

# **2004 Annual Report of Water Use versus Stream Flow on Designated Rivers**

## **November 14, 2006**

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### **Definitions and Acronyms**

**Affected Water User** (or AWU) (Env-Ws 1902.03) means a water user required to be registered under Env-Wr 700, or successor rules, and having a withdrawal or return location within 500 feet of a designated river or within 500 feet of a river or stream in its tributary drainage area.

**Aggregate Water Use** (Env-Ws 1902.04) means the total water use by all Affected Water Users at, and upstream from, any location on a designated river, being the difference between the sum of water withdrawals and the sum of measured registered water returns. Aggregate Water Use is averaged for a month and may not represent withdrawal and return of water conditions during any one day.

**cfs** means cubic feet per second. One cfs is equal to 7.4814 gallons per second or 448.9 gallons per minute.

**cfsm** means cubic feet per second of flow per square mile of stream drainage area. This is a means of comparing streamflow per unit area (square miles).

**7Q10** means the lowest average flow rate for a 7-day period on an annual basis with an expected recurrence interval of once in every 10 years, determined for a location on a river or stream, and expressed in terms of volume per time period, usually in cfs.

**Designated River** means a river or river segment that is designated under RSA 483.

**Destination** means:

- (1) A location to which water is discharged;
- (2) A facility to which water is transferred;
- (3) Any water-containing product(s) created by a water user; or
- (4) Evaporative losses occurring as a result of water use.

**Discharge** means a return of water to the environment usually to the subsurface like a septic field or directly to a surface water body by a registered water user. Discharges have WUSD\_ID (Water User Source or Discharge Identification Number) like 20057 20057-D01, where the first number (20057) represents the water user's identification number and the second, hyphenated number (20057-D01) represents the water user's discharge location. In this case D01 indicates the first or only discharge location of this facility. Water users may have more than one registered discharge.

**Gage** means a stream flow measurement station on a river. Stream gages used in this report are operated and maintained by US Geological Survey.

**General Standard** is a set of quantitative values for assessing aggregate water use at any river location relative to stream flow at that location. The General Standard has four tiers of water use that reflect the assumption that more water is available for use when stream flow is greater. Rivers that are not in compliance are not necessarily impaired or threatened due to flow alteration, but there is sufficient withdrawal relative to monthly mean streamflow to warrant concern and further analysis.

**Env-Ws 1903.02 Estimation and Report of Aggregate Water Use and Streamflow.**

(c) A designated river shall be not in compliance with the general standard if:

- (1) The average monthly aggregate water use exceeds 5 percent of 7Q10 when average monthly stream flow is less than or equal to 0.5 cfsm;
- (2) The average monthly aggregate water use exceeds 0.02 cfsm when average monthly stream flow is greater than 0.5 cfsm and less than or equal to 1.0 cfsm;
- (3) The average monthly aggregate water use exceeds 0.04 cfsm when average monthly stream flow is greater than 1.0 cfsm and less than or equal to 4 cfsm; or

(4) The average monthly aggregate water use exceeds 0.16 cfs when average monthly stream flow is greater than 4 cfs.

**Impact Point Use** means the incremental water use at a single point on a Designated River. An impact point may be a single surface water withdrawal from the Designated River, the point where groundwater would enter the Designated River if it had not been captured by a well, or the confluence of a tributary where water is being used with the Designated River. Impact Point Use where a tributary enters the Designated River may include water use from several water user sources or withdrawals, and is equal to the sum of these uses.

**Protected Instream Flows** means flow requirements for a Designated River established by the Commissioner of DES based on an Instream Flow Study conducted under Env-Ws1900 as required by RSA 483 and Laws of 2002, Chapter 278.

**Registered water users** are described under Env-Wr 700 as water users using more than 140,000 gallons per week during any year. They are required to register with DES and to report monthly water use.

**Return** means the release of water to the environment, as defined in Env-Wr 101.36. The Instream Flow Rules require that returns assessed in this report be registered (under Env-Wr 700 or successor rules) and measured.

**Source** means a withdrawal location usually from a well or surface water body. Sources have WUSD\_ID (Water User Source or Discharge Identification Number) like 20057 20057-S02, where the first number (20057) represents the water user's identification number and the second, hyphenated number (20057-S02) represents the water user's source of the withdrawal. In this case S02 indicates the second source of this facility. When the first and second numbers do not match, such as 20351 20061-S01, this indicates that water is transferred from the source of the water user identified by the second number to the water user identified by the first number as in the case of a municipal water system delivering water to an institution or factory. Water users may have more than one registered source.

**Transfers** occur when registered water users have sources or discharges that are controlled by other registered water users, such as a public water supply or waste water treatment facility. Facilities that transfer water from or to AWUs are also considered Affected Water Users. Because they may not have a physical location in the GIS coverage, some transfers may not be identified in this process.

**WMPA** means Water Management Planning Area, (Env-Ws 1902.16) or the tributary drainage area to a Designated River for which a Water Management Plan is required.

**WUSD\_ID** means Water User Source or Discharge Identification Number. The WUSD\_ID is comprised of a paired set of numbers like 20057 20057-D01, where the first number (20057) represents the water user's identification number and the second, hyphenated number represents the water user's source or discharge location. A source identification number uses an "S"; a discharge ID number uses a "D." Water transferred to or from one registered user to another would use a

different value from the WU ID for the SD ID representing the source (20509 20005-S01) or for a discharge to another registered user (20670 20081-D01).

**Withdrawal** means removal of water from the environment by means of a well or surface water intake. The Instream Flow Rules require assessment of registered (under Env-Wr 700 or successor rules) withdrawals within 500 feet of a Designated River or on of its tributaries.

## 2004 Annual Report of Water Use versus Stream Flow on Designated Rivers

### I. Introduction

Instream flow is one of the key protection measures provided under RSA 483 the Rivers Management and Protection Act. RSA 483 gives DES the authority and responsibility to maintain flow to support instream public uses in rivers that have been designated by the Legislature for special protection under the Act. In 2002, a broad coalition of New Hampshire business and conservation interests joined together to enact compromise legislation, which became Chapter 278, Laws of 2002 (from House Bill 1449-A) that calls for a pilot program for instream flow protection. With the advice and input of the statewide Rivers Management Advisory Committee (RMAC), DES adopted Env-Ws 1900 known as the Instream Flow Rules (ISFR) effective May 29, 2003.

Env-Ws 1903.02 of the ISFR requires annual reporting of water use versus streamflow for the Designated Rivers. Please refer to [http://www.des.state.nh.us/rules/desadmin\\_list.htm#waterq](http://www.des.state.nh.us/rules/desadmin_list.htm#waterq) to read a copy of these rules. The ISFR require the annual report to include:

- (1) An estimate of water use for each Affected Water User.
- (2) An estimate of aggregate water use at each withdrawal or return location.
- (3) An estimate of stream flow at each withdrawal or return location.
- (4) A record of the month(s) and location(s) not in compliance with the General Standard for Designated Rivers without established Protected Instream Flows under Env-Ws 1905.
- (5) A description of the WMPA [Water Management Planning Area] for Designated River(s) that are not in compliance with the General Standard.
- (6) For each Designated River with protected instream flows established under Env-Ws 1905, a record of the date(s) and location(s) at which protected instream flows were not maintained.

Fourteen Designated Rivers were defined in the Rivers Management and Protection Act (RSA 483) in 2004 as shown in the map below. Of these 14 rivers, the Contoocook and the Piscataquog include branches that are also Designated River segments. These branches require individual assessment that must be incorporated into the assessment of the main branch of the Designated River.

The ISFR require that “each designated river without established protected instream flows under Env-Ws 1905, estimate the month(s) and identify the location(s) not in compliance with the general standard.” No protected instream flows were established by 2004, so assessments were made using the General Standard. The General Standard is a reference tool for comparatively evaluating water use on the Designated Rivers. A river is not in compliance with the General Standard, as defined in Env-Ws 1903.02(c), if:

- (1) The average monthly aggregate water use exceeds 5 percent of 7Q10 when average monthly stream flow is less than or equal to 0.5 cfs;
- (2) The average monthly aggregate water use exceeds 0.02 cfs when average monthly stream flow is greater than 0.5 cfs and less than or equal to 1.0 cfs;

# DESIGNATED RIVERS

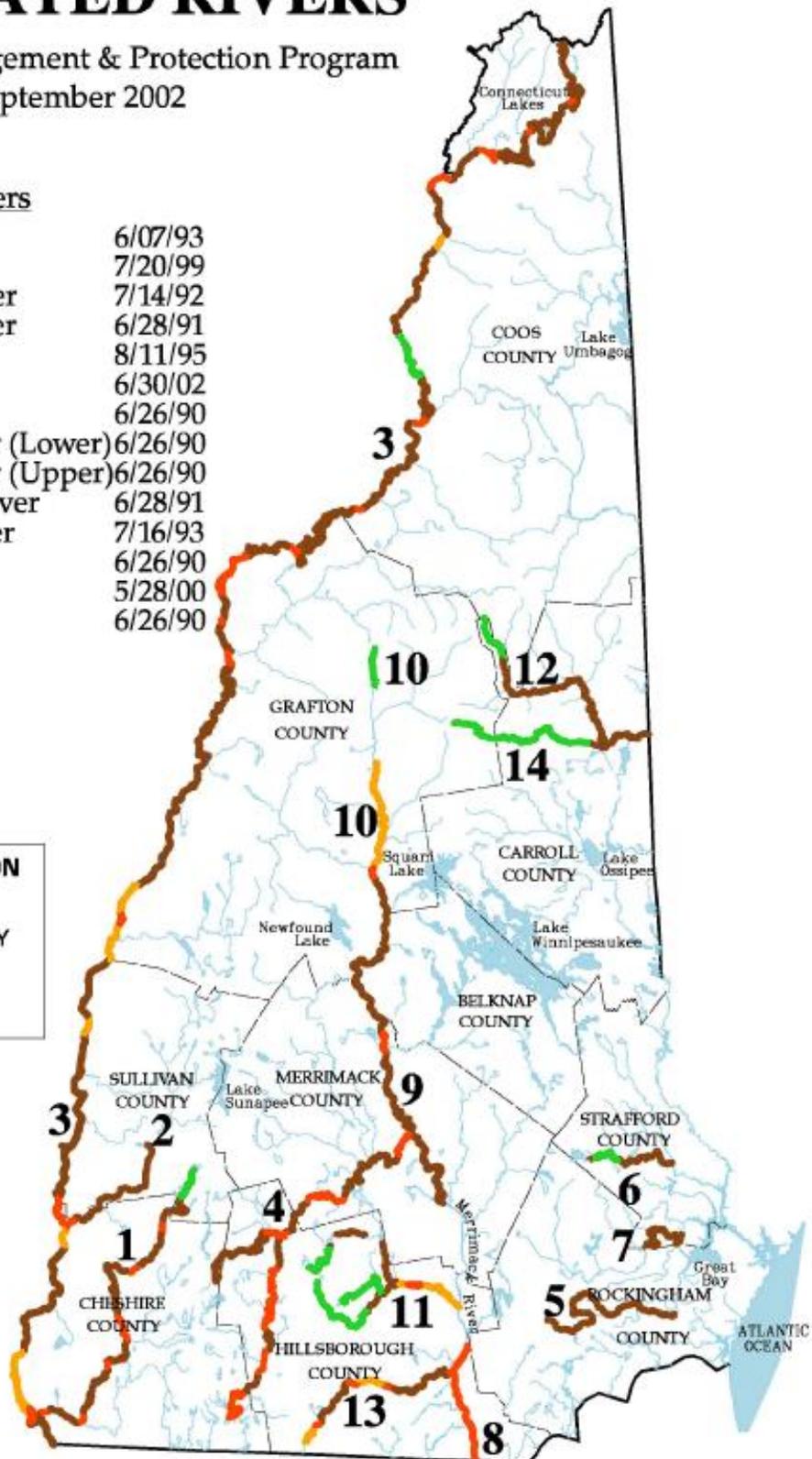
NH Rivers Management & Protection Program  
September 2002

## Designated Rivers

- |     |                         |         |
|-----|-------------------------|---------|
| 1.  | Ashuelot River          | 6/07/93 |
| 2.  | Cold River              | 7/20/99 |
| 3.  | Connecticut River       | 7/14/92 |
| 4.  | Contoocook River        | 6/28/91 |
| 5.  | Exeter River            | 8/11/95 |
| 6.  | Isinglass River         | 6/30/02 |
| 7.  | Lamprey River           | 6/26/90 |
| 8.  | Merrimack River (Lower) | 6/26/90 |
| 9.  | Merrimack River (Upper) | 6/26/90 |
| 10. | Pemigewasset River      | 6/28/91 |
| 11. | Piscataquog River       | 7/16/93 |
| 12. | Saco River              | 6/26/90 |
| 13. | Souhegan River          | 5/28/00 |
| 14. | Swift River             | 6/26/90 |

### RIVER CLASSIFICATION

- COMMUNITY
- RURAL-COMMUNITY
- RURAL
- NATURAL



NHDES Watershed Management Bureau

(3) The average monthly aggregate water use exceeds 0.04 cfsm when average monthly stream flow is greater than 1.0 cfsm and less than or equal to 4 cfsm; or

(4) The average monthly aggregate water use exceeds 0.16 cfsm when average monthly stream flow is greater than 4 cfsm.

This report includes individual Watershed Management Planning Area (WMPA) reports with the results of the assessment for each of the fourteen Designated Rivers and two reports for branches of Designated Rivers. Each WMPA report identifies the gages used, water users in the WMPA, and includes a narrative description of the times and locations where the General Standard was not met during 2004. Each WMPA report includes the following information:

1) **DR WMPA map** showing the Watershed Management Planning Area for the Designated River with locations of stream flow gages and water use sources and discharges.

2) **Table of Water Use** - A listing of monthly water use in cfs by source and discharge for each reporting AWU in the WMPA. These sources and discharges are sorted by the drainage areas of their impact points on the Designated River beginning at the most upstream point.

3) **Table of Aggregate Water Use** - Aggregate water use is estimated by summing all registered upstream water withdrawals (+) and returns (-) at each impact point.

4) **Tables of Estimated Monthly Stream Flow** - Monthly values for stream flow are described as flow per unit area (cfsm) for the gages used in the assessment.

5) **Table of Estimated Monthly General Standard at Each Impact Point** - The monthly values for the General Standard in cfsm, cfs or both are calculated for each impact point.

6) **Table of Estimated Margin of Aggregate Water Use below the General Standard** - At each impact point and for each month, the difference between the aggregate water use and the General Standard is determined. A negative value indicates that water use exceeds the General Standard at the impact point.

8) **Graphs of incremental and aggregate water use versus the General Standard** - Monthly graphs show the General Standard compared to the water use and aggregate water use at each impact point.

## II. Annual and Monthly Climatological Conditions

Stream flow and water use are strongly correlated with weather conditions. The table below identifies the deviation from the monthly normal precipitation for each month in 2004. The 2004 departure from the annual average precipitation (1971-2000) is shown in the figure below. Monthly departures from monthly 1971-2000 average precipitation are illustrated in Appendix A. Also shown below are the amounts of departure from the normal summer temperatures. This is shown by comparing the normal to the current year's Cooling Degree Days (CDD). A cooling degree day is a unit used to relate the day's temperature to the energy demands of air conditioning. Cooling degree days are calculated by subtracting 65 from a day's average temperature. For example, if the day's high is 90°F and the day's low is 70°F, the day's average is 80°F. Eighty minus 65 is 15 cooling degree days. Cooling degree days can be used to compare the current summer to past summers.

CDD definition source: [www.usatoday.com/weather/resources/askjack/waskdays.htm](http://www.usatoday.com/weather/resources/askjack/waskdays.htm)

2004	NH precipitation departure from normal (inches)*	Precipitation as percent of normal**	2004 CDD Concord, NH ***	Concord NH CDD 1971-2000 norms!	2004 departure from 1971-2000 norms
January	-2.67	25%	0	0	0
February	-1.47	46%	0	0	0
March	-1.89	46%	0	0	0
April	1.48	141%	4	2	2
May	1.43	137%	24	18	6
June	-1.38	65%	56	82	-26
July	0.67	117%	142	173	-31
August	1.73	142%	156	133	23
September	0.64	117%	23	33	-10
October	-1.97	50%	0	1	-1
November	-0.19	95%	0	0	0
December	0.62	117%	0	0	0
Annual	-3.00	91.50%	405	442	-37

\* Average of monthly departure values from all reporting stations in NH

\*\* Sum of precipitation as a percent of normal monthly precipitation from all reporting stations in NH [www.erh.noaa.gov/gyx/climate.shtml](http://www.erh.noaa.gov/gyx/climate.shtml)

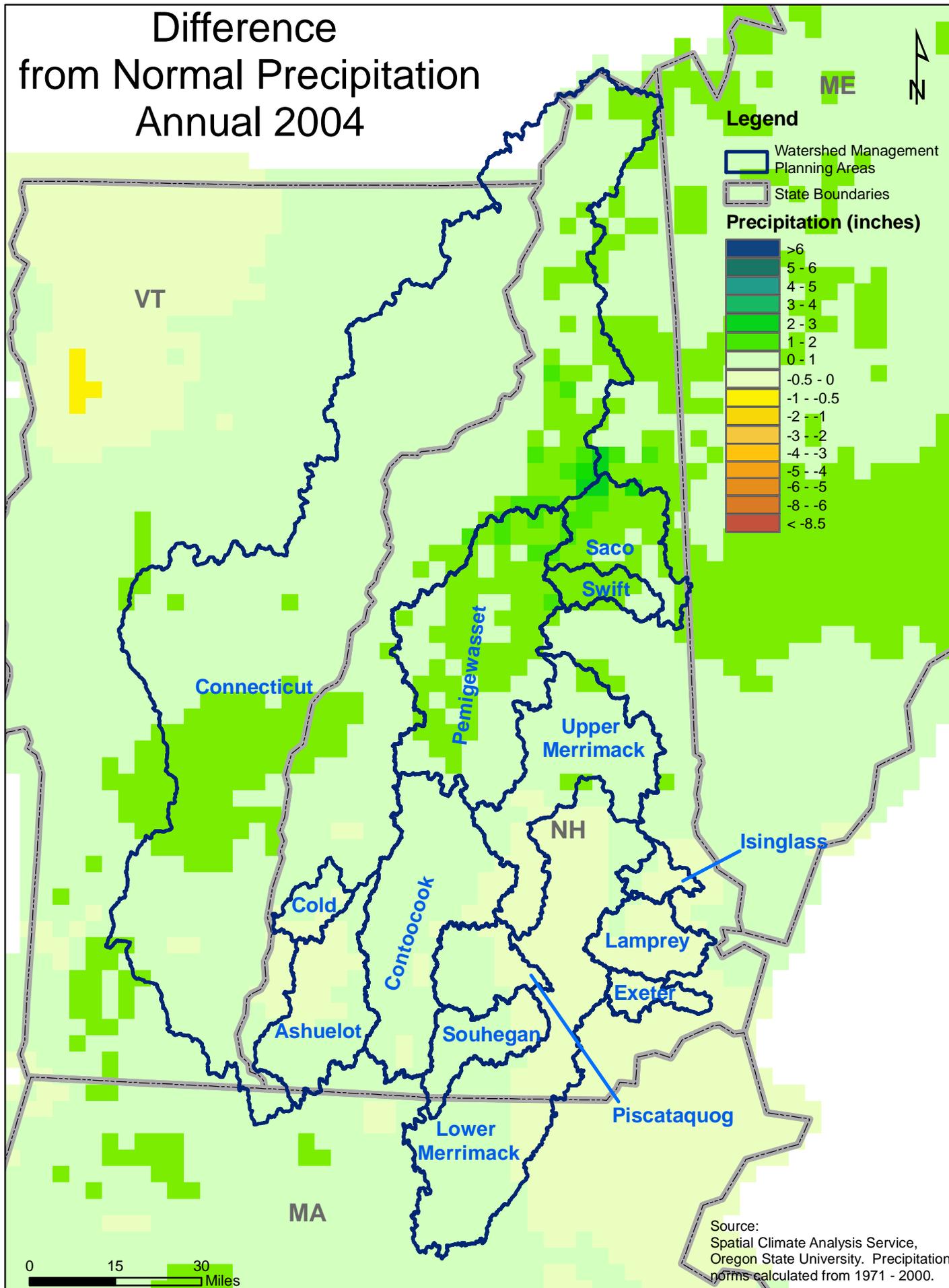
\*\*\* Concord NH 2004 Cooling Degree Days Source

[www.weather.gov/climate/index.php?wfo=gyx](http://www.weather.gov/climate/index.php?wfo=gyx)

!Concord NH normal CDD Source:

[www.ncdc.noaa.gov/oa/climate/online/ccd/nrmcdd.html](http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmcdd.html)

# Difference from Normal Precipitation Annual 2004



### **III. Methods**

This assessment compares water use to stream flow conditions. Water use data are reported to DES on a regular basis by registered users. Stream flow data are available from USGS gages on most of the Designated Rivers. The assessment requires aggregating water use at stream locations. The result is a comparison between aggregate water use and some standards for water use, either PISF values or a set of placeholders for the PISF called General Standards.

Some procedures in this year's assessment were changed from last year's assessment. One addition was the identification of water users taking water outside the watershed area. The process for identifying water users based on GIS coverages was refined by linking water users to their sources and discharges outside the WMPA for more complete identification of an AWU's water use. New GIS coverages for hydrography showed where streams are classified as intermittent lead to some water users dropping out of the Affected Water User category because their sources and discharges were greater than 500 feet from a perennial stream.

#### **A. Water Use Estimates**

Water use data are available for registered water users from the DES Water Use database. Registration is required under the Water Use Registration and Reporting Rules for water users who use more than 140,000 gallons during a week (13.9 gpm on a continuous basis) in any year. Monthly water use data are self-reported by water users to DES either quarterly or annually depending on water use type. DES records these data in the Water Use Database and a data link to DES's GIS coverages is updated periodically. This annual report uses the monthly water use estimates from the data linked to the GIS coverage on April 14, 2004.

Every effort was made to use reported data including individual queries to the Water Use data base to retrieve late entries for this report however in a number of instances data was not reported for the 2004 calendar year. To complete the data set for 2004, missing water use data was populated by interpolation from the months before and after the missing point or by using trends or averaged data from previous years' water use reports as seemed most appropriate. The choice of method was based on the most reasonable expectation of water use given DES's understanding of the water use type.

Under the Instream Flow Rules, monthly aggregate water use must be assessed versus average monthly streamflow. Aggregate water use is defined as the total water use by all affected water users at and upstream from any location on a designated river, being the difference between the sum of water withdrawals and the sum of measured, registered water returns. Measured registered water returns exclude water uses such as irrigation, where the intent is for the water to be taken up and used by the plants. Also, excluded are uses where water losses or water return cannot or is not measured. However, water returns were calculated as equal to the inflow where water use is a pass-through use without expectation of losses such as at a hydroelectric dam.

Water withdrawals and returns may occur directly on the Designated River or on a tributary. Effects of withdrawals and returns were assessed at every impact point on the Designated River. An impact point is where the water use affects the Designated River. A withdrawal or return directly at the Designated River has an impact point at that location. For groundwater withdrawals, the impact point is the point where a surficial flow line from the well meets the Designated River,

which is topographically downhill to the stream. This is meant to represent the point where groundwater would enter the river if the well were not withdrawing water. The impact point for water use in a tributary watershed is the confluence of that stream with the Designated River. One or more water users may exist on a tributary resulting in a single impact point for all the upstream water use.

## **B. Aggregate Water Use Estimates**

Water use on the Designated River is aggregated at each impact point and also at each end of the Designated River by finding the difference between the sum of water withdrawals and the sum of measured registered water returns for all upstream sources and discharges. Water use by intermediate users, such as an industry receiving water from a municipal public water supply, are transfers of water. A transfer of water is not aggregated so as not to double count. Transferred water is part of the withdrawal or return values reported for the source or discharge. The aggregate water use is reported in cfs.

## **C. Stream Flow Estimates**

Monthly stream flows were estimated for the impact points on the Designated Rivers. Monthly stream flows are used to determine the General Standard criteria for each impact point. Stream flows were interpolated or extrapolated from USGS stream flow gages. Stream flow estimates in this report rely on the concept that streamflow will vary uniformly with drainage area. This is not always true especially as one goes to much larger or much smaller drainage areas than the reference data. Streamflow estimates will be most accurate at locations closest to the gage. Future reports are expected to measure stream flow using regression methods to define monthly stream flow at impact points.

### **Stream Flow Data Source**

Daily streamflow values were taken from the USGS website, which provides data on a provisional basis (<http://waterdata.usgs.gov/nh/nwis/current/?type=flow>), meaning they are preliminary and have not received final approval by USGS. Daily average streamflow data in cfs were downloaded from the USGS web pages then imported to Excel worksheets.

Gages are first selected from the active, total record stream gages on a Designated River. Partial record gages may be used where no total record gages are available. Partial record gages may not be well calibrated for measuring low flows because their main use is measurement of high flows. Where gages on the Designated River were not available, surrogate gages within the Water Management Planning Area were used, or as a final resort, gages in other similar watersheds were used where no gages were active in the Water Management Planning Area.

Where a surrogate gage was necessary, gages were identified that are within watersheds similar to the watersheds of the ungaged Water Management Planning Area. Drainage basin size, elevation, and location were used as the criteria to identify a set of possible surrogate gages. Surrogate gages were used in two ways. One way was to compare the surrogate gage's flow to a historically active gage in the WMPA using linear regression. The regression equation was then used to create data for the historical data location using 2004 data from the surrogate gage. The second use was to use the surrogate gage directly with compensation for drainage basin size. The gages used for the 14 Designated Rivers are identified below.

In some cases, where there is more than a single gage measuring the Designated River, there are different cfs values for various segments of the Designated River. On occasions, such as at the confluence of the Winnepesaukee River with the Upper Merrimack Designated River, data from gages on a tributary was used to assist in defining the streamflow assessment.

**Gages for each DR for 2004 GS Flow transposition**

**Ashuelot**

<a href="#">01158000</a>	ASHUELOT RIVER BELOW SURRY MT DAM, NEAR KEENE, NH
<a href="#">01160350</a>	ASHUELOT RIVER AT WEST SWANZEY, NH
<a href="#">01161000</a>	ASHUELOT RIVER AT HINSDALE, NH

**Cold**

Surrogate station at

<a href="#">01154000</a>	SAXTONS RIVER AT SAXTONS RIVER, VT
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**Connecticut**

<a href="#">01129200</a>	CONNECTICUT R BELOW INDIAN STREAM NR PITTSBURG, NH
<a href="#">01129500</a>	CONNECTICUT RIVER AT NORTH STRATFORD, NH
<a href="#">01131500</a>	CONNECTICUT RIVER NEAR DALTON, NH
<a href="#">01138500</a>	CONNECTICUT RIVER AT WELLS RIVER, VT
<a href="#">01144500</a>	CONNECTICUT RIVER AT WEST LEBANON, NH
<a href="#">01154500</a>	CONNECTICUT RIVER AT NORTH WALPOLE, NH

**Contoocook**

<a href="#">01085500</a>	CONTOOCCOOK R BL HOPKINTON DAM AT W HOPKINTON, NH
<a href="#">01086000</a>	WARNER RIVER AT DAVISVILLE, NH
<a href="#">01087850</a>	CONTOOCCOOK RIVER AT RIVER HILL, NEAR PENACOOK, NH

**Exeter**

<a href="#">1073587</a>	EXETER RIVER AT HAIGH ROAD, NEAR BRENTWOOD, NH
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**Isinglass**

<a href="#">01072870</a>	ISINGLASS R AT ROCHESTER NECK RD, NR DOVER, NH
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Note: This gage is scheduled to close September 30, 2006 if funding support is not found.

**Lamprey**

<a href="#">01073500</a>	LAMPREY RIVER NEAR NEWMARKET, NH
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**Merrimack (Lower)**

<a href="#">01092000</a>	MERRIMACK R NR GOFFS FALLS, BELOW MANCHESTER, NH
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**Merrimack (Upper)**

<a href="#">01081500</a>	MERRIMACK RIVER AT FRANKLIN JUNCTION, NH
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### Pemigewasset

<a href="#">01075000</a>	PEMIGEWASSET RIVER AT WOODSTOCK, NH
<a href="#">01076500</a>	PEMIGEWASSET RIVER AT PLYMOUTH, NH
<a href="#">01081000</a>	WINNIPESAUKEE RIVER AT TILTON, NH

### Piscataquog

#### Surrogate stations at

<a href="#">01094000</a>	SOUHEGAN RIVER AT MERRIMACK, NH
<a href="#">01082000</a>	CONTOOCCOOK RIVER AT PETERBOROUGH, NH
<a href="#">01085500</a>	CONTOOCCOOK R BL HOPKINTON DAM AT W HOPKINTON, NH

### Saco

<a href="#">01064500</a>	SACO RIVER NEAR CONWAY, NH
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### Souhegan

<a href="#">01094000</a>	SOUHEGAN RIVER AT MERRIMACK, NH
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### Swift

<a href="#">1064500</a>	SACO RIVER NEAR CONWAY, NH
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## **Monthly Stream Flow Data Processing**

Monthly mean streamflows were estimated for 2004 using data provide by USGS. Values for 2004 Water Year (WY) had been estimated or corrected from their provisional status available on the internet. Data for October through December 2004, representing the early part of 2005 WY are still provisional in status.

Where no active gages were identified in the Water Management Planning Area, such as for the Cold River, surrogate data from other gages were used. The Cold River gage is inactive. A surrogate data set was created for 2004 from a nearby gage on the Saxton River in Vermont. These gages have similar basin size, elevation, and location. They also have 38 years of contemporaneous data collection. Monthly average flows for each gage were paired for the period when both gages were active. A comparison of flows was then conducted by running a linear regression on monthly average flows for the gages' mutually active period to calculate slope and intercept values. Monthly average stream flows for the inactive gage on the Cold River were then estimated for 2004 using the monthly averages from the surrogate gage calculated with the regression equation. Where no historical gage was available for regression, data from a surrogate gage was adopted from nearby watersheds. The surrogate stream flow was usually averaged from at least two gages, which was converted to a cfsm value and then applied to the target river.

Stream flow at each impact point is determined by areal transposition methods. Monthly average stream flows in cubic feet per second at a gage were converted to cfsm by dividing the monthly stream flow by the gage's drainage area in square miles. The drainage areas of each impact point can then be multiplied by this flow value to yield the average monthly stream flow at each location. Between two gages, where more than a single gage might apply to an impact point, interpolation of the stream flow at each gage is used. The watershed area between the two gages is measured and the ratio of that area above and below the impact point is used as the ratio of the monthly stream flow used from each gage.

$$AMS_{(ip)} = \left\{ \left( \left[ 1 - \left( \frac{[DA_{(ip)} - DA_{(ug)}]}{[DA_{(dg)} - DA_{(ug)}]} \right) \right] * AMS_{(ug)} \right) + \left( \left[ 1 - \left( \frac{[DA_{(dg)} - DA_{(ip)}]}{[DA_{(dg)} - DA_{(ug)}]} \right) \right] * AMS_{(dg)} \right) \right\} * DA_{(ip)}$$

Where:

$AMS_{(ip)}$  = average monthly stream flow at an impact point between gages

$DA_{(ip)}$  = drainage area of the impact point in square miles

$DA_{(ug)}$  = drainage area of the upstream gage in square miles

$DA_{(dg)}$  = drainage area of the downstream gage in square miles

$AMS_{(ug)}$  = average monthly streamflow of the upstream gage in cfsm;

$AMS_{(dg)}$  = average monthly streamflow of the downstream gage in cfsm

#### D. General Standard Determination

The General Standard is a quantitative way to evaluate water use among streams of different sizes and characteristics. When the rivers have protected flows established for them, water use will be assessed based on the protected flows instead of the General Standard. The General Standard is not a Protected Instream Flow, but instead is a set of criteria for evaluating water use in watersheds where a protected flow has not yet been established. Water use is compared to the General Standard, which is derived from monthly stream flow per unit area. When stream flow is higher, the General Standard for water use is higher. When aggregate water use exceeds the General Standard, the stream segment is not in compliance with the General Standard. The General Standard acts as a means of assessing water use versus stream flow that is comparable on all the Designated Rivers. Rivers that are not in compliance are the highest priorities for developing protected instream flows.

The four water use criteria in the General Standard are expressed as values in cfsm making these values drainage basin-size dependent. To calculate the General Standard for the impact points in the watershed, the monthly streamflow at a gage location is converted to cfsm by dividing the flow by the gage's drainage area. Streamflow in cfsm for each impact point is then compared to the four tiers of the General Standard as described in Env-Ws 1903.02 (c) of the Instream Flow Rules, which are listed above.

The General Standard usually increases linearly with increasing watershed area because of the linear interpolation/extrapolation method used to calculate stream flows. It is interesting to note that in rivers with more than one gage, the General Standard can decrease with increasing watershed area. This is the result of flows at a gage that do not increase proportionally relative to the size of the drainage basin during these months, that is, unit flows (cfsm) for this section of the river were lower than they were upstream.

The General Standard should not be interpolated between gages. This would result in hybridized General Standard values in those cases where the General Standard varied between the two gages. Instead stream flow must be interpolated for the impact point using the method above and the General Standard is then defined based on this value.

The General Standard includes a reference to 7Q10 in the lowest of the water availability criteria. The stream flow statistic known as 7Q10 represents the flow that is the lowest 7-day average flow with a statistical recurrence interval of 10 years. Values for each gage were usually taken from values derived by USGS for gages with sufficient periods of record. These data and the USGS methods can be found at [http://www.des.state.nh.us/rivers/instream/Archive/pourpt/Gage\\_Pourpoint\\_20010327.xls](http://www.des.state.nh.us/rivers/instream/Archive/pourpt/Gage_Pourpoint_20010327.xls) and <http://www.des.state.nh.us/rivers/instream/Archive/pourpt/compute.htm>. Additional values were taken from USGS WRI 02-4298, "Development of Regression Equations to Estimate Flow Durations and Low-Flow-Frequency Statistics in New Hampshire Streams." In some cases, a value for 7Q10 was averaged from nearby gages.

#### **E. Comparison of Aggregate Water Use with the General Standard**

The Aggregate Water Use and the General Standard criteria are determined at each impact point on the Designated River. At the locations and months that the Aggregate Water Use exceeds the General Standard criteria, the river is not in compliance with the General Standard. These locations and times are identified in the individual river reports for each WMPA. Graphs for each month show the General Standard with the impact point water use and with the aggregate water use for all water users upstream of the impact point. The General Standard criteria increase with increasing streamflow, therefore the graph shows the General Standard criteria increasing in the downstream direction as estimated streamflow increases.

## IV. Summary of Results

### Summary of 2004 Water Use versus General Standard for NH Designated Rivers

The 2004 assessment is the second annual assessment of water use versus streamflow under New Hampshire's Instream Flow Program. For 2004, the Department identified 465 registered sources and 163 registered, measured discharges that were included in this report (totals do not include water transfers). Highlighted values in the table below are the totals for the WMPA including other Designated Rivers as tributaries.

More water users did not meet the definition of Affected Water User this year than last because of the improved GIS hydrography coverages applied to the exception for water users more than 500 feet from the Designated River or tributary. New GIS coverages differentiated between perennial and intermittent streams. Water users that were near intermittent streams may have dropped out this year. Therefore, a total of 52 sources and six discharges were not part of the assessment.

### Designated River WMPA summaries for 2004 water use versus stream flow assessment

WMPA	Drainage Area (square miles)	AWU Registered Sources in the WMPA	AWU Registered Measured Returns in the WMPA	Hydropower facilities registered as AWUs in the WMPA
Ashuelot	422	23	12	5
Cold	102	1	0	0
Connecticut (other than Ashuelot+Cold)		120	54	21
Connecticut	6740	144	66	26
Pemigewasset	1023	50	20	8
Contoocook (North Branch)	121	3	2	2
Contoocook (Main stem)	764	56	22	14
Contoocook	764	59	24	16
Upper Merrimack (other than Pemigewasset and Contoocook)		55	19	6
Upper Merrimack	2428	164	63	30
Piscataquog (South Br + Middle Br)	104	2	0	0
Piscataquog (North Br.)	76	1	0	0
Piscataquog (main stem without branches)		5	3	3
Piscataquog (main stem and branches)	218	8	3	3
Souhegan	220	21	6	3
Lower Merrimack (other than tribs.)		74	22	7
Lower Merrimack	4046	267	94	43
Swift	114	5	0	0
Saco (other than Swift)		18	2	0
Saco	425	23	2	0

Exeter	76	12	0	0
Isinglass	74	4	0	0
Lamprey	212	15	1	0
Totals		465	163	69

Future annual assessments for the Designated Rivers will use the rivers' Protected Instream Flow values when they are adopted. For 2004, no Protected Instream Flow values had been established so all assessments were done using the General Standard. The Contoocook and Piscataquog Designated Rivers include separate branches, which were assessed individually. The fourteen Designated Rivers have seventeen segments because of these branches. Seven of the seventeen Designated River segments were in compliance with the General Standard for the entire year. There was no registered water use on the Middle Branch of the Piscataquog in 2004. Aggregate Water Use exceeded the General Standard criteria in the remaining ten Designated River segments. July was the most commonly exceeded month (9 times) followed by August (6 times). The Isinglass River was not in compliance during any month in 2004. The Contoocook (mainstem) was not in compliance for eleven months in 2004.

#### **Designated Rivers Not in Compliance with the General Standard**

<b>Designated River Name</b>	<b>River Mile-Months not in Compliance with the General Standard*</b>	<b>Months Not In Compliance with the General Standard</b>
Isinglass	134.4	All months
Contoocook (mainstem)	59.7	All months except April
Souhegan	48.3	February, July through November
Exeter	28.8	July
Lamprey	24.2	February, July, August
Merrimack (Lower)	14.7	August
Ashuelot	9.1	July, August
Contoocook (North Branch)	4.1	July, August, October
Piscataquog (main stem)	3.1	July
Cold	0	None
Connecticut	0	None
Merrimack (Upper)	0	None
Pemigewasset	0	None
Piscataquog (Middle Branch)	0	None
Swift	0	None
Saco	0	None
* The sum of the products of the river miles not in compliance with the General Standard and the number of months those miles were not in compliance.		

The General Standard is an assessment and illustration tool to compare basins of different sizes using normalizing criteria. It is not considered to be a protected flow for the river. Lack of compliance with the General Standard is not a violation. Monthly stream flow and water use used in these assessments may not illustrate acute impacts occurring for shorter durations. Because of the averaging affect of assessing water use and stream flows with monthly values, conditions resulting from shorter duration low flows or high intensity water use may not be observable.