Snow's Intervale"
10. Walking path crossing Hurd Brook between McClelland School (Brock Street) and Rochester Fairgrounds
11. Windshield survey of Willow Brook (a.k.a Wardley Brook on USGS topographic map)
12. Route 125 bridge over Cocheco River (a.k.a. sampling station #19CCH)
13. Axe Handle Brook Park, off Route 125 near motel
14. Gonic Mills
15. Pickering Ponds (closed wastewater treatment lagoons)

Issues Identified Through Tour and Interviews:

Potential Sources Identified:

- "Old box factory" at the foot of River Street – Potential industrial and solid waste from former uses, potential petroleum and solvent from automotive repair operations
- Former landfill at "old" Granite Ford location, (Peirce Ford site, DES ID # 13868) on Farmington Road – Municipal solid waste, gas emissions and possible source of groundwater runoff
- Potential contaminated site, Route 125 and Brock Street – Petroleum contamination from former use
- Non-point source runoff and solid waste dumping in "urbanized" stream channel within heavily settled areas of Rochester
- Poorly regulated development sites – non-point source sediment runoff, loss of riparian buffer
- Rochester Fairgrounds - with no public sewer hook-up, during high-use periods probable septic discharge
- Waste Management Landfill – possible groundwater discharges from closed, unlined Turnkey facility, windborne litter and gas emissions from Waste Management site.

Overview of the Watershed:

The purpose of this trip was to view and better understand the known and possible impacts on water quality and riparian ecosystems along the Cocheco River and its immediate tributaries in Rochester, NH. Emphasis was placed on the heavily settled areas in the city.

Areas of concern along the Cocheco River in Rochester, as expressed by George Bailey and Lorie Chase, focused on what could be described as lack of focus on river corridor stewardship. Principle concerns regarded the dumping of trash and fill materials into the river and its tributaries. These pollutants have evidently been, and continue to be dumped over the steep embankments that characterize the riparian area through the central portion of the city. An example of this was observed along the back of properties along Congress Street. The City recently adopted an ordinance establishing a 75-foot buffer setback from the selected rivers and streams and a 50-foot buffer setback from wetlands.

Historical land use patterns appear as if the city has turned its back on the natural resource areas adjacent to the river. Significant portions of the Cocheco River's riparian zone are inaccessible due to topographic relief and/or private property ownership restrictions. This has resulted in neglected and abused stretches of the river corridor and its tributary areas.

According to Lorie Chase, the water quality in the main stem of the Cocheco River is generally very good as it passes through downtown Rochester. Downstream of the Rochester Fairgrounds and the confluences with Hurd and Willow Brooks (as measured at the Route 125 bridge) water quality impacts become more apparent.

Outside the densely developed portion of the city, tributaries are generally not heavily influenced by man-induced activities. Willow (Wardley) Brook and Hurd Brook bring drainage from urbanized and developing sections of Rochester to the main stem of the Cocheco. These tributaries have shown intermittent high bacterial (e.Coli) contamination through the historical sampling period. Axe Handle Brook has generally shown good water quality indicators. However, an ongoing residential development in the Route 202 – Dry Hill Road area poses a potential threat to this tributary because this development is not serviced by the city sewer system.

Point Source Contaminants

The City of Rochester wastewater treatment facility was not toured. Attendees discussed their perspectives regarding the city's wastewater collection system and the treatment plant's capabilities and limitations. The treatment plant was recently upgraded to meet or exceed applicable discharge standards. The collection system was regarded to be in good condition with no significant problems with illicit connections or combined sewer outflows. A review of the city's wastewater collection and treatment system will be completed later during the interview phase of this project.

George Bailey noted that the Lyndall manufacturing plant on Chestnut Hill Road is the city's single largest water user. He also stated that they have their own wastewater treatment facility. It is unclear whether this plant discharges directly to the Cocheco River, or if the facility has an industrial pre-treatment plant that discharges to the Rochester wastewater system.

No other permitted direct discharges to the Cocheco River or its tributaries were viewed or discussed.

Non-Point Source Pollution Sources

Numerous non-point source pollution source types were viewed and discussed.

Septic systems:
Attendees expressed concern about premature residential and commercial development in outlying portions of the town where there could be water quality impacts resulting from widely distributed on-site wastewater disposal systems. The recent approvals of several Planned Unit Developments (PUDs) in areas not presently serviced by the city's wastewater collection and treatment system were noted. It is unclear whether or when the city will extend sewer service to these remote development sites. The attendees were unfamiliar with the status of on-site wastewater disposal facilities in the un-sewered portions of the city.

Some concern was expressed about "transient" sources of septic effluent. The Rochester Fairgrounds are reportedly owned and operated by a multi-family private trust. There are no permanent toilet facilities in the area where carnival workers park their trailers. Improper disposal of human waste has been a problem in the past. Outhouses were formerly piped directly to the river. The city has encouraged the fairground's owners to invest in new toilet facilities, but a long-term solution to this problem has not been implemented. Other issues discussed at the fairgrounds included a snow dump area on highlands above river that was used until recently. Disposal of animal manure is also seen as not managed well. Refuse from fair visitors and campers was observed near the top of the riverbank. Reportedly junked cars and other large refuse are present near "Snow's Intervale", city-owned land across the river and upstream from the Allen School.

Large-scale developments are seen as a growing threat to natural resources within the Rochester portion of the Cocheco River watershed. Encroachment of housing and commercial developments into ecologically sensitive riparian and wetland areas is recognized as being detrimental to the maintenance of the existing water quality. The City of Rochester has recently adopted local zoning ordinances that establish a 75-foot buffer setback from the Cocheco and Isinglass Rivers and the Axe Handle and Willow Brook. A 50-foot buffer setback from wetlands was also established. George Bailey expressed some concern regarding local enforcement of the new buffer setback ordinances and also complementary conditions of approval for State of NH Wetlands Bureau permits. New development projects adjacent to the river (and its tributaries) have been approved without on-site storm water detention and treatment facilities. Untreated, rapid storm water run-off from expansive areas of impervious surface associated with these sites is regarded as a threat to water quality. Such projects may not be meeting the intended run-off detention and treatment standards of Best Management Practices (BMPs) referenced in the EPA's Phase II storm water management program.

The Cocheco River in Rochester is not classified as a Class IV river and is therefore not subject to the riparian buffer protection regulations of the state's Shoreland Protection Act.

<u>Uncontrolled landfills and contaminated sites</u>:

During the tour, three sites were visited where known or suspected wastes have been buried or discharged.

The most apparent uncontrolled landfill is a former dump located at the "old" Granite Ford dealership on Farmington Road. This site appears to be a former gravel pit that was reportedly used as a landfill. The Ford dealership was constructed on top of the landfill. A review of DES on-line files regarding this site (DES One-Stop ID #13868, also known as the Peirce Ford site) indicates that site investigations have been underway since October 1996 (DES Site #199611022). The site, which abuts the Cocheco River, was characterized in a site investigation report submitted to the DES in October 1997. Subsequently, a remedial action plan that incorporates: 1) a groundwater management permit, 2) a gas-venting program, and 3) activity and use restrictions, was accepted by the DES in October 1998. The owners of the site apparently attempted to gain DES approval to reconstruct the dealership and were turned down. The site was then sold. The most recent regulatory activity on the site was the DES approval of a soils management plan in November 2003. Lorie Chase indicated that sampling of the river in a cove downstream from this site (Stop #8 at end of Beauview Street) has shown elevated specific conductance, possibly related to seepage of contaminated groundwater. According to George Bailey, one long-range transportation improvement project proposes to construct a new bridge in this area, along the PSNH right of way, to provide access between North Main Street and Chestnut Hill Road and alleviate downtown traffic congestion.

Two other suspected contaminated sites were visited during the tour. These were considered significant to the attendees primarily because of their proximity to the river. One potential contaminated site is the "old box factory" at the foot of River Street. This site was most recently used by an auto repair business. Possible industrial and/or solid waste may be buried at site. The potential exists for residual petroleum or solvents related to auto repair business at the site. There are no indications of contamination problems at this site in DES on-line databases. There is a proposal to redevelop this site as a housing project. Attendees discussed if there is a way to get money for water quality investigations prior to starting the redevelopment project.

A second potential contaminated site that was visited was located at the corner of Route 125 (Gonic Road?) and Brock Street. According to the DES on-line databases, this site is identified as the Landry Foreign Auto Salvage site (DES ID #5115, Site #19870820). The site is registered as a leaking underground storage tank site with known soil contamination. The DES on-line activities log indicates on-going soil remediation activities.

Some concern was expressed regarding the Waste Management Landfill in Rochester Neck Road. There are possible groundwater discharges from closed, unlined Turnkey Landfill portion of this facility. Windborne litter and odors associated with gas emissions from the active Waste Management portion of site are also a concern. Follow-up interviews are anticipated with Waste Management representatives.

Further review of DES on-line databases revealed that there are 127 registered remediation sites within the City of Rochester. Additional review of these data is anticipated.

<u>Other Watershed Stewardship Issues</u>:

Some concern was expressed regarding the condition and maintenance of natural areas surrounding the Cocheco River and its tributaries. The Coalition has conducted several river clean-up events in Rochester. Large quantities of debris and litter have been collected. Dense shrubby growth of invasive, non-native plant species have been noted and removed when possible. The Coalition has also worked to remove fallen trees and submerged logs from the main stem of the river to allow passage of canoes. These efforts have resulted in temporarily or spatially improved access, but a clear navigable channel has yet to be completed.

At several places throughout Rochester, clear evidence of bank erosion was noted. River and stream bank stabilization through the placement of riprap or diversion of storm water runoff appears to be needed.

The DES is reportedly investigating the feasibility of removing the dam at Gonic Mills. This dam appears to have been partially breached. Removal of the dam would likely destabilize river bottom sediments for several miles upstream. This might lead to mobilization of contaminants long buried in the sediment that has accumulated behind the dam. The DES is reportedly investigating the quality of these sediments.

<u>Watershed Enhancement Projects</u>:

The attendees visited a former concrete plant on Chestnut Hill Road that is being considered for wetland mitigation site. This former gravel pit area will be excavated to provide some of the fill needed to widen of the Spaulding Turnpike between Exits 12 and 16. The site will then be re-contoured to create wetlands to mitigate the loss of wetlands anticipated through the construction of the Turnpike widening.

Pickering Ponds (the former treatment lagoons at the City wastewater treatment plant off Pickering Road) were visited. The southern three to four ponds at this facility are no longer used for wastewater treatment. They have been opened up for public recreation and also provide enhanced wildlife habitat.

Appendix C

City of Dover – Cocheco River Watershed
Tour Report - November 14, 2003

Notes from Meeting with Cocheco River
Watershed Coalition (CRWC) Stakeholders

Meeting Date: November 14, 2003
Location: Dover, NH
Attendees: Danna Truslow
Thomas Fargo, Chairman, Dover Conservation Commission
Lorie Chase, Director CRWC
Ed Mullen, CRWC

Purpose: To gain an insight into issues affecting the water quality of the Cocheco River and it tributaries in the vicinity of Dover, NH.

Itinerary: Attendees gathered at the Waste Management Inc. parking area near the Rochester Neck Road Bridge over the Isinglass River in Rochester. Tom Fargo said that he had invited Dean Peschel, Environmental Programs Director for the City of Dover. Dean had indicated that he would try to catch up with the tour after an early morning appointment, although he did not join us. Ed Mullen stated that he could not join in the tour. It was decided that the tour would initially follow the main stem in the area of the Strafford County lands then work up tributaries in northwest Dover. The stops were as follows:

1. The area adjacent to the Waste Management parking area, including the City of Dover pump station on the Isinglass River (located in Rochester).
2. Windshield survey of Brox gravel pit on Glen Hill Road.
3. The City of Dover gravel pits on Glen Hill Road including the groundwater recharge basin associated with the Calderwood and Campbell water supply wells.
4. Windshield survey of Minniciello site on Glen Hill Road.
5. Windshield survey of the former Dover municipal landfill on Tolend Road.
6. Watson Road bridge over the Cocheco River (CRWC monitoring point #11-Cch)
7. Windshield survey of wetland complex at confluence of Cocheco River and Reyners Brook
8. Tour of the Cocheco River trail at the Strafford County land, including monitoring point #12-Cch located at the former cover bridge abutment.
9. Sixth Street bridge over Blackwater Brook
10. Varney Road bridge over Reyners Brook
11. Windshield survey of Country Homes Estates subdivision located on Cordeiro Drive (including the "big tree" red oak on Karen's Way).
12. Windshield survey of Blackwater Brook in the area of Blackwater Road.
13. Bridge over Clark Brook on Old Dover-Rochester Road (in Rochester).
14. Return to Strafford County complex where Lorie departed tour.
15. Windshield survey of urbanized Berry Brook watershed near Sixth Street.

Issues Identified Through Tour and Interviews:

Potential Sources Identified:

- Windblown dust from Brox Industries and City of Dover gravel pits on Glen Hill Road
- Minichiello Brownfield site on Glen Hill Road
- Former Dover municipal landfill, particularly groundwater discharge from the "eastern plume area"
- Non-point source runoff associated with housing developments located along tributaries in northwest Dover and adjacent areas of Rochester and Somersworth
- Poorly regulated development sites – non-point source sediment runoff, loss of riparian buffer
- Storm sewers and non-point source runoff in the urbanized Berry Brook watershed in north Dover.

Overview of the Watershed:

The purpose of this trip was to view and better understand the known and possible impacts on water quality and riparian ecosystems along the Cocheco River and its immediate tributaries in Dover, NH. The tour was limited to the non-tidal portion of the watershed in Dover. The tidal portion of the Cocheco River is outside the scope of this investigation. The boundaries of the non-tidal Cocheco River watershed are sketched on the attached map.

Primarily Lorie Chase and Tom Fargo identified areas of concern along the Cocheco River in Dover. Tom is the Chairman of the Dover Conservation Commission and has worked professionally on groundwater remediation efforts at the Dover municipal landfill. With the exception of the Tolend Road landfill, the tour identified very few specific potential sources of contaminants that are likely to impact the Cocheco River water quality.

Northwest Dover, and adjacent areas in Rochester and Somersworth, is undergoing rapid commercial and residential development. In Dover, a light industrial and technology business park, located on Sixth Street near Exit 9 of the Spaulding Turnpike, is approaching full development. Outer Sixth Street is also the locus of large-scale residential development. Only a few of the recently completed residential developments are serviced by the city's sewer system. Many residential developments in this area are serviced by the municipal water supply but rely on individual or community septic systems. The city is currently extending sewer service to outer Sixth Street (construction was on-going at the time of the tour).

Development is taking place along the Cocheco tributaries of Reyners Brook and Indian Brook. The Blackwater Brook area in Dover has not experienced large-scale development and is relatively intact ecologically. Ongoing efforts by the Dover Conservation Commission and Water Department have led to the preservation of over 100 acres of the Blackwater Brook drainage to protect a future water supply source area. However, upstream areas along Clark and Blackwater Brooks in Rochester and Somersworth are being developed rapidly. If built, the proposed Exit 10 of the Spaulding Turnpike would pass through this area, and is likely accelerate development.

Point Source Contaminants

The City of Dover wastewater treatment facility discharges to the tidal portion of the Cocheco River and is therefore considered outside of this study.

The city is aware that illicit discharges of sewerage have been a source of bacterial contamination of the Cocheco River. These discharges are usually associated with sanitary and storm sewer cross-connections. Prior to 1970, Dover had a combined sanitary and storm water sewer collection system. This system was reconstructed in the early 1970's as separate collection systems in an effort to avoid combined sewerage overflows. During construction of the sanitary sewer collection system, some service connections were apparently missed. For the past seven years, Dover has an ongoing program to stop all illicit sanitary sewer discharges to the Cocheco River and its tributaries. This work continues as part of the City's EPA Phase II Stormwater Management Plan.

No other permitted direct discharges to the Cocheco River or its tributaries were viewed or discussed.

Non-Point Source Pollution Sources

Numerous non-point source pollution source types were viewed and discussed.

Septic systems:
As noted above, residential and commercial development in is occurring in areas not serviced by the Dover municipal sewer system. There is a concern that water quality impacts may result from failure of on-site wastewater disposal systems. The city is currently extending sewer service to the outer Sixth Street area to address, in part, the recognized failure of a number of septic systems in this area.

Dover's 2000 Master Plan established a policy that the city will not extend sewer service into outlying areas unless there is a need to address existing septic system failures. This policy reflects an effort to avoid premature development and sprawl. When new subdivisions are constructed, the city requires that the developer build the wastewater collection system to meet its engineering standards, and then the city will assume responsibility for maintaining the system. A large residential subdivision (Alden Woods) recently constructed off Sixth Street included the extension of the sewer system into the Reyners Brook sub-watershed. This construction has facilitated the future extension of sewer service to other residential subdivisions in this area. There are known septic system failures in the "Indian Nation" (Cherokee, Apache Drives, etc.) subdivision located on the Dover-Somersworth line between Varney and Old Rochester Road. The city is pursuing funding to extend sewer service to this area.

Riparian Buffer Preservation

The Cocheco River in Dover (downstream of the confluence with the Isinglass River) is classified as a Class IV river and is therefore subject to the riparian buffer protection regulations of the state's Shoreland Protection Act. The City of also has a Conservation District overlay that mimics the requirements of the state's shoreland protections and also extends them to include a 50-foot buffer along all streams not subject to the state law. Planning Board approval is required prior to the disturbance of the ground surface within the Conservation District overlay. Dover's Codes Enforcement Officer/Building Inspector and Engineering Technician enforce this requirement on development sites. The maintenance of the forested buffer is not well policed in areas not subject to building permit or Planning Board conditions of approval.

Dover has a wetlands protection district zoning ordinance that echoes the State's wetlands rules. All state wetlands dredge and fill permits, except boat docks, are enforced locally through Planning Board Conditional Use Permits. The city has recently expanded its wetlands protection zoning ordinance to include a 50-foot no building setback from wetlands on new development sites. The construction of driveways and access roads is generally allowed within these setback areas with Planning Board approval.

Uncontrolled landfills and contaminated sites:

During the tour, two sites were visited where known or suspected wastes have been buried or discharged.

The largest uncontrolled landfill in the Dover is the former municipal landfill on Tolend Road. The following summary of the landfill's operational history and associated remedial activities is adapted from a 2003 DES Superfund Program Update[4].

> The Dover Municipal Landfill (Site) accepted municipal and industrial refuse for on-site disposal from approximately 1961 to 1979. The Site occupies approximately 55 acres of land four miles to the southwest of the City of Dover in a generally rural setting. The Site is approximately 2,100 feet south of the Calderwood municipal supply well, 600 feet west of the Cocheco River, and 1,400 feet northeast of the Bellamy Reservoir. The Bellamy Reservoir, supplies a major portion of the drinking water to Portsmouth, Newington, Newcastle, Greenland, and parts of Rye, Madbury, and Durham, New Hampshire.
>
> The Site was added to the National Priorities List in September 1983. Sampling of residential well water in the vicinity of the Site revealed contamination had migrated approximately 200 feet to the east of the landfill. The City of Dover promptly installed a water main to service all affected and potentially affected homes in the area of the Site. Studies undertaken at the Dover Municipal Landfill indicated that the Bellamy Reservoir and the Calderwood municipal supply well, as well as private residential wells located in the vicinity of the Site, were potentially threatened by ground water contamination emanating from the landfill.
>
> The Remedial Investigation was completed in March 1989. In 1988, the Potential Responsible Parties (PRPs) signed an Administrative Order with EPA and DES (Agencies) to conduct the Feasibility Study, which was completed in early 1991.
>
> EPA issued the Record of Decision (ROD) formalizing the preferred remedy in September 1991. The major components of the preferred remedy include capping the landfill, installing a leachate collection

[4] http://www.des.state.nh.us/HWRB/supfun02.asp?theLink=dover

trench and/or ground water extraction wells, and treating leachate on-site with discharge to the Cocheco River or pretreating leachate on-site with discharge to the Dover wastewater treatment plant.

The PRPs proposed further study of the contaminant plume located to the south of the landfill (southern plume). They believe the contaminants to be naturally attenuating such that the plume will not impact the Bellamy Reservoir. The Agencies agreed to allow the PRPs to conduct additional studies of the southern plume. The report findings were inconclusive and recent ground water quality data suggest that a plume of ground water containing elevated concentrations of contaminants of concern is migrating south toward the Bellamy Reservoir. As such, the PRPs have been directed to perform additional characterization of the southern plume, install monitoring and sentinel wells as appropriate, and implement remedial actions as necessary to protect public health and the environment from releases of impacted ground water.

Investigation and remediation of a portion of the landfill trench and swale were completed in November 2000. The primary component of this remedial action involved removal of arsenic- and VOC-impacted sediment, with off-site disposal. Final remedial action of the trench and swale areas will be coordinated with implementation of a final remedy.

Construction of the preferred remedial action, described in the 1991 ROD, was scheduled to begin in June 1997. However, the Agencies agreed to postpone implementation of the remedy to allow the PRPs to explore an alternative remedy at the Site. Specifically, the PRPs constructed a pilot-scale treatment zone demonstration (TZD) to evaluate the site-specific viability of augmenting existing biodegradation of contaminated ground water by injecting sodium benzoate and oxygen.

The TZD operations began in December 1997 and continued through November 2001. Interim assessments were completed periodically during the TZD, along with a Final Report submitted December 31, 2001. Furthermore, monthly meetings between the PRPs and Agencies began in June of 2000 and continued through November 2001 to establish and quantify performance criteria and identify and communicate Agency concerns relative to the TZD.

At a meeting held on November 2, 2001, the PRPs proposed to abandon enhanced bioremediation as a final remedy and introduced an alternate remedy that includes a permeable vertical barrier along the downgradient landfill toe to facilitate the injection of air and stripping of contaminants (alternate remedy). The PRPs proposed this revised conceptual design in response to many uncertainties the Agencies raised in preceding monthly meetings regarding the TZD and full-scale implementation of enhanced bioremediation technology at this Site. The Agencies agreed to allow the PRPs to evaluate the alternate remedy and its incorporation into the TZD Final Report.

To expedite review and ultimately reduce costs to the PRPs, the Agencies did not attempted to provide detailed comments on the entire TZD Final Report, due to the fact that the PRPs proposed to abandon a full-scale version of the TZD. However, in an attempt to clarify, substantiate, and document Agency concerns eluded to by the Group in the Draft Final Report, a comment section was provided that detailed Agency concerns and supported the Agencies' requirement for a "continuous solution" (i.e., delivery other than point injection) to convey anaerobic and aerobic amendments for a full-scale application of the TZD. In addition, detailed comments were provided for the Draft Revised Focused Feasibility Study (RFFS), included as Appendix C of the TZD Final Report.

Agency comments to the RFFS are currently being addressed by the PRP consultants, and a revised RFFS is due to be resubmitted to the Agencies in the first quarter of 2004. Pending review and modifications to the RFFS, the Agencies will make a determination whether to proceed with a ROD amendment for the alternate remedy or require the PRPs to implement the 1991 ROD remedy. In any case, a full-scale source control remedy is expected to begin construction within 2 years.

Only a portion of the Dover Municipal landfill lies within the Cocheco River watershed. Contaminated groundwater emanating from that part of the landfill, flows in a northeasterly direction toward the Cocheco River. This region of subsurface contamination is known as the "eastern plume". Both the 1991 ROD remedy and the proposed amended ROD remedy will address the "eastern plume" by controlling the migration of contaminants near the boundary of the landfill. Groundwater seeps along the bank of the Cocheco River (part of the "eastern plume") have been evaluated by the PRPs and the Agencies. The Agencies have concluded that the river's water quality is impacted by the groundwater seeps, but the level of impact is below the threshold for remedial action. The PRPs have committed to complete additional aquatic toxicity tests to confirm these findings.

During the tour, the attendees passed another suspected contaminated site. This site is known as the Minichiello property, located on Glen Hill Road. The site was considered significant to the attendees because of its proximity to the river. The site is an abandoned auto service facility and scrapyard. The City of Dover assumed ownership of the property in the 1960s as part of wellhead protection efforts associated with development of the nearby Calderwood water supply well. Some clean up of the site was completed at the time of transfer of ownership. The City of Dover is attempting to characterize potential contamination at the site through an EPA "greenfields" demonstration project grant administered through the Office of State Planning Coastal Program. The goal is to address any residual contamination at the site and then dedicate the land to recreational use. The grant funds were recently diverted to another project.

A review of DES on-line databases revealed that there are 121 registered remediation sites within the City of Dover. Additional review of these data is anticipated.

<u>Other Watershed Stewardship Issues</u>:

The Isinglass River is a major tributary to the Cocheco. The confluence of these two rivers marks the point below which the Cocheco River is designated a Class IV river (subject to the state's Shoreland Protection Act). A review of the map of the Cocheco River watershed indicates that the Isinglass River sub-watershed comprises approximately 43% of the land area within the Cocheco River watershed[5]. The Cocheco River Watershed Coalition has not completed a significant amount water quality assessments within the Isinglass sub-watershed.

The City of Dover has a permit to pump up water from the Isinglass River to artificially recharge groundwater in the vicinity of the city's Calderwood and Campbell water supply wells. The attendees viewed the pump station and recharge basin.

In June 2002, the Isinglass River received designation into the NH Rivers Management and Protection Program (RMPP). This makes the Isinglass eligible for regulation through the state's Instream Flow Rules. The RMPP designation also established a Local Advisory Committee (LAC) for the river and empowered that committee to provide comments on projects regulated by the DES. The LAC has been conducting water quality sampling with the assistance of the DES Volunteer River Assessment Program (VRAP). The Isinglass LAC is currently in the process of developing a Watershed Management Plan.

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[5] GRANIT GIS data indicates that the total area of the Cocheco River watershed is 185.1 square miles. The total area of the Isinglass River watershed is 80.4 square miles.

Appendix D

TITLE L
WATER MANAGEMENT AND PROTECTION
CHAPTER 485-A
WATER POLLUTION AND WASTE DISPOSAL
Classification of Waters

TITLE L
WATER MANAGEMENT AND PROTECTION
CHAPTER 485-A
WATER POLLUTION AND WASTE DISPOSAL
Classification of Waters

Section 485-A:8

485-A:8 Standards for Classification of Surface Waters of the State. – It shall be the overall goal that all surface waters attain and maintain specified standards of water quality to achieve the purposes of the legislative classification. For purposes of classification there shall be 2 classes or grades of surface waters as follows:

I. Class A waters shall be of the highest quality and shall contain not more than either a geometric mean based on at least 3 samples obtained over a 60-day period of 47 Escherichia coli per 100 milliliters, or greater than 153 Escherichia coli per 100 milliliters in any one sample; and for designated beach areas shall contain not more than a geometric mean based on at least 3 samples obtained over a 60-day period of 47 Escherichia coli per 100 milliliters, or 88 Escherichia coli per 100 milliliters in any one sample; unless naturally occurring. There shall be no discharge of any sewage or wastes into waters of this classification. The waters of this classification shall be considered as being potentially acceptable for water supply uses after adequate treatment.

II. Class B waters shall be of the second highest quality and shall have no objectionable physical characteristics, shall contain a dissolved oxygen content of at least 75 percent of saturation, and shall contain not more than either a geometric mean based on at least 3 samples obtained over a 60-day period of 126 Escherichia coli per 100 milliliters, or greater than 406 Escherichia coli per 100 milliliters in any one sample; and for designated beach areas shall contain not more than a geometric mean based on at least 3 samples obtained over a 60-day period of 47 Escherichia coli per 100 milliliters, or 88 Escherichia coli per 100 milliliters in any one sample; unless naturally occurring. There shall be no disposal of sewage or waste into said waters except those which have received adequate treatment to prevent the lowering of the biological, physical, chemical or bacteriological characteristics below those given above, nor shall such disposal of sewage or waste be inimical to aquatic life or to the maintenance of aquatic life in said receiving waters. The pH range for said waters shall be 6.5 to 8.0 except when due to natural causes. Any stream temperature increase associated with the discharge of treated sewage, waste or cooling water, water diversions, or releases shall not be such as to appreciably interfere with the uses assigned to this class. The waters of this classification shall be considered as being acceptable for fishing, swimming and other recreational purposes and, after adequate treatment, for use as water supplies. Where it is demonstrated to the satisfaction of the department that the class B criteria cannot reasonably be met in certain surface waters at all times as a result of combined sewer overflow events, temporary partial use areas shall be established by rules adopted under RSA 485-A:6, XI-c, which meet, as a minimum, the standards specified in paragraph III.

III. The waters in temporary partial use areas established under paragraph II shall be free from slick, odors, turbidity, sludge deposits, and surface-floating solids of unreasonable kind or quantity, shall contain not less than 5 parts per million of dissolved oxygen; shall have a hydrogen ion concentration within the range of pH 6.0 to 9.0 except when due to natural causes; and shall be free from chemicals and other materials and conditions inimical to aquatic life or the maintenance of aquatic life. These criteria shall apply during combined sewer overflow discharges and up to 3 days following cessation of said discharge. At all other times the standards and uses specified in paragraph II shall apply.

IV. Notwithstanding anything contained in this chapter, the department in submitting classifications relating to interstate waters to the New England Interstate Water Pollution Control Commission for review and approval, as provided for under the terms of Article V of the compact whereby the interstate commission was created by RSA 484, shall submit such classifications in accordance with the standards of water quality as currently adopted by said interstate water pollution control commission provided, however, that the standards for any classification thus submitted for review and approval shall not be less than, nor exceed the standards of the classification duly adopted by the General Court as provided for in RSA 485-A:9 or 10.

V. Tidal waters utilized for swimming purposes shall contain not more than either a geometric mean based on at least 3 samples obtained over a 60-day period of 35 enterococci per 100 milliliters, or 104 enterococci per 100 milliliters in any one sample, unless naturally occurring. Those tidal waters used for growing or taking of shellfish for human consumption shall, in addition to the foregoing requirements, be in accordance with the criteria recommended under the National Shellfish Program Manual of Operation, United States Department of Food and Drug Administration.

VI. Notwithstanding anything contained in this chapter, the commissioner shall have the authority to adopt such stream classification criteria as may be issued from time to time by the federal Environmental Protection Agency or its successor agency insofar as said criteria may relate to the water uses specified in RSA 485-A:8, I and II, provided, however, that the criteria thus issued shall not result in standards that are less than nor exceed the standards of the classification duly enacted by the general court as provided for in RSA 485-A:9 or 485-A:10.

VII. All tests and sampling for the purposes of examination of waters shall be performed and carried out in a reasonable manner and whenever practicable, in accordance with the commonly accepted scientific method as selected by the department. The waters in each classification shall satisfy all the provisions of all lower classifications. The minimum treatment for the lowest classification shall be as follows:

(a) For sewage, secondary treatment and disinfection as necessary to comply with water quality standards.

(b) For industrial wastes and combined sewer overflows, such treatment as the department shall determine. Appeal from any such determination shall be in the manner provided for in RSA 21-O:14.

VIII. In prescribing minimum treatment provisions for thermal wastes discharged to interstate waters, the department shall adhere to the water quality requirements and recommendations of the New Hampshire fish and game department, the New England Interstate Water Pollution Control Commission, or the United States Environmental Protection Agency, whichever requirements and recommendations provide the most effective level of thermal pollution control.

IX. Subject to the provisions of RSA 485-A:13, I(a), the fish and game department may use rotenone or similar compounds in the conduct of its program to reclaim the public waters of the state for game fishing.

Appendix E
Strafford Regional Planning Commission
Draft Regional Master Plan – May 2004

Master Plan for Non-Point Source Pollution Prevention - Water Resources

Water Resources: Introduction/Authority/Role

(1) The Regional Master Plan Water Resources section includes policies and strategies related to water resource protection. Controlling non-point source pollution (NPSP) is critical for protecting water resources in every municipality in the region. Strategies that reduce non-point source pollution have many other environmental benefits for a municipality, including preserving natural species of fish and other wildlife, and protecting open land.

(2) Per RSA 36:47, II, "For the purpose of assisting municipalities in complying with the preparation of a local Master Plan implementation section, which is a long range action program of specific actions, time frames, allocation of responsibility for actions, description of land development regulations to be adopted, and procedures which the municipality may use to monitor and measure the effectiveness of each section of the plan" (See RSA 674:2, III (m)), the Strafford Regional Planning Commission "shall compile a local water resource management and protection plan, hereafter referred to as the local water plan. Once the local water plan has been adopted, it shall be placed on file with the office in accordance with RSA 675:9. The plan shall be made available to the public upon reasonable request and payment for any costs incurred in the duplication of the report" (See RSA 4-C:22, I).

(3) Further, "Municipalities are hereby authorized and encouraged to enter into agreements with other municipalities for the purpose of developing and implementing regional water plans and ordinances to enhance the effectiveness of their local water plans where water protection needs to extend beyond municipal boundaries. Appropriate action of the municipalities by ordinance, resolution or other action shall be necessary before any such agreement may enter into force, and the agreement shall be adopted pursuant to RSA 53-A. Municipalities are encouraged to seek the assistance of their regional planning commission in the development and implementation of their regional water plan, and shall coordinate these plans with the regional water resource planning efforts of their commission" (See RSA 4-C:23).

Water Resources: Policy Goals

(1) Protect the quantity and quality of water resources and balance their use consistent with conservation and development needs:

(a) In cooperation with local municipalities and the private sector.

(b) Consistent with other regional and local Master Plan policies and implementation strategies.

(c) In balance with the protection of environmental resources, the maintenance of community well being, and the ability of municipalities to provide and finance community facilities and on-going services.

(2) Protect water resources from contamination and depletion by managing and controlling sources and volumes of non-point source pollution.

Water Resources: Policy Principles

(1) Water resources will be protected for the health, safety and welfare of all water users.

(2) Growth will not compromise (degrade) environmental quality.

(3) Water resource protection conservation and management will use Best Management Practices.

(4) Water resource practices will be consistent with regional and municipal Master Plan growth policies and implementation strategies.

(5) Water resource operations will be consistent with sustainable, energy efficient practices.

(6) Municipal land use ordinances and regulations will insure water resource protection.

(7) Municipalities will have code enforcement personnel to enforce zoning ordinance and subdivision regulation issues and administer permit applications and inspect and monitor construction to meet standards.

(8) Municipalities will be encouraged to participate in inter-municipal water resources management efforts.

(9) Municipalities will be encouraged to view development in light of a municipality's role as a watershed steward, for water and land resources.

(10) Land overlaying aquifers and land adjacent to surface waters will be conserved or protected.

(11) Shore-side (riparian) buffers that filter pollutants before water discharges into lakes, streams, and wetlands will be preserved.

(12) The implementation or continuation of water quality monitoring programs for lakes, streams and wetlands will be encouraged.

(13) Proper erosion control measures and Best Management Practices (BMPs) for storm water will be in place when land use alterations occur within the watershed boundary.

(14) An intact forest canopy and understory will be maintained on steep, highly erodable, slopes.

Water Resources: Policy Standards

(1) Water runoff quantity and quality from new development shall not exceed pre-development water quantity and quality runoff.

(2) All new use of existing water resources shall comply with the applicable standards as well as state public health safety and septic system regulations and requirements.

(3) Sources for other standards include:

(a) Best Management Practices to Control Nonpoint Source Pollution as referenced in: A Guide for Citizens and Town Officials. January 2004. NH DES.
(b) Following the Flow: NPS Assessment. Natural Resource Conservation Service and University of New Hampshire Cooperative Extension.
(c) How Greenways Work: A Handbook on Ecology. 1992 2nd Edition. Ipswich MA: National Park Service and Atlantic Center for the Environment.
(d) Saving Special Places: Community Funding for Land Conservation. December 2002. Society for the Protection of New Hampshire Forests.
(e) Open Space for New Hampshire: A Toolbook of Techniques for the New Millennium. 2000. New Hampshire Wildlife Trust.
(f) New Hampshire's Changing Landscape. 1999. Society for the Protection of New Hampshire Forests and the NH Chapter of the Nature Conservancy.
(g) New Hampshire Everlasting: An Initiative to Conserve Our Quality-of-Life. September 22, 2001. Society for the Protection of New Hampshire Forests.
(h) See existing Zoning Ordinance and Subdivision Regulations.
(i) Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities. 1997 (Revised Edition). Audubon Society of New Hampshire.
(j) Identification and Documentation of Vernal Pools in New Hampshire. 1997. New Hampshire Fish and Game Department Non-game and Endangered Wildlife Program.
(k) A Guide to Developing and Re-Developing Shoreland Property in New Hampshire. Third Edition, 1999. North Country and Southern NH Resource Conservation and Development Area Councils.
(l) Municipal Guide to Wetland Protection. September 1993. State of New Hampshire.

Water Resources: Implementation Strategies

To implement the policies, the following strategies are initiated in cooperation with local municipalities:

Master Plan and Consistency

(1) Monitor and update regional and local Master Plan Water Resource: Non Point Source Pollution policies and implementation strategies to ensure they:

(a) Define regional and local water resource policy goals, principles, standards, and implementation strategies for:
   i. A minimum of the next five years.
   ii. Water resource pollution prevention measures, both new and revised.
   iii. Water resources that have a need for "special" protection.

(b) Amend, as appropriate, the Regional Master Plan implementation program that describes actions over the next five years to meet water resource non point source pollution prevention goals.

(2) Maintain and update the various data components of the local Master Plan Water Resources section per RSA 4-C:22 as follows:

(a) Inventory of water resources by category, geographic location, use and condition.

(b) Projection of water resource quality.

(c) Analysis of non-point source pollutants including but not limited to: sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks; oil, grease, and toxic chemicals from runoff and energy production; excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas; bacteria and nutrients from livestock and pet wastes; faulty septic systems; atmospheric deposition; and hydro modification.

(d) Analysis of the existing and probable future water resource characteristics and opportunities within the municipality, to prevent non-point source pollution.

(e) Analysis of the existing and planned infrastructure capacity, including but not limited to sewage and water treatment, sewer and water lines, roads, and school capacity.

(f) Assessment of the local government's present and prospective water needs and its capacity to accommodate those needs.

(g) Identification of water resources within the local government where runoff is most likely to occur.

(h) Analysis of the capabilities, constraints, and degree of progress made by the public and private sectors in meeting the water resource needs.

(i) Identification and comprehensive assessment of state and local regulatory barriers to protecting water resources, including development policies, zoning, subdivision, and related codes and their administration.

General

(1) Take reasonable and prudent precautions to protect all water resources from incompatible land uses, thus protecting the health and general welfare of the community.

(2) Amend development standards and take other actions, including the adoption of incentives, to promote energy efficient practices and the use of sustainable and/or recyclable materials.

(3) Ensure sufficient water supplies exist for use by the region's residents, as well as native wildlife and plant communities.

(4) Use best management practices, careful monitoring of activities, and restoration for land uses within watersheds to prevent pollutants from entering water sources.

(5) Support developing an effective and enforceable system to monitor non-point source pollution over time.

(6) Identify and map districts for Shoreland Protection and Wetlands Protection.

(7) Adopt in the town regulations, State standards for storm water management and require a storm water management plan for each subdivision and site design.

(8) Coordinate water resources database management with State and Strafford Regional Planning Commission boards to further the protection and management of the water resources of the region.

(9) Use existing overlay protection districts: wetlands, prime wetlands, shoreland protection, and aquifer protection to identify areas requiring special attention from developers

<u>Zoning/Other Ordinances</u>

(1) Review the zoning ordinance and subdivision regulations to ensure that prevention/cleanup of water resources is consistent with the Master Plan Land Use

policies, supports designated growth areas in the community, and is consistent with the capacity of municipal services to serve new or redeveloped sites.

(2) Amend zoning ordinances to allow higher densities, in clustered development design to lower the amount of impervious surface coverage.

(3) Modify ordinances to leave 4-8 feet of sand and/or gravel above the estimated seasonal high water table at gravel operations.

(4) Amend the zoning ordinance to control the use of excavation sites. Various types of controls are available, and could be implemented during the excavation permit application process under RSA 155-E.

Development

(1) Direct development to environmentally suitable areas.

(2) Locate new development close to existing developed areas and existing roadways, away from surface waters.

(3) Continue prohibition of construction within the 100-year floodplain.

(4) Strive to preserve 25% open space in each municipality.

(5) Reduce the impervious cover in a development.

(6) Reduce soil erosion potential by reducing the amount of clearing and grading on the site.

(7) Reduce the cost of storm water management by concentrating runoff in one area and reducing runoff volumes.

(8) Implement a restrictive steep slope ordinance that limits development on highly erodable lands within certain buffer areas.

(9) Implement riparian buffer protection standards in subdivision and site plan regulations.

(10) Strictly controlled or no clearing in areas of stream buffers, forest conservation areas, wetlands, springs, and seeps, highly erodable soils, and storm water infiltration areas.

(11) Integrate erosion and sediment controls into watershed, wetlands, lakes, streams, and river protection overlay zones.

(12) Soil stabilization through the reestablishment of cover within two weeks, using hydro seeding or bark/mulch/straw in colder climates until seeding is possible.

(13) Perimeter controls to retain or filter runoff such as earthen dikes and silt fences.

(14) Apply catch or trap basins to capture suspended sediments during large storms.

(15) Use vegetation in stormwater management plan to stabilize soil, filter out pollutants, and reduce runoff volume.

(16) Implement BMP techniques to control stormwater runoff such as: infiltration systems, detention systems, retention systems, constructed wetland systems, filtration systems, and vegetated systems.
  - (a) Divert runoff around sites where pollutants could be picked up by surface flow.
  - (b) Inspect areas periodically where potential pollutants may be transported by runoff into waterbodies.
  - (c) Keep parking areas, outdoor storage areas, and streets clean of debris.
  - (d) Clean out catch basins and other flow control devices regularly to prevent backup and overflow of sediments and pollutants.

(17) Use low-impact development design approaches when possible such as creating a multi-functional landscape and infrastructure.
  - (a) Use open, vegetated drainage systems.
  - (b) Flow and Conveyance System designed to:
    - i. Maximize overland sheet flow; involve wider, rougher, and longer flow paths.
    - ii. Include pockets of vegetation in flow path
    - iii. Disperse flows from large paved surfaces in multiple directions using sheet flow when feasible.

<u>Conservation Design</u>

(1) Use narrower and shorter streets, driveways, and rights-of-way.

(2) Allow for smaller lots, narrower setbacks and frontages, and require less roadway.

(3) Reduce parking area size and use permeable surfaces for overflow parking areas.

(4) Reduce amount of area maintained as lawn; use drought-tolerant species of grass to reduce watering.

(5) Disconnect impervious surfaces (e.g. slope driveways toward vegetated areas).

(6) Maintain significant vegetated buffers for surface waters and do not mow to edge of water.

(7) Use open, grassed swales to convey storm water.

(8) Integrate smaller scale BMPs and landscape features throughout the site.

(9) Require enhanced performance septic system or regular septic system inspections when development is not served by sewers.

(10) Encourage onsite collection or infiltration of rainfall and/or runoff from individual home sites.

Wetlands

(1) Protect water resources through the use of a wetlands conservation overlay zone applied to salt marshes, wetlands, and surface waters (ponds, first order streams, headwaters).

(2) Consider placing mandatory conservation easements on wetlands within subdivisions.

(3) Consider providing stricter protection of the ecological services of wetlands, such as filtration.

(4) Officially designate prime wetlands for the region.

(5) Preserve areas surrounding wetlands; particularly prime wetlands and other high value wetlands with legal standing.

(6) Develop wetland buffer/setback requirements for inclusion in the Zoning Ordinance that encourages good stewardship of forest and farm lands within these zones while restricting intense land uses such as buildings, septic systems and roadways.

Aquifers/Wells/Groundwater

(1) Initiate studies to conclusively confirm or deny the existence of potential aquifers, identify sustainable yield rates from known aquifers, examine the potential for artificial recharge of groundwater, and establish a system of monitoring groundwater resources.

(2) Establish an aquifer protection overlay district or similar zoning tool to protect groundwater resources.

(3) Protect aquifers through the use of best management practices and monitoring of activities for existing development located within zones.

(4) Negotiate, when needed, mutually beneficial municipal agreements that protect aquifers, crossing municipal boundaries.

(5) Ensure plentiful and safe groundwater supplies through aquifer recharge protection ordinances.

(6) Pursue follow up testing of wells to determine the current state of the region's groundwater resources.

(7) Study the region's per capita water use and groundwater recharge and estimate the effect that future population growth in SRPC would have on groundwater supplies and understand the region's water resource needs vs. availability in the future.

(8) Identify alternatives to monitoring groundwater to detect potential contamination.

(9) Protect water supplies around wells and rivers through establishment or upgrade of ordinances, such as wellhead protection districts, well recharge areas, aquifer protection districts, and substantial riparian setbacks for water conservation.

Road Salting

(1) Study the impacts of road salting on the region's ground and surface water supplies.

(2) For lesser-traveled roads, apply salt in a 4-8 foot strip along the centerline of a two-lane road.

(3) Disposed or stockpiled snow should be stored on pervious surfaces at least 25 feet from the high water mark and/or edge of the bank of surface water.

(4) Snow storage area should be at least 75 feet from private wells, 200 feet from community wells, and 400 feet from municipal wells.

(5) Store de-icing compounds on sheltered, impervious surfaces and locate salt piles at least 100 feet from streams and flood plains.

Landfills

(1) Devise a system whereby the SRPC receives regular updates on the status of landfill contamination plumes and their effects on the water quality of the nearby surface and groundwater.

Collaborative Efforts and Educational Outreach

(1) Facilitate communication, education and cooperation amongst consumers, water providers (utilities), and other applicable organizations to link all parties of interest in water resources.

(2) Support the efforts of watershed associations, regional planning commission, and municipalities to coordinate water protection and management within the watersheds. Incorporate policies, regulations and other actions from watershed management plans through the Planning Board, Conservation Commission, and Water District.

(3) Educate municipal officials on the importance of controlling non-point source pollution.

(4) Work with the Conservation Commission to notify citizens of potential volunteer water quality monitoring activities that exist and that would facilitate the monitoring of surface waters.

Appendix E
Strafford Regional Planning Commission
Draft Regional Master Plan – May 2004

Master Plan for Non-Point Source Water Pollution Prevention - Land Use

Land Use: Introduction/Authority/Role

(1) The Regional Master Plan Land Use section includes policies and implementation strategies related to land use. Guiding land use is critical for controlling non-point source pollution (NPSP) and thereby protecting water resources in every municipality in the region. Strategies that reduce non-point source pollution have many other environmental benefits for a municipality, including preserving natural species of fish and other wildlife, and protecting open lands.

(2) Per RSA 36:47, II, "For the purpose of assisting municipalities in complying with the preparation of a local Master Plan implementation section, which is a long range action program of specific actions, time frames, allocation of responsibility for actions, description of land development regulations to be adopted, and procedures which the municipality may use to monitor and measure the effectiveness of each section of the plan" (See RSA 674:2, III (m)), the Strafford Regional Planning Commission "shall compile a land use section upon which all the following sections shall be based. This section shall translate the vision statements into physical terms. Based on a study of population, economic activity, and natural, historic, and cultural resources, it shall show existing conditions and the proposed location, extent, and intensity of future land use." (See RSA 674:2, II (b)).

(3) Further, innovative land use controls may be implemented such as cluster development. "An innovative land use control adopted under RSA 674:16 shall contain within it the standards which shall guide the person or board which administers the ordinance. An innovative land use control ordinance may provide for administration, including the granting of conditional or special use permits, by the planning board, board of selectmen, zoning board of adjustment, or such other person or board as the ordinance may designate." (See RSA 674:21, I and II).

(4) Pursuant to the authority vested in the Strafford Regional Planning Commission (SRPC) and in local governments by RSA 36:47, I and II; 9-A; 672:1, III-e; and 674:2, the Commission adopts the following regional policies and related implementation strategies.

Land Use: Policy Goals

(1) Protect land resources and balance their use and development consistent with conservation and development needs:

(a) In cooperation with local municipalities and the private sector.

(b) Consistent with state and other regional and local Master Plan policies and implementation strategies.

(c) In balance with the protection of environmental resources, the maintenance of community well being, and the ability of municipalities to provide and finance community facilities and on-going services.

(2) Encourage orderly growth and development to maximize the control of haphazard and unplanned development and use of land, which results over time, in the inflation of the amount of land used per unit of human development, and of the degree of dispersal between such land areas.

Land Use: Policy Principles

(1) Land will be protected for the health, safety and welfare of all users.

(2) Local Planning Boards are encouraged to develop plans that are consistent with the policies, principles, and priorities established in the (state) comprehensive development plan. (RSA 9-A:1, IV)

(3) Land uses and development/conservation practices will be consistent with regional and municipal Master Plan policies and implementation strategies including those related to land use and growth management.

(4) Land uses will be consistent with and encourage sustainable /energy efficient operations, management practices and materials.

(5) Municipal land use ordinances and regulations will insure water resource protection.

(6) Traditional, compact settlement patterns will be maintained to efficiently use land, resources, and infrastructure investments. (Consistent with State Smart Growth Principles)

(7) Choices and safety in transportation will be provided to create livable, walkable communities that increase accessibility for people of all ages, whether on foot, bicycle, or in motor vehicles and reduce pollution. (Consistent with State Smart Growth Principles)

(8) The working landscape will be maintained by sustaining contiguous tracts of open land in farm, forest, and other natural resource uses, and by minimizing land use conflicts with these uses. (Consistent with State Smart Growth Principles)

(9) Environmental quality will be protected by minimizing impacts from human activities and by planning for and maintaining natural areas that contribute to the health and quality of life of communities and people. (Consistent with State Smart Growth Principles)

(10) The community will be involved in the planning and implementation of development to ensure that development retains and enhances the sense of place, traditions, goals, and values of the local community. (Consistent with State Smart Growth Principles)

(11) Growth will be managed locally, and collaborative efforts will be encouraged with neighboring towns to achieve common goals and address common problems more effectively. (Consistent with State Smart Growth Principles)

(12) Municipalities will have code enforcement personnel to enforce zoning ordinance and subdivision regulation issues, administer permit applications, and inspect and monitor construction to meet standards.

(13) Land will be conserved that protects water quality and quantity, including land above aquifers and land providing buffers adjacent to surface waters, such as streams, lakes and wetlands.

(14) Shore-side (riparian) buffers will be preserved that filter pollutants before water discharges into lakes, streams and wetlands.

(15) Land will be protected from erosion using control measures and Best Management Practices (BMPs) when land use alterations occur.

(16) Vegetation on land will be protected, including forest canopy and understory on steep, highly erodible slopes.

Land Use: Policy Standards

(1) Existing municipal, state and federal standards related to land use planning, development and conservation regulations including zoning, site plan review regulations and subdivision regulations.

(2) Standards in <u>Best Management Practices to Control Nonpoint Source Pollution, A Guide for Citizens and Town Officials</u>, NH Dept of Environmental Services, January 2004.

(3) Overall impervious coverage of development should not exceed ten percent (10%) of a watershed's land area.

(4) Preserve a minimum of 25% of a municipality's land for open space.

(5) Future subdivision, use and development within 250' of the state's public waters shall meet minimum standards per the Comprehensive Shoreland Protection Act (RSA 483-B)

(6) All development shall be setback from watershed shed protection areas as follows:
   (m) 250' to provide for controlled development.
   (n) 100' to provide for limited development.
   (o) 50" to provide for no or very restricted development.

(7) Site excavation standards per the State Alteration of Terrain or Site Specific Permit Program (RSA 485-A:17).

(8) Wetland protection standards per RSA 482_A and the rules promulgated under that law (Env-Wt 100-700).

(9) Septic system design standards related to design and operation per RSA 485-A and Administrative Rule Env-Ws 1000.

(10) Sources for other standards include:

(p) Following the Flow - NPS Assessment. Natural Resource Conservation Service and University of New Hampshire Cooperative Extension.
(q) How Greenways Work: A Handbook on Ecology. 1992 2nd Edition. Ipswich MA: National Park Service and Atlantic Center for the Environment.
(r) Saving Special Places: Community Funding for Land Conservation. December 2002. Society for the Protection of New Hampshire Forests.
(s) Open Space for New Hampshire: A Toolbook of Techniques for the New Millennium. 2000. New Hampshire Wildlife Trust.
(t) New Hampshire's Changing Landscape. 1999. Society for the Protection of New Hampshire Forests and the NH Chapter of the Nature Conservancy.
(u) New Hampshire Everlasting: An Initiative to Conserve Our Quality-of-Life. September 22, 2001. Society for the Protection of New Hampshire Forests.
(v) Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities. 1997 (Revised Edition). Audubon Society of New Hampshire.
(w) Identification and Documentation of Vernal Pools in New Hampshire. 1997. New Hampshire Fish and Game Department Non-game and Endangered Wildlife Program.
(x) A Guide to Developing and Re-Developing Shoreland Property in New Hampshire. Third Edition, 1999. North Country and Southern NH Resource Conservation and Development Area Councils.
(y) Municipal Guide to Wetland Protection. September 1993. State of New Hampshire.
(z) Achieving Smart Growth in New Hampshire. April 2003. New Hampshire Office of State Planning.

Land Use: Implementation Strategies

To implement the policies, the following implementation strategies are initiated in collaboration with local municipalities:

Master Plan and Consistency

(1) Monitor and update regional and local Master Plan Land Use policies and implementation strategies to ensure they:

(a) Define regional and local land use policy goals, principles, standards, and implementation strategies for:
i. A minimum of the next five years and preferably ten years.
ii. Land use pollution prevention measures, both new and revised.
iii. Land that has a need for "special" protection.

(2) Maintain and update the various data components of the local Master Plan Land Uses section per RSA 674:2, II (b) as follows:

(a) Analysis of the existing and probable future land uses, characteristics and opportunities within the municipality.

(b) Analysis of the existing and planned infrastructure capacity, including but not limited to sewage and water treatment, sewer and water lines, roads, and school capacity.

(c) Assessment of the local government's present and prospective land needs and its capacity to accommodate those needs.

(d) Analysis of the capabilities, constraints, and degree of progress made by the public and private sectors in meeting land needs.

(e) Identification and comprehensive assessment of state and local regulatory barriers to protecting land, including development policies, zoning, subdivision, and related codes and their administration.

General

(1) Take reasonable and prudent precautions to prevent incompatible land uses, thus protecting the health and general welfare of the community.

(2) Amend development standards and take other actions, including the adoption of incentives, to promote energy efficient practices and the use of sustainable and/or recyclable materials.

(3) Identify and map districts for Shoreland Protection and Wetlands Protection.

(4) Coordinate a land resources database management with State and Strafford Regional Planning Commission boards to further the protection and management of the land in the region.

(5) Use existing overlay protection districts: wetlands, prime wetlands, shoreland protection, and aquifer protection to identify areas requiring special attention from developers.

Zoning/Other Ordinances

(1) Review the zoning ordinance and subdivision regulations to ensure that protection and maintenance of water resources are consistent with the Master Plan Land Use policies, support designated growth areas in the community, and are consistent with the capacity of municipal services to serve new or redeveloped sites.

(2) Promote cluster or planned unit development and amend zoning ordinances to allow higher densities in clustered or planned unit development designs.

(3) Modify ordinances to leave at least four to eight feet of sand and/or gravel above the estimated seasonal high water table at gravel operations.

(4) Amend the zoning ordinance to control the use of excavation sites. Various types of controls are available, and could be implemented during the excavation permit application process under RSA 155-E.

Development

(1) Direct development to environmentally suitable areas, while protecting prime and active agricultural lands, wildlife habitat, as well as unique natural or man-made features.

(2) Locate new development close to existing developed areas and roadways, away from surface waters.

(3) Continue prohibition of construction within the 100-year floodplain.

(4) Strive to preserve 25% open lands in each municipality.

(5) Amend ordinances so overall impervious coverage of development does not exceed 10% of a watershed's land area.

(6) Reduce soil erosion potential by reducing the amount of clearing and grading on the site.

(7) Integrate erosion and sediment controls into aquifer, wetlands, lakes, streams, and river protection overlay zones.

(8) Limit development on steep slopes that are highly erodible.

(9) Implement riparian buffer protection standards in subdivision and site plan regulations.

(10) Strictly control or allow no clearing in areas of stream buffers, forest conservation areas, wetlands, springs, and seeps, highly erodable soils, and storm water infiltration areas.

(11) Reestablish cover within two weeks for soil stabilization using hydro seeding or bark/mulch/straw in colder climates until seeding is possible.

Downtown/Town Center Development

(1) Concentrate development in the downtown area as the primary business district.

(2) Take steps to curb the expansion of strip commercial development in areas outside of the downtown areas.

(3) Encourage any future site design to provide pedestrian linkages with the downtown area and ensure the downtown area is pedestrian-friendly providing adequate sidewalks and pedestrian facilities and bikeways.

(4) Provide more areas for landscaping, open space, and trees throughout downtown.

Conservation Design

(1) Use narrower, shorter streets, driveways, and rights-of-way.

(2) Allow for smaller lots, narrower setbacks and frontages, and require less roadway.

(3) Reduce parking area requirements, and use permeable surfaces for overflow parking areas.

(4) Reduce amount of area maintained as lawn.

(5) Use drought-tolerant species of grass to reduce watering.

(6) Disconnect impervious surfaces (e.g. slope driveways toward vegetated areas).

(7) Maintain significant vegetated buffers for surface waters; do not mow to edge of water.

(8) Use open, grassed swales to convey storm water.

(9) Integrate smaller scale best management practices for water retention and landscape features throughout the site.

(10) Require enhanced performance septic system, or regular septic system inspections when development is not served by a public sewer system.

(11) Encourage onsite collection or infiltration of rainfall and/or runoff from individual home sites.

<u>Water Resources</u>

(1) Insure that sufficient water supplies exist for use by the region residents, as well as native wildlife and plant communities.

(2) Adopt in municipal regulations, state standards for storm water management and require a storm water management plan for each subdivision and site design.

(3) Use vegetation in storm water management plan to stabilize soil, filter pollutants, and reduce runoff volume.

(4) Implement best management practices to control storm water runoff such as: infiltration systems, detention systems, retention systems, constructed wetland systems, filtration systems, and vegetated systems.

(a) Divert runoff around sites where pollutants could be picked up by surface flow.
(b) Inspect areas periodically where potential pollutants may be transported by runoff into water bodies.
(c) Keep parking areas, outdoor storage areas, and streets clean of debris.
(d) Clean out catch basins and other flow control devices regularly to prevent backup and overflow of sediments and pollutants.

(5) Use low-impact development design approaches when possible for example:
(a) Create a multi-functional landscape and infrastructure.
(b) Use open, vegetated drainage systems.
(c) Use flow and conveyance system designed to:
i. Maximize overland sheet flow, and involve wider, rougher, and longer flow paths.
ii. Include pockets of vegetation in flow path
iii. Disperse flows from large paved surfaces in multiple directions using sheet flow when feasible.

Wetlands

(1) Protect water resources through the use of a wetlands conservation overlay zone applied to salt marshes, wetlands, and surface waters (ponds, first order streams, headwaters).

(2) Consider placing mandatory conservation easements or deed restrictions on wetlands within subdivisions.

(3) Consider providing stricter protection of the ecological services of wetlands, such as filtration.

(4) Officially designate prime wetlands for the municipalities in the region.

(5) Preserve areas surrounding wetlands; particularly prime wetlands and other high value wetlands with legal standing.

(6) Develop wetland buffer/setback requirements for inclusion in the Zoning Ordinance to encourage stewardship of forest and farm lands while restricting intense land uses such as buildings, septic systems and roadways.

Aquifers/Wells/Groundwater

(1) Establish an aquifer protection overlay district or similar zoning tool to protect groundwater resources.

(2) Protect aquifers through the use of best management practices and monitoring of activities for existing development located within zones.

(3) Negotiate, when needed, mutually beneficial municipal agreements that protect aquifers, crossing municipal boundaries.

(4) Ensure plentiful and safe groundwater supplies through aquifer recharge protection ordinances.

(5) Protect water supplies around wells and rivers through establishment or upgrade of ordinances, such as wellhead protection districts, well recharge areas, aquifer protection districts, and substantial riparian setbacks for water conservation.

Collaborative Efforts and Educational Outreach

(1) Facilitate communication, education and working relationships amongst residents, developers, and other interested organizations to foster land protection programs and assess opportunities for more environmentally sound land use development and conservation practices.