



Souhegan River Water Management Plan



30 August 2013

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Souhegan River Water Management Plan

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Glossary

ACOE	U.S. Army Corps of Engineers
ac-ft	acre-foot = 43,560 cubic feet
ADO	Affected Dam Owner
AWU	Affected Water User
cfs	cubic feet per second
cfs/m	cubic feet per second per square mile
DES	NH Department of Environmental Services
ESWM	Ecologically Sustainable Water Management (Richter and others - 2003)
FERC	Federal Energy Regulatory Commission
GRAF	General Resident Adult Fish
IPUOCR	Instream public uses, outstanding characteristics and resources
km	kilometers
km ²	square kilometers
mi	mile
mi ²	square miles
NHF&GD	New Hampshire Fish & Game Department
NHNHB	New Hampshire Natural Heritage Bureau
NRCS	Natural Resources Conservation Service
PISF	Protected instream flow
psi	Pounds per square inch
RSA	Revised Statutes Annotated
RTE	Rare, Threatened or Endangered species
SRWMPA	Souhegan River Water Management Planning Area
7Q10	Lowest continuous seven day discharge having a ten year recurrence interval
UNH	University of New Hampshire
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile organic compounds
WMP	Water Management Plan
WMPA	Water Management Planning Area

EXECUTIVE SUMMARY

Introduction and Purpose

As of May 28, 2000, the Souhegan River from the confluence of its south and west branches in New Ipswich downstream to the Merrimack River was listed as a Designated River under the New Hampshire Rivers Management and Protection Program Act (RSA 483). This designation means that the Souhegan River has been acknowledged, through a public nomination and legislative process, as important to the state for its outstanding natural and cultural resources. A designated river is managed in order to protect these resources.

Without enough water, the Souhegan River cannot support the human and natural uses that depend on it. Water in varying amounts is needed to keep wildlife, plants and their habitats healthy and thriving in the Souhegan River. Many human uses are also tied to the river's flow, including swimming, boating and fishing. **The purpose of this water management plan is to guide water use to minimize negative consequences to any particular user or natural use.**

In 2002, the state legislature created a pilot program through Chapter 278 (HB 1449-A), which directed the N.H. Department of Environmental Services (NHDES) to study and establish protected instream flows and a watershed management plan for the designated portions of the Lamprey and Souhegan rivers. **A protected instream flow is the amount of water needed to support the human and natural uses that depend on the river, and the management plans detail the actions to be implemented to maintain the protected flows.** The Souhegan and Lamprey rivers are the first rivers in the state to have water management plans for instream flows.

The Souhegan River watershed's geographic study area is 220 square miles and includes all or portions of 16 communities located in southern New Hampshire (see Figure 1). Water moving over this land area drains to the Souhegan Designated River.

The state administrative rules Env-Wq 1900 provided guidance for how the Souhegan River flows were calculated as well as what had to be included in the plan. Visit <http://des.nh.gov/organization/divisions/water/wmb/rivers/instream/categories/rules.htm> for a list of links to related state laws and administrative rules.

The Souhegan River Protected Instream Flows

Protected instream flows for the Souhegan River are presented in the Final Souhegan River Protected Instream Flow Report published in 2008 by NHDES, and subsequently updated on August 30, 2013. The protected flows were established by the NHDES Commissioner as numerical translations of the narrative water quality standards for flow in Env-Wq 1700, specifically adapted to the Souhegan Designated River. The Souhegan River Water Management Plan implements the protected flows described in the Souhegan River Protected Instream Flow report with input from the affected users. Adherence to this Management Plan should allow for the attainment of water quality standards in the Souhegan River.

The Souhegan Designated River protected instream flows recognize that wildlife, plants and habitats, and most human uses, are best supported by maintaining natural river flows – both the

highs and the lows. Even floods and droughts have important roles in natural river environments. All of the flow dependent uses were studied to determine the flows necessary to support them, taking into account the river's range of natural conditions at different times of the year. Flow characteristics considered for each use include magnitude, timing, frequency, and duration. In general, when the flow needs of the one resource that has the most stringent flow needs are satisfied, then the other resource needs are also satisfied.

- The protected instream flows for **humans** consider boating, swimming, fishing, hydropower and pollution abatement.
- The protected instream flows **for fish and aquatic life** take into account: native fish; introduced fish; fish that travel back and forth between fresh and saltwater to lay their eggs; mussels; insects; and rare, threatened or endangered fish species. Instream flows were calculated for six distinct biological periods or "bioperiods," describing different times of year when various species of fish have critical flow needs.
- Protected instream flows for **wildlife and plants growing near and around the river** account for reptiles, frogs and plants.

Protected flows for wildlife and plants were only established when those flow needs were not already met by the flows established for fish and aquatic life, which typically had the most stringent flow needs of all of the users.

Souhegan River Water Management Plan

The Souhegan River Water Management Plan presents the actions to be taken in order to support and maintain the protected instream flows. The water management plan was developed with oversight and input from a stakeholder advisory committee. This committee included affected water users and dam owners who met during the draft plan's development to discuss management alternatives. Feedback was gathered from residents in the affected communities at a public hearing on the draft plan in May of 2011 and from written comments submitted by interested parties. See Appendix H for a summary of the comments and how they were addressed by DES. Appendix I contains the complete text of submitted public comments.

Affected Users

The Water Management Plan applies to each **Affected Water User** and **Affected Dam Owner** in the Souhegan River Water Management Planning Area

Affected Water Users are those water users that are required to be registered under the State's Water Use Registration and Reporting Rule (Env-Wq 2102) and have a withdrawal or discharge within 500 feet of a designated river or within 500 feet of a river or stream in its tributary drainage. Fourteen Affected Water Users are included in this Plan representing a diverse group of water use types: agriculture (1), aquaculture (1), bottled water (1), industrial (1), irrigation (2), hydroelectric power (2), remediation (2) and water suppliers (4). An **Affected Dam Owner** is an owner of a dam whose impoundment has a surface area greater than 10 acres in the watershed area of a designated river. This plan includes 14 Affected Dam Owners, including privately owned (6), municipally owned (2), and state owned (6) dams. These dams are used for flood control (5), hydropower (1), recreation (6), water supply (1), and combined flood control and public water supply (1).

How the Water Management Plan Works

Recognizing that all users compete for a finite resource in times of low flow, **the goal of the water management plan is to identify, quantify and organize water uses to minimize the impact on all.** The Souhegan River Water Management Plan includes three sets of management sub-plans: **Conservation Plans, Water Use Plans, and Dam Management Plans.** As river flows reach certain flow and duration thresholds, more actions under the sub-plans take effect. Each of the sub-plans present the activities recommended to best meet the needs of users and resources while at the same time meeting the protected instream flows. The Conservation Plans (Appendix A) and Water Use Plans (Appendix B) are tailored to each Affected Water User, and the Dam Management Plans (Appendix C) are specific to each Affected Dam.

River flow can be higher or lower than the flow thresholds established by DES and still be protected – it is the length of time combined with the level of flow that determines whether and what type of management action is necessary. More management is required as flows fall below thresholds for longer durations. Tables 1a and 1b describe the seasonal instream protected flow levels and durations for the Souhegan Designated River. The allowable duration of low flows depends on the natural flow conditions. Counting the days when stream flow is below the protected instream flows determines whether the flow protection goals are being met. DES tracks the Souhegan River flows at the stream flow gages at the U.S. Geological Survey (USGS) 01093852 Souhegan River near Milford, NH for the upper Souhegan River and at USGS 01094000 Souhegan River at Merrimack, NH for the lower Souhegan River, comparing gage readings to the protected instream flows.

Management of flows is needed to prevent *Catastrophic* conditions. Conservation and implementation of Water Use Plans reduce the frequency of *Catastrophic* conditions. Dam Management Plans help offset the effects of *Catastrophic* conditions. When low flows exceed the *Allowable* timeframe, it is deemed a *Persistent* condition. When a third consecutive *Persistent* condition occurs or the *Catastrophic* duration is exceeded twice in ten years, a *Catastrophic* condition has been reached, which activates the Dam Management Plans.

Conservation Plans

Conservation Plans are used to reduce the overall water demand. Conservation applies at all times. **The purpose of Conservation Plans is to identify potential reductions in water use and system losses.** Under the Conservation Plans, the Affected Water Users are required to meet the State's Water Conservation Rule requirements, which focus on accurate recording of water use and minimizing water losses.

Water Use Plans

The purpose of the Water Use Plans is to reduce and spread the impacts of water use on surface waters during low flows. Under the Water Use Plans, the Affected Water Users that directly or indirectly withdraw water from the Souhegan Designated River or its tributaries may have to reduce their water use or find alternate sources during low flow periods, typically summer and early fall. **Methods include incorporating outdoor water use restrictions and reducing direct surface water withdrawals.** These will most commonly consist of infrequent outdoor watering restrictions.

Dam Management Plans

The primary component of the Dam Management Plans, a two-day flow pulse, comes into play only during rarely-occurring Catastrophic conditions, when management is needed to relieve stress in the river environment system. **The purpose of Dam Management Plans is to reset stream flow conditions.** This is accomplished by mimicking a precipitation event through the release of a two-day “relief pulse” from affected dams. **Two-day “relief pulses” will be managed across a selected group of impoundments to minimize the water level change within the dam impoundments.** The resulting **downstream flow benefit would be large enough to “reset” the system during low flow periods.**

Four dams were selected to create managed low flow events by producing “relief pulses” for the Souhegan River, including, Sites 12A, 19 and 35 and Waterloom Pond. None of these dams, except Waterloom Pond, are currently configured for implementing the relief pulses, so additional analysis and reconfiguration will be required, as will outreach to abutters and stakeholders. The Plans for these four dams state that water levels in the impoundments will **not be lowered more than 24 inches** from the combined effects of natural conditions and withdrawals for instream flow purposes.

Next Steps and Implementation

The protected instream flows will be maintained by implementing this Water Management Plan designed for the Souhegan Designated River. Adoption of this Plan is only the beginning of the process to protect instream flows. Many actions are needed to implement the components of the Plan. For example, the Affected Water Users will submit Water Conservation Plans to the DES Drinking Water and Groundwater Bureau for review and approval. During the implementation of these plans, adjustments will be made as needed to support existing and future human uses as equitably as possible.

In some cases there are costs associated with implementing the Management Plans. Cost was a consideration when developing the sub-plans with the water users and dam owners. Much of the Plan’s overall cost will be borne by DES as the owner operating the flood control dams being used to manage stream flows.

The objective of the Water Management Plan is to maintain the protected instream flows while supporting managed water needs. Since the proposed water management actions are new approaches to the management of water resources, adaptive management will be applied when needed. Once implemented, the Water Management Plan will be reviewed and its success in meeting its objectives will be evaluated. If the results of the evaluation indicate that parts of the plan need revision, then DES will work with the Affected Water Users and Affected Dam Owners to address these issues.

DES expects that this document will be revised at the end of the pilot study period to improve its effectiveness as well as to accommodate any new water users or dam owners. In 2015, the NH General Court will review the two pilot projects – the Souhegan and the Lamprey – to determine future actions pertaining to protected instream flow for these and other designated rivers.

SOUHEGAN RIVER WATER MANAGEMENT PLAN

I. INTRODUCTION

Protected instream flows are to be established and enforced for each designated river pursuant to the 1988 Rivers Management and Protection Program (RSA 483:9-c.) Later legislation, Chapter 278, Laws of 2002, created a pilot program to study and establish protected instream flows and adopt water management plans for only the Souhegan and Lamprey Designated Rivers.

The development of the Souhegan River Water Management Plan was completed in two phases. The first phase was the development of the protected instream flows for the Souhegan Designated River. During the development of the protected instream flows, the flow-dependent protected entities on the Souhegan Designated River were identified and their protected instream flows established. The second phase was the development of this Water Management Plan. The Water Management Plan's purpose is to maintain the protected instream flows on the Souhegan Designated River.

This introduction provides a brief summary of the findings of the protected instream flow study, which are the foundation of the Water Management Plan presented in this document. The Water Management Plan includes Conservation, Water Use and Dam Management Plans for Affected Water Users or Affected Dam Owners located within the Souhegan River Water Management Planning Area ("Planning Area").

Effective as of May 28, 2000, the Souhegan River from the confluence of its south and west branches in New Ipswich downstream to the Merrimack River was listed as a Designated River. In accordance with New Hampshire RSA 483, the Rivers Management and Protection Program, a designated river is a river managed and protected for its outstanding natural and cultural resources. In 2002, the state legislature directed the New Hampshire Department of Environmental Services (DES) to establish protected instream flows and adopt a Water Management Plan for the Souhegan Designated River. The procedures for defining the protected flows followed the New Hampshire Code of Administrative Rules Env-Wq 1900 Rules for the Protection of Instream Flow on Designated Rivers, also known as the Instream Flow Rules. The Souhegan River Protected Instream Flows were proposed in February 2007 (DES 2007), presented at a Public Hearing in March 2007, and, after public comment, described in the Souhegan River Protected Instream Flow Report in April 2008 (DES 2008), and subsequently updated on August 30, 2013.

The Souhegan River Protected Instream Flow Report (DES 2008) delineates the flows needed in the Souhegan Designated River throughout the year to meet the needs of all water-dependent users including humans and ecosystems, or to preserve cultural resources. The Protected Instream Flow Report also demonstrates that the instream flows will not always be met. In such events, management strategies are warranted in order to maintain or restore sufficient water in the river. As directed by Laws of 2002, Chapter 278, the Pilot Instream Flow legislation, the management strategies are to focus on flow and flow regulation.

The Water Management Plan for the Souhegan Designated River represents the integration of the characteristics and needs of all affected water users and affected dams with the instream flow

needs. Management actions under the plan have also been revised to consider the values and interests of the residents and users of the impoundments affected by the Plan.

To identify these values and interests, DES contacted and interviewed all the affected water users and dam owners in order to develop their individual management plans. In addition, numerous meetings were held with the Souhegan River Water Management Planning Area Advisory Committee (SR WMPAAC) to solicit comments from stakeholder groups regarding the development of the Water Management Plan. The draft Water Management Plan was distributed for review, and after thirty days a public hearing was held to present the Plan and invite public comment. Comments were received and revisions made in response to these comments.

Recognizing that all users compete for a finite resource in times of low flow, the Water Management Plan identifies, quantifies, organizes and guides future water use to minimize the impact on all users while minimizing negative consequences to any particular user or natural use. The implementation of this Water Management Plan is required to result in maintenance of the established protected instream flows without diminution of the enjoyment of outstanding river characteristics. The Plan accounts for all of the instream public uses of the river segment including recreation, fisheries, and wildlife as well as environmental, cultural, historical, archaeological, scientific, ecological, aesthetic and community significance, plus the river's use for hydropower generation, pollution abatement, agriculture and public water supply.

A. Definition of Protected Instream Flows and Identification of Protected Entities

The Instream Flow Pilot Program's legislatively-defined protection goals are to maintain water for instream public uses, protect the resources for which the segment is designated, and to regulate the quantity and quality of instream flow along a designated river to conserve and protect outstanding characteristics. Maintaining the protected instream flows attains the water quality standards for flow quantity. Management of this waterbody, therefore, should be conducted so as to maintain the protected flows.

Specific categories of the instream public uses, outstanding characteristics and resources are described in RSA 483, the New Hampshire Rivers Management and Protection Program. Collectively, the instream public uses, outstanding characteristics and resources are called the "protected entities" in the Instream Flow Program.

The processes for defining the protected flows and developing the water management plan are described in administrative rule Chapter Env-Wq 1900 Rules for the Protection of Instream Flow on Designated Rivers, commonly called the Instream Flow Rules. Each of the protected entities identified in statute was studied to determine its level of flow-dependence on the Souhegan Designated River. The determination of whether an identified entity was considered to be flow-dependent was based on biological or physical needs. Those entities that were not flow dependent were not studied further.

The findings of this assessment were presented in the Instream Protected Uses, Outstanding Characteristics, and Resources of the Souhegan River and Proposed Protective Flow Measures for Flow Dependent Resources Final Report (Normandeau Associates, Inc. et al., 2004). The flow-dependent protected entities include: hydropower; pollution abatement; recreation (boating, fishing and swimming); the maintenance and enhancement of aquatic fish and life; fish and

wildlife habitat; and rare, threatened and endangered fish, wildlife, vegetation or natural/ecological communities.

B. Natural Flow Paradigm

The development of the protected instream flow values was performed within the framework of the Natural Flow Paradigm developed by Leroy Poff et al. (1997). The Natural Flow Paradigm recognizes that the natural variability of stream flows determines the geomorphic and biologic characteristics of a stream or river. The natural flow pattern is the stream flow that is not affected by diversions, discharges, or withdrawals. Substantial changes from the natural flow pattern cause ecosystem impairment, whether it is habitat loss, mortality, or loss of function; however, there is flexibility within the natural flow variability that allows for water use.

The application of the Natural Flow Paradigm concept in this study implies that the principal management objective is to allow streams to flow as close to their natural flow pattern as possible. Low flows and floods are expected to occur as natural conditions within the range of natural flows. Typical human influences tend to reduce flow variability by removing floods and droughts. This may make the availability of stream flow more reliable for human use, but is detrimental to biological integrity. Understanding the potential for the human alteration of the natural flow pattern of the Souhegan River and the impact of alteration on its protected entities was a major objective of the Instream Flow study.

It is important to recognize that the natural stream flow (even in the absence of any human intervention or water use) will not always meet all of the ecosystem flow needs, nor should it. Native communities are adapted to meet periods of stress that occur within the natural ranges of frequency and duration. The Natural Flow Paradigm recognizes that uncommon natural extremes such as flood and droughts have important functions in supporting riverine ecosystems. Protecting flow variability is necessary to ensure that the ecosystem provides the variety of habitat conditions necessary to support the entire ecosystem. This is why the description of protected flows requires the use of the flow components: flow magnitude, frequency, duration, timing and rate of change. Water management measures are required where uses and changes in watershed-wide conditions increase the durations or frequencies of flow conditions above or below specified flows.

C. Protected Flow Assessment for Flow-Dependent, Instream Public Uses

Protected instream flows were developed for specific, flow-dependent, instream public uses as required by RSA 483 and Env-Wq 1900. The instream public uses were divided into three groups: human uses; riparian wildlife and vegetation; and fish and aquatic life. Each of these three groupings of flow-dependent uses was assessed using methods appropriate for their flow needs. Human instream uses were assessed using surveys and questionnaires. A floodplain transect method was used to assess riparian wildlife and vegetation. Fish and aquatic life were assessed using an incremental habitat model that evaluates habitat quality versus stream flow.

Flow-dependent protected entities were studied to determine the flow components necessary for their function, as well as any constraints, such as season-specific needs. The detailed delineation, flow needs, discussion, and assessment of each water use/resource is described in the report Souhegan River Protected Instream Flow Report (DES 2008).

D. Souhegan River Protected Instream Flows

The Souhegan River Instream Flow Report (DES 2008) defines the protected instream flow standards for the Souhegan Designated River. The protected instream flows represent the important thresholds for maintaining the ecological and human uses. The protected flows are described using terms of magnitude, timing, frequency and duration following the Natural Flow Paradigm, which recognizes that the needs of instream entities are best supported by maintaining the natural variability of stream flows.

1. Protected Flows for the Upper and Lower Souhegan River

Protected instream flows were developed separately for two segments of the Souhegan Designated River due to differences in the river's characteristics in the upper and lower parts of the watershed. The designated river was divided at West Milford, downstream of the North River Road Bridge and just east of the Wilton and Milford town line. Several changes in the river's characteristics occur in this vicinity. First, the river changes from a third to fourth order¹ stream at the confluence with Stony Brook in Wilton. Second, the zoographic ecosystem type changes in this vicinity from Northeastern Highlands (upstream) to Northeastern Coastal Zone (downstream). Finally, the geology of the watershed changes at this point from more upland and glacial till dominated in the headwaters to floodplain and stratified drift dominated downstream. Because of these differences, there is a difference in the composition of the instream fish communities between the upper and lower portions of the river. As a result, the protected flows of these two river segments were investigated, analyzed and evaluated separately.

Tables 1a and 1b present the protected flows that maintain the patterns of natural flow variability in the upper and lower Souhegan Designated River, respectively. These protected flows come from comparing the timing and magnitude of the various flow needs for fish, riparian vegetation, riparian wildlife, and human uses. The emphasis of this comparison was to determine the controlling protected flow. The protected instream flow magnitudes include durations, which are tied into natural frequencies of occurrence. By maintaining the flow magnitudes within their appropriate durations, the natural variability of stream flows is protected.

Fish tend to be the most sensitive to flow, and so the flow needs for fish are the most stringent. The flow needs of riparian wildlife and vegetation that are not met by fish flows are incorporated in additional protected instream flow recommendations.

2. Protected Instream Flow for Human Uses

Flow-dependent human uses of the Souhegan Designated River include recreation (boating, fishing and swimming), hydropower and pollution abatement. However, these flows are not always available, which results in seasonal or selective use of the river for recreation (white-water boating and swimming) and hydropower generation. These traditionally opportunistic uses utilize the flows when they occur, but do not expect these flows to be continuously available. Flows to support recreational fishing are considered to be the same as those required to support aquatic life and fish (see next section). Flows for pollution abatement are permit-dependent and

¹ Stream order, sometimes referred to as the Stadler Order, is determined by the confluence of streams. First order stream are ones to which no other streams drain. A second order stream is created by the confluence of two first order streams, and so on.

are based on infrequent low flow values (7Q10), which are lower than the established protected flows. As a result, a specific protected instream flow value for pollution abatement was not established for the Souhegan Designated River.

3. Protected Instream Flows for Fish and Aquatic Life

Protected instream flow values for fish and aquatic life were defined in the Souhegan Instream Flow Study report for each of the six biologically significant periods or bioperiods (overwintering, spring flood, Clupeid² spawning, General Resident Adult Fish (GRAF) spawning, rearing and growth, and salmon spawning) by both magnitude and duration (Tables 1a and 1b). Each bioperiod's protected flows consist of three flow magnitudes including Common, Critical and Rare, where:

- The Common flow is the flow corresponding to the optimal habitat conditions, above which the frequency of occurrence begins to decline significantly;
- The Critical flow magnitudes result in less habitat availability than that provided by the common flow, but this habitat magnitude is not unusual; and,
- The Rare flow magnitudes result in habitat that is severely reduced and very uncommon.

Each protected flow magnitude is characterized by two durations: *Allowable* and *Catastrophic*. The durations define limits on the consecutive days when flow is below a protected magnitude. Repeated occurrences when stream flow is below a flow magnitude for longer than these durations result in a *Catastrophic* condition. A *Catastrophic* condition is a water quality violation requiring management.

Stream flow at levels below a protected magnitude for durations shorter than the Allowable duration is acceptable and is a typical condition. Flow below a protected magnitude for more than the Allowable duration, but less than the *Catastrophic* duration, is a *persistent condition*. A persistent condition that occurs for three consecutive years within the same bioperiod is a *catastrophic condition* representing an impaired flow regime requiring management. Flow below a protected magnitude for durations longer than the catastrophic duration that occurs twice in one bioperiod within ten years is a catastrophic condition representing impaired water quality requiring management.

The upper Souhegan flows in Table 1a are assessed using the USGS gage 01093852 Souhegan River near Milford, NH. The lower Souhegan flows in Table 1b are relative to the downstream index location at the USGS gage 01094000 Souhegan River at Merrimack, NH. The protected flow magnitudes in Tables 1a and 1b are also described in cubic feet per second per square mile of drainage area (cfs/m), so that they can be applied anywhere along the designated river by multiplying by the drainage area in square miles.

Note that the original Protected Instream Flow established on April 1, 2008 was superseded by a new declaration of establishment on August 30, 2013. In the period following the establishment of the Protected Instream Flow for the Souhegan Designated River, DES became aware of an issue related to the protected flow in the Salmon Spawning Bioperiod (also known as Bioperiod 6, which runs from Oct. 1 through Nov. 14). An overly cautious flow assessment related to the

² Fish of the family Clupeidae such as alewife and river herring.

quality of fish habitat was used for that Bioperiod. The analysis selected the more resource-conservative value over a flow range where the habitat availability was the same. The habitat quality was the same at 0.1 cubic feet per second per mile (cfs) as it was at 0.3 cfs. When 0.3 cfs was chosen as the Rare protected flow, a greater number and volume of flow deficits were defined than at 0.1 cfs. Since using the lower value will not reduce habitat quality, DES reassessed Bioperiod 6 using the alternate value. The protected instream flow for Bioperiod 6 for Rare flows is changed from 70 cfs (0.4 cfs) to 39 cfs (0.23 cfs). The allowable and catastrophic durations remain the same.

These protected flow and duration prescriptions are intended to be used as thresholds to determine when management actions are necessary to maintain and support fish and aquatic life in the Souhegan Designated River. The specific management actions to be taken are described in the next sections and appendices of this Souhegan River Water Management Plan.

Table 1a. Protected Instream Flows for the upper Souhegan Designated River.

Upper Souhegan Protected Instream Flows for Fish		Common flow				Critical flow				Rare Flow			
Time of Year	Bioperiod	Common flow (cfs)	Common flow (cfsm)	Allowable duration (days)	Catastrophic duration (days)	Critical flow (cfs)	Critical flow (cfsm)	Allowable duration (days)	Catastrophic duration (days)	Rare flow (cfs)	Rare flow (cfsm)	Allowable duration (days)	Catastrophic duration (days)
Nov 15 – Feb 28	Over-Wintering	204	2.0	35	50	51	0.50	15	30	31	0.30	5	10
Mar 1 – Apr 30	Spring Flood	389	3.8	28	36	113	1.1	12	16	82	0.80	5	7
May 1 – Jun 14	Shad Spawning	215	2.1	25	40	61	0.60	10	15	38	0.37	4	7
Jun 15 - Jul 14	GRAF Spawning	24	0.23	20	27	11	0.11	10	20	8	0.08	10	15
Jul 15 – Sep 30	Rearing & Growth	31	0.30	30	42	16	0.16	15	35	10	0.10	5	30
Oct 1 – Nov 14	Salmon Spawning	41	0.40	30	40	10	0.10	12	23	10	0.10	10	23

Table 1b. Protected Instream Flows for the lower Souhegan Designated River.

Lower Souhegan Protected Instream Flows for Fish		Common flow				Critical flow				Rare Flow			
Time of Year	Bioperiod	Common flow (cfs)	Common flow (cfsm)	Allowable duration (days)	Catastrophic duration (days)	Critical flow (cfs)	Critical flow (cfsm)	Allowable duration (days)	Catastrophic duration (days)	Rare flow (cfs)	Rare flow (cfsm)	Allowable duration (days)	Catastrophic duration (days)
Nov 15 – Feb 28	Over-Wintering	342	2.0	35	50	86	0.50	15	30	51	0.30	5	10
Mar 1 – Apr 30	Spring Flood	650	3.8	28	36	188	1.1	12	16	137	0.80	5	7
May 1 – Jun 14	Shad Spawning	178	1.0	15	25	96	0.60	5	10	88	0.50	5	10
Jun 15 - Jul 14	GRAF Spawning	39	0.23	17	25	239 / 26	1.4 / 0.15	13 / 15	23 / 20	325 / 17	1.9 / 0.10	10 / 10	10 / 10
Jul 15 – Sep 30	Rearing & Growth	103	0.60	20	40	26	0.15	15	20	17	0.10	5	10
Oct 1 – Nov 14	Salmon Spawning	184	1.1	23	40	96	0.60	12	40	39	0.23	5	10

Bold values are upper limits for instream flow for protection of GRAF spawning. Flows should not be created that exceed these magnitudes and durations.

4. Protected Instream Flows for Riparian Wildlife and Vegetation

Protective flows vary greatly among the numerous plants, natural communities, and wildlife species associated with the Souhegan Designated River riparian corridor. Flow-dependent riparian entities can be sorted into three groups with similar flow needs:

1. Periodic flood protected instream flows (annually or less in frequency);
2. Minimum seasonal protected instream flows (winter, spring, and/or summer); and,
3. Protected instream water levels (not flows).

Group 1 includes high and low energy riverbank plant communities, floodplain forests and oxbow/backwater swamps that depend on periodic flooding to inundate low areas, deposit nutrients, eliminate flood intolerant plants, or disperse seeds. Depending on landscape position, these communities may flood once a year to once every hundred years, typically in late winter/early spring, for days to weeks (Table 1c). These high flows range from greater than 500 cfs (2.8 cfs/m) every one to three years to at least 3,200 cfs (18.7 cfs/m) every two to ten years, with greater flows occurring less frequently. There is no intent to create floods for these entities, nor should such flood events be deliberately prevented through management practices.

Group 2 includes the animals and plant communities that have annual minimum winter, spring and/or early summer flow requirements. Plant communities in oxbow/backwater swamps require minimal flows during the summer. For example, Fowler's Toad requires minimum flows to maintain breeding pools while Wood Turtles have minimum flow requirements in winter to protect them during hibernation. The minimum protective monthly flow for all of these entities is 34 cfs (0.2 cfs/m) from May through September, and, from December through February should be greater than the average flow during the last two weeks of the previous November (Table 1c). These flows occur naturally in most years, and should not be prevented by management activities or human water uses.

Group 3 are the plants and animals that are sensitive to the rare summer flood events. Turtle eggs and nestlings in the high floodplain, larval amphibians in floodplain pools, and blooming aquatic and emergent plants may be harmed by summer floods. Daily flows that are less than 1,000 cfs (5.85 cfs/m) in June through September should be protective of all of these entities (Table 1c). However, high flow criteria for these sensitive entities are discussed in this report to inform regulators contemplating management actions that might result in unnatural flood events (such as a dam release); it is not intended to imply that naturally occurring floods, regardless of timing, should be controlled for the protection of these particular sensitive resources.

Table 1c shows the protected instream flows for riparian vegetation and wildlife comprised of flow magnitudes in cubic feet per second per square mile of drainage area (cfs/m). Flow magnitudes are defined within specific months and assigned a frequency of occurrence equivalent to the historical occurrence.

Table 1c. Protected Instream Flows for Riparian Wildlife and Vegetation.

Species	Timing and value of instream flow
Wood Turtle (lower Souhegan only)	<5.85 cfs (June through September) December through February flow should exceed the average flow of the last two weeks of the previous November
Fowler's Toad (lower Souhegan only)	>2.335 cfs at least once to fill wetlands (March through May) >0.175 cfs at least monthly to maintain breeding pools (June through mid-August)
Wild Senna and Wild Garlic	>18.7 cfs on a frequency of once every 2-10 years
Twisted Sedge/Fern Glade (upper Souhegan)	>2.8 cfs once every 1-3 years (December through April)
Silver Maple Floodplain Forest (lower Souhegan only)	>11.7 cfs once every 1-3 years
Sycamore Floodplain Forest (lower Souhegan only)	>17.5 cfs once every 1-3 years
Oxbow/Backwater Marsh (lower Souhegan only)	>3.5 cfs at least once to fill (March through April) >0.2 cfs at least monthly in summer (May through September)

II. SOUHEGAN RIVER WATER MANAGEMENT PLAN

Chapter 278 (Laws of 2002) created a pilot program to study and establish protected instream flows and adopt water management plans for the designated portions of the Lamprey and Souhegan Rivers. Under the Instream Flow Rules (Env-Wq 1906), the Water Management Plan (WMP) will define how the protected instream flows of the Souhegan Designated River will be maintained. The WMP will include a Conservation and Water Use Plan for each Affected Water User and a Dam Management Plan for each Affected Dam Owner within the Souhegan River Planning Area (“Planning Area”). The terms Affected Water User, Affected Dam Owner and Water Management Planning Area are defined as follows:

- Affected Water User – means a water user required to be registered under Env-Wq 2102 Water Use Registration and Reporting 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;
- Affected Dam Owner – means an owner of a dam with an impoundment possessing a surface area greater than 10 acres in the watershed area of a designated river; and
- Water Management Planning Area – means the tributary drainage to a designated river for which a water management plan is required.

The characteristics of the Souhegan River Planning Area and its Affected Water Users and Affected Dam Owners are discussed in the following sections.

A. Souhegan River Water Management Planning Area

The protected instream flows were developed only for the protected entities identified in the Souhegan Designated River. However, the water use and management activities in the upstream watershed area also affect the flow in the Designated River segment. As a result, the Protected Instream Flow study focused on the Souhegan Designated River, but the Water Management Plan examines water use and dam operations within both the designated section and its upstream watershed. This watershed area inside New Hampshire is referred to as the Souhegan River Water Management Planning Area (“Planning Area”).

The Planning Area includes the portion of the Souhegan River watershed in New Hampshire, which comprises 96 percent (or 211 sq. miles) of the total area of the Souhegan River watershed (Figure 1). Although located in the headwaters of the Souhegan River watershed, the Towns of Ashby and Ashburnham, Massachusetts are not within the Planning Area because the Instream Flow Rules do not apply outside of New Hampshire. The 16 towns and portions of towns in New Hampshire include:

- | | | |
|--------------|----------------|----------------|
| ▪ Amherst | ▪ Lyndeborough | ▪ New Ipswich |
| ▪ Bedford | ▪ Mason | ▪ Peterborough |
| ▪ Brookline | ▪ Merrimack | ▪ Temple |
| ▪ Goffstown | ▪ Milford | ▪ Wilton |
| ▪ Greenfield | ▪ Mont Vernon | |
| ▪ Greenville | ▪ New Boston | |

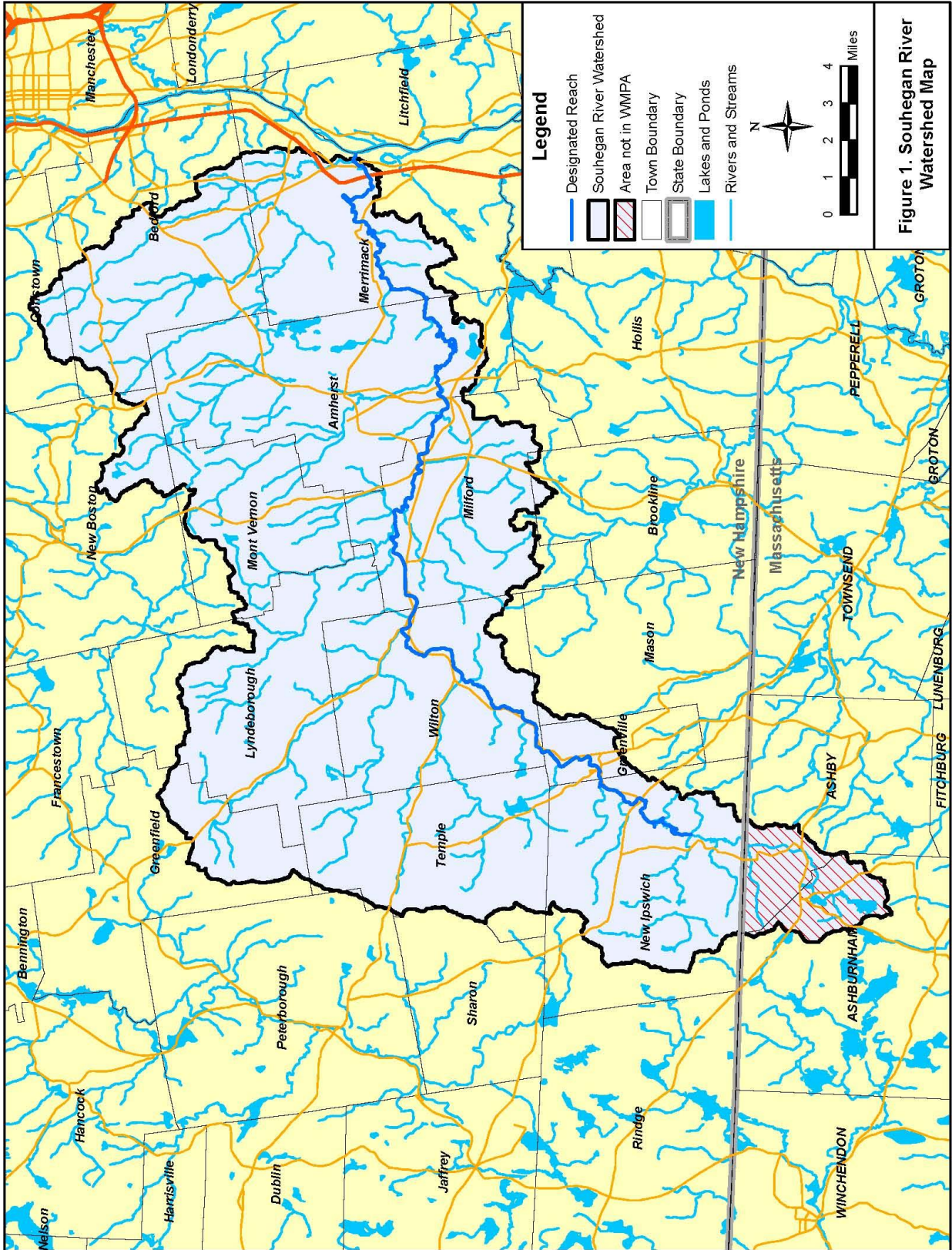


Figure 1. Souhegan River watershed.

1. Watershed Description

The Souhegan River watershed encompasses 220 square miles (570 km²) of New Hampshire and Massachusetts. The Souhegan River is formed by the confluence of the South Branch and the West Branch in New Ipswich. This confluence is also the beginning of the Souhegan Designated River. The South Branch originates at Stodge Meadow Pond near the Watatic Mountains in Ashburnham, Massachusetts and flows northeast through Ashby and into New Ipswich, New Hampshire where it joins the West Branch. The West Branch forms from the confluence of Fox Brook and Stark Brook, which originate along the east slope of New Ipswich Mountain and Barrett Mountain. The Souhegan River then flows to the north and east to join the Merrimack River in Merrimack, New Hampshire.

The southwestern portion of the watershed is mountainous, while the central and eastern portions are dominated by hills. Runoff from these upland areas form the major tributary streams in the watershed including (from source to outlet): Blood Brook (Wilton); Stony Brook (Wilton); Purgatory Brook (Milford); Great Brook (Milford); Beaver Brook (Amherst); and, Baboosic Brook (Merrimack).

Numerous private and publicly owned dams have been constructed on the tributary streams and the main stem of the Souhegan River. These dams have been constructed for different uses including flood control, hydropower, recreation and water supply. Notable dams along the main stem of the Souhegan River include Waterloom Pond Dam, Otis Falls Dam, Chamberlain Falls Dam and Pine Valley Dam, all of which are used for hydropower production. Notable dams and impoundments on tributaries to the Souhegan River include Burton Pond Dam, Osgood Pond Dam, Pratt Pond Dam, and Wheeler Pond Dam, which are used for recreation. Several flood control dams were constructed in the 1960s and 1970s including Souhegan River Sites 8, 12A South, 12A North, 15, 19, 33, and 35.

Much of the land in the watershed is undeveloped, particularly in its upper reaches. Land development is greatest near the municipal centers of Amherst, Greenville, Milford and Wilton. In particular, the corridor along the river from Wilton to Milford and parallel to State Route 101A has the highest percentage of commercial, industrial and residential development (Nashua Regional Planning Commission, 2006).

2. Designated River Description

Effective May 28, 2000, New Hampshire designated the Souhegan River under the Rivers Management and Protection Program. The Souhegan Designated River flows approximately 31 miles (50 km) from the junction of the West and South Branches in New Ipswich to its confluence with the Merrimack River in Merrimack, New Hampshire. Along its length, the Souhegan Designated River drops at an average slope of 26 feet per mile. In most places its grade is relatively gradual, but at others, like Wildcat Falls in Merrimack, the grade can be significant.

The Souhegan Designated River has been divided into an upper and lower section based on the physiography of its watershed, with the dividing point located in west Milford (DES 2008). The upper portion of the Souhegan Designated River flows through narrow, bedrock controlled valleys with stratified drift deposits. Its channel is relatively steep and straight, and is dominated by step-pool sequences, transitioning to runs and glides, which is characteristic of A and B type

streams (Rosgen 1996). The substrate consists of cobbles and bedrock, and an increasing proportion of sand downstream.

The lower portion of the Souhegan Designated River flows through broad valleys underlain by deposits of stratified drift and alluvium. The channel has a low gradient, meandering form that includes numerous oxbows and a distinct floodplain, which is characteristic of a C type stream (Rosgen 1996). However, due to incision, the river in this stretch also displays F type fluvial geomorphology, meaning that the channel consists of runs, pools and glides, while its substrate is dominated by sand. Near the end of the Souhegan Designated River its gradient increases, flowing over several bedrock-controlled cascades and coarser substrate.

B. Individuals Affected by the Water Management Plan

The Souhegan River Water Management Plan applies to the Affected Water Users and the Affected Dam Owners in the Planning Area. The Affected Water Users and Affected Dam Owners included in this Water Management Plan are introduced in the following sections.

1. Affected Water Users

Affected Water Users under the Instream Flow Rules are required to have a Conservation Plan and a Water Use Plan as their part of the Water Management Plan. The fourteen Affected Water Users included in the Souhegan River Water Management Planning Area are listed below and their locations are shown in Figure 2. Table 2 contains a summary of water use by each of the Affected Water Users.

- Amherst Country Club/Ponemah Green Family Golf Center
- Robert Greenwood (now Alden Hydro, LLC)
- Greenville Water Works
- Peter De Bruyn Kops
- Milford Fish Hatchery (New Hampshire Fish and Game)
- Milford Water Works
- Monadnock Mountain Spring Water, Inc.
- OK Tool Source Area
- Pennichuck Water Works
- Pilgrim Foods, Inc.
- Pine Valley Business Center
- Savage Municipal Water Supply Superfund Site
- Souhegan Woods Golf Club
- Wilton Water Works

Registered water users within the Planning area that are not included in this Plan are: Barrett Hill Farm (#20823), Pike Industries Wilton Quarry (#20281) and Trombly Gardens (#20854). Barrett Hill Farm and Trombly Gardens are both agricultural water users that make seasonal direct withdrawals from the Souhegan Designated River. However, reported water use from the Souhegan River by Barrett Hill Farm has been below the reporting requirement threshold, and no water use has been reported by Trombly Gardens. As a result, neither of these water users was included in the Plan. Pike Industries owns and operates the Wilton Quarry (#20281), which has a direct withdrawal from Stony Brook, a major tributary of the Souhegan River. Since 2006, water use by the quarry has been below the threshold for reporting to DES and, based on information provided by Pike Industries, future water use from Stony Brook will remain below the reporting limit due to a permanent infrastructure change at the facility. Therefore, Pike Industries was not included in the Plan.

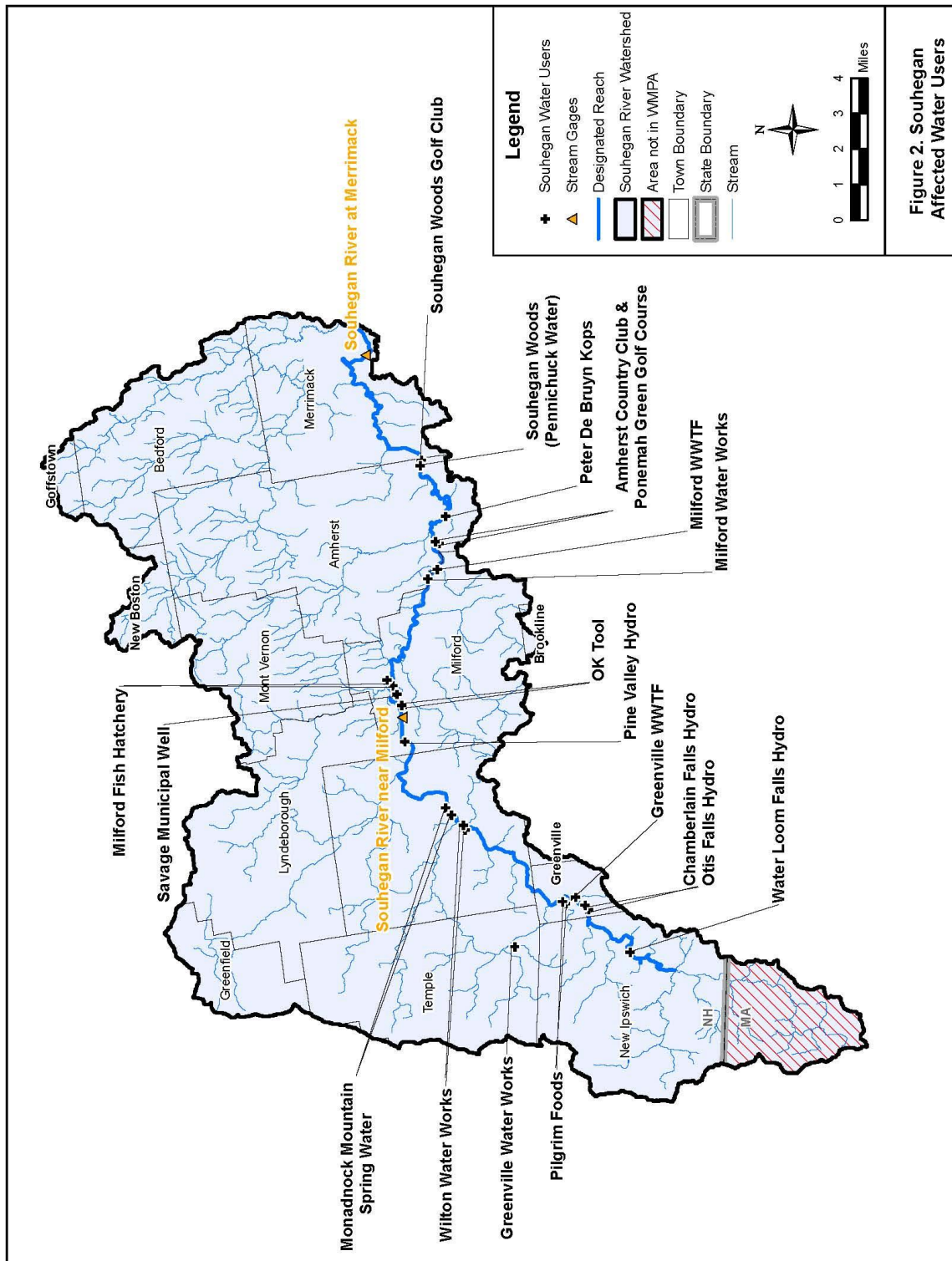


Figure 2. Location map of affected water users in the Souhegan River Water Management Planning Area.

Table 2. Water Use Summary for Affected Water Users in the Souhegan River Water Management Planning Area.

Water User	Water User ID	Annual Water Use (thousands gallons)			Annual Water Use (cubic feet per second)			Monthly Water Use (thousands gallons)			Monthly Water Use (cubic feet per second)		
		Max	Min	Average	Max	Min	Average	Max	Min	Average	Max	Min	Average
Amherst CC/Ponemah GC	20190/20624	34,434	8,518	24,314	0.146	0.036	0.103	17,094	0	2,011	0.854	0	0.102
Chamberlain Falls Dam	20230	7,471,724	2,103,763	4,681,495	31.675	8.918	19.846	1,166,825	0	393,271	60.200	0	20.000
Greenville WW	20047	67,383	41,386	54,019	0.286	0.175	0.229	7,542	1,923	4,556	0.389	0.099	0.232
Milford Fish Hatchery (Both Wells)	20218	1,034,568	235,872	802,969	4.386	1.000	3.404	103,788	3,240	73,365	5.180	0.170	3.740
Milford Fish Hatchery (River Well)	20218 - S01	663,408	117,936	505,129	2.812	0.500	2.141	66,309	0	46,041	3.310	0	2.340
Milford Fish Hatchery (Field Well)	20218 - S02	466,560	117,936	297,839	1.978	0.500	1.263	51,336	0	27,642	2.570	0	1.410
Milford WW	20100	373,745	210,790	306,522	1.584	0.894	1.299	38,397	8,413	25,456	1.918	0.420	1.296
Monadnock Mountain Spring (Both Wells)	20621	34,107	6,629	19,515	0.145	0.028	0.083	3,733	442	1,653	0.187	0.023	0.084
Monadnock Mountain Spring (Mansur Well)	20621-S01	17,054	4,804	9,992	0.072	0.020	0.042	1,866	245	846	0.103	0.014	0.043
Monadnock Mountain Spring (Intervale Well)	20621-S02	17,190	1,824	10,070	0.073	0.008	0.043	1,866	245	870	0.103	0.014	0.044
OK Tool (Both Wells)	20832	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OK Tool (Extraction Well 1)	20832 - S01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OK Tool (Extraction Well 2)	20833 - S02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Otis Falls Dam	20229	7,817,142	2,483,040	5,511,998	33.139	10.526	23.367	1,323,756	192	453,546	68.300	0.010	23.100
Pennichuck Water - Souhegan Woods	20659	21,591	7,944	15,060	0.092	0.034	0.064	3,444	145	1,242	0.172	0.007	0.063
Peter De Bruyn Kops	20383	520	0	100	0.002	0	0.0004	178	0	8	0.009	0	0.0004
Pilgrim Foods (Total)	20681	17,308	2,803	12,387	0.073	0.012	0.0525	2,225	0	1,204	0.111	0	0.0610
Pine Valley Hydro	20782	21,401,970	11,523,637	18,226,815	90.729	48.852	77.269	3,355,258	0	1,504,260	167.600	0	76.590
Savage Well	20833	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Souhegan Woods GC	20523	56,799	17,436	34,856	0.241	0.074	0.148	16,340	0	2,885	0.816	0	0.147
Water Loom Dam	20228	6,676,170	2,763,326	4,893,967	28.302	11.715	20.747	950,690	416	408,038	49.100	0.021	20.800
Wilton WW (Both Wells)	20065	115,240	61,647	81,223	0.489	0.261	0.344	11,672	0	6,767	0.583	0	0.344
Wilton WW (Everett Well)	20065-S01	92,229	30,759	43,556	0.391	0.130	0.185	9,684	0	3,589	0.484	0.000	0.183
Wilton WW (Abbott Well)	20065-S02	54,392	0	37,667	0.231	0.000	0.160	6,597	0	3,260	0.330	0.000	0.004

Notes:

NA - Not available

2. Affected Dam Owners

Affected Dam Owners under the Instream Flow Rules are required to have a Dam Management Plan as their part of the Water Management Plan.

The Affected Dams and the Affected Dam Owners in the Lamprey River Water Management Area are listed below in Table 3 and the locations of the Affected Dams are shown in Figure 5.

The initial list of Affected Dam Owners in the Planning Area included 13 owners responsible for 23 dams. Additional information was obtained from the DES Dam Bureau and the locations of the dams were confirmed during a field reconnaissance. The list was subsequently reviewed and revised based on the information obtained from the DES Dam Bureau and field reconnaissance. Those dams not meeting the definition of an affected dam were dropped from the study. The nine Affected Dam Owners included in this Plan are:

- Robert Greenwood (now Alden Hydro, LLC) – Waterloom Pond Dam (175.09)
- Town of Milford – Osgood Pond Dam (159.04)
- NH Water Division – Souhegan River Site 8 Dam (147.28), Site 12A South (234.11), Site 15 (254.30), Site 19 (175.19), Site 33 (254.34) and Site 35 (175.21)
- Pratt Pond Association – Pratt Pond Dam (175.03)
- Ms. Emmagene Riccitelli – Dream Lake Dam (007.15)
- Mr. David Somero – Wheeler Pond Dam (175.23)
- Mr. Herb Swartz – Swartz Pond Dam (147.31)
- Ms. Barbara Woodward (SNVK LLC) – Burton Pond Dam (147.17)
- Town of Wilton – New Wilton Reservoir Dam (254.09)

The Pennichuck Water Works was included in the Affected Dam Owners list since it owned the Merrimack Village Dam (156.01). The Merrimack Village Dam was removed in 2008, so it was not included in the Plan. The U.S. Air Force Station, (Joe English Pond Dam (007.01)) and Freestyle Farm, LLC (Vijverhof Pond Dam (007.09)), were dropped from the Plan because the dams they own are located in the Baboosic Brook watershed, a tributary that discharges into the Souhegan Designated River approximately 1,000 feet upstream of its confluence with the Merrimack River. Management of these dams would have virtually no effect on stream flows in the Souhegan Designated River.

Figure 3 shows the location of each affected dam, most of which are in the middle to upper portions of the Planning Area. The dams are used for a variety of purposes which include:

- Flood control – NH Water Division Souhegan River Site 8, 12A South, 15, 19, 33 and 35 dams;
- Hydroelectric power – Waterloom Pond Dam;
- Recreation – Burton Pond Dam, Dream Lake Dam, Osgood Pond Dam, Pratt Pond Dam, Swartz Pond Dam and Wheeler Pond Dam; and,
- Water supply – Souhegan River Site 12A (Toby Reservoir) and New Wilton Reservoir Dam.

Note that Souhegan Site 12A has both flood control and water supply uses.

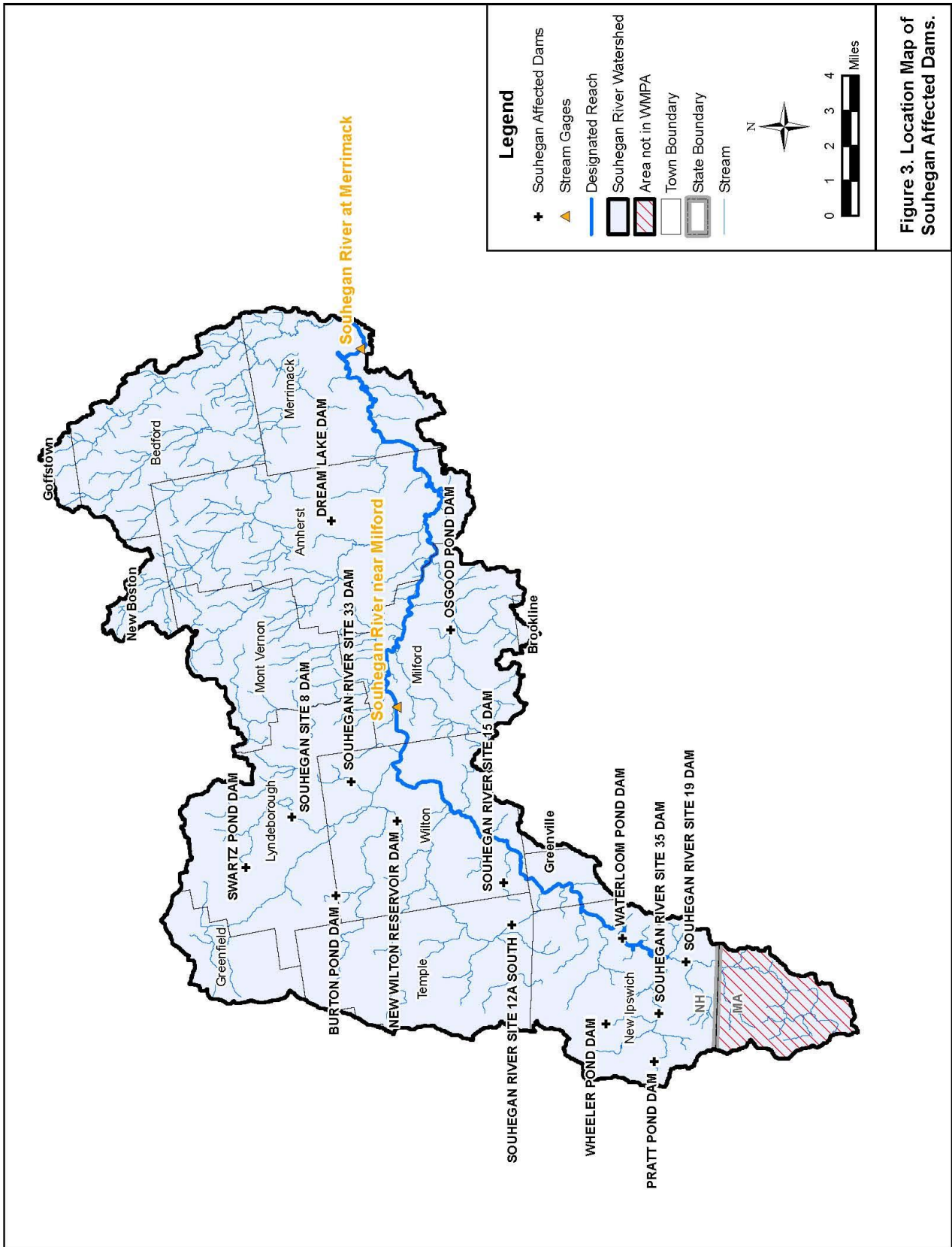


Figure 3. Location map of Affected Dams in the Souhegan River Water Management Planning Area.

C. Is There a Present Need for Management of the Souhegan River Instream Flows?

Management of Souhegan Designated River stream flows is driven by the need to balance the goal of natural variability in stream flow with the competing effects on stream flow of off-stream water use and watershed development. Conditions working against meeting the Instream Flow Program's goals include both increasing water use and changes in watershed-wide conditions that affect stream flow. If either of these conditions results in not meeting the protected flows, then management is required to meet the instream and off-stream protected entities' needs and to avoid water quality impairment.

Water withdrawals are one possible cause of not meeting the protected flow conditions. While total water withdrawals can be considerable, a substantial part of the water used is later returned to the river, though often somewhat reduced in volume. This results in cumulative reductions from upstream to downstream as well as reduced volume in segments of the river between the points of withdrawal and return.

Another cause of changes to the natural variability of stream flow is watershed-wide activities such as changes to land use, including increased impervious surfaces, and sewer inflow and infiltration – all of which result in more rapid runoff and lower retention of precipitation. More rapid runoff results in higher peak flows and lower low flows, as well as, more rapid recession rates following peak flow events. Management of flows resulting from these conditions may be partially successful, but a more direct and effective response may require management of the causes.

1. Aggregate water use versus standards for stream flow

There are several indicators of an existing need for the management of Souhegan River instream flows. One indicator is the results of the annual assessment of water use and stream flow performed by DES. Under the Instream Flow Rules (Env-Wq 1903), DES is required to prepare an annual assessment of aggregate water use and stream flow for each of the designated rivers. This assessment uses a simple accounting method that adds the aggregate water uses along the designated river and credits discharges by all the identified AWUs within each Water Management Planning Area. The aggregate water use is compiled on a monthly basis and is then compared with standards for water use [General Standard described in Env-Wq 1903.02 (c)] derived from mean monthly stream flow.

DES reports describe annual water use versus stream flow for the Souhegan River from 2003 through 2006 (DES 2003, 2004, 2005 and 2006). While the General Standard does not represent protected flows, exceeding it identifies locations and months that may be of concern for flow. During these four years, the aggregate water use exceeded the General Standards along portions of the Souhegan Designated River, most frequently during the months of July (3 of 4 years), August (all years) and September (all years). The results of these assessments also identified the reaches of the river where the aggregate water use exceeded the General Standards. This occurred at least once each year during the July to September periods for the reach of the river beginning at the Wilton Water Works wells and ending at the confluence with the Merrimack River. Less frequent but notable exceedances occurred for the short reach of the river between the Milford Fish Hatchery wells and its discharge (three times in three years), and for the reach

between the Wilton Water Works wells and the Milford Wastewater Treatment Facility discharge. During these periods, the ratio of the maximum value of aggregate water use to stream flow ranged from 3.7 percent (September 2004) to 21.05 percent (September 2005). These results highlight the concentration of water use along the Souhegan Designated River between Wilton and Milford and the imbalance between water use and stream flow in this portion of the river, particularly during the summer and early fall.

2. Water use versus the protected instream flows

The Final Souhegan River Protected Instream Flow Report (DES 2008) presented the protected instream flows compared to hydrographs of the Souhegan River representing several different hydrologic conditions and time periods (wettest and driest three years periods, average three years, five year period and thirty year period). The conclusion drawn from these comparisons was that, in general, all but the protected instream flows for fish are regularly met in the Souhegan Designated River (DES 2008).

The occurrence of flows below protected magnitudes were assessed for selected sections of the Souhegan Designated River and compared with water use. Based on this assessment, the section of the river where the Milford Fish Hatchery is located was identified as of potential concern (DES 2009).

The average withdrawals by the NHF&G Milford Fish Hatchery and the Town of Milford water supply wells were analyzed by UNH based on the estimated induced recharge caused by the wells (UNH 2005). The induced recharge of these wells, either individually or in combination, does not cause flows to fall below the protected instream flow. However, during those periods when flows fall below the protected instream flow, the induced recharge may increase the duration of flows below the protected threshold.

UNH also analyzed the flow duration curve of the Souhegan Designated River for existing conditions and under naturalized flow conditions (i.e. when Affected Water User withdrawals and discharges are removed or not considered). These two curves, shown in the Instream Flow Report, are nearly the same due to the minimal amount of storage management in the watershed as well as the very small net withdrawals from the system (i.e. much of the water used is returned before being measured by the stream gage).

Continuous duration is another component of the protected instream flows defined for each protected flow magnitude. The frequencies of flows occurring below the protected instream flows and also exceeding the protected flow durations were assessed by DES in 2009. This analysis was performed on subsets of the flow record comprising various periods of 30 years (1948 to 1977), five years (2000 to 2004), three years with the highest flows (1951 to 1953), three years with average flow (1945 to 1947) and three years with the lowest flow (1964 to 1966). During the most restrictive bioperiods,³ which coincide with the periods of lowest flows, for the 3 year period representing average flows, the Rare protected instream flow was exceeded roughly 10 percent of the time and for a duration greater than catastrophic (10 days) only once. These results suggest that flow management may occasionally be necessary to maintain the protected instream flows.

³ Rearing & Growth, July 15 – September 30

3. Water use and population trends

Another indicator of the need for the management of the Souhegan River instream flows is the increase in population and, as a result, water use. The total population of the 16 towns that comprise the Planning Area has grown from 32,822 people in 1960 to 127,082 in 2010 (OEP 2010), a rate of 6.9 percent a year. Although only three towns currently utilize the Souhegan Designated River as a water supply source or have water supply wells along it, continued growth will require additional water supply development. For the three municipalities identified as Affected Water Users, namely Greenville, Milford and Wilton, the change in population and water use provides some insight into the future. As shown in Figure 4a, the change in population in these three communities varies. All three communities have experienced population growth since the 1960s, of which Milford experienced the largest growth (4.2 percent annually), while Greenville and Wilton experienced slower growth (1 to 1.6 percent annually). The population of Milford continued to grow in the past two decades as population growth slowed or slightly declined in Greenville and Wilton.

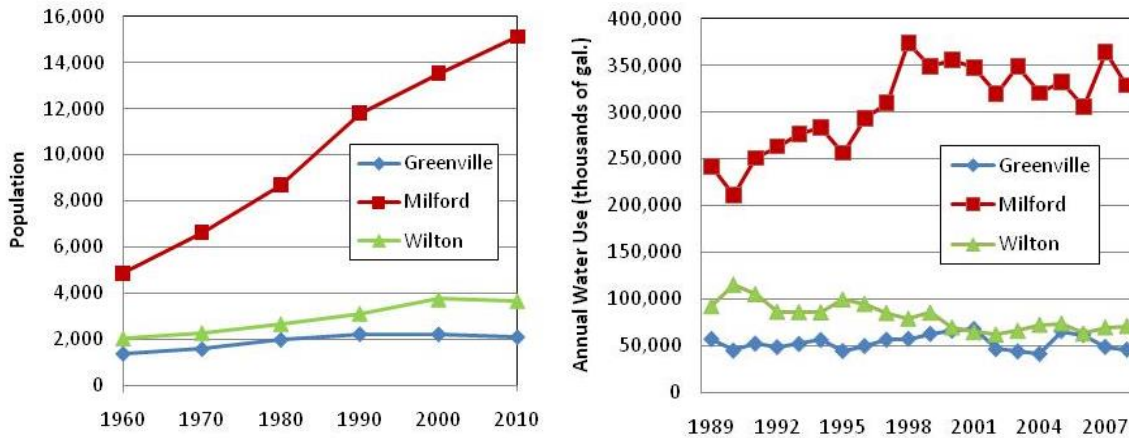


Figure 4. (a) Population of Greenville, Milford and Wilton by decade (1960 – 2010). (b) Annual Water Use (in thousands) for Greenville, Milford and Wilton by year (1989 – 2008).

Water use in these communities also changed (Figure 4b). Greenville and Wilton’s annual water use declined by roughly 20 percent from 1989 to 2008, while water use in Milford during this period increased by 36 percent. The increase in water use by Milford exceeds the overall decline in water use by Greenville and Wilton, such that there is a net increase in overall demand by public water supplies. Greenville projects higher future business water use despite lower per capita use. While the 20-year trend was up, it should be noted that water use over the 10-year periods from 1998-2008 was essentially level, so there is uncertainty with respect to the long-term trend.

Continued growth in the Towns of Amherst, Merrimack and Milford, which are located along the lower portion of the Souhegan Designated River, will probably result in increased water use in the Planning Area. The most likely source for these future water supplies will be the stratified-drift aquifers found along the corridor of the lower Souhegan Designated River between Milford and Merrimack. The development of additional large groundwater withdrawals along the

Souhegan Designated River may increase induced recharge from the river and will reduce base flow, requiring further management actions to maintain the protected instream flows.

4. Impervious Surface and Other Watershed Conditions

A growing pressure on stream flows is the increase of impervious area in the watershed. Although the State of New Hampshire and most towns have embraced low impact development for stormwater management, regulations generally apply only to larger-scale facilities and development, resulting in a gradual increase in imperviousness. Impervious areas reduce infiltration, which results in lower base flow in rivers and streams, especially during the low flow times of the year. Similarly, reduced quantity and quality of riparian buffers, along with expanded sewer lines and storm drain systems, have also had significant effects on stream flow that can be greater than actual water withdrawals.

D. Are the Souhegan River Instream Protected Flows Manageable?

The objective of flow management under this Water Management Plan is to maintain the protected instream flows and meet water demands of the Affected Water Users. Management of the Souhegan River flows under the Water Management Plan will be accomplished by three methods. The Conservation Plan component of the Water Management Plan will reduce water loss and waste. Water Use Plans will spread and flatten water use when flow conditions are stressed. Under the Dam Management Plans, releases of water to provide relief pulses will increase flows downstream of the dams to offset stressed conditions. DES assessed the sufficiency of each of these components to maintain the protected flows, and whether these volumes are available.

1. Management of Water Use

Management options available to maintain the Critical and Rare protected flows include reducing the effects of water use on the river and supplementing river flow by releasing water stored in impoundments. These dam and water use management options will be applied when needed following an extended low flow condition. Conservation plans are expected to affect water use and losses on a more continuous basis.

It should be noted that the induced recharge effects of the Milford Fish Hatchery and the Milford Water Works withdrawals on stream flow are complicated by local hydrogeologic conditions. These withdrawals deserve more detailed analyses to separate the effects of pumping from other effects on stream flow. Also, while the water withdrawals are large, they are taken from the subsurface and most of the water volume is returned to the surface water nearby, which may largely offset the effects of the withdrawal.

2. Management by Releasing Stored Water from Impoundments

Another mechanism to maintain river flows is to use releases of stored water to offset flow deficits. Water stored behind dams and other impoundments could be released as a relief flow when the protected instream flows are not being met in order to raise the flow above the protected flow. Relief flow releases will be applied to each catastrophic condition whether as a result of repeated exceedance of persistent durations (greater than Allowable durations) or a single exceedance of catastrophic duration.

A relief flow replicates the natural variability of flows by interrupting the low flow condition. A two-day relief flow period was suggested by the aquatic experts on the project team: this flow relief duration is believed to be sufficient to significantly reduce the stress on the aquatic ecosystem during extended periods of low flow. When studying the historic record of low flows, a typical small storm has a similar effect, increasing stream flow above the protected instream flow value for about two days. Relief flows volumes to offset deficits were calculated based on providing two-day relief flows sufficient to equal the protected flow magnitude.

Relief flows would be applied to offset catastrophic conditions in either the upper or lower Souhegan Designated River segments. These events do not occur at the same times in the upper and lower segments. Different flow criteria were developed for the upper and lower Souhegan because of their differing characteristics. So while low flow conditions may exist on both river segments, the effects on habitat, and the resulting need to manage flow conditions, are different and will not occur simultaneously.

The University of New Hampshire (Shump 2007) and DES performed statistical based flow deficit analyses to investigate the feasibility of managing flows by releasing water stored in impoundments. One objective of these analyses was to determine the deficit volumes of individual catastrophic conditions and the cumulative bioperiod and annual flow deficits. The 30-year stream flow record (1946-1975) used to develop the protected instream flows was also used to compute the relief flow volumes needed to meet the protected instream flows when catastrophic conditions occurred. These deficit volumes were then used to determine the storage volume needed to offset the deficit flow conditions and the bioperiod-specific flow releases.

3. Deficit Flow Analysis

In the 2005 UNH study, median deficit flows were evaluated for each bioperiod for the upper and lower Souhegan protected flows using a 30-year stream flow record (WY 1947-1976). The largest median flow deficit occurs on the lower Souhegan Designated River and is for the Common flow threshold during the Spring Flood bioperiod. See Table 3. The next largest median deficit flow is the Critical flow threshold during the Salmon Spawning bioperiod on the lower Souhegan River. Note that the Common flow deficits are several times larger than the Critical and Rare flow deficits.

Table 3. Results of flow deficit analysis with flow and storage needs for the Upper and Lower Souhegan Designated River (UNH).

Upper Souhegan River	Common	Critical	Rare
Bioperiod with largest median deficit flow	SF	SF	SF
Deficit Flow (cfsm)	1.188	0.161	0.160
Deficit Flow at Wilton Road - Souhegan R station 25 (cfs)	121.18	16.42	16.32
Storage Volume needed for two days of deficit flow (ac-ft)	480.70	65.15	64.74
Lower Souhegan River			
Bioperiod with largest median deficit flow	SF	SS	SF
Deficit Flow (cfsm)	1.119	0.261	0.186
Deficit Flow at USGS gage in Merrimack (cfs)	191.35	44.63	31.81
Storage Volume needed for two days of deficit flow (ac-ft)	759.07	177.05	126.17

SF – Spring Flood (March 1 to April 30).

SS – Salmon Spawning (October 1 – November 14).

Based on these initial UNH results, DES engaged in a more detailed analysis to determine the relief flow volumes and rates needed to meet future deficits. Relief flow management was assessed for the conditions during the thirty year period November 15, 1946 through November 14, 1976.⁴ Stream flow conditions were compared to the protected flow magnitudes and durations. Catastrophic flow events (when a relief flow release would have been applied) were identified within each bioperiod and each year. Flow deficits for the two-day period following these events were identified and the greater of the two magnitudes was used in order to provide sufficient flow to offset the deficit for both days.⁵ The 90th percentile of the cumulative annual relief flow releases was used to define the storage requirements to meet the deficits. Next, the 90th percentile plus 20% of the cumulative annual deficits for each bioperiod was used to identify a bioperiod-specific release. Flow data from recent years, November 15, 2001 through November 14, 2012, were used to check the 30-year results with recent conditions.

The results of the deficit and relief pulse analyses are described below, separated into the Lower Souhegan River and Upper Souhegan River. The Lower Souhegan River protected flow criteria differ from the Upper Souhegan criteria. As noted elsewhere in this report, the Lower Souhegan River is less steep and is subject to greater use and development pressure. As such, the number of Catastrophic flow events over the past 30 years is much greater for the lower part of the river system.

Lower Souhegan River

Relief flow pulses for Bioperiods 1 through 6⁶ for the thirty year period, 1946-1975, would have been applied 63 times using the Established Souhegan Protected Instream Flows (April 1, 2008). The greatest cumulative annual deficit volume during the 30 year period was for 1965 when 658 acre-feet would have been needed to offset ten flow deficits. The greatest annual deficit volume in recent years was 262 acre-feet to offset the flow deficits during the spring drought period of 2012.

Two additional factors were considered during the assessment. The first was the drought of the 1960s⁷ that is part of the thirty year record. This drought represents a continuous four-year period of below normal precipitation, much of which was characterized as a severe to extreme drought.⁸ This period contains some widely divergent conditions from the hydrologic record occurring during the rest of the 30-year period and the 2001-2012 periods. As a result, extreme cases of management would have been required during these drought years. The four year period from 1963-1966 contained 29 potential relief flow events, while the remaining 26 years contained only 19 events. From 1963 to 1966, the number of events per year ranged from five to

⁴ The Souhegan gage at Merrimack was closed WY1977 through WY2001 (1996-10-01 through 2001-09-30. Flow data are available at

http://waterdata.usgs.gov/nh/nwis/dv/?site_no=01094000&agency_cd=USGS&referred_module=sw.

⁵ Analyzed without using partial catastrophic events with the assumption that flows would be forecasted by the time management started.

⁶ November 15 is the start of BP1. The period from November 15 to the end of the calendar year is included as part of the following year's assessment.

⁷ <http://pubs.usgs.gov/wsp/1879f/report.pdf> describes the 1962-1966 drought on Long Island, NY

⁸ NH Water Resources Primer (Document No. - R-WD-08-23) – Chapter 12 Floods and Droughts - http://des.nh.gov/organization/divisions/water/dwgb/wrpp/documents/primer_chapter12.pdf

10, while the maximum number of management events in the remaining years was four events per year. Development of management plans for conditions this rare was deemed impractical because of the improbability of such conditions repeating within the planning horizon. Second, a reassessment was conducted of BP6, the bioperiod which covers October 1 through November 14. The vast majority of release flow events would have occurred during this bioperiod. Of the 63 potential relief events over the thirty year period, 38 occurred during BP 6.

During the reassessment of the Bioperiod 6 Rare and Critical flow magnitudes and durations, it was discovered that an overly cautious flow assessment was used for the Rare magnitude. The original analysis failed to note that aquatic habitat quality was the same at 0.1 cubic feet per second per mile (cfs/m) as it was at 0.3 cfs/m. When 0.3 cfs/m was chosen as the Rare protected flow, a greater number and volume of catastrophic conditions and resulting flow deficits were defined. Since using the lower value will not reduce habitat quality, DES reassessed Bioperiod 6 using the alternate value. The protected instream flow for Bioperiod 6 for Rare flows has been changed from 70 cfs (0.4 cfs/m) to 39 cfs (0.23 cfs/m) and the allowable and catastrophic durations remain the same.⁹ All lower Souhegan assessments were completed with this revised criteria.

As a result, deficit values, identified using the revised Bioperiod 6 Rare flow value and excepting 1963-1966, would have been applied 19 times instead of 63. The greatest annual deficit volume would have been 273 acre-feet occurring in 1952. The greatest annual deficit volume for the period 2002-2012 was 147 acre-feet for the unprecedented drought conditions occurring during the spring of 2012. See Appendix E for bioperiod-specific and annual deficit data and figures.

Upper Souhegan River

Relief flow pulses on the upper Souhegan for Bioperiods 1 through 6 for the thirty year period (1946-1975) would have been applied 17 times during 30 years using the Established Souhegan Protected Instream Flows (April 1, 2008). When reassessed without the 1963-1966 drought period, relief flow pulses would have been applied three times.

The Upper Souhegan River has fewer water deficits than the lower part of the river for two reasons. Chiefly, because it has fewer users and less development, it behaves more naturally. Second, the upper Souhegan has a different stream character because it is a smaller stream located higher up in the watershed and has different flow requirements.

It should also be noted that assessing the upper Souhegan River must also rely on estimated data. For most of the last 30 years, there was no water flow gage to track river flow. The upper river's stream flow gage in Milford was established in 2008. All the flow data used to develop the deficit values were transposed from the downstream gage in Merrimack. These stream flow data are estimates rather than actual data. The flow deficits on the Upper Souhegan River will be revisited in the future once more data are available from the Milford gage.

Given those qualifications, the greatest cumulative annual deficit volume during the 30 year period was for 1965 when 259 acre-feet would have been needed to offset six flow deficits. Outside of the drought years of 1963-1966, the greatest annual deficit volume was for 1968 when 73 acre-feet would have been needed. The greatest annual deficit volume during the period

⁹ Souhegan River Establishment Declaration, August, 2013

2002-2012 was 49 acre-feet, which would have applied to all three years when deficits occurred: 2002, 2010 and 2012.

4. Certain Bioperiods and Common Flows Will Not be Actively Managed

Some conditions have been identified as currently being outside the need for active management. Management needs have been evaluated for the expected conditions based on historical stream flow conditions, and, in some bioperiods when conditions are attaining the protected flow needs, management needs remain undefined. These conditions will continue to be tracked and management needs will be defined if they begin to occur.

For example, Spring Flood bioperiod¹⁰ protected flows were consistently met until the unprecedented drought conditions of 2012. This period has the highest protected flow magnitudes for both the upper and lower Souhegan River sections. The cumulative current diversions' effect on springtime flows is small. There is little reason to manage these very large flows, but the 2012 conditions point to the potential for changing conditions that would need to be addressed.

Similarly, there is little reason to address Common protected flows at this time. Common flows represent optimal conditions for flow-dependent fish, the absence of which are assumed to represent a chronic stress as opposed to the acute stress levels occurring when Catastrophic conditions under Critical and Rare flow magnitudes occur. Common flows are also much higher than the Critical and Rare flows and would require much larger storage volumes of water to offset periods of deficient flow. Water use records indicate that water withdrawals are not large enough to be affecting Common flows. Effects on Common flows are likely to result from land use changes and development effects affecting the watershed at large. Practically speaking, managing stream flows in response to effects from changes in watershed conditions by using storage in the watershed is not sustainable, and other management techniques will be needed outside the Instream Flow Program to address them. Furthermore, attempting to manage Common flows is likely to make management of the Critical and Rare flows, during which acute stress occurs, difficult or impossible.

In analyzing the frequency (both in magnitude and duration) of Catastrophic events under Rare and Critical flow criteria, DES found that 76% of those events occur in Bioperiod 5 (Rearing and Growth) or Bioperiod 6 (Salmon Spawning).¹¹ Of the historical management events over the past 30 years, 17 on the upper and 48 on the lower Souhegan River, 50 would have occurred during these two bioperiods. Therefore, the management actions in this plan are focused on these bioperiods. That is not to say that no management can occur outside of these two bioperiods. However, DES will take an adaptive management approach. This approach will include active management of Bioperiods 5 and 6 through relief flows and evaluation of management needs for the remaining four bioperiods. The need for active management in all bioperiods will be reassessed in 2015 in a statutorily required report to the New Hampshire Legislature.

¹⁰ BP 2 occurring from March 1 to April 30.

¹¹ BP 5 and BP 6 cumulatively occur from July 5 – Nov 14.

5. Relief Flow Release Rates By Bioperiod

Relief flow releases were determined for specific flow deficits within a bioperiod. Values for the Critical and Rare flow deficits that exceeded Allowable or Catastrophic durations were identified for the 30 years of the record and for the years 2002-2012. Each deficit flow release event was evaluated for its volume below the protected flows. All two-day deficit values over the 30 years were identified and listed by bioperiod. In many years, these deficit volumes were zero and, therefore, management would not have been needed. As noted above, the period of record between 1963 and 1966 was removed from the analysis because it was an anomalous period. The 90th percentile of the population of combined Critical and Rare deficit events¹² was calculated from the remaining deficits for each bioperiod. In some cases there were no events to analyze for the 90th percentile. In such cases, no deficit flow was calculated and no management flows are recommended. Where too few events occurred to calculate a 90th percentile value, the second largest or lacking that, the largest, value was used.

The Catastrophic condition is expected to occur on average once in ten years in each bioperiod. Therefore, not all of deficit conditions events must or should be managed. Managing for the largest historical deficits would exceed the management goal by preventing all Catastrophic conditions from occurring. The 90th percentile represents a release rate that should result in one Catastrophic condition in 10 years. However, if few deficit events occurred during the assessment period, the relief flow events might exceed management goals. For planning purposes, a deficit value was selected even when only a few deficit events occurred. In cases in which fewer than three data points were available, the second to maximum was applied, or the maximum was applied when only one deficit event occurred.

The 90th percentile deficit values were converted into relief flow release rates. When a relief flow release is needed, the 90th percentile of the deficit flows for that bioperiod plus a 20% buffer will be used for all relief flow pulses. The buffer is to offset attenuation of the relief flow pulse that may result from water loss to wetlands, storage delays behind downstream dams, or variations in arrival times from the various impoundments from which the relief flows are released. Bioperiod-specific release volumes for the upper and lower Souhegan River are presented in Appendix E. Relief flow rates were compared to the population of deficit values as a verification check.

As deficit events occur in the future the values can be used to refine the release rates. During the early years, the management practice will be to apply the bioperiod-specific release rates. As more practical experience is developed, event specific releases may be able to be applied.

6. Effects of Relief Flows on Impoundment Levels

Sites 19 and 35 are upstream of the Souhegan Designated River and so they can apply relief flows over the entire River. The draft Water Management Plan used only two impoundments, Flood Control Sites 19 and 35, located in the upper Souhegan River watershed. A hydraulic analysis was performed to determine the structural capacity of Sites 19 and 35 by DES Dam Bureau using the SITES computer program. The analysis, based on the dams' structural integrity alone, determined that Souhegan River Site 19 has roughly 499 ac-ft of storage potentially available, while Souhegan River Site 35 has 118 ac-ft potentially available (Mattaini 2009).

¹² The 100th percentile value would represent the largest deficit.

These results indicate that sufficient water could be stored and released from one or both of these dams to provide for annual relief flows. However, use of Site 19 and Site 35 for relief flow must be significantly less than the facilities' structures could sustain in order to attain water quality standards within the respective impoundments and to maintain the use and enjoyment of these impoundments.

Large water level changes described in the draft Water Management Plan (four to ten feet) would have been needed to maintain protected flows if only these two impoundments were used. These large changes are not appropriate for the water quality of the impoundments, or for the use and enjoyment of the impoundment by the land owners. After public comment and further review, the draft Water Management Plan has been extensively revised.

DES has determined that a water level change of less than two feet must be maintained as an approximation of natural water level changes in an impoundment. Larger changes risk habitat losses and affect the use and enjoyment of the impoundments by dam owners and abutters. DES's decision to limit water level changes in any impoundment used for instream flow management means that additional storage is necessary from other impoundments in the watershed.

DES evaluated the potential for other impoundments to provide storage within a water level limit of less than two feet of change. Smaller water level changes than two feet will be applied wherever possible. DES will work with the dam owners and abutters to finalize the impoundment changes by which relief flows will be made. Relief flows are expected to require changes to the dam structures and the starting or ending levels of water in the impoundments. Water for relief flows may come from additional water stored above the current levels or from release of water from the existing levels. In many cases, the best solution will be a combination of approaches: storage of some additional water for relief flows, as well as obtaining relief flows from the existing storage.

DES identified the overall storage volumes needed to support relief flows and the relief flow volumes that will come from each individual impoundment. DES used the annual historical release flow volumes¹³ to identify the storage needs for relief flow management. Providing storage at least equal to the 90th percentile of the cumulative annual deficits should be sufficient to meet the relief flow management needs. The upper Souhegan's 90th percentile of annual relief flows was 60 acre-feet and the lower Souhegan's was 221 acre-feet. The minimum storage goal to be used for instream flow management in the impoundments is 221 acre-feet. The maximum historical annual management was 87 acre-feet in 1968 in the upper Souhegan River and 327 acre-feet in 1952 in the lower Souhegan River.

Table 4 shows the annual storage available using up to two feet of water. The total storage volume estimate available in seven impoundments is 775 acre-feet. Two feet of water level change may not be practicable from all the potential facilities. However, 775 acre-feet vastly exceeds the 256 acre-feet release flow in 1956 and 1968, as well as the 327 acre-feet release flow in 1952, which are the largest flow deficit volumes outside the 1963-1966 drought years. Also, some impoundments will be more effective and more practically applied for release flows than others. Therefore this plan identifies a subset of four of these dams to be used in flow management. Of the impoundments in Table 4, Site 19, Site 35, Waterloom Pond and Site 12A

¹³ Release flows are generally the 90th percentile of the deficit volumes plus 20%.

will be used. Table 4 also shows the likely practicable upper limit of water level change in each of the impoundments and the associated storage volume. The maximum water level change is two feet in Site 12A and the least is 0.75 feet (9 inches) in Waterloo Pond. Both Site 19 and Site 35 are limited to 1.5 feet of change. The cumulative volume associated with these water level changes is 347 acre-feet—still well above the minimum storage goal of 221 acre-feet and above the 327 acre-feet maximum historical release flow.

Site 19 and Site 35 do not need to generate the entirety of the relief flow volume because stream flow increases in the downstream direction. Further, most of the relief flows will be needed downstream in the lower Souhegan River, and because the relief flow requirements are larger in the lower Souhegan, Waterloo Pond and Site 12A, downstream of Sites 19 and 35, can incrementally increase flow to increase the relief flow as the relief pulse moves downstream. Sites 19 and 35 need only to maintain sufficient flow protection until the relief pulse reaches Waterloo Pond. From there, the combined effects of all three will be used to maintain flow downstream, likewise, to where Site 12A will be added in. Based their relative location in the watershed, Site 19 and 35 need only be responsible together for 21% of each flow release, Waterloo for 17%, and Site 12A for 62%. So long as each upstream impoundment supports at minimum these respective portions of the overall release, the instream flows will be met for the intervening segments.

The largest release volume is for Bioperiod 6 (revised) equal to 88 acre-feet. The lower Souhegan River has the more frequent flow release management needs. The largest common annual management need is two events per year.¹⁴ The number of events times the largest bioperiod-specific release volume would require 176 acre-feet as the largest, most likely relief flow volume. Table 4 shows that by applying storage at the ratios in the paragraph above, water level changes of about half the practicable upper limit of water level change described for each impoundment would be used.

Sufficient storage using four upper Souhegan River impoundments is available to manage the historical maximum annual deficits. Most years (21 of the 37 years)¹⁵ would have required no management. The most common maximum annual relief flow scenario would use about half of the practicable storage volume available for stream flow protection. The volume of water in storage needs to provide for the anticipated management for one year and is a function of the size of the releases and the number of times a release is applied. Outside of the 1963-1966 drought years, upper Souhegan deficits have occurred at most once per year. The maximum upper Souhegan release volume was 59 acre-feet, representing the Bioperiod 2 deficit plus a 20% buffer.

The focus of management of flows from Sites 19 and 35 will be twofold: 1) protecting the instream flows in the upper part of the Souhegan Designated river during the Rearing and Growth bioperiod (Bioperiod 5 which runs from July 15 – September 30); and, 2) assisting the protection of instream protected flows in both the upper and lower Souhegan Designated River during the Salmon Spawning bioperiod (Bioperiod 6 which runs from October 1 – November 14). Only if stored water is available after Bioperiod 5 can that water can be used to augment downstream needs during Bioperiod 6.

¹⁴ Outside of the 1963-1966 drought years, the largest number of relief flow releases of four would have occurred once in 1957. The 90th percentile of annual event frequency is two events per year.

¹⁵ 1946-1963, 1966-1975, and 2002-2012

Table 4. Available and effective impoundment storage behind Affected Dams and effects of use on water levels.

Dam Name	Surface Area at Normal Full Pool (acres)	Estimated Volume in 2 vertical Feet (ac-feet)	Available Water Level Change (ft)	Estimated Practicable Volume Available for Relief Flows (ac-ft)	Impoundment Contribution to Maximum Common Annual Volume (ac-ft)	Water level Change from Maximum Common Annual Volume (ft)	Water level Change from Maximum Anticipated Annual Volume (inches)
Site 19	25	50	1.5	37.5	18.4	0.7	8.8
Site 35	24.9	49	1.5	37.35	18.4	0.7	8.8
Waterloom Pond	75	150	0.75	56.25	14.9	0.4	4.8
Site 12A South	108	216	2	216	54.9	1.0	12.2
Site 15*	69	138	--	--	--	--	--
New Wilton Res.*	22.1	44	--	--	--	--	--
Site 8*	40	80	--	--	--	--	--
Osgood Pond*	24.16	48	--	--	--	--	--
Sum	775		347.1	106.6			

* The impoundments behind these dams will not be used under this Water Management Plan.

Table 5. Upper and Lower Souhegan River Two-Day Release Volumes and Rates by Bioperiod (DES).

Upper Souhegan Release						
Bioperiod	Bioperiod name	Start	End	Volume needed to meet 90% of historical deficits (ac-ft)	Volume needed to meet 90% of historical deficits with 20% buffer (ac-ft)	Two-day flow release contribution (cfs)
1	Overwintering	15-Nov	28-Feb	47.3	56.8	14.3
2	Spring Flood	1-Mar	30-Apr	48.9	58.7	14.8
3	Clupeid Spawning	1-May	14-Jun	--	--	--
4	GRAF Spawning	15-Jun	14-Jul	--	--	--
5	Rearing & Growth	15-Jul	30-Sep	28.9	34.7	8.7
6	Salmon Spawning	1-Oct	14-Nov	--	--	--
Lower Souhegan Release						
Bioperiod	Bioperiod name	Start	End	Volume needed to meet 90% of historical deficits (ac-ft)	Volume needed to meet 90% of historical deficits with 20% buffer (ac-ft)	Two-day flow release contribution (cfs)
1	Overwintering	15-Nov	28-Feb	31.7	38.1	9.6
2	Spring Flood	1-Mar	30-Apr	--	--	--
3	Clupeid Spawning	1-May	14-Jun	--	--	--
4	GRAF Spawning	15-Jun	14-Jul	--	--	--
5	Rearing & Growth	15-Jul	30-Sep	27.0	32.4	8.2
6 revised	Salmon Spawning	1-Oct	14-Nov	73.5	88.2	22.2

E. Strategies for Maintenance of the Protected Instream Flows

The protected instream flows will be maintained by implementing management actions under the three sub-plans of the Water Management Plan. The three water management sub-plans are: the Conservation Plan – to reduce water losses and unnecessary water use; the Water Use Plan – to shift, spread, and reduce water use impacts on stream flow; and, the Dam Management Plan – to manage catastrophic flow events. Implementation of management actions will be based on tracking daily river flows at two USGS stream flow gages and comparing them to the protected instream flows. The gages used to track flow conditions are 01094000 Souhegan River at Merrimack, NH and 01093852 Souhegan River near Milford, NH

Another management component is assessing hydrologic conditions using parts of the Ecologically Sustainable Water Management (ESWM) method developed by Richter and others (2003) to track changes in flow conditions. This tool will be used during the implementation period following the Water Management Plan adoption to show whether the protected flows are meeting the variability expectations of the Natural Flow Paradigm.

Lastly, there is a *de minimis* amount of water that is always available for use regardless of stream flow. The *de minimis* amount is distributed among water users who have a direct effect on stream flow.

1. De Minimis Amount

The Instream Flow Rules require that a *de minimis* amount of water is always available for off-stream use. “*De minimis* amount” means an aggregate water use at any river location equal to 5 percent of 7Q10 at that location. The *de minimis* amount represents a small amount of flow to large water users, yet the amount may be of significant value to smaller users. The *de minimis* amount will be apportioned among water users that have surface water impacts. Unless otherwise required, the *de minimis* flows will be applied mainly to small users and then used to buffer management errors (too little flow released, too much withdrawn, etc.) *De minimis* amounts may need to be reapportioned if new surface water users are added to the Water Management Plan.

The *de minimis* amount equals 420,000 gallons per day (292 gallons per minute) or 0.65 cfs.

2. Conservation Plan Strategy

A Conservation Plan is required if the Affected Water User meets the requirements for submitting a Water Conservation Plan under Env-Wq 2101. Plans developed under these rules apply Best Management Practices according to water use type. These plans focus on improving water efficiency through water audits, leak detection and the use of appropriate water conservation measures. Implementation of these plans will result in reduction of both water losses and unnecessary water use to support the protected instream flows. The Instream Flow Program will coordinate the Instream Flow Conservation Plans with the DES Drinking Water and Groundwater Bureau.

3. Water Use Plan Strategy

The Water Use Plans vary by water use type and primarily focus management actions on direct withdrawals and on water uses that induce recharge from out of the river. Wells that do not induce recharge are currently excluded from management because of the delay between management and an effect on the river flows. All direct withdrawals or wells that induce recharge have management actions that apply when flows drop below the Critical flow magnitude. The purpose of the Water Use Plans is to reduce, shift, and spread the effects of water use on stream flow. For example, public water system customers may be asked to reduce outside water use during persistent low flow periods. In-river storage in impoundments may be used to continue withdrawals during low flows so long as stream flow through the dam is equal to inflow into the impoundment. Alternate sources of water are required when stream flow conditions fall below Critical magnitudes during summer and early fall.

Agricultural water users and public water supplies are identified in statute for particular support under the Instream Flow Program. Identification of grants, loans and other assistance in developing alternate water supplies will be made available.

4. Dam Management Plan Strategy

Dam management is employed to provide relief flow pulses when conservation and water use actions are not sufficient. The relief pulse is released from stored water for the two days immediately after a Catastrophic condition occurs. The relief pulse volume will result in raising stream flow above the Critical and Rare protected flow magnitudes. A relief flow is defined as a two-day pulse, or release of water, intended to interrupt the duration of the Catastrophic flow condition for the Rare and Critical protected instream flows. The release of the relief flow pulse will reset the stream flow pattern by reducing the duration when flow is below protected levels. In any particular year, dam management activities may never occur or may occur on a frequency of one or more events per bioperiod in the six bioperiods.

The Dam Management Plans will require completion of additional activities before management can be implemented to support the protected instream flows. The proposed Dam Management Plan presented in the Draft Souhegan River Water Management Plan Report (June 23, 2011) described storing water in two flood control dams that could be released when protected flows were not being met. However, the draft plan was subsequently modified to limit the maximum change in water levels, thereby requiring an increase in the number of facilities that will be used to store and release water for relief flows. All but one of the dams will require retrofitting of their release structures to make possible management of relief flow pulses.

Relief Flows Applied to Catastrophic Conditions

A relief flow is applied when persistent or Catastrophic flow conditions occur as shown in Tables 1a and 1b. When the river flow is less than the protected instream flow, and the allowable duration is exceeded, the system enters a *persistent duration*. The third consecutive persistent condition represents a *catastrophic condition* requiring management. Dam management actions will be triggered at the beginning of the onset of the third persistent event. If a low flow event continues and the catastrophic duration is exceeded, then a catastrophic condition requiring management occurs. Catastrophic conditions (as flows and durations) are, by definition, expected to occur in a bioperiod once within a ten-year period. Therefore, in order to

better mimic natural hydrology, relief pulses may not occur every time a Catastrophic condition is reached. If the frequency of catastrophic events is found to increase, then long term, watershed-scale management actions may be required to offset or reduce the frequency of these events.

Relief Flow Volumes Calculated

The management goal is to prevent Catastrophic events from occurring more than once in ten years, which is equivalent to achieving protected instream flows 90% of the time. To release flows to create the protected flow condition requires calculation of the flow deficits when Catastrophic conditions occur. Defining a relief flow volume that meets or exceeds the deficit 90 percent of the time will meet the management goal.

Events when Catastrophic conditions occur will be managed by releasing a defined volume to raise stream flow above the Critical or Rare magnitude specific to each bioperiod. To define the release volume for each bioperiod, the flow deficits between the protected flows and the historical stream flows were evaluated for the Common, Critical and Rare protected flows¹⁶ using the 30-years of flow data from 1946-1976. The deficit during the first two days of a Catastrophic condition was computed and these data established the distribution of flow deficits. The 90th percentile volume was identified for each bioperiod. As discussed previously, these calculations were modified by removing the anomalous period of 1963-1966. The distributions of the deficit volumes and release flow volumes for Rare and Critical flows appear in Appendix E.

Flow release pulses are expected to be attenuated by the distance between the release locations and the end of the Souhegan Designated River and by evaporation and storage losses into river banks and wetlands. As a conservative measure, a 20% buffer was added to each bioperiod's 90th percentile deficit to provide a safety factor. Most deficits will be less than the 90th percentile value, so the buffer will ensure that protected flows are met when the larger deficit events are occurring. More finely tuned releases may be possible after sufficient management experience, at which point, this strategy may be revisited with added complexity.

Relief Flows Applied

Relief pulses will only be applied to Catastrophic events in the Rare and Critical range of protected flows. The Common flow events will be tracked and if attainment of these flows and durations indicate an expanding problem, recommendations will be advanced by DES for implementing watershed-wide measures, such as reducing impervious surfaces, more rigorous stormwater management with green infrastructure, improving riparian buffers, or modifying dam operations. Similarly, no management is planned for other bioperiod flows because those deficits are so infrequent that defining a flow release would be inappropriate. DES determined that these flows are outside the current need for management. Tracking will determine whether trends in meeting the protected instream flows during these bioperiods support this assumption.

The DES Dam Bureau may release stored water in anticipation of forecasted storm events to maximize flood storage potential. The hydroelectric dams located downstream of the selected

¹⁶ See Section D.4 for discussion why Common flow deficits will not be managed.

flood control dams may produce electricity during a release, but must pass the relief flows un-attenuated in timing or in volume to the river reach downstream of their facilities.

Sources of Relief Flow

The Draft Water Management Plan has been revised by reducing the amount of water level change in any dam selected for management to two feet or less to better protect habitat within each impoundment. This change has resulted in less water being available from the two impoundments originally intended for dam management. The strategy has changed from operating two dams that control flows for the entire Designated River to operating several dams in succession through the watershed. Each successive dam will provide additional volume. Since river flow is correlated with watershed size, a smaller amount of water is needed in the upper watershed where the river is smaller. More water will be added as the river size increases downstream by releasing water from impoundments in the middle to lower watershed.

Relief flow releases are developed in Dam Management Plans for Site 19, Site 35, Site 12A (also called Tobey Reservoir) and Waterloom Pond. The Dam Management Plans include the bioperiod specific flow releases that each impoundment will contribute to relief flows. While the water level change for each impoundment is defined, the configuration of the storage (i.e., above or below present normal levels) and the mechanism to release the water require additional work. To the extent that water levels could be raised over private lands, DES will seek approvals and flowage access from those owners. Finally, the outlet structures of these dams are not readily amenable to operation and will require funding and reconstruction to make them operable for managed stream flow releases.

Other Dam Management Strategies

Another dam management strategy is that no dam operations should create excessively low flows, and especially not reduce flows when the river is already below critical instream flows. If impoundment draining and refilling are necessary for maintenance, etc., these should be coordinated in advance with the DES Instream Flow Program and the river flow should be monitored by the dam owner during such episodes.

5. Strategy for Management of Other Protected Instream Flow Criteria

The protected flow conditions for non-motorized boating and riparian vegetation and wildlife will be tracked and managed on a multi-year timescale. For recreational boating, the number of days of occurrence of flows greater than 150 cfs annually in the upper Souhegan¹⁷ will be tracked by DES to ensure that the frequency trend of these events continues to match historical occurrence rates. The management strategy will consider this protected instream flow in the context of preserving the frequency of its occurrence. The instream flow for recreational boating use will continue to be met as it has been historically (that is, opportunistically). Management will not attempt to meet recreation needs on a continuous basis.

The instream flows supporting riparian wildlife and vegetation will be assessed by DES each year, so that management of these protected flows will respond to the previous year's conditions

¹⁷ Boating in the lower Souhegan was found not to be flow dependent because of the predominantly flatwater conditions.

and apply flow protections the following year. If the watershed did not meet these instream flows, then management actions for the following year may have to be implemented to ensure the conditions are met or to prevent actions that would preclude them. This approach recognizes the ability of many plants and semi-aquatic wildlife to survive occasional water level changes through relocation, dormancy, or other physiological adaptations not available to fish

6. Strategy for Ensuring Continued Flow Variability

Supporting and maintaining a sustainable water resource for the range of protected entities is the major goal of the Instream Flow Program. This requires maintaining flow variability as described by the Natural Flow Paradigm (Poff et al. 1997). Richter (Richter et al. 2003) delineated a hydrologic assessment framework to track whether operational activities represented Ecologically Sustainable Water Management (ESWM). Under this approach, the flow of the Souhegan Designated River will be tracked on a regular basis and compared with short, intermediate and long term hydrologic characteristics to identify positive and negative trends. DES will use the assessments of short, intermediate, and longer term conditions described by the ESWM protocols to diagnose maintenance of the Natural Flow Paradigm and determine whether flow variability is being maintained.

F. Application of Components of the Souhegan River Water Management Plan

The Water Management Plan is composed of three sub-plans: Conservation Plans, Dam Management Plans and Water Use Plans. The strategies for applying these sub-plans have been described above. The following sections summarize the individual plans contained under each sub-plan. Each of these sub-plans represents the activities and procedures determined to best meet the needs of all users and resources while maintaining the protected instream flows.

The prompts for management actions in these plans are determined from flow measurements at the United States Geological Survey stream gages 01094000 Souhegan River at Merrimack, NH and 01093852 Souhegan River near Milford, NH. The actions in this Water Use Plan are based on mean daily flow conditions and protected flow conditions recorded and defined on the DES web page at: Upper Souhegan River, <http://www2.des.state.nh.us/OneStopPub/Watershed/souhegan-upper-pisf-track.xls>; Lower Souhegan River, <http://www2.des.state.nh.us/OneStopPub/Watershed/souhegan-lower-pisf-track.xls>.

1. Conservation Plans

The purpose of conservation plans is to reduce water losses and waste. The content required in each Conservation Plan is described in Env-Wq 1906.02. To summarize, under the Conservation Plans, each Affected Water User is characterized as to its historic water use, opportunities for conservation are delineated, existing conservation efforts are identified, and conservation measures that could be implemented in the near term are described. Conservation Plan requirements under the Instream Flow Program will be met if the Affected Water User meets the requirements for Conservation Plans under Env-Wq 2101. Conservation Plans are regulated by the DES Drinking Water and Groundwater Bureau.

This section provides a summary of the individual Conservation Plans for each water user by type.

Agriculture

Peter de Bruyn Kops operates a commercial farm in Amherst and in the past has withdrawn water directly from the Souhegan Designated River as well as from a domestic well and an oxbow pond. Water use is on an “as needed basis” to irrigate a mixture of crops. From 2000 to 2003 Mr. de Bruyn Kops reported no water use, and thereafter ceased reporting to DES.

No actions are required by Mr. De Bruyn Kops as long as his water use from the Souhegan Designated River remains below the required reporting limit. Once his water use exceeds this limit he is to notify the DES. At this point DES will assist Mr. De Bruyn Kops in meeting the requirements of the Water Use Registration and Reporting Rules (Env-Wq 2102), including verifying that his water use measurements are accurate within 10 percent.

Aquaculture

The New Hampshire Fish and Game Department’s Milford Fish Hatchery (Milford Fish Hatchery) extracts water from two overburden wells located 273 feet and 668 feet north, respectively, of the Souhegan Designated River. Water use by the fish hatchery is continuous and supports the needs of its aquaculture production. During 1989-2008, the Milford Fish Hatchery used 803 million gallons of water on an average annual basis.

The Milford Fish Hatchery is a vintage (1973) facility. Because of its age, the fish hatchery has implemented only basic water conservation practices, including: metering the water supply wells; performing water use and conservation audits; determining minimum flows rates; minimizing water use for tank and facility washing; repairing pipes and tanks to minimize leaks; establishing a routine maintenance program; and, reusing water. Without major modifications in the design of the facility, the potential for the implementation of additional water conservation measures is limited.

Bottled Water

Monadnock Mountain Spring Water, Inc. (Monadnock Mountain) extracts water from two overburden wells in Wilton located 84 and 529 feet northwest, respectively, of the Souhegan Designated River. During the period of 1995-2008, production from the wells was nearly continuous during normal business hours. Monadnock Mountain Spring Water, Inc. used 19.5 million gallons of water for its bottling operations on an average annual basis.

Recording water meters are installed on both wells. The meter readings are checked with recorded bottle water production volumes and reported wastewater discharge amounts to detect any variation in expected well production and to detect any leaks. In addition, water storage is checked routinely for leaks. Monadnock Mountain has implemented most of the water conservation measures expected of a commercial business as part of its normal operations.

Hydroelectric Power

Alden Hydro, LLC operates three dams on the Souhegan Designated River for the production of hydroelectricity: the Chamberlain Falls Dam; the Otis Falls Dam; and, the Waterloom Pond Dam. The Chamberlain Falls Dam and Otis Falls Dam are located in Greenville, while the Waterloom Falls Dam is located in New Ipswich. All three dams divert water from upstream impoundments to run through the hydroelectric operations and return the water to the river

immediately downstream of the dams. The dams' highest water usage occurs during March and April in response to snowmelt and rainfall runoff. These facilities are operated on a run-of-river basis, such that total inflow equals total outflow, and there is no significant change in impoundment storage for power production. During 1989-2008, water use ranged from 4,890 million gallons for the upstream dam (Waterloom) to 4,680 million gallons (1991-2008) for the downstream dam (Chamberlain Falls) on an average annual basis.

Pine Valley Business Center operates the Pine Valley Mill Dam located on the Souhegan Designated River in Milford, just downstream of the Milford/Wilton town line. Water is diverted from the impoundment to the hydroelectric operations and returned to the river approximately 0.6 miles downstream of the dam. During the period 2005-2008, the Pine Valley Dam used 18,200 million gallons of water for hydropower production on an average annual basis.

Because these four hydroelectric operations do not consumptively use water from the Souhegan Designated River, no conservation measures are proposed for these Affected Water Users and no implementation schedule is proposed.

Industrial

Pilgrim Foods, Inc. uses water from two on-site wells and from the Town of Greenville water supply system as production water for the manufacturing of food products (mustard, vinegar and fruit juices) at its facility off of Old Wilton Road in Greenville. During the period 1999-2008, Pilgrim Foods, Inc. used 12.4 million gallons of water from their combined sources on an average annual basis.

Pilgrim Foods, Inc. records its water use by metering each of its on-site sources, and the Town of Greenville is responsible for the water meter used to record the Pilgrim Foods, Inc. use of municipal water. Water use data are reported to DES quarterly. Presently, Pilgrim Foods, Inc. does not test or calibrate its water meters. The company has not performed a formal water audit to identify existing water uses, leaks or the potential for further water conservation measures.

Irrigation

Amherst Country Club/Ponemah Green Family Golf Center has one registered water withdrawal from the Souhegan Designated River. The withdrawal is managed jointly for the irrigation of 105 acres of greens, fairways and tees at both facilities, which are adjacent to one another on Ponemah Road in Amherst. The withdrawal is located on the south bank of the river at the Amherst Country Club. Water is typically withdrawn from April to October. During the period 1989-2008, Amherst Country Club/Ponemah Green Family Golf Center used 24.3 million gallons of water from the river on an average annual basis.

Amherst Country Club/Ponemah Green Family Golf Center measures its water use with an electronic flow sensor on the main irrigation distribution line. Water use is recorded digitally, summarized monthly and reported to DES annually. To ensure accuracy, the flow measurement sensor is checked annually.

Irrigation is conducted only when needed based on daily checks of the greens, tees, fairway soil moisture, visual turf grass stress as well as weather forecasts. Application volume is controlled by an automatic system using timers and automatic shut-off valves. Only greens, fairways and

tees are targeted for irrigation. Irrigation is usually performed overnight. The irrigation water distribution system is checked constantly for leaks from April to November, and any detected leaks are promptly corrected. A water system maintenance program is in place and sprinkler heads and valves are checked regularly. Drought-resistant turf grasses have been incorporated on some tee areas. On greens, wetting agents are used to hold moisture during hot periods.

Souhegan Woods Golf Club withdraws golf course irrigation water from the Souhegan Designated River just upstream of the Amherst/Merrimack town line. Water is typically withdrawn from April to October to irrigate 70 acres of golf course fairways and greens, and for equipment cleaning. During the period 1991-2008, Souhegan Woods Golf Course used 34.9 million gallons of water from the river on an average annual basis.

Souhegan Woods Golf Club records its water use at its pump house, summarizes its use monthly and reports to DES annually. The water use recording meters are checked and calibrated each spring upon system start-up.

Water use is on an as needed basis, varying from every day to twice a week, depending on plant water demand and weather conditions. The irrigation system is checked for leaks daily through a visual inspection and by monitoring pressure in the pump house. The club uses turf/soil cultivation techniques such as aeration, verticutting, top-dressing, soil analyses and wetting agents to improve water efficiency.

Remediation

The OK Tool Source Area includes two wells used to extract contaminated groundwater associated with the Savage Municipal Water Supply Superfund Site, which is managed by DES. Groundwater extracted by the metered wells is treated to remove volatile organic compounds and then returned to the subsurface through a recharge trench. Water use is nearly continuous during normal treatment operations. Average annual water use by the OK Tool remediation wells is estimated to be 36.3 million gallons.

Under the Water Conservation Rules (Env-Wq 2101), at a minimum, the meters used to record water use at the sites will be maintained per industry practice (AWWA 1999).

The Savage Municipal Water Supply Superfund Site uses three wells to extract contaminated groundwater. The contaminated groundwater extracted by these wells is treated to remove volatile organic compounds and injected into the subsurface or discharged to the Souhegan River. Average annual water use by the Savage Well remediation wells is expected to be 236 million gallons.

The operation of the Savage Well remedial system is the responsibility of the Potentially Responsible Parties associated with the site. Because of the complicated legal agreements associated with this site and because all the water withdrawn is returned to the river, DES agreed that a Water Conservation Plan would not be required for the Savage Well site.

Water Supplies

The Greenville Water Works withdraws water from the Site 12A Flood Control/Tobey Reservoir in Temple as a drinking water source for the Town of Greenville. The reservoir discharges to Richardson Brook, a tributary to the Souhegan Designated River. During the period 2000-2008, 54 million gallons of water was withdrawn from the reservoir on an average annual basis.

The water treatment plant output is metered, and the meters are tested every six months and calibrated if they do not meet their operational requirements. Greenville does not have a formal leak detection plan in place, but the Water Works responds to individual leakage problems and checks any service connections that show with increasing water use. Greenville has replaced some of its water distribution piping system, which appears to have contributed to a reduction in system water use. However, Greenville does not regularly estimate its unaccounted-for water.

Milford Water Works has three primary overburden wells and one newer backup well as the primary drinking water supply for the Town of Milford. The wells are located on the north side of the Souhegan Designated River in Amherst. The system also has an interconnection with Pennichuck Water for additional water. During the period 1989-2008, the two primary wells produced 307 million gallons of water on an average annual basis.

Milford Water Works meters all water users, but does not routinely test commercial or residential meters except when high water use is recorded. Information on water conservation is also distributed to water users in mailings. Well water meters are tested annually and calibrated as necessary.

DES approved the Town of Milford's Water Conservation Plan for its backup well in September 2011. Having now implemented the approved plan, the Town satisfies the Conservation Plan requirements of the Instream Flow Program.

Pennichuck Water operates the Souhegan Woods Community Water System (CWS) overburden well in a development off of County Road in Amherst. The well is located 99 feet north of the Souhegan Designated River. This system also has an interconnection with the Merrimack Village District as a supplemental water supply. During the period 1999-2008, this well produced 15.1 million gallons of water on an average annual basis.

The water source is metered and maintained per the American Water Works Association (AWWA 1999) recommendations. Well production is totaled monthly and reported quarterly to DES. Water users in the Souhegan Woods CWS are individually metered, and water use is recorded and billed monthly. Educational information on water conservation measures is mailed to water users and is available at the Pennichuck Water website. Pennichuck Water checks well production against water use totals summed from individual meters monthly to determine if there are any discrepancies. If the discrepancy is greater than 15 percent, a leak inspection is performed.

Wilton Water Works operates two wells for the water supply for the Town of Wilton. These overburden wells are located in Wilton east of Route 31, 849 and 97 feet west, respectively, of the Souhegan Designated River. During the period 1989-2008, these wells produced 81.2 million gallons of water on an average annual basis.

Wilton Water Works tests the water meters at the wells regularly and calibrates them approximately every two years. Customers of the Wilton Water Works are metered, and service meters are inspected when problems are suspected. Wilton Water Works does not estimate unaccounted-for water use and does not perform regular water audits. Leak detection is performed on a case-by-case basis.

2. Water Use Plans

The purpose of the water use plans is to reduce the effects of water withdrawals on stream flow by applying outdoor water use restrictions and alternative sources during summertime low flows. The Water Use Plans apply to each Affected Water User. Individual Water Use Plans were developed for the Affected Water Users¹⁸ identified in this document. The content required in each Water Use Plan is described in Env-Wq 1906.04. The elements of these individual plans include defining water use patterns and needs of the Affected Water User (AWU), identifying the potential for water use modification and sharing, and developing an implementation schedule and costs.

A summary of the individual water use plans appears in the following paragraphs. The management actions focus on direct surface water withdrawals and on groundwater sources that induce recharge. Actions are applied to reduce and spread peak water usage during low flows in the summer through the late summer and fall bioperiods (July 5 through November 14). The water use plans include reductions in outside water use for public water supplies and use of alternate water supplies during low flow periods. The individual Water Use Plans summarized below may be found in Appendix B.

Agriculture

Mr. Peter de Bruyn Kops operates a commercial farm in Amherst and reported intermittent water withdrawals from the Souhegan Designated River during the period 1989 through 1991 and from 1994 through 2003. The facility has been officially inactive as a water user since 2003 and has not reported water uses since that time.

Management of Peter de Bruyn Kops' farm operations has limited potential to support the protected instream flows on the Souhegan Designated River unless water use changes from its current below-reporting-threshold level. If water use by Peter de Bruyn Kops' farm operations meets the water use reporting threshold, Mr. de Bruyn Kops will be required to reduce his direct withdrawal from the Souhegan Designated River to the *de minimis* amount (Env-Wq 1902.07) when the daily mean discharge falls below the Critical protected flow for a period exceeding its Catastrophic duration, or when the daily mean discharge falls below the Rare threshold.

The *de minimis* amount for Mr. de Bruyn Kops, the Amherst Country Club/Ponemah Green Family Golf Center and Souhegan Woods Golf Club combined is 0.65 cfs (416,876 gallons per day), to be shared equally among those withdrawing water under this condition. The provisions of this particular Water Use Plan will not go into effect until Mr. Peter de Bruyn Kops re-activates his registration as a water user.

Aquaculture

The Milford Fish Hatchery withdraws water from two registered ground water wells located along the Souhegan Designated River. The wells are the sole water supply source for the fish hatchery's operations. Water use is continuous and supports the needs of the aquaculture production at the fish hatchery year round. The groundwater pumped from the aquifer is free of fish pathogens, thereby limiting the potential for disease, and its nearly constant temperature provides cooling conditions for the fish in the summer and warmth during the winter.

¹⁸ Part II. Section B. Individuals Affected by the Water Management Plan

Based on the results of an analysis of the effects of the well withdrawals on the river (Task 2 Report, UNH 2005), the two production wells at the Milford Fish Hatchery, under average pumping rates, extract between 22 and 35 percent of their water from the Souhegan Designated River via induced infiltration. In order to support the protected instream flows during the summer and early fall when flows are typically the lowest in the river, pumpage of the two wells would have to be reduced by between 30 and 50 percent, under average conditions, to limit induced infiltration.

The goal for the Milford Fish Hatchery would be to reduce induced recharge from its water supply wells when flows in the river are seasonally at their lowest. Specifically, induced recharge by the wells should be reduced during the two bioperiods occurring from June 15 to September 30 when the daily mean discharge in the Souhegan Designated River, as measured at the USGS gage in Merrimack (01094000), falls below the Rare protected flow level of 17 cfs for longer than the 10 day, Catastrophic duration (DES 2008). The reduction in pumping from the wells would be rescinded when daily mean discharge, from a natural recharge event, exceeds 17 cfs for two consecutive days.

Alternatively, the Milford Fish Hatchery could consider relocating its discharge point upstream closer to the area of the well withdrawals or developing one or more new water supply wells at locations sufficient distance from the river to minimize induced infiltration.

Bottled Water

Monadnock Mountain Spring Water, Inc. withdraws water from its two registered groundwater wells primarily during normal business hours (9 am – 6 pm) during the week. When pumping exceeds demand, excess water fills storage, and when pumping is less than demand, stored water makes up the difference for the bottling operations.

Mean daily water use for Monadnock Mountain has ranged from a minimum of 0.023 cfs (14,736 gallons per day) on July, August and September 1995, to a maximum of 1.92 cfs (1.24 million gallons per day) in October, November and December 2001, with an overall average use was 0.09 cfs (53,515 gallons per day) for the period of 1995 to 2008 (Table 2).

The potential for water use management by Monadnock Mountain to support the protected instream flows on the Souhegan Designated River is limited. This limited potential is based on the results of an assessment of the effects of the well withdrawal impacts on the Souhegan River (Task 2 Report, UNH 2005). The results of this study showed that the pumping of the Monadnock Mountain wells did not induce recharge from the Souhegan Designated River under average or maximum pumping conditions. As a result, no Water Use Plan actions are currently proposed for this facility as part of this Water Management Plan.

Hydroelectric Power

The four hydroelectric facilities located on the Souhegan Designated River (from upstream to downstream) include the Waterloom Pond Dam, Otis Falls Dam, Chamberlain Falls Dam and the Pine Valley Mill Dam. All of these dams are operated on a run-of-river basis and as such are dependent upon stream flow for power production. Chamberlain Falls, Otis Falls and Waterloom Pond dams are owned and operated by Alden Hydro, LLC, while the Pine Valley Mill Dam is owned and operated by Pine Valley Business Center.

If sufficient flow is available, the three Alden Hydro, LLC facilities can produce hydroelectric power at any time or season. Water is diverted from the impoundment located above each dam, run through the on-site power production facility and then returned to the river from 10 to 75 feet downstream of the dams. When the hydropower facilities are not operating, all of the flow in the river goes over each dam's spillway. As part of their FERC license requirements to operate, all three of these facilities are required to meet minimum outflow requirements of 10 cfs during the summer (June through September) and 15 cfs during the winter (October through May). The hydropower production at these facilities is effectively limited to flows in excess of 20 cfs because of the efficiency of the turbines installed at each site.

Hydropower production at the Pine Valley Mill Dam includes the diversion of water from the impoundment located above the dam through a 0.6 mile penstock to the turbines in a former mill building, from which the water is returned to the river. When the hydropower facility is not operating, flow either goes over the dam or through the bypass pipe that discharges immediately downstream of the dam. Flow is not diverted through the penstock when the hydroelectric facility is not operating. The hydroelectric operations at the Pine Valley Mill can operate 24 hours a day, when flows are greater than 40 cfs. The hydropower operations are limited by a FERC required minimum instream flow of 25 cfs combined with a turbine efficiency limit of a minimum of 15 cfs.

Per the Instream Flow Rules (Env-Wq 1906.03), DES coordinated with the Public Utilities Commission (PUC) to assess the effect of the protected instream flows on existing hydropower facilities. The PUC related that while it no longer has much involvement with hydroelectric dams because these dams now eschew PUC-regulated long-term contracts, existing hydroelectric facilities may benefit from summer time releases (Franz, 2011).

The four hydroelectric facilities have limited potential to manage their water use to support the protected instream flows on the Souhegan Designated River beyond passing of any relief flows released from the dams located upstream during a water management action event. The relief flows can be used for power production as long as they are passed through the facility un-attenuated.

Industrial

The Pilgrim Foods, Inc. water supply includes the Town of Greenville water system and two on-site wells. Pilgrim Foods has used the Town of Greenville water system since it started reporting its water use in 1999 and this remains its principal source of water. Pilgrim Foods also used water from a well (Souhegan River Well) that they leased from the Town, but ceased using this source when the lease expired in 2006. The two on-site wells were inactive from 1999 through 2008, but Pilgrim Foods started using these wells in 2009 so they could reduce the amount of water they purchase from the Town of Greenville. The production of these wells ranges from 4 - 8 gpm (Dube Well) to 12 - 15 gpm (Davis Well) (20681-S03). Pilgrim Foods can also store 20,000 gallons of water in on-site storage tanks. Water use by Pilgrim Foods is daily, Monday through Friday during normal operating hours (7 am to 4 pm).

Between 1999 and 2008 annual water use by Pilgrim Foods ranged from a high of 17.2 million gallons (2006) to a low of 2.80 million gallons (2002) and has averaged 12.39 million gallons (Table 2). During this period, annual water use by Pilgrim Foods has increased by 9.50 million

gallons or 140 percent. This represents an increase of 951,200 gallons a year or 14 percent over the ten year period. The increase in water use by Pilgrim Foods directly reflects the increased production at the facility over this time.

Annual water use by Pilgrim Foods increased steadily from 1999 to 2007, except for a significant drop in 2002. The dramatic reduction in water use that year was due to a fire at the facility in December 2001, which significantly impacted their business operations. Since its peak in 2007, annual water use declined slightly in 2008.

Water use is year round, and the highest total monthly and average monthly water use occurs during the period from the spring to the fall when demand for the Pilgrim Foods, Inc. products (mustard, vinegar and fruit juices) is greatest. The highest total monthly water use was 2.23 million gallons (May 2001), the lowest total monthly water use was 0 (January 2002), and average monthly use was 1.20 million gallons.

Mean daily water use by Pilgrim Foods, Inc. has ranged from a minimum of 0.00 cfs (several months of no reported water use) to a maximum of 0.11 cfs (71,742 gallons per day)(May 2001), and an average use of 0.006 cfs (39,426 gallons per day) for the period of 1999 to 2008 (Table 2).

Pilgrim Foods, Inc. has limited potential to support the protected instream flows on the Souhegan Designated River. Its principal water source is the Town of Greenville, which obtains its water from the Tobey Reservoir. Supplementing this source is groundwater withdrawn from two on-site wells that are located several hundred feet from the Souhegan Designated River and a tributary of it. These wells reportedly are pumped at rates between 4 to 8 gpm (Dube Well) and 12 to 15 gpm (Davis Well), which are relatively low pumping rates. It is expected that the pumping of these wells at their normal or maximum rates does not induce recharge from the river or the tributary stream. In addition, the wastewater produced by the facility is initially treated on site and is then discharged into the Town of Greenville's sewer system. This wastewater is further treated at the Town of Greenville wastewater treatment facility and is then discharged to the Souhegan Designated River upstream of the Pilgrim Foods, Inc. facility. As a result, no Water Use Plan actions are currently proposed for this facility as part of this Water Management Plan.

Irrigation

The Amherst Country Club/Ponemah Green Family Golf Center and the Souhegan Woods Golf Club (also located in Amherst) both directly withdraw water seasonally (spring through fall) directly from the Souhegan Designated River to irrigate their golf courses. Of the two operations, Souhegan Woods Golf Club uses a larger amount of water. The facilities' water demand typically peaks when flows on the river are seasonally low. The direct withdrawals by these golf courses can reduce flow in the Souhegan Designated River. Because their use is entirely consumptive, no water is directly returned to the river.

The *de minimis* amount for Mr. de Bruyn Kops, the Amherst Country Club/Ponemah Green Family Golf Center and Souhegan Woods Golf Club combined is 0.65 cfs (416,876 gallons per day), to be shared equally among those withdrawing water under stream flow conditions below the Protected Instream Flows.

Amherst Country Club/Ponemah Green Family Golf Center

The Amherst Country Club/Ponemah Green withdraws water from the Souhegan Designated River using two 7.5 hp sump pumps, resting 8-10 inches off the bottom of the river. Water is withdrawn on an “as needed” basis to irrigate 105 acres of golf course fairways, greens and tees. Irrigation of the courses is necessary to ensure that the various grasses used at the courses remain healthy and adequately watered and to meet user expectations in terms of course appearance, condition and playability. Irrigation is typically performed on a daily basis from early evening to early morning (10-12 hours), when necessary.

Between 1989 and 2008 annual water use by Amherst County Club/Ponemah Green ranged from a high of 34.4 million gallons (1999) to a low of 8.52 million gallons (1989), and average annual use was 24.3 million gallons (Table 2). During this period, annual water use increased by 6.86 million gallons or 81 percent. This represents an increase of 343,000 gallons a year or 4.1 percent per year. Since 2005, annual water use has declined by 18.5 million gallons or roughly 55 percent.

Mean daily water use by Amherst Country Club/Ponemah Green has ranged from a minimum of 0 cfs (several months), to a maximum of 0.854 cfs (551,957 gallons per day) in July 2002 and the average was 0.176 cfs (113,752 gallons per day) for the April through October period and 0.102 cfs (65,925 gallons per day) annually during the last 20 years (Table 2).

Souhegan Woods Golf Club

The Souhegan Woods Golf Club withdraws water from the Souhegan Designated River via a suction line that extends approximately 15 feet out from the shore and approximately six feet below the water surface. Water is withdrawn on an “as needed” basis to irrigate 70 acres of golf course fairways and greens and for equipment cleaning. Irrigation of the courses is necessary to ensure that the various grasses used at the courses remain healthy and adequately watered and to meet user expectations in terms of course appearance, condition and playability. Irrigation is typically performed on a daily basis from 8 pm to 6 am, when needed.

Between 1991 and 2008, annual water use by Souhegan Woods Golf Club ranged from a high of 56.8 million gallons (2001) to a low of 17.4 million gallons (2003), and average use was 34.9 million gallons (Table 2). During this period, annual water use increased by 7.27 million gallons or by 27 percent. This represents an increase of 404,000 gallons a year or 1.5 percent per year. Water increased from 1991 to its peak in 2001, and then declined to its low in 2003 due to changes in water use management to increase water use efficiency. These changes included the introduction of new turf grasses and wetting agents and improvements in pumping operations. Water use increased again between 2003 and 2008.

Mean daily water use by Souhegan Woods Golf Club has ranged from a minimum of 0 cfs (December through February in all years, November in all but one year (1999), ten years in March, two years in April and October) to a maximum of 0.816 cfs (527,397 gallons per day) in August 2001 and the average was 0.249 cfs (160,934 gallons per day) for the April – October period and 0.147 cfs (95,009 gallons per day) annually during the past 18 years (Table 2).

Both Amherst Country Club/Ponemah Green and Souhegan Woods Golf Club are solely dependent upon the direct withdrawal of water from the Souhegan Designated River for the

irrigation of their golf courses. As a result, they currently have limited potential to manage their water use to support the protected instream flows. During those infrequent periods when a reduction in water withdrawals would be needed to support the protected instream flows, alternative off-stream sources of water may have to be used. These off-stream sources may include:

- withdrawals from existing ponds on the golf courses;
- the development of additional water hazard/storage ponds; and
- the development of a new groundwater supply

These alternatives require additional evaluation to determine their feasibility. Important factors in determining their feasibility would include: the amount of water made available by the development of each alternative; the identification and evaluation of any hydrologic impact to the Souhegan Designated River as a result of the development of the alternative; and the cost of the implementation of each alternative and their permitting requirements.

The highest mean and total monthly water use by both golf courses (Amherst Country Club/Ponemah Green and Souhegan Golf Club) occurs during the months from June through September, which also coincides with the two bioperiods (GRAF Spawning and Rearing & Growth – June 15 to September 30) that have the lowest protected instream flow values (Critical flow of 26 cfs and Rare flow of 17 cfs) (DES, 2008). To support the protected instream flows, the two golf courses will be required to reduce their direct withdrawals of water from the Souhegan Designated River to the de minimis amount (Env-Wq 1902.07) when daily mean discharge, as measured at the USGS gaging station (01094000) in Merrimack, falls below the Critical flow threshold of 26 cfs for a period exceeding its Catastrophic duration of 20 days or when the daily mean discharge falls below the Rare threshold of 17 cfs.

While the de minimis withdrawal amount is slightly higher than the historical average monthly water use (in cfs) by each golf course, it is less than their respective historical average water usages during the months of June through September. This suggests that more stringent water conservation measures would need to be implemented as a management action by the golf courses to reduce water demand until such time as an alternative source(s) could provide supplemental water. The reduction in the direct withdrawal of water from the Souhegan Designated River will be rescinded when daily mean discharge from a natural recharge event, as measured at the USGS gaging station (01094000) in Merrimack, exceeds 26 cfs for two consecutive days.

Remediation

The OK Tool Source Area includes two wells used to extract contaminated groundwater associated with the Savage Municipal Water Supply Superfund Site, which is managed by DES. Groundwater extracted by the metered wells is treated to remove volatile organic compounds and then returned to the subsurface through a recharge trench. Water use is nearly continuous during normal treatment operations. Average annual water use by the OK Tool remediation wells is estimated to be 36.3 million gallons.

The Savage Municipal Water Supply Superfund Site uses three wells to extract contaminated groundwater. The contaminated groundwater extracted by these wells is treated to remove volatile organic compounds and injected into the subsurface or discharged to the Souhegan

River. Average annual water use by the Savage Well remediation wells is expected to be 236 million gallons.

The potential for water use management by the operation of the remedial systems at the OK Tool and the Savage Well sites to support the Protected Instream Flows on the Souhegan Designated River is limited. The remediation systems extract groundwater, treat it and then either reintroduce the treated water back into the source aquifer or discharge it to the Souhegan Designated River. The groundwater withdrawn at the sites is effectively recycled or discharged directly into the river. As a result, no Water Use Plan actions are currently proposed for these sites as part of this Draft Water Management Plan.

Water Supplies

There are four water suppliers located within the Planning Area: Greenville Water Works; Pennichuck Water (Souhegan Woods); Milford Water Works; and, Wilton Water Works. Greenville Water Works is the only water supply system that uses surface water as its supply source. The three other water supplies produce drinking water from groundwater wells located along the Souhegan Designated River. Of the four systems, Milford Water Works uses the largest amount of water annually, while Pennichuck Water (Souhegan Woods) uses the least (Table 2). This difference reflects differences in the number of water service connections in these systems: 8,500 hookups in Milford and 115 hookups at Souhegan Woods.

For each system, daily water use follows a diurnal pattern, whereby the greatest water demand occurs during the day (morning through evening) and the lowest overnight. Seasonally, the highest water use occurs during the summer and late fall, due to the high demand for outdoor water use. This period is also when flows on the Souhegan Designated River are their lowest, and as a result water use management actions are proposed.

Greenville Water Works

The Town of Greenville's water supply source is the Tobey Reservoir, which is located in Temple, New Hampshire east of Route 45. Water withdrawn from the reservoir is pumped to a nearby water treatment plant. The water treatment facility is capable of treating 0.25 million gallons of drinking water per day. Greenville recently completed a new 600,000 gallon storage tank, which brings its treated water storage capacity to 750,000 gallons. The treated water is distributed to residents and businesses located within the Town.

Between 2000 and 2008, annual water use by the Greenville Water Works ranged from a high of 67.4 million gallons (2001) to a low of 41.4 million gallons (2004), with an average annual use of 54.0 million gallons (Table 2). During this period, annual water use declined by 19.86 million gallons or 30 percent. This represents an average decrease of 2.21 million gallons per year or 3.4 percent per year over this nine year period. The lack of any growth in water use is attributable to no significant new development occurring in the town and also reflects the improvements made to the water distribution system to reduce leakage.

As with each of the water suppliers, total and average monthly water usage by Greenville Water Works is highest during summer and lowest during winter. This seasonal pattern reflects increased outdoor water usage (lawn irrigation, garden watering, vehicle washing, etc.) during the summer months, which is a minimum during the winter months. The highest total monthly water use was 7.54 million gallons (April, 2005), the lowest total monthly water use was 1.92

million gallons (May and June, 2004), while the average monthly water use was 4.56 million gallons (Table 2).

Mean daily water use by Greenville Water Works has ranged from a minimum of 0.099 cfs (63,986 gallons per day) in June 2004 to a maximum of 0.389 cfs (251,419 gallons per day) in April 2005, and an average use was 0.232 cfs (149,946 gallons per day) for the period of 1999 to 2008 (Table 2).

Greenville's water use could be managed to support the Protected Instream Flow to a very limited degree. Greenville's water supply source is the Tobey Reservoir, which has a reserved capacity of 212.5 million gallons (652 acre-feet) for the Town's water supply, which is three times greater than Greenville's reported maximum annual water use of 67.4 million gallons (2001). Reduced water use will have little impact on river flow because the discharge from the Greenville waste water treatment plant is upstream from the discharge of the Tobey Reservoir. Given the low consumptive losses in the system, the Protected Instream Flow deficits are not substantially remedied by reduced use in the Greenville water system. As such, the Water Use Plan calls for actions such as outdoor use restrictions only when water supply capacity in Tobey Reservoir is low or other system infrastructure problems occur.

Pennichuck Water – Souhegan Woods Community Water Supply

Pennichuck Water provides water to the Souhegan Woods CWS from one overburden groundwater supply well located along the Souhegan Designated River. Groundwater is withdrawn from the well on a daily basis to provide drinking water and fire protection to the 115-home, Souhegan Woods subdivision. The well pump runs about five hours per day during the low water use season (winter), and about 17 hours per day during the high water use season (summer). When pumping, the well is pumped at a uniform rate (~61 gpm). When pumping exceeds demand, excess water fills storage (capacity of 51,000 gallons), and when pumping is less than demand, stored water makes up the difference. The system is also interconnected with the Merrimack Village District (MVD) water supply, which can be utilized as a supplemental water source.

Between 1999 and 2008, annual pumpage by the Souhegan Woods CWS well ranged from a high of 21.6 million gallons (2002) to a low of 7.94 million gallons (2004), and average use was 15.1 million gallons (Table 2). During this period, annual water use from the Souhegan Woods CWS well decreased by 5 million gallons or 27.5 percent. This represents a decrease of 500,000 gallons a year or 2.8 percent per year averaged over the 10 year period. Pennichuck Water credits the overall decline in water use to the increased use of water saving fixtures by residents and changing demographics within the community.

The highest total monthly use was 3.44 million gallons (August 2001), the lowest total monthly use was 145,000 gallons (December 2003), while the average monthly use was 1.24 million gallons (Table 2). The average daily water use by the Souhegan Woods CWS well has ranged from a minimum of 0.007 cfs (4,718 gallons per day) in December 2003 to a maximum of 0.17 cfs (111,167 gallons per day) in August 2001, and average use was 0.06 cfs (40,847 gallons per day) (Table 2).

Pennichuck Water's Souhegan Woods community water supply is supported by one well, which is supplemented by water provided by the Merrimack Village District from wells located outside the Planning Area. Pennichuck Water's Souhegan Wood's well does not appear to induce

recharge from the Souhegan Designated River, thereby reducing the potential for management of this well to support the protected instream flows. Accordingly, no additional actions are management actions are required.

Milford Water Works

The Milford Water Works supply source consists of three wells in a single wellfield, Curtis Wells #1, #2, and #2A, which are located along the Souhegan Designated River. Groundwater is withdrawn from the wells continuously since they are the principal water supply for the Town of Milford. Wells #1 and #2 are pumped at a fairly uniform rate of 700 gallons per minute (gpm), with #2A used to supplement #2 as necessary. The Town water system includes 1.25 million gallons of storage.

When pumping exceeds demand, excess water fills storage, and when pumping is less than demand, stored water makes up the difference. When demand exceeds supply from the wellfield, the Town purchases additional water from the Pennichuck Water distribution system. In 2008, the Curtis Wells supplied 88.6 percent of the water needed and the remaining 11.4 percent was purchased from Pennichuck Water. Pennichuck's Water supply sources are located outside of the SRWMPA.

Between 1989 and 2008 annual pumpage from the Curtis Wellfield ranged from a high of 374 million gallons (1998) to a low of 211 million gallons (1990), and average pumpage was 307 million gallons (Table 2). During this period, annual pumping from the Curtis Wellfield increased by 87.6 million gallons or 36.2 percent. This represents an increase of 4.4 million gallons a year or 1.8 percent per year over the 20 year period.

Water use increased from 1989 to its maximum in 1998 and since then has ranged from 305.9 million gallons (2006) to 364.4 million gallons (2007). The plateau in water use reflects the supply limitation of the Curtis Wellfield and a contracted cap on the water available from Pennichuck Water. Due to decreasing production from Curtis Well #2, the Town installed a supplemental well, Curtis Well #2A. This well is operated to supplement pumping from Curtis Well #2 and does not increase overall water production by the Town.

The highest total monthly use for the Curtis Wellfield was 38.4 million gallons (August 2006), the lowest total monthly use was 8.41 million gallons (March 2002), and average monthly use was 25.5 million gallons (Table 2). The average daily water use for the Curtis Wellfield has ranged from a minimum of 0.42 cfs (271,454 gallons per day) in March 2002 to a maximum of 1.92 cfs (1.24 million gallons per day) in August 2006 and average use was 1.30 cfs (840,216 gallons per day) for the period of 1988 to 2008 (Table 2).

The Milford Water Works water supply includes the three wells located along the Souhegan Designated River and an interconnection with the Pennichuck Water distribution system. One of the wells (Curtis Well #2) has been shown to induce recharge from the river. Milford's wells could be managed to reduce induced recharge from the river to support the protected instream flows. These management actions are described in a section below.

Wilton Water Works

The Wilton Water Works supply source consists of two overburden groundwater wells, Everett Well and the Abbott Well, which are located along the Souhegan Designated River. These two

ground water wells are the current water supply sources for residents and businesses in the Town. Water is withdrawn from the wells continuously in an alternating pattern to reduce drawdown in the aquifer. The active well is pumped 6 to 8 hours and then shut down for 16 to 18 hours. When system demand exceeds the present pumping rate of the active well, the second well automatically comes on line. The pre-set flow rate for the Abbott Well is 400 gpm, while the Everett Well pumping rate is pre-set at 450 gpm. When pumping exceeds demand, excess water fills storage (one tank of 616,000 gallons), and when pumping is less than demand, stored water makes-up the difference.

Between 1989 and 2008 annual water use by Wilton Water Works ranged from a high of 115.2 million gallons (1990) to a low of 61.6 million gallons (2002), and average use was 81.2 million gallons (Table 2). During this period, annual water use decreased by 21.4 million gallons or 23 percent. This represents a decrease of 1.07 million gallons a year or 1.2 percent per year over the 20 year period. A major decline in water use occurred after 1995 and is most likely due to the metering of all of the water users in the Town during that year. Prior to the installation of water meters, water users only paid a flat base fee.

The highest total monthly use was 11.7 million gallons (June 1991), the lowest total monthly use was 0 gallons in December 2008, but this was due to the recording meters being damaged as a result of an ice storm. Otherwise, the lowest total monthly water use was 2.1 million gallons in November 2002. The average monthly use was 6.8 million gallons (Table 2). Mean daily water use by Wilton Water Works has ranged from a minimum of 0 cfs (0 gallons per day) in December 2008 to a maximum of 0.583 cfs (376,805 gallons per day) in June 1991 and average use was 0.344 cfs (222,980 gallons per day) for the period of 1988 to 2008 (Table 2).

As noted above, Wilton's water supply consists of two production wells, one of which (Abbott Well) has been shown to induce flow from the Souhegan Designated River. Wilton's wells could be managed to reduce induced recharge from the river to support the protected instream flows. These management actions are described in the section below.

Water Management Plan Actions for Milford and Wilton Water Works

Outdoor water use reductions will be accomplished by implementing the measures included in the Towns' Emergency Plans. Since outdoor water use is heaviest during the summer and early fall the outdoor water use reduction plan will apply to the two bioperiods that correspond with the highest levels of water use, occurring from June 15 to September 30, and when flows in the Souhegan Designated River fall below the Critical and Rare protected instream flow levels (DES, 2008). Under this Water Use Plan, outdoor water use will be reduced in three stages: an alert that includes voluntary water conservation; water use restrictions; and, a water use ban.

The first action for the water suppliers is an alert to its customers that voluntary water conservation measures should be taken and that further actions may begin soon. The alert will be issued by DES and enacted by Wilton on the day after daily mean discharge at the upper gage falls below 11cfs during the GRAF Spawning bioperiod (June 15-July 14) or below 16 cfs during the Rearing and Growth bioperiod (July 15-September 30). Milford will take action on the day after daily mean discharge at the lower gage falls below 26 cfs (both bioperiods in the lower river have the same flow magnitude). The Towns will advise their water users through their existing emergency notification process as to implement voluntary water conservation measures and prepare for further actions. An alert may be rescinded when daily mean discharge from a

natural recharge event exceeds the appropriate protected flow threshold for the current period for two consecutive days.

The next action stage begins as follows: for Wilton, if daily mean discharge at the upper gage continues to decline and fall below the Critical protected flow level of 11 cfs during the GRAF Spawning bioperiod (June 15-July 14) for longer than the 20 day Catastrophic duration or below 16 cfs during the Rearing and Growth bioperiod (July 15-September 30) for longer than the 35 day Catastrophic duration; or, for Milford, if daily mean discharge falls below the Critical protected flow level of 26 cfs for longer than 20 days during either period (June 15-September 30). When any of these conditions are met, the Towns will implement outside water use restrictions as described in their Emergency Plans. Restrictions on watering gardens, lawns, and other landscaped areas, the washing of cars, trucks, RV's, driveways, sidewalks, patios and decks, as well as the filling of swimming pools from the water system will be imposed. These restrictions may be rescinded when daily mean discharge from a natural recharge event exceeds the appropriate flow threshold for the current period for two consecutive days.

The final action stage begins as follows: for Wilton, if daily mean discharge at the upper gage falls below the Rare protected flow level of 8 cfs for longer than the 15 day, Catastrophic duration, during the GRAF Spawning bioperiod (June 15-July 14), or below 10 cfs for longer than the 30 day Catastrophic duration during the Rearing and Growth bioperiod (July 15-September 30); or, for Milford, if daily mean discharge falls below the Rare protected flow level of 17 cfs for longer than 10 days for either period (June 15-September 30). When any of these conditions are met, a ban on outside water use will be imposed, as described in the Emergency Plans. The ban on outside water use may be rescinded when daily mean discharge from a natural recharge event exceeds the appropriate protected flow threshold for the current period for two consecutive days.

Whenever operational considerations of the water systems allow during periods when outdoor water use restrictions are recommended or during a ban on outdoor water use, Milford and Wilton will manage pumping from their respective water supply wells to further minimize potential impacts to the Souhegan Designated River. This includes minimizing the withdrawal of groundwater from the wells located closest to the river and balancing this reduction with increased pumping from the wells farthest from the river and operating the withdrawal at lower withdrawal rates over longer periods of time in preference to higher withdrawal rates for shorter periods.

3. Dam Management Plan

Under the Instream Flow Rules (Env-Wq 1906.04) the Dam Management Plan is to include information on the characteristics and operational procedures of the affected dams, a description of the potential water available for release to maintain the protected instream flows, any impacts to the impoundments or receiving water due to flow management, and an evaluation of the potential for dam management. An individual Dam Management Plan will be prepared for each affected dam "so that the net effect of the implementation of all the individual plans, in cooperation with implementation of the water use plan, is maintenance of the protected instream flows." These plans also will include an implementation schedule.

The Affected Dam Owners, and their associated affected dams, included in this Plan were identified individually and by type in a previous section. Individual Dam Management Plans were prepared for each affected dam based on information obtained from the DES Dam Bureau and from a questionnaire completed by each Affected Dam Owners, and based on information provided by the Affected Dam Owners during phone conversations, meetings and/or electronic mail. The individual Dam Management Plans are found in Appendix C. Each plan includes a discussion of the dam location and receiving stream, the dam design, any existing minimum flow, property agreements or water quality limits for the dam, an assessment of potential water availability, potential impacts of the storage and release of relief flows, the potential for dam management to support instream flow requirements, dam management activity, schedule for plan implementation, and the estimated cost of the implementation of the plan.

Each of the dams was screened for their potential to support the protected instream flows based on their storage volume, location within the Planning Area, size of their contributing watershed, distance to the Souhegan Designated River, and the condition of the existing dam to store and release water for flow management (Table 6). The greatest weight was given to the potential storage volume and the dam's location in the Souhegan River Watershed Management Planning Area.¹⁹ Sites 19 and 35 were initially selected as the means for relief flow management on the Souhegan Designated River. In response to comments received on the Draft Souhegan River Water Management Plan Report, DES evaluated the suitability of several additional affected dams so that the maximum water level change can be limited to a maximum of two feet, thereby reducing impacts to impoundment habitat and abutting properties.

When water management activities are necessary, water will be released from the dams, in coordination with other dams in the watershed, to create relief flows to support the protected instream flows on the Souhegan Designated River. Relief flows will be released to support flows on the Souhegan Designated River when they fall below the Critical or Rare protected flow magnitudes for a period greater than their Catastrophic duration. A flow management release will also be initiated when Catastrophic conditions occur as a result of repeated persistent events during these bioperiods. If a flow management release is needed then a two-day relief flow will be released from the dams. Protected flow conditions will be evaluated at the two gages measuring flow on the upper and lower segments of the designated river. Flow conditions will be evaluated based on the mean daily flow records from the USGS gaging stations 01093852 Souhegan River near Milford, NH and 01094000 Souhegan River at Merrimack, NH.

Flood Control

As shown in Table 6, the dams having the greatest potential storage volume are the state owned flood control dams. This network of dams was built in the 1960s and early 1970s to reduce the impact of flooding in this watershed. The Natural Resources Conservation Service²⁰ and the N.H. Water Resources Board (now part of the DES Dam Bureau) were primarily involved in the design, construction and operation of the dams (DES, 2008). Of the six flood control dams

¹⁹ The Souhegan River Watershed Management Planning Area comprises the watershed area that contributes flow to the Souhegan Designated River.

²⁰ At that time named the U.S. Department of Agriculture Soil Conservation Service

considered, Souhegan River Site 12A²¹, Souhegan River Site 19 and Souhegan River Site 35 were identified as candidates for instream flow management. Considering the volume of water that could be potentially available from Sites 19 and 35, the DES Dam Bureau performed a preliminary assessment of their use for flow management (Appendix D). Based on the results of this analysis, these structures could hold roughly 500 ac-ft in Site 19 and 118 ac-ft (38.5 million gallons) Site 35. Releasing this much water would result in large water level changes. The anticipated effects of a water level change of this scale are described in a report in Appendix G. The anticipated effects of large water level changes and the interests of the impoundment area's land owners led to a reduced use of these impoundments and the introduction of other impoundments into the plan.

Sites 19, 35 and 12A flood control facilities are located in drainages in the upper portion of the Planning Area. Site 19 and Site 35 are located on the South and West Branches headwater streams of the Souhegan River in New Ipswich, and Site 12A is located on Richardson Brook in Temple. Within two feet of the current water levels, the Sites 19, 35 and 12A dams have 291 acre-feet of water storage potentially available. Combined releases from these dams and from Waterloo Pond Dam, with usable storage estimated at 56 acre-feet, could provide for instream flow management along the full length of the designated river.

The primary use of Souhegan River Site 12A, 19 and 35 dams is described by the DES Dam Bureau as flood control. The DES Dam Bureau owns the dams, but they were developed with funding from the NRCS for multiple uses. DES discussed the proposed use of the dams for supporting the instream flows with the NRCS which agreed with this concept so long as their ability to provide flood control remained uncompromised (Ellsmore, 2012). As a result of this understanding, the use of these dams will be expanded to include instream flow management under the Dam Management Plans. If a flow management release is needed, a two-day relief flow will be released from these three dams.

There are three constraints relative to the use of the Souhegan River Site 19 and 35 dams for flow management of the Souhegan Designated River. The first constraint is the potential impact to wetlands. To reduce the potential impact to existing wetlands and to neighboring private property, DES will limit the maximum change in water level at each site, for the storage and release of relief flows, to less than two feet.

Based on a review of information available from the New Hampshire Natural Heritage Bureau, there do not appear to be any federal or state-listed Rare, Threatened or Endangered species or any Exemplary Natural Communities in the vicinity of either Site 19 or 35.

The second constraint is that the outlet structures on these dams are not designed for the release of relief flows. In order to make the outlet structures work, the gate systems and inlets would need to be retrofitted. The cost to retrofit the outlet structures was estimated by the DES Dam Bureau to be \$136,000 for each dam. A source of funding will need to be identified for retrofitting, operation and maintenance of these dams for flow management.

²¹ Site 12A is also a water supply dam. See additional discussion concerning the water supply aspects of this dam and its use for instream flow protection under the Water Supply section.

Table 6. Summary of Affected Dam characteristics for water management.

Name	Dam Code	Drainage Area (sq. mi.)	Impoundment Size (acres)	Maximum Storage (ac-ft)	Permanent Storage (ac-ft)	Net Storage (ac-ft)	Control Storage Volume	Location in SRWMPA	Distance to SDR (mi)
BURTON POND DAM	147.17	0.46	40	350	300	50	No	Middle	6
DREAM LAKE DAM	7.15	0.25	10.4	36.24	15.44	21	No	Lower	4
NEW WILTON RESERVOIR DAM	254.09	0.4	22.1	335	240	95	Yes	Middle	2.5
OSGOOD POND DAM	159.04	5.24	24.16	270	57	213	No	Middle	2.1
PRATT POND DAM	175.03	0.74	35	110	58	52	No	Upper	4.2
SOUHEGAN RIVER SITE 8 DAM	147.28	4.7	40	2721	180	2541	Yes	Middle	4.5
SOUHEGAN RIVER SITE 12 A SOUTH	234.11	5.6	108	3310	690	2620	Yes	Upper	1.6
SOUHEGAN RIVER SITE 15 DAM	254.3	1.1	69	708	74	634	Yes	Upper	1.2
SOUHEGAN RIVER SITE 19 DAM	175.19	11.4	25	2072	85.3	1987	Yes	Upper	0.6
SOUHEGAN RIVER SITE 33 DAM	254.34	1	12	900	24	876	Yes	Middle	1.8
SOUHEGAN RIVER SITE 35 DAM	175.21	6.4	24.9	1787	37	1750	Yes	Upper	2.5
SWARTZ POND DAM	147.31	0.25	10.6	42.2	21	21	No	Middle	7.2
WATERLOOM POND DAM	175.09	23.1	75	665	420	245	Yes	Upper	0
WHEELER POND DAM	175.23	0.23*	11	32.89	10.89	22	No	Upper	4.1

Notes:

Bold - DES Dams

* - value from StreamStats

SRWMPA - Souhegan River Water Management Planning Area

SDR - Souhegan Designated River

The third constraint relates to the current landowner flowage right agreements at Site 19 and Site 35. Currently, there are at least 39 landowners that have agreements with the DES Dam Bureau that only allow for the temporary storage of water for flood control and limit permanent flooding to the area at an elevation equal to the low level inlet of the outlet structure. These agreements may need to be re-negotiated to allow for periods during which water would be stored temporarily, which would result in a 1 to 2 foot increase in water levels compared to non-flood conditions. The state may have to incur costs to acquire additional flowage rights. An alternative approach is to lower the existing water level which would not violate the existing agreements, however, the head loss in such a configuration has not yet been calculated.

Hydroelectric Power

While there are other hydropower dams on the Souhegan River, the Waterloom Pond Dam is the sole affected dam producing hydropower on the Souhegan Designated River. Waterloom has this distinction because its surface area is greater than 10 acres, while the other hydropower facilities' impoundments are smaller than this so that they are not considered as Affected Dam Owners. Waterloom Pond dam is located downstream of the Souhegan River Site 19 and 35 dams. According to DES Dam Bureau records ponds surface area is 75 acres. The dam is operated on a run-of-river basis, but water levels are controlled per operating procedures included in an Emergency Action Plan on record with the DES Dam Bureau. During the summer and in the "advent of heavy forecasted rain" the water level at the spillway will be drawn down two feet. During the fall, draw down of up to two feet may be required in the event of forecasted hurricanes or heavy rain. Maximum water level above the spillway cannot exceed 14 inches; otherwise the excess water must be passed downstream.

DES discussed management of Waterloom Pond with the dam's previous owner who agreed that management would be acceptable to his operations and would likely fit within his federal licensing agreements. Water level changes would be limited likely within less than nine inches because of property owners on the banks.

Recreation

None of the six dams used for recreation have the volume required to support the protected instream flows. In addition, most of these dams are privately owned and do not have outlet controls that can be used to actively manage flows from the dam. The dam with the largest potential available volume (48 acre-feet within two foot water level change) is Osgood Pond Dam. This dam is owned by the Town of Milford. Although water levels in the impoundment are not actively managed, the existing outlet structure could be used for this purpose. The major issue relative to the use of the Osgood Pond Dam is the amount of sediment deposition that has occurred in the impoundment, which has significantly reduced its storage volume. The Army Corps of Engineers has proposed an aquatic ecosystem restoration project for Osgood Pond, which would include the hydraulic dredging of sediment over a 15 acre area to increase the depth of the pond to 10 feet, thereby increasing the storage capacity of the impoundment. This project has been delayed many times. The use of this dam for flow management will be re-evaluated in the future should the pond

restoration project occur, since releases of water from this dam would help maintain the protected instream flows in the lower half of the Souhegan Designated River.

Water Supply

Two of the affected dams are used for water supply: Souhegan River Site 12A South and the New Wilton Reservoir Dam. The Souhegan River Site 12A South Dam (also known as the Tobey Dam) is used for flood control, but also impounds the Tobey Reservoir, which is the water supply source for the Town of Greenville. Site 12A is located downstream of Waterloo Pond.

According to the DES Dam Bureau records the impoundment's surface area is 108 acres. A monument at the dam notes that 652 ac-ft (212 million gallons) is water supply storage. Considering that the annual water use by the Town of Greenville has ranged from 41.4 to 67.4 million gallons, the water supply would not be impacted by use of the dam for flow management. However, the property surrounding the impoundment area is owned by the state, so additional storage could be added to the reservoir to ensure sufficient water supply and instream flow management needs are met. Because this is a flood control dam, the NRCS requires that 85 percent of the flood storage be available following a previous storm event. Fulfilling this condition leaves 393 ac-ft (128 million gallons) above its permanent storage (and storage for Greenville's water supply) for flow management. As a result, DES includes Site 12A as a flow management facility for the Water Management Plan. With two feet of additional storage, more than 216 acre-feet of storage is available without impacting the water supply.

DES has discussed with NRCS the addition of instream flow management to the designated uses (flood control and water supply) of the dam and has received its initial support for this change. DES has also discussed the use of Site 12A for instream flow management with the Town of Greenville. The Town initially agreed with this concept based upon the understanding that the storage and release of water from the dam for instream flow management will not result in a water level change exceeding two feet and will not result in a reduction in the volume of water (652 ac-ft) designated for water supply use.

When water management activities are necessary, water will be released from the Site 12A Dam, in coordination with other dams in the watershed, to create relief flows to support the protected instream flows on the Souhegan Designated River.

Water released from the Tobey Reservoir discharges into Richardson Brook, which flows 1.6 miles to the south, at which point it discharges into the Souhegan Designated River, approximately 1.3 miles downstream of Greenville. The short distance from the reservoir to the Souhegan Designated River and the lack of any significant fringing wetlands suggests that losses would be minimal, thereby providing relief flow to over 28 miles of the designated river.

A potential constraint for the use of the Souhegan River Site 12A South dam for flow management is the need to reconfigure the dam's outlet structure. In order to make the outlet structure suitable for flow releases, the gate system and inlet would need to be retrofitted. The cost to retrofit the outlet structures was estimated by the DES Dam Bureau to be \$136,000. A source of funding will need to be identified for the retrofitting, operation and maintenance of the dam for instream flow management.

Although the status of the New Wilton Reservoir Dam is for water supply, it has not been used for this purpose since 1988, due to the development of the Abbott and Everett Wells in Town. The potential available storage volume is relatively small, there is limited watershed area for replacing released water and it is located in the central portion of the SRWMPA, so it could only provide limited relief applied to the lower half of the Souhegan Designated River. Due to these limitations, this dam is not currently considered a candidate for instream flow management.

G. Financial Assistance

Under the Instream Flow Rules (Env-Wq 1906.06) the Water Management Plan is to identify any local, state or federal financial assistance programs that could provide funding for plan implementation for AWUs engaged in agriculture or public water supply. Several financial assistance programs are available that could assist agricultural AWUs through the Natural Resources Conservation Service (NRCS). Potential financial assistance may be available from the Agricultural Management Assistance, Conservation Innovation Grants and Conservation Stewardship Program.

The Agricultural Management Assistance program provides grants to agricultural producers to address several conservation related issues, including water management. The agricultural producer works with NRCS staff to develop a conservation plan, which becomes the basis for the contract. Payments are limited to \$50,000 per person per fiscal year and funds are awarded on a competitive basis. The Conservation Innovation Grants program is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies. The funds are awarded annually through a competitive process. The availability of funding varies and requires a 50 percent match from non-federal funds. The Conservation Stewardship Program is voluntary conservation program that supports ongoing stewardship of private, working agricultural land. Through the Conservation Stewardship Program, the NRCS provides financial and technical assistance to eligible agricultural producers to conserve and enhance soil and water resources. The Conservation Stewardship Program pays participants for conservation performance; the higher the performance, the higher the payment. Funding is based on a competitive process and a person or legal entity may not receive more than \$40,000 in any year or more than \$200,000 during any five-year period.

The cost of implementing the plans by the public water supplies is not expected to be significant, but there are several potential sources of financial assistance that may be available. Several federal funded and state managed programs that might be able to provide assistance exist, including the Drinking Water State Revolving Loan Fund, Local Source Water Protection Grants and Watershed Restoration Grants. The availability of funding varies depending on the program and the awarding of assistance may be based on a competitive selection process. A summary of the financial assistance programs potentially available to these AWUs is included in Appendix F.

H. Water Management Plan Implementation

Affected Water Users and Affected Dam Owners will begin implementing their Conservation, Water Use and Dam Management Plans upon adoption of the Water Management Plan by DES. DES will develop long-term monitoring strategies. All of the

Water Management Plan components are subject to revision utilizing adaptive management concepts if management activities do not prove to be effective in meeting the water quality standards.

1. Dam Management Plan Implementation

Through the implementation of the Dam Management Plan component of the Water Management Plan, several issues need to be addressed. The steps that need to be taken in implementing the Dam Management Plan component include: 1) outreach to and negotiations with abutters; 2) reevaluation of storage goals and revisions to storage management plans (if needed); and, 3) reconfiguration of the outlet structures in the three flood control facilities—Site 12A, Site 19 and Site 35. These steps are more fully developed in the paragraphs below.

Step 1 - Outreach to abutters at each facility: implementation may require additional agreements beyond those made with the Affected Dam Owner. At flood control facilities, easements to inundate land to specified levels were acquired. Easements with abutting land owners may need to be revised to store the additional water for stream flow management. Because arranging revisions of these easements is beyond the scope of the Water Management Plan development, which envisioned agreements only with the owners of the dams, this part of implementing the Water Management Plan was previously identified in the draft Plan as an additional task that needed to be completed before implementation. This task is also included for other facilities where easements apply.

Step 2 – Reevaluate storage goals and renegotiate easements or revise storage management plans: depending on the results of negotiations, changes in storage at one facility may require subsequent offsetting changes at one or more other facilities. This would require additional landowner and stakeholder outreach.

Step 3 – DES has developed a preliminary estimate of the cost to reconstruct the outlet structures in the three flood control dams. These outlet structures are currently designed to operate passively and have no active management capacity to allow for flow releases of stored water. The estimated cost is \$136,000. This funding will need to be acquired and the reconstruction conducted before these dams can be actively managed.

2. Management Actions Prompted by Stream Flow Gage Conditions

The actions in this Water Use Plan are initiated based on mean daily flow conditions recorded at two USGS gaging stations. Affected Water Users and Affected Dam Owners are expected to know the current conditions relevant to implementing their management plans.

For the upper Souhegan the gage used is identified as 01093852 Souhegan River (Site WLR-1) near Milford, NH. Daily data for this gage station can be found at http://waterdata.usgs.gov/nh/nwis/dv/?site_no=01093852&agency_cd=USGS&referred_module=sw. For the lower Souhegan the gage used is identified as 01094000 Souhegan River At Merrimack, NH. Daily data for this gage station can be found at http://waterdata.usgs.gov/nh/nwis/dv/?site_no=01094000&agency_cd=USGS&referred_module=sw.

DES provides on its website the river flow from these gage stations. These pages include tables and charts describing the protected instream flow status and may be found at <http://www2.des.state.nh.us/OneStopPub/Watershed/souhegan-upper-pisf-track.xls> and <http://www2.des.state.nh.us/OneStopPub/Watershed/souhegan-lower-pisf-track.xls>. These same data can also be accessed through <http://des.nh.gov/organization/divisions/water/wmb/rivers/instream/souhegan/index.htm>.

Affected Water Users and Affected Dam Owners are expected to refer to these pages to know the current conditions relevant to implementing their management plans. They may also contact the DES Instream Flow Program for current and forecasted conditions.

3. Long-Term Monitoring Plan

DES is developing a program of long-term monitoring of ecosystem conditions to evaluate the effectiveness of the instream flows and the Water Management Plans on meeting Water Quality Standards as demonstrated by long-term trends in biological conditions. Current funding and staff levels may not be available to conduct the monitoring of every desirable biological and water quality parameter, however, some level of monitoring will be conducted by existing staff.

4. Compliance and Enforcement

DES will determine how compliance with the Water Management Plan will be enforced. The Instream Flow Rules (Env-Wq 1907) state that “affected water users and affected dam owners shall comply with the provisions of an adopted water management plan.” Currently no guidance is provided on how non-compliance will be established and what enforcement actions will be taken.

5. Management Plan Recordkeeping and Documentation

Upon the implementation of the Souhegan River Water Management Plan, Affected Water Users and Affected Dam Owners will keep records to document the actions and the dates and times that management actions were taken to meet their Water Management Plans. From time to time, DES will conduct audits of the management activities taken by the Affected Water Users and Affected Dam Owners in response to protected stream flow conditions. Documentation of existing conditions that cannot be gathered elsewhere (such as from a continuous stream gage) should be made prior to undertaking management activities. This documentation shall include records of conditions affected by the management activities described in their individual Water Management Plans, including but not limited to changes in dam gate conditions, number of stoplogs in place, static water levels in impoundments, and pumping rates. These records will be retained and made available to DES on request. DES recommends, but does not require, that Affected Water Users and Affected Dam Owners create and retain documentation of the costs associated exclusively with water management activities defined by their Water Management Plans.

6. Adaptive Management

Since the establishment of the protected instream flows and the water management actions are new approaches to the management of water resources in the Souhegan River Water

Management Planning Area, adaptive management will be employed. Once implemented, DES will evaluate the Water Management Plan for its success in meeting its objective of maintaining the protected instream flows.

DES will review all the Water Use Plans, Conservation Plan and Dam Management Plans with the affected entities following the adoption of the Souhegan River Water Management Plan. This review will include an analysis of the expected results of actions taken by Affected Water Users and Affected Dam Owners. Through the review, DES will work with the affected entities to determine if changed conditions may require updates to the Plan. Further, an Affected Water User or Affected Dam Owner may apply for a waiver to revise its management actions. The waiver request must apply to conditions that affect only that Affected Water User or Affected Dam Owner and do not affect others' use or operations. If the results of this review indicate to DES that parts of the Water Management Plan needs to be revised, then DES will work with the Affected Water Users and Affected Dam Owners to address the change.

III. SUMMARY

The Souhegan Water Management Plan's goal is to protect the Souhegan Designated River while managing uses of its water. This Water Management Plan presents the management actions to be taken by each Affected Water User and Affected Dam Owner in the Souhegan River Water Management Planning Area in order to support and maintain the protected instream flows established for the Souhegan Designated River.

An Instream Flow Study for the Souhegan Designated River delineated the protected instream flows (DES 2009). The protected flows were established in 2013 as translators of the narrative water quality standards specifically for the Souhegan Designated River. The State of New Hampshire recognizes this Water Management Plan as the means to ensure compliance with the narrative standards set forth in Administrative Rules. The communities and water users in the Souhegan watershed not only benefit from the direct use of the river, but also from the health of the river. In order to maintain the instream flows, water users and dam owners must be considerate of the impact of their individual and collective use on stream flows. This Water Management Plan was developed to help guide those entities.

The Water Management Plan comprises Conservation Plans, Water Use Plans and Dam Management Plans to meet flow protection goals. DES has developed individual management plans for all Affected Water Users and Affected Dam Owners. DES presented a draft report describing the proposed Water Management Plan to the public at a hearing in 2011. After considering the comments received through the hearing process, the report was revised, resulting in this Water Management Plan.

Major changes from the draft plan were made with respect to the facilities proposed to be used for relief pulses during low-flow events. Responding to public comment and internal analysis, DES has expanded the number of facilities that may be used for flow management and reduced the amount of water that any single facility application will contribute.

An important issue that has been reiterated during the development of this Water Management Plan is that it should embrace an adaptive management approach. Adaptive management has been incorporated in the plan implementation such that if the desired outcomes are not being achieved, management strategies may be adapted to meet objectives.

Several critical issues remain to be resolved in the implementation of the Souhegan Water Management Plan. These include:

- DES will meet with abutters and stakeholders around the dams identified for flow management to discuss the final configuration of the dams and any needs for increased flowage on private property.
- The re-design and modification of the outlet structures at the selected flood control sites will be required in order to create releases of the relief flows. Potential funding sources will need to be identified.
- DES will establish a program of long-term monitoring with a schedule for the review of the Water Management Plan to assess its effectiveness and to incorporate any modifications as needed. Potential funding sources will need to be identified if monitoring funds are inadequate.

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Appendices

Appendix A – Conservation Plans

Appendix B – Water Use Plans

Appendix C – Dam Management Plans

Appendix D – DES Dam Bureau Relief Flow Assessment for Sites 19 and 35

Appendix E – DES Water Management Bureau Flow Deficit Analysis

Appendix F – Financial Assistance Summary Table

Appendix G – Souhegan River Water Elevation Evaluation April 2009

Appendix H – Summary of Public Comments and DES Responses

Appendix I – Public Comments