

WATER USE PLAN

University of New Hampshire/Durham Water System (#20066)

Introduction

The following individual Water Use Plan (WUP) has been prepared for the University of New Hampshire/Durham Water System (UDWS), which supplies water for the University of New Hampshire and for the Town of Durham, New Hampshire. The WUP was prepared using information provided by the UDWS and from their water use records reported to the Department of Environmental Services (DES). The UDWS has three registered water sources; the Lee Well, the Oyster River and the direct withdrawal from the Lamprey Designated River in Durham.

Because one of its registered water sources is located on the Lamprey Designated River; UDWS is considered to be an Affected Water User (AWU) under the Instream Flow Rules (Chapter Env-Wq 1900). Under Chapter Env-Wq 1900, individual WUPs are to be prepared for each AWU located within the Lamprey River Water Management Planning Area (WMPA). Since this water withdrawal is located within the watershed of the Lamprey Designated River, it is also located within the Lamprey River WMPA. Each individual WUP is to include:

- Water use data and information to define water use patterns and needs for each AWU,
- A description of the potential for water use modification, sharing or both to meet the protected instream flow requirements, including water use patterns and needs,
- An estimate of implementation costs of the plan for each AWU, and
- An implementation schedule for the individual WUP.

Water Source and Uses

The UDWS withdrawal from the Lamprey River is registered with DES as Water User ID #20066-S02. The pumping station and intake, which were constructed in 1970, are located in the reservoir approximately 2,700 feet upstream of Wiswall Dam. The original underground raw water main, also constructed in 1970, transferred water withdrawn at the pump station and discharged directly to the Oyster River at a location approximately 1 mile upstream from UNH's Arthur Rollins Water Treatment Plant (ARWTP) in Durham. To improve the efficiency of the withdrawal, another raw water main was constructed in 2002, which was connected to the original pipe at an intermediary location and run directly to the ARWTP. This withdrawal improvement project, which also included upgrades at the pump station, allowed water withdrawn from the reservoir to be pumped directly to the ARWTP thereby avoiding losses of the transferred water within the Oyster River and riparian wetlands. A Section 401 Water Quality Certificate was issued as part of the 2002 withdrawal improvement project that imposed operational limitations on the withdrawal when the Lamprey River flow fell below 45 cfs as measured at the United States Geological Survey (USGS) stream gage at Packers Falls near Newmarket. The Wiswall Dam, the Wiswall Reservoir and the intake are all located on the Lamprey Designated River.

From 1970 to 2002, withdrawals from the Lamprey River were used to supplement the Oyster River supply source in times of drought. Water was not withdrawn from the Lamprey River on a regular

basis because the original transfer was inefficient and increased the turbidity in the Oyster River making it difficult to treat. As a result, infrequent withdrawals were made when demand was high and the available supply from the Oyster River was limited. With the direct connection between the Lamprey River and the ARWTP completed, more frequent water usage for trials and experimentation with the new system configuration occurred from 2002 until 2004. From 2004 through 2008 the use of the Lamprey River withdrawal was infrequent and sporadic while a variety of operational complications were resolved and the UDWS developed a plan to operate within the limitations of the Section 401 Water Quality Certificate. In Late 2006, the Lamprey River became the principal source of water for the UDWS whenever flows, as measured at the USGS gaging station at Packers Falls, exceed 45 cubic feet per second (cfs). When flows fell below 45 cfs, the Oyster River was used. This practice was followed since an approved flow monitoring plan to operate in accordance with the Section 401 Water Quality Certificate was still in its developmental stages. In September and October of 2010, the UDWS withdrew from the Lamprey River when flows fell below 45 cfs in accordance with an approved flow monitoring plan as required by the Section 401 Water Quality Certificate. The water from the Lamprey and Oyster Rivers is treated at the ARWTP and then distributed to the water system, while the Lee Well, which represents 25 percent of the total supply, supplies the system directly after just disinfection.

Water Use Patterns

Lamprey River withdrawals are metered and withdrawal volumes are recorded daily and totaled monthly with the monthly and daily water use data being reported quarterly to DES. Water use data for the UDWS Lamprey River withdrawals for the years of 1988 through 2008 were obtained from DES. From January 1988 through December 1992, there is no record of any Lamprey River water use on file with DES except for the months of October through December in 1988, during which water use was reported as zero. From January 1993 through December 2008, the monthly water use records are complete. The water use data are presented in Figures 1 and 2 and summarized in Tables 1 and 2.

From 1970 to 2009, withdrawals from the Lamprey River were sporadic due to the complexities and system deficiencies described above. During this time supply needs were usually met with withdrawals from the Oyster River and the Lee Well. Withdrawals from the Lamprey River typically occurred during August and September, when demand increases in response to the return of UNH students to Durham and decreased at the end of May with the conclusion of the UNH spring semester and decline in student population. Withdrawals from Wiswall Reservoir were also occasionally made during periods when flow on the Lamprey River exceeded 45 cfs to take advantage of the higher quality of the Lamprey River water to reduce the requirements of water quality treatment.¹ Starting in 2009, the Lamprey River became the principal source of water for the UDWS when flow on the Lamprey River exceeds 45 cfs.

Annual water use from the Lamprey River from 1993 through 2008 has ranged from a high of 121.0 million gallons (2003) to a low of 0 gallons (multiple years) (Figure 1) with an average annual use of 21.9 million gallons (Figure 2 and Table 1). Withdrawals from the Lamprey River were greater from 2002 through 2004 than during all other years. As described above, this was a result of trials

¹ Subsequent evaluation shows that the reduced treatment cost is nearly offset by higher electric costs to pump the water from the Lamprey to the ARWTP.

and experimentation as the Lamprey River withdrawal was transitioned from a direct discharge to the Oyster River Reservoir to a direct connection with the ARWTP. This period also coincided with several summers of below normal discharge on the Lamprey and Oyster Rivers due to regional drought conditions. Between 1993 and 2008 water withdrawals from the Lamprey River were sporadic and have little correlation to UDWS overall water use patterns.

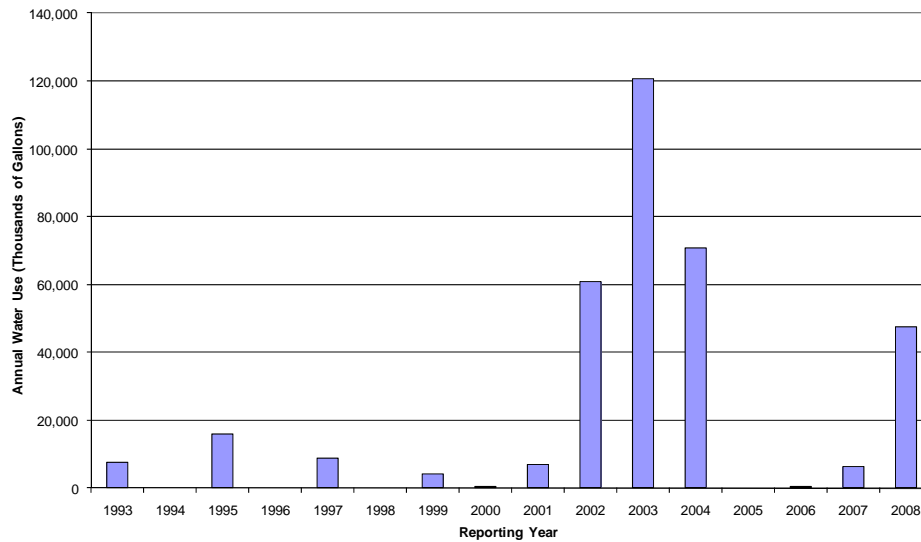


Figure 1. UDWS Lamprey River Diversion Total Annual Water Use (1993 through 2008).

Table 1. UDWS Lamprey River Diversion Average Annual Water Use Statistics (1993 through 2008, years with incomplete data have been omitted).

	Low	High	Average
(thousand gal)	0	121,000	21,900
(cfs)	0	0.5120	0.0929
(cfsm at impact point)	0	0.0028	0.0005
(cfsm at Packers Falls Gage)	0	0.0028	0.0005

Monthly water use from the Lamprey River ~~during this time period was~~ highly variable due largely to seasonal demand, but is also affected by weather conditions and the availability of water from the Oyster River. The total and average monthly water usage ~~during this time period was~~ greatest during the summer and fall and lowest during the winter (Figure 2). This apparent seasonal use pattern reflects increased use of the Lamprey River due primarily to droughts during the summer and the return of students to UNH in the fall. In addition, the use of this source during the summer and fall periods of the year reflects when water availability is limited in the Oyster River.

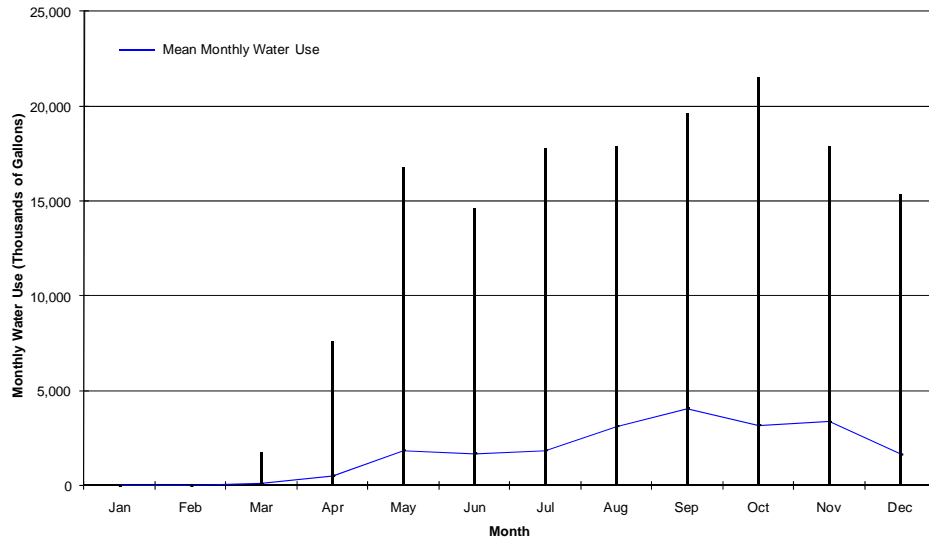


Figure 2. UDWS Lamprey Diversion Total Monthly Water Use (1988 and 1993 through 2008).

Table 2. UDWS Lamprey Diversion Monthly Water Use Statistics (1988 and 1993 through 2008).

	Low	High	Average
(thousand gal)	0	21,500	1,780
(cfs)	0	1.0700	0.0904
(cfsm at impact point)	0	0.0058	0.0005
(cfsm at Packers Falls Gage)	0	0.0059	0.0005

The highest total monthly usage from the Lamprey River was 21.5 million gallons (October 2003), while no water use was reported for multiple months during multiple years (Table 2). The average monthly usage from the Lamprey River was 1.78 million gallons for October to December 1988 and from January 1993 through December 2008. As described above, between 2002 and 2008 the UDWS was in a period of transition and operationally evaluating the Lamprey River withdrawal and optimizing treatment methods at the Water Treatment Plan which resulted in sporadic usage and therefore it may not be reflective of future use pattern and provides limited value with respect to predicting future use patterns.

The monthly water use data were converted to flow in cubic feet per second by dividing the monthly totals by days and then multiplying this result by a flow unit conversion factor. Based on these values, the total water use of the Lamprey River pump station has ranged from a minimum of 0 cfs (multiple occurrences), to a maximum of 1.07 cfs (0.69 million gallons per day) (during October 2003) with a mean monthly water use of 0.09 cfs (58,169 gallons per day) over the period 1988 to

2008 (Table 2). Again, it should be noted, that withdrawals from the Lamprey River for most of the record were not continuous, so the average includes long periods when no water was withdrawn.

Potential for Water Use Management to Meet Protected Instream Flows

UDWS has the potential to manage water use to support the Protected Instream Flows due to the availability of multiple water sources and the potential for reducing system water demand through the use of water conservation measures. The alternative sources include the Oyster River Reservoir, the Lee Well, and storage in the Wiswall Reservoir. The UDWS also has an established Emergency Response Plan that includes a multi-stage, outside-water-use plan to reduce system demand during periods of drought.

The capacity of the UDWS pumps at the withdrawal from the Lamprey Designated River is 2.8 cfs (1.8 million gallons per day.) The effects of withdrawals have the greatest impact during periods when stream flow is lowest, which typically occurs during the months of August and September. August and September also happen to be when water demand by UDWS increases due to the arrival of UNH students to begin the fall semester.

UDWS has alternative water sources available from the Oyster River and the Lee Well. The Oyster River reservoir has an estimated storage volume ranging from 9 to 14.7 million gallons (Underwood Engineers, Inc. 2007). Water withdrawn from the Oyster River is treated and then distributed to the water supply system. The Oyster River watershed is more than ten times smaller than the Lamprey watershed and so has less water available for consumptive use. Due to the requirement for treatment, water supply from the Lamprey River and Oyster River is limited by the maximum capacity of the Arthur Rollins treatment plant, which is 1.55 million gallons per day. The Lee Well has an estimated sustainable yield of 0.54 million gallons per day and discharges directly into the water distribution system after disinfection.

UDWS has an established Emergency Response Plan with a multi-stage, outside-water-use reduction and public awareness/voluntary conservation plan that applies during periods of drought. UDWS has indicated an interest and a willingness to coordinate reasonable reductions of outside water use during agreed upon with stream flow conditions in order to reduce system demand and support the protected flows.

This Water Use Plan must be coordinated with the Dam Management Plan developed for the Wiswall Dam (State Dam ID #071.04).

Water Use Plan Activity [Proposed]

The main components of the UDWS Water Use Plan are listed below and described further where necessary in the paragraphs below.

- Withdrawals affecting downstream flow may be limited or restricted during agreed upon low flow conditions.

- Withdrawals from reservoir storage may continue so long as the reservoir’s water level drawdown and rate of drawdown conditions are met: basically that water is reasonably taken from storage and not stream flow (inflow to the reservoir equals outflow).
- The Affected Water User will manage withdrawals from the Lamprey River in cooperation with operation of the Wiswall dam.
- UDWS will acknowledge receipt of DES notifications when an upstream relief flow release is to be made. During the relief flow releases UDWS will actively manage their withdrawal from the Wiswall Reservoir to ensure that the relief pulse is passed, or UDWS shall ensure that the nominal bioperiod release volume is released from Wiswall Reservoir.
- Summertime outside watering use restrictions and conservation measures outlined below will be implemented when limited source water availability correspond with low river flow periods in order to limit the impacts of water demands on the Lamprey River flow.
- Longer periods at lower pumping rates will be the preferred operational procedure for withdrawals from the Lamprey River during instream flow management events.

Comment [DC1]: This puts an unreasonable burden on the UDWS and would too easily result in a violation of the WUP. Without some idea of the actual volume of the relief flow that might arrive at Wiswall it is unreasonable to expect the UDWS to come up with a plan to “ensure the relief pulse is passed”. And, how and who determines what the “nominal bioperiod release volume” is? Where is nominal bioperiod release volume defined? Undefined terms do not belong in the WUP.

The UDWS withdrawal on the Lamprey River (20066-S02) may be operated at up to its maximum pumping capacity of 2.8 cfs so long as the maximum reservoir drawdown is no more than 18 inches below the Wiswall Dam spillway and maximum water level change is no more than one inch of drawdown per day based on a weekly average.

Comment [DC2]: The ability to base the 1 inch per day drawdown on a weekly average is needed in order to manage the reservoir outflow by removing 1 stop log at a time which would result in a release of “slugs” of water much like a relief pulse. This is also essential if for some reason outflow is managed with a low level gate in which case it is extremely tricky to maintain a steady drop in pool elevations.

If the commissioner declares that a water supply emergency exists or if a fire event occurs which affects public health and safety and requires continued withdrawal, then the conditions in this paragraph will be set aside for the duration of the emergency conditions. The UDWS shall maintain records of: river flow at the USGS Packers Falls stream gage, river flow just downstream of Wiswall dam, dates and times of withdrawals, and the pumping flow rate, daily withdrawal volumes during emergency conditions including times of beginning and end of emergency conditions, reasons for the emergency, and the name and office of the public official who declared the emergency. Within 60 days of the end of an emergency the UDWS shall file with DES a report describing the times and amounts of water withdrawal and reservoir water levels and rates of change under the emergency, causes of the emergency, and, unless the emergency was caused by one-time, non-recurring circumstances such as fire or a contamination event, detailing specific steps that will be taken to avoid recurrence of emergency conditions.

During a relief flow release conducted under the Lamprey Dam Management Plan, the UDWS will maintain outflow equal to inflow to the Wiswall Reservoir based on a daily average. The effective period of a relief flow release is expected to be approximately three days because DES estimates that the release flow pulse once begun will take approximately 23 hours to reach the Wiswall Reservoir and will then continue for 48 hours.

DES will send the UDWS a notification of a release flow at least 48 hours prior to its arrival at Wiswall Dam stating the scheduled start time and the anticipated arrival time at Wiswall Dam. The Affected Water User will acknowledge receipt of the notification within 24-48 hours. The Affected Water User will coordinate with the Wiswall Dam Affected Dam Owner to monitor inflow to the Wiswall Reservoir. During the effective period of the relief pulse, the Wiswall Dam Affected Dam Owner will operate dam (i.e. open gates or remove stop logs in the Wiswall Dam, or other) to pass the relief flow. Alternatively, the Wiswall Dam Affected Dam Owner may, with approval of the

Comment [DC3]: What happens if UDWS gets the notification at 4 PM on a Saturday?

UDWS, operate the dam to create a relief flow. The relief flow created that way must be equal to the current bioperiod's 90%ile event volume, but without the volume of the 20 percent buffer released to compensate for losses.

Comment [DC4]: Without the UDWS's inserted language, an unreasonable burden is placed on the UDWS for the same reasons stated in a previous related comment. With some actual relief flow tests the UDWS has no assurance that this degree of dam management is realistic or practicable. Agreeing to implement this level of detailed dam management prior to any field testing could too easily result in a violation of the WUP.

Summertime outside water use reductions and calls for conservation measures as outlined below will be implemented by the UDWS to reduce the impact of outside water use on the Lamprey River and the UDWS water supply during defined flow and water system conditions. Measures to reduce outside water use will be enacted as part of the UDWS Emergency Response Plan (UNH/Durham Water Supply, 2009 or most recent version). Outside water use is typically heaviest during the summer and early fall. The outside water use reduction plans will be applied during the two bioperiods (June 20 through October 6). Under this Water Use Plan, the goal of reducing outdoor water use will be accomplished in four water conservation stages based on Lamprey River flow and system demand as compared to the maximum available capacity of the combined system source water. Maximum available capacity is defined as the amount of water available to the UDWS from the system's combined water sources on a given day. When stream flows in the Lamprey are below 18 cfs, the system's water sources will comprise the Lee Well, the Oyster River surface water withdrawal and the remaining storage within the drawdown limits of Wiswall Reservoir.

The prompts for these conservation actions are determined from flow measurements at the USGS gaging station on the Lamprey River at Packers Falls near Newmarket (0173500). The UDWS will act on the Water Use Plan based on mean daily flow conditions recorded at this gage or based on conditions defined on the DES web page at:

http://www2.des.state.nh.us/onestoppub/watershed/lamprey_pisf_tracking.xls

Comment [DC5]: UDWS needs to evaluate this online information to assess its implications on the system. We also question whether it is appropriate to reference any online information that might be subject to change.

The four water conservation stages escalate from alert messages and voluntary measures under Stage 1 to a mandatory ban on outside water use and broader restrictions under Stage 4:

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Stage 1 Alert. The first action is an alert that voluntary water conservation measures should be taken and further actions may begin soon. The alert will be enacted by the UDWS on the day after daily mean discharge at the gage falls below 18 cfs (the Critical protected flow level) and when system demand is \geq 75% of the maximum available capacity. UDWS will inform its water users through its notification process to implement voluntary water conservation measures and prepare for further actions as described in **Stage 1** of the Emergency Response Plan (UNH/Durham Water Supply 2009 or recent version). An alert is rescinded when daily mean discharge exceeds 25 cfs for two consecutive days.

Stage 2 Alert. If daily mean discharge in the Lamprey Designated River continues to decline and fall below the Critical protected flow level of 18 cfs for longer than 15 days (the GRAF Spawning bioperiod's persistent duration) during this period, and when system demand is \geq 80% of the maximum available capacity, then UDWS will implement outside water use restrictions as described in **Stage 2** of the Emergency Response Plan (UNH/Durham Water Supply 2009 or recent version). These restrictions include, but are not limited to; a ban on vehicle washing and filling of swimming pools, and limited watering of lawns

and gardens, with the additional provision that lawn watering is limited to odd/even days. These restrictions will be rescinded when daily mean discharge exceeds 18 cfs for two consecutive days.

Stage 3 Alert. If daily mean discharge in the Lamprey Designated River falls below the Rare protected flow level of 16 cfs during this period for longer than 15 days (the catastrophic duration), and when system demand is $\geq 85\%$ of the maximum available capacity, then the actions described under **Stage 3** of the Emergency Response Plan (UNH/Durham Water Supply 2009 or recent version) will be imposed, including, but not limited to; a ban on vehicle washing and filling of swimming pools, no watering of lawns and limited watering of vegetable gardens. These restrictions on outside water use will be rescinded when daily mean discharge exceeds 16 cfs for two consecutive days.

Stage 4 Alert. If daily mean discharge in the Lamprey Designated River falls below the Rare protected flow level of 16 cfs during this period for longer than the 25 days (catastrophic duration plus 10 days), and when system demand is $\geq 90\%$ of the maximum available capacity, then a complete ban on outdoor water use will be imposed as described under **Stage 4** of the Emergency Response Plan (UNH/Durham Water Supply 2009 or recent version), including, but not limited to: a ban on vehicle washing, filling of swimming pools, and lawn and garden watering. These restrictions on outside water use will be rescinded when daily mean discharge exceeds 16 cfs for two consecutive days.

The Town's water system customers and the students at the University of New Hampshire will be notified of the implementation of the water conservation stages through a public notice process by the Town and the University. This process will include mailings, posters, emails and notices on the Town and University web sites. The Town will also publish an emergency notice in the local newspaper and post notices in ten prominent areas around the Town (Town of Durham 1999) in the event of a Stage 4 Alert.

Currently UDWS has the ability to request only voluntary conservation measures of Town of Durham water users. The legal authority to impose mandatory water use restrictions on Town of Durham water users is conditional upon the Durham Town Council adopting a water use restriction ordinance defining such authority, conditions of restrictions, and commensurate penalties. The Town Council of Durham by approving this Water Use Plan agrees to adopt the Water Use Plan conditions above as part of its permanent ordinances / raise these conditions before a town vote to make them permanent town ordinances.

Comment [DC6]: Obviously, this is a statement the Durham Town Council will need to discuss and vote to approve.

Nothing in this plan precludes the UDWS from implementing more restrictive water use actions on its own initiative.

Whenever operational considerations of the water treatment plant, pumping station, water use, etc. allow, UDWS will operate the withdrawal at lower withdrawal rates over longer periods of times in preference to higher withdrawal rates for shorter periods.

Whenever operational considerations of the water treatment plant, pumping station, water use, etc. allow, UDWS will use the Lamprey River withdrawal to preserve the capacity of the Lee well and any other groundwater supplies until flow conditions on the Lamprey River fall below the Critical magnitude and exceed the persistent duration for any of the six proposed bioperiods as presented in the Lamprey River Protected Instream Flow Report (DES 2009). When these conditions are met, the UDWS will, with proper consideration of the long- and short-term capacity of its groundwater supply(s), ~~manage/operate~~ its water supplies to ~~limit/minimize~~ impacts on its surface water sources.

Estimated Water Use Plan Implementation Costs

The proposed water use management actions are: 1) withdrawal from Wiswall Reservoir is available so long as the limit on pumping drawdown is less than 18 inches below the spillway and at no more than one inch per day based on a 7-day average; 2) acknowledgment of DES notification of an imminent relief flow release; 3) withdrawals during the effective period of a relief flow release must be coordinated with Wiswall dam management; 4) implementation of summertime, outdoor water use reductions or bans based on system demand and available system capacity, and adoption by Town Council of these measures and 5) whenever possible, water withdrawals from the Lamprey will be conducted preferably at a lower rate for shorter durations instead of longer durations to higher rates.

To implement this plan (and to meet the conditions of the existing 401 Water Quality Certification monitoring plan) the UDWS will install a water level gage in the Wiswall Reservoir to provide remote measurement of the reservoir level in order to manage withdrawals within the limitations established in this plan. UDWS will also ~~install/develop~~ a flow measurement ~~gage immediately downstream at the outlet~~ of the Wiswall Dam to provide ~~more~~ accurate ~~river-reservoir out~~flow data with which to manage withdrawals in conformance with this plan. The estimated cost for the design and installation of these gages is \$10,000 to \$30,000 depending upon the technology used to record and transmit the water level data.

Comment [DC7]: This value will need to be confirmed when the project design is completed and constructed. It is also anticipated that there will be additional operation and maintenance cost associated with both water level and flow measurement.

Water Use Management Plan Implementation Schedule

By June 1, 2012, UDWS will implement its Water Use Plan and will institute the proposed measures for the management of outdoor water use during the summer and early fall when flows on the Lamprey Designated River fall below the Critical or Rare protected instream flow levels. UDWS will update this Plan in response to any applicable changes in the state's Rules for the Protection of Instream Flow on Designated Rivers (Env-Wq 1900).

Comment [DC8]: This sounds like the UDWS is agreeing to any change that may come after the fact.....?

Water User Contact Information

Water User: University of New Hampshire/Town of Durham Water System

Address: Town of Durham Department of Public Works
100 Stone Quarry Drive, Durham, NH 03824

Contact: David Cedarholm, Town Engineer

Phone: 868-5578

Email: dcedarholm@ci.durham.nh.us

Address: UNH Energy and Utilities
17 Leavitt Lane, Durham, NH 03824
Contact: Jim Dombrosk, Director Energy and Utilities
Phone: 862-2345
Email: jim.dombrosk@unh.edu

Conversion Factors for Volume and Flow Units

1	cubic foot =	7.481	gallons
1	gallon =	0.1337	cubic feet
1	acre-foot =	43,560	cubic feet
1	acre-foot =	325,872	gallons
1	cfs =	448.86	gpm
1	cfs =	646,358.4	gpd
1	cfs =	0.65	MGD
1	gpm =	0.002227866	cfs
1	gpd =	0.00000154713	cfs
1	MGD =	1.5471	cfs

Sources of Information

Env-Wq 1900 Rules for the Protection of Instream Flow on Designated Rivers, effective 5/29/03.

Department of Environmental Services (DES) 2009. Final Lamprey Protected Instream Flow Report. Prepared by Normandeau Associates, Inc., Rushing Rivers Institute and the University of New Hampshire. NHDES-R-WD-08-26.

UNH/Durham Water Supply 2009. UNH/Durham Water Supply Emergency Response Plan. Prepared by Wesley R. East, Chief Operator. Original date August 2002 and Revised March 2009.

Personal communication with David Cedarholm, P.E., Town of Durham.

Personal communication with Wesley East. UNH/Durham Water System.

Survey of Lamprey River Affected Water Users performed by Normandeau Associates, Inc. completed by Wesley East. UNH/Durham Water System.

Underwood Engineers, Inc. 2007. Draft Update to Water Resources Management Plan
Durham NH University of New Hampshire dated October 2007.

Water use reports on file with the Department of Environmental Services (DES).