RECLAMATION
Managing Water in the West

DRAFT Henrys Fork Watershed Basin Study Water Needs Assessment

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Pacific Northwest Regional Office
Snake River Area Office
Boise, Idaho

April 2011

MISSION OF THE U.S. DEPARTMENT OF THE INTERIOR

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Photograph on front cover: View of Teton Mountain range and Henrys Fork watershed.

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1.0 INTRODUCTION

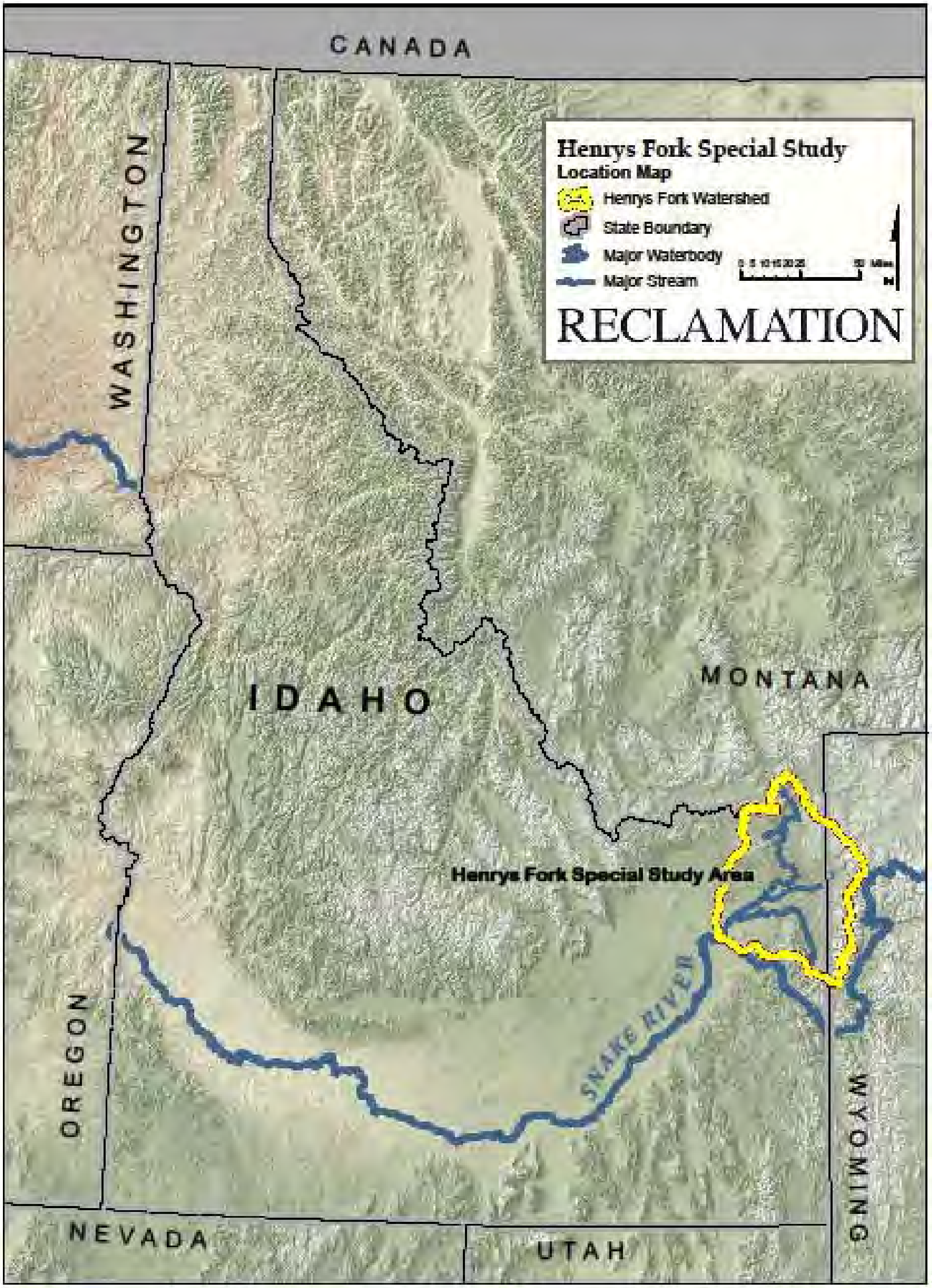
The Henrys Fork River is a major tributary to the Snake River, joining it in the northwest corner of the Upper Snake River basin near Rexburg, Idaho (Figure 1). The Upper Snake River basin extends from its headwaters in western Wyoming through southeastern Idaho to Milner Dam near Burley, Idaho (Figure 2). The Upper Snake River region produces approximately 21 percent of all goods and services within the State of Idaho, resulting in an estimated value of $10 billion annually. Water is the critical element for this productivity. The Henrys Fork watershed provides irrigation water for over 200,000 acres in the Upper Snake River basin and sustains a world class trout fishery.

The State of Idaho requested assistance from the Bureau of Reclamation (Reclamation) in finding more water storage to meet the water needs of the State. The State submitted a proposal under Reclamation's WaterSMART Basin Program to study the water supply in the Henrys Fork River of the Snake River, specifically to look at options to help resolve state-wide water supply issues. Reclamation accepted the proposal and is providing technical assistance and scientific studies in conjunction with the State and the Henrys Fork Watershed Council.

Within the Henrys Fork Basin Special Study (Basin Study) area, population growth, urban development, increasing irrigation needs, and a continuing drought are depleting water resources. The request was elevated to the basin level study to include a comprehensive assessment of the water resources and hydrology of the Henrys Fork. The Basin Study is intended to assist future planning efforts and to provide specialized information that contributes to future decision-making processes at the state and local levels. Objectives of the Basin Study are to identify relevant in and out-of-basin water supply issues that could be resolved with changes to operation of water supply systems, modifications to existing facilities, development of new facilities, or non-structural changes. This Basin Study will identify opportunities for the development of water supplies, improvement of water management through optimization, conservation, and sustainment of environmental quality.

The water management issues being addressed by the Basin Study are complex and involve understanding the surface/groundwater interactions and the interface with the larger Eastern Snake Plain Aquifer (ESPA). As an essential step in the WaterSMART Basin Program, this water needs assessment was developed and divided into three sections:

- Henrys Fork Watershed Hydrology
- Current Water Use in the Henrys Fork Watershed and the Upper Snake River
- Future Water Needs in the Henrys Fork Watershed



35
36 **Figure 1. Henrys Fork watershed location map.**

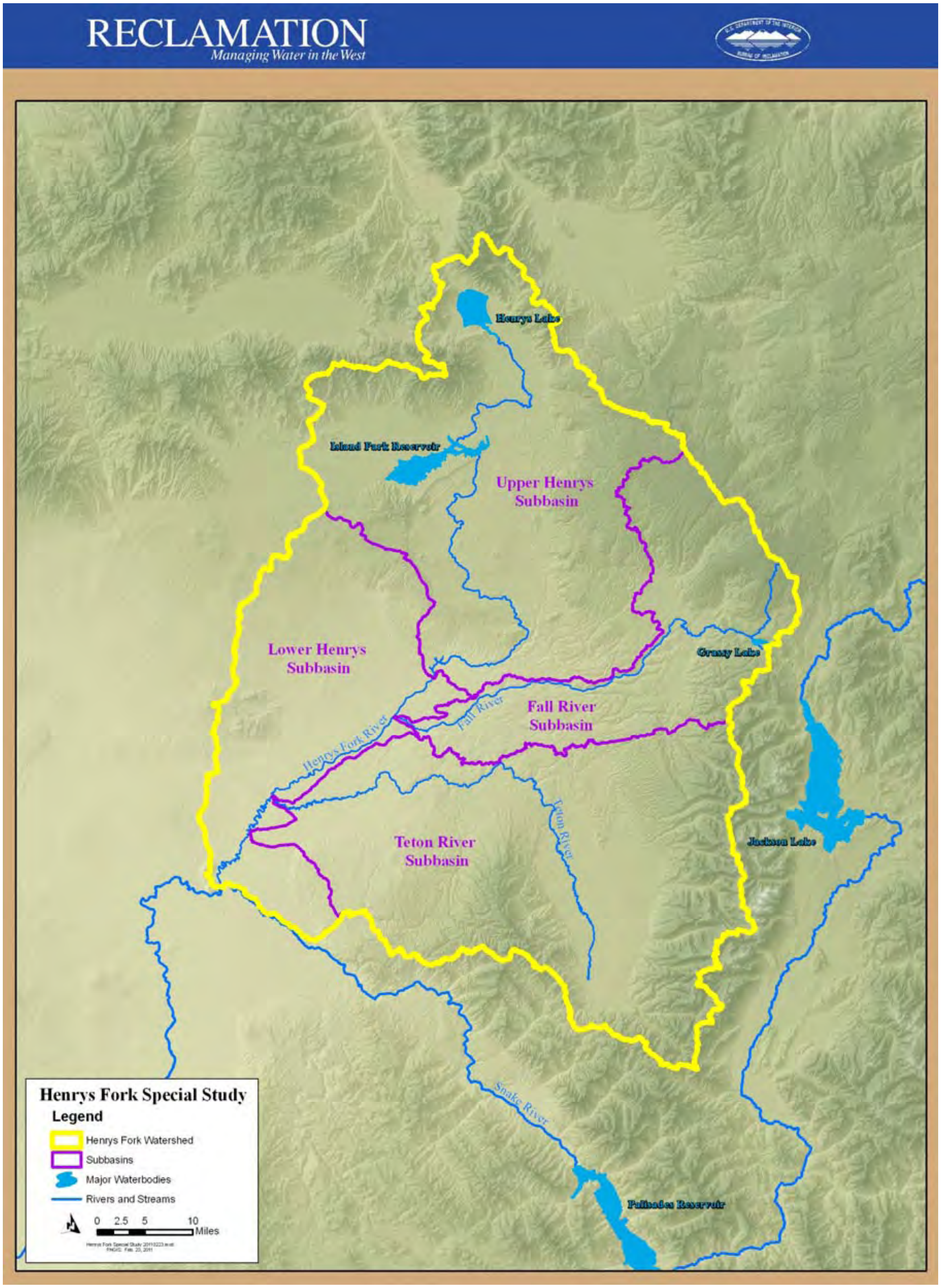


Figure 2. Map of Henrys Fork subbasins, major tributaries, and reservoirs.

2.0 HENRYS FORK WATERSHED HYDROLOGY

Physical Hydrology

The timing, frequency, magnitude, duration, and rate of change in flows are the elements of a river's hydrologic regime. The geology, geomorphology of the watershed, along with climate and precipitation amounts, types, and timing, also influence the hydrology of a region. In the Henrys Fork watershed, construction of dams and diversion structures have altered the hydrologic regime by lowering peak discharges in order to refill reservoirs and increasing summer discharges due to releases for irrigation purposes (Bayrd 2006).

Surface Water

The Basin Study area is upstream of the confluence of the Henrys Fork and Snake rivers. The Henrys Fork watershed has the four major subbasins: upper Henrys Fork River, lower Henrys Fork, Fall River, and Teton River. The United States Geological Survey (USGS) identifies the upper Henrys Fork River watershed as hydrologic unit code (HUC) 17040202;[1] the lower Henrys Fork River watershed as HUC 17040203;[2] the Fall River is part of HUC 17040202[3] watershed; and Teton River watershed as HUC 17040204[4] (IDEQ 1998).

Precipitation over the Henrys Fork watershed ranges from 15 inches at St. Anthony to over 40 inches in the eastern section above Island Park Dam. Over 70 percent of the precipitation falls between November and May, mainly in the form of snow (Reclamation 1980).

River flows are described in terms of their mean annual natural flows and are extensively measured at numerous gaging stations (Figure 3). The total water supply, computed as the mean annual rainfall over the total watershed area (30-year average) is 4,878,000 acre-feet. Almost half (2,333,600 acre-feet) of this water is lost to evaporation and deep groundwater on an annual basis and a little more than half (2,544,400 acre-feet) is measured as surface water (Van Kirk 2011).

[1] http://water.usgs.gov/lookup/getwatershed?17040202
[2] http://water.usgs.gov/lookup/getwatershed?17040203
[3] http://water.usgs.gov/lookup/getwatershed?17040202
[4] http://water.usgs.gov/lookup/getwatershed?17040204

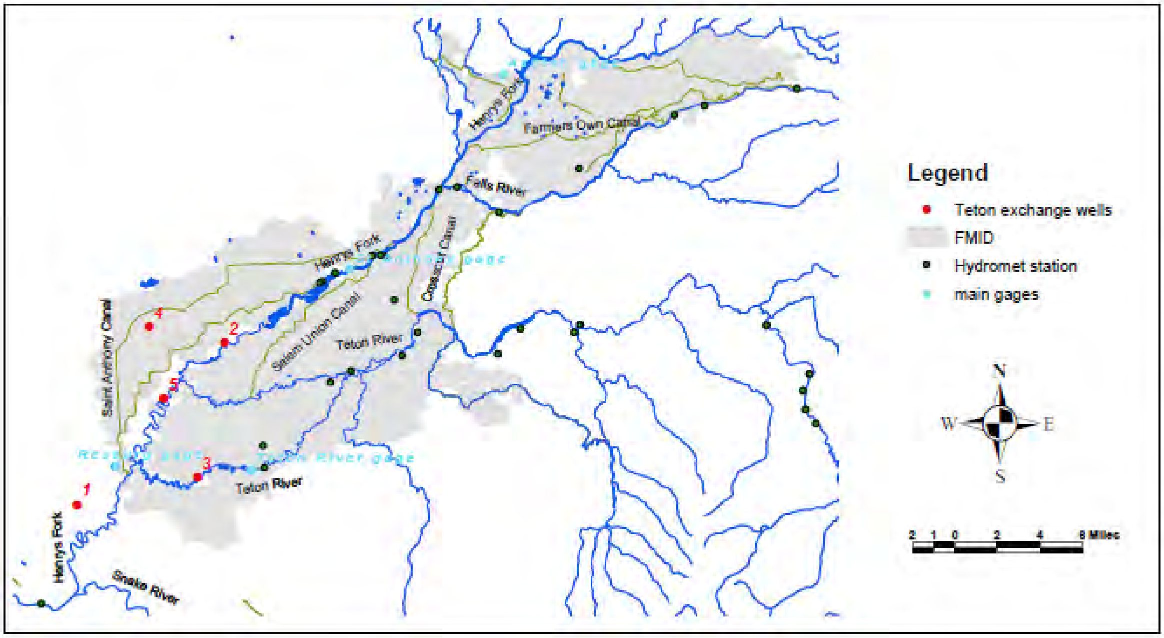


Figure 3. **Location of gaging stations, major canals, and the Teton Exchange Wells on and near the Henrys Fork River (Reclamation 2004).**

The Henrys Fork River is the largest river in the watershed, with a natural discharge of around 1.2 million acre-feet per year above the Fall River confluence. The Teton River's natural discharge is over 600,000 acre-feet per year and Fall River's is about 700,000 acre-feet per year (Table 1). Under natural, unregulated conditions, the total watershed discharge would be around 2.5 million acre-feet per year (Figure 4). A portion of this total discharge is seepage from the lower Henrys Fork into the Eastern Snake Plane aquifer. Due to the increased evapotranspiration of irrigation, storage, and canal conveyances, the total regulated discharge is around 1.6 million acre-feet per year. Much of the water lost to reservoir, stream, and conveyance system seepage and irrigation is regained through the discharge of aquifers (Van Kirk 2011).

Table 1. Surface water supply, mean annual natural flows for Henrys Fork River basin (Van Kirk 2011).

Source	Segment	30-Year Mean Annual Flow acre-feet	30-Year Mean Annual Flow acre-feet	Percent of Total
Upper Henrys Fork River			1,225,356	48.2%
	Henrys Lake	41,768		1.6%
	Henrys Lake to Island Park	439,072		17.3%
	Island Park to Ashton	744,516		29.3%
Fall River			699,914	27.5%
Teton River			618,863	24.3%
	Teton Above S. Leigh	304,084		12.0%
	Teton S. Leigh to St. Anthony	314,779		12.4%
Total Henrys Fork River watershed			**2,544,133**	**100.0%**

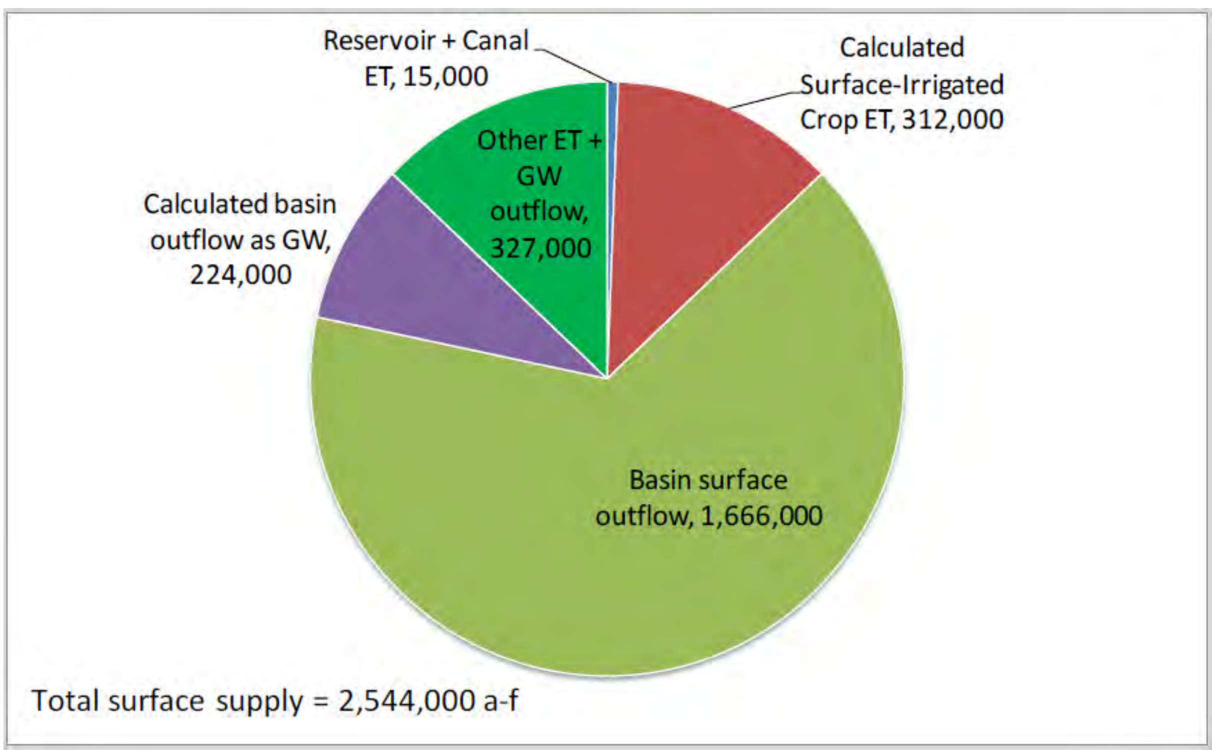


Figure 4. Water budget for Henrys Fork River basin surface supply (Van Kirk 2011).

Figure 5 and Figure 6 show the average monthly flows hydrographs of the Henrys Fork and Teton rivers gaging stations, and Figure 7 shows the mean annual discharge of the Henrys Fork River at Rexburg. The Henrys Fork reach between Ashton and Rexburg is a gaining reach for most of the year, with gains that range from about 500 cubic feet per second (cfs) in October to over 2,000 cfs in May. During July, August, and September, this river segment is a losing reach due to irrigation releases. Some of the diverted water reenters the river as irrigation return flows to the Henrys Fork or Teton rivers (Reclamation 2004). Van Kirk (2004) said that water storage and irrigation deliveries have altered river and stream hydrology in the Henrys Fork subbasin. This alteration is highest during low water years and greatest in the upper portion of the basin (Reclamation 2004).

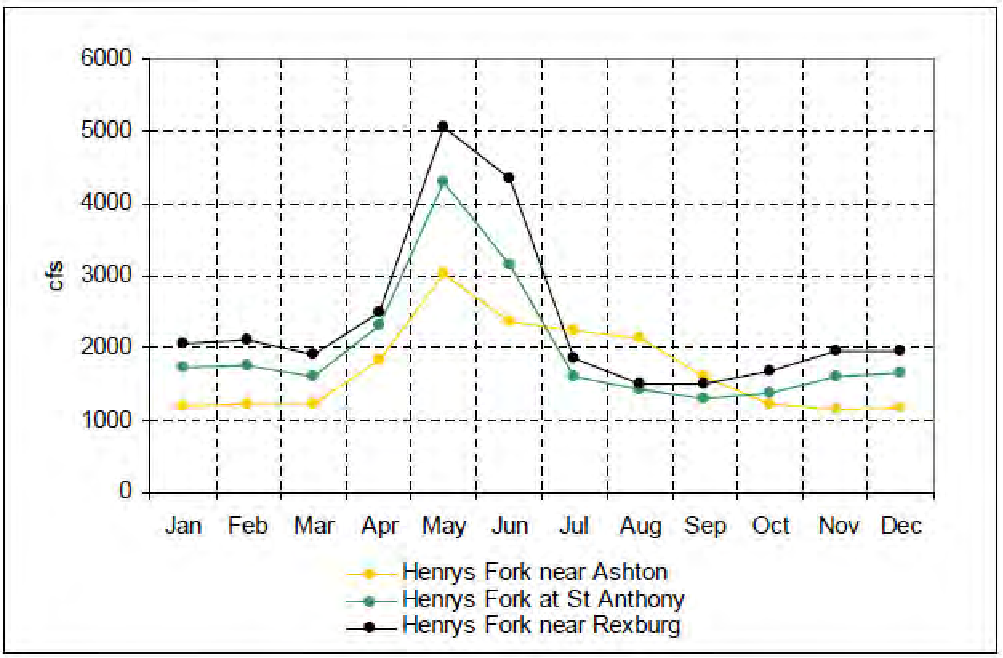


Figure 5. Average monthly flows at three gaging stations on the Henrys Fork of the Snake River from 1977 to 2002 (Reclamation 2004).

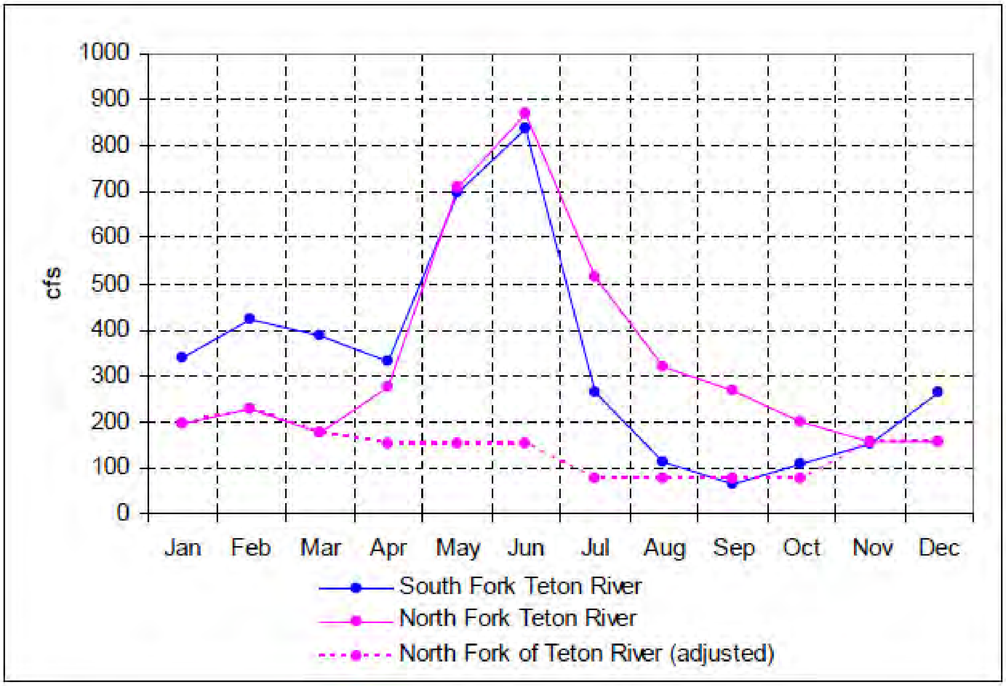


Figure 6. Average monthly flow in the Teton River (from gaging stations at Rexburg and Teton, respectively) from 1977 to 2002 (Reclamation 2004).

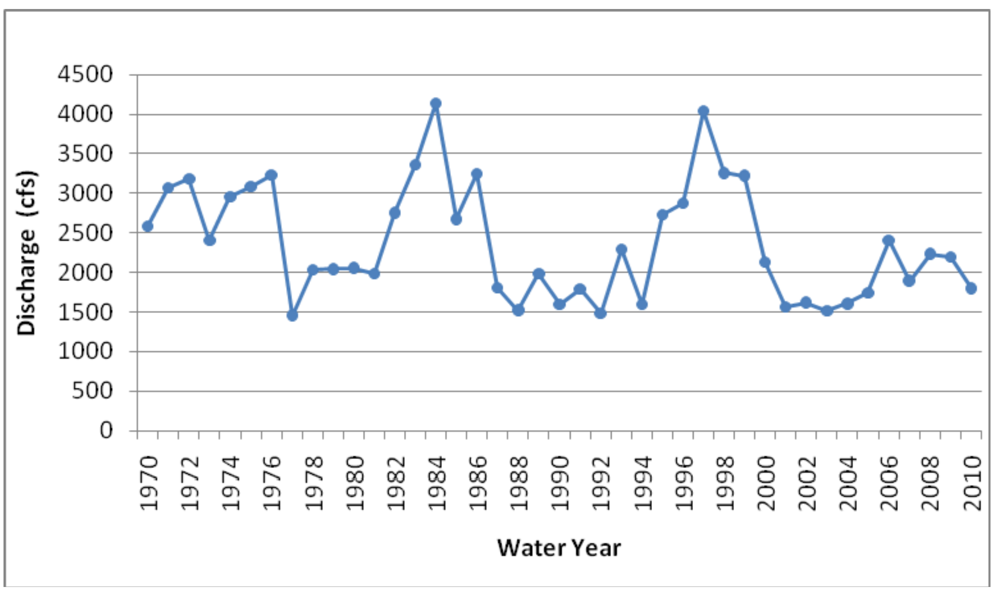


Figure 7. Mean annual discharge (cfs) in the Henrys Fork River near Rexburg (USGS 2011c).

Existing Surface Water Storage

Flows in the Henrys Fork River are regulated by three reservoirs, one hydroelectric powerplant diversion, and multiple irrigation diversions. Irrigation water is stored in three reservoirs in the Basin Study area: Henry's Lake, Island Park, and Grassy Lake (Figure 2). Henry's Lake dam was constructed and is operated by North Fork Reservoir Company (NFRC) to irrigate company patrons' lands. Island Park and Grassy Lake reservoirs were constructed and are operated by Reclamation. NFRC and FMID water storage in the reservoirs takes place primarily with base flows in the winter. Reservoir storage is accomplished under Idaho's prior appropriation doctrine.

In 2004, Reclamation transferred title to the canals, laterals, and other components of the water distribution system; Cross Cut Diversion Dam; the Cross Cut Canal; and the Teton Exchange Wells to FMID (Reclamation 2004).

Henry's Lake and Dam

NFRC constructed a dam across the outlet of the natural Henrys Lake to increase the storage capacity of the lake and supply irrigation water to the St. Anthony area. The 90,000 acre-feet of storage serves lands under the Company's jurisdiction.

Grassy Lake Dam and Reservoir

Grassy Lake Dam is located on Grassy Creek in Wyoming near the southern edge of Yellowstone National Park. Its storage capacity of 15,500 acre-feet provides supplemental water. There are no releases during the winter. Summer releases from Grassy Lake Dam are made on demand, usually in July and August. Additional releases may be made in late summer, if needed, to draft Grassy Lake to its winter operation level of 12,200 acre-feet.

Island Park Dam and Reservoir

Island Park Dam, located north of Ashton, Idaho on the Henrys Fork River, has a total storage capacity of 135,500 acre-feet. Releases from the reservoir are made in consultation with FMID based on water supply, reservoir carryover, and irrigation demand. April is normally the fill target for the reservoir. Releases during irrigation season are generally maintained at 1,200 cfs at the St. Anthony gage, but during years of low runoff, an operating target of 1,000 cfs is moved downstream to the Rexburg gage. Winter releases are determined in October or early November based on carryover storage and fall inflow. A release of 300 cfs is usually targeted although 100 cfs is the lower limit to be released. In years with good carryover and good winter inflows, releases may be increased in late winter to avoid filling when there is heavy ice cover on the reservoir. In cooperation with FMID, releases may be made for fish and swan habitat at the request of the Idaho Department of Fish and Game if water is available. Ramping rates and schedules are discussed with the Idaho Department of Fish and Game to reduce harm to fisheries.

Cross Cut Diversion Dam

The Cross Cut Diversion Dam diverts water from the Henrys Fork River between Ashton and St. Anthony, immediately below the confluence with the Fall River.

Groundwater

There are three main aquifers in the study area which influence the flows in the Henrys Fork watershed as well as a localized shallow aquifer (Bayrd 2006). The Yellowstone Plateau Aquifer, formed of rhyolite, covers hundreds of square miles and is recharged by snowmelt. It discharges hundreds of thousands of acre-feet annually to the headwaters of the Henrys Fork River. The Teton Valley Aquifer, which is comprised of alluvial fan and basin fill deposits, covers 90 square miles. Recharge to the Teton Valley Aquifer comes from stream channel, irrigation canal, and irrigation activity seepages.

The ESPA, which extends into the southwestern corner of the Basin Study area, is located in basalt and interbedded sediments of the Snake River Plain. Stream channel and irrigation seepage within the Basin Study area contribute to recharge of the ESPA. The ESPA discharges to the Snake River and springs outside of the Basin Study area. The impact of future Teton Exchange Well pumping on ground water gains in the Henrys Fork River basin and on the potential for depletions to the Snake River flows has been identified as a concern by the Bureau of Reclamation (Reclamation 2004).

Aquifer recharge from irrigation seepage is a major component to the Henrys Fork watershed hydrology. Recharge from irrigation seepage to the Teton Valley Aquifer, ESPA, and localized shallow aquifers is greater than prior to irrigation development, but is less than recharge during the early and mid-1900s. When the irrigation systems were first constructed, there were unlined canals and laterals with high seepage rates. Since the late 1970s, many canals have been lined and irrigation systems have been converted to sprinkler systems. These changes have resulted in less recharge to the aquifer from irrigation sources (Van Kirk 2010b). Similarly, discharge from the Teton Valley Aquifer, ESPA, and localized shallow aquifers is also greater than it was prior to irrigation development, but it is less than the discharges during the early and mid-1900s.

The hydrology of the Henrys Fork watershed is currently being studied through a U.S. Department of Agriculture grant to Humbolt University. One goal of the study is to create modeling tools to study the impacts potential projects and water management decisions would have on the Henrys Fork River and the ESPA. Other outcomes of the study include estimating the historical water supply and the current water budgets in the Henrys Fork watershed (Table 2).

Table 2. Water budget for Henrys Fork River basin (Van Kirk 2011).*

	Component - Annual Values	Value acre-feet	
Surface Supply	Reservoir & Canal ET	15,000	
	Surface-Irrigated Crop ET	312,400	
	Basin Surface Outflow	1,666,000	
	Known Basin Outflow as Ground Water	224,000	
	Other ET & Ground Water Outflow	327,000	
		Total Surface Supply	**2,544,400**
Deep ground water and non-irrigated ET		**Total deep ground water and non-irrigated ET**	**2,333,600**

*The sum of the component uses equal total water supply at 4,878,000 acre-feet (see Section 2.0, Surface Water).

Teton Exchange Wells

In the early 1970s, Reclamation drilled five wells to serve the Lower Teton Division of the Teton Basin Project (Figure 3). In 1977, FMID and Reclamation entered into a contract to allow use of the wells as a supplemental water supply in low water years. During low water years, FMID pumps water from the wells into the lower Henrys Fork River, the lower Teton River, and the North Branch Independent Canal to increase the water supply. Although the well water is discharged directly into the Henrys Fork River, it does not provide a net benefit to the instream flows, but replaces storage water that was released from Island Park Reservoir for irrigators downstream from FMID. The five wells provide up to 30,000 acre-feet annually during the irrigation season.

3.0 CURRENT WATER USE

Agricultural Water Use

Irrigated agriculture and its related food processing are the main economic activities in the Henrys Fork River basin (IDWR 1992). The primary crops grown in the Basin Study area are barley, wheat, potatoes, vegetables harvested for sale, and forage (Ag 2007). Livestock water supplies come from irrigation canals or from livestock access to streams and springs in the Basin Study area.

FMID lands encompass areas of Fremont, Madison, and Teton Counties in eastern Idaho. FMID estimates that over 70 percent of the acreage is sprinkler irrigated; the remaining lands are flood or subirrigated. FMID provides a supplemental water supply to some 1,500 water users irrigating over 235,000 acres associated with the original Upper Snake River Storage Division of the Minidoka Project and the Lower Teton Division of the Teton Project (Reclamation 2004). The canals through which FMID water is delivered existed prior to FMID's creation.

The FMID service area is about 220,000 acres, which includes almost all of the irrigated acreages served by the canal system. This acreage all occurs in the Henry's Fork watershed. In addition, there are another 200,000 acres in the watershed that have irrigation water rights, so these lands, in theory, can also be irrigated by water originating in the basin. In practice, the vast majority of the irrigation water applied to lands in the watershed is applied to the FMID lands. However, the total acreage with irrigation water rights in the basin is over 400,000 acres. In addition, because the most senior natural flow water rights in the upper Snake system are downstream of the HF watershed, in effect, the HF watershed provides more irrigation water for irrigation out of the basin than in the basin.

When irrigation diversions begin (as early as April 1), water is available for storage only to the extent that freshet flows exceed the demands of water users with priority water rights. In accordance with spaceholder contracts for reservoir storage, water is stored in a manner that will maximize reservoir storage. Consequently, water physically stored in one reservoir may actually belong to another reservoir.

Four major irrigated regions in the Henrys Fork watershed represent 77 percent (181,000 acres) of the irrigated lands (Figure 8). These four regions currently use over 1.1 million acre-feet of irrigation water (Table 3). Figure 9 shows the average daily flow hydrographs for the four main diversions from the Henrys Fork between St. Anthony and Rexburg: the Egin Canal, the St. Anthony Union Feeder, the Independent Canal, and the Consolidated Farmers Ditch. Average monthly diversions range from a low of 275 cfs during winter months to a high of almost 900 cfs during the irrigation season (Reclamation 2004).

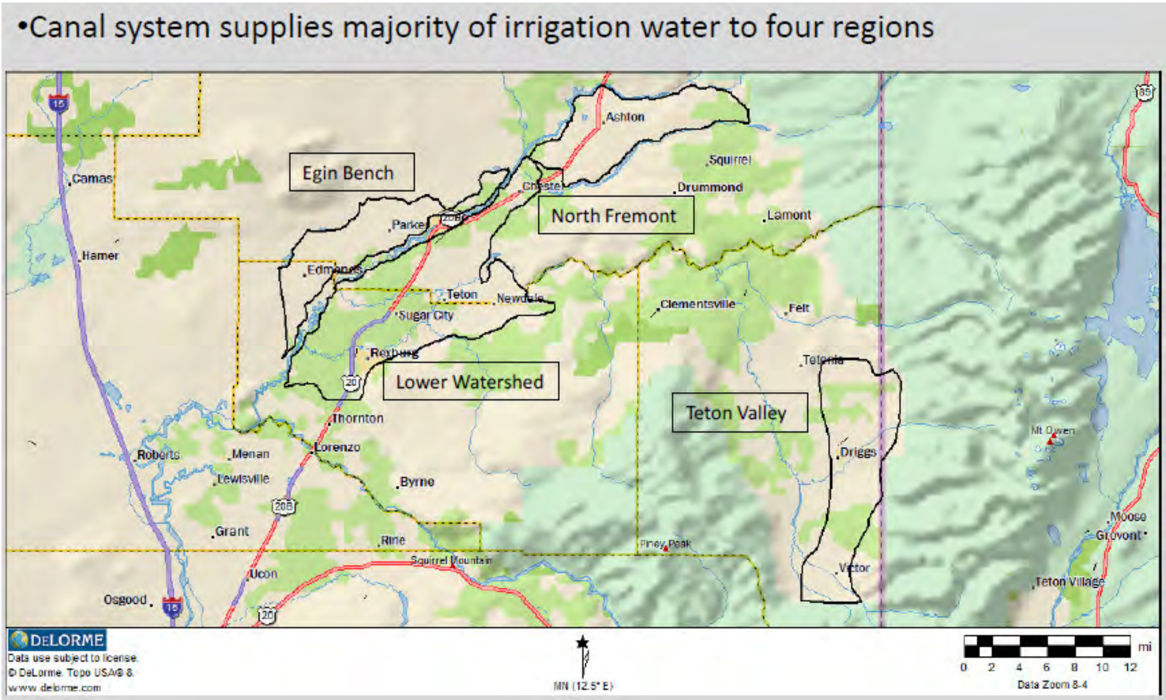


Figure 8. Major irrigated regions in the Henrys Fork watershed by canal zone.

Table 3. Summary of the four canal-irrigated regions.

Region	Irrigated acres	Average Annual Diversion (acre-feet)
Egin Bench	30,500	368,351
Lower Bench	73,000	641,724
North Freemont	32,500	41,681
Teton Valley	45,000	81,161
Totals	181,000	1,132,917

Note: The Four Canal Irrigated Regions represent 181,000 acres which is 77 percent of the Henry Fork watershed's irrigated acreage.

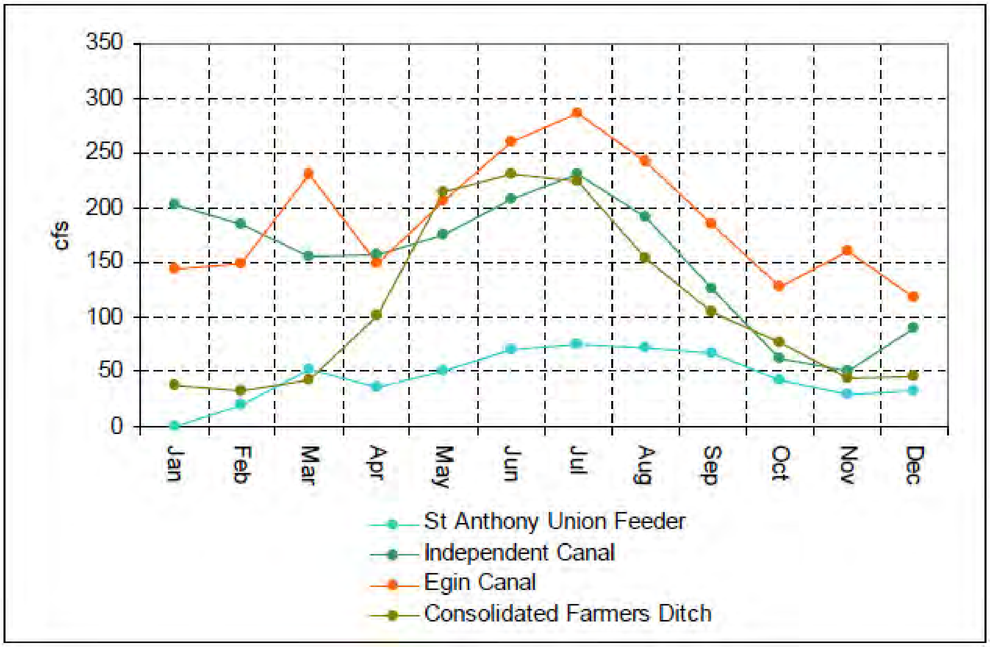


Figure 9. Combined average monthly flow in St. Anthony Union Feeder, Independent Canal, Egin Canal, and Consolidated Farmers Ditch from 1977 to 2002.

The volume of diversions for the remaining 23 percent of the irrigated lands in the Henrys Fork River basin has not been ascertained at this time. Assuming that water use is the same as in the four irrigated regions mentioned in Table 3, an extrapolated estimation would be that 1,471,320 acre-feet (1,132,917 divided by 0.77)) are diverted annually for the irrigated lands in the Henrys Fork River basin.

The Teton Exchange Wells have operated in 10 of the past 25 years, but much more extensively in some years than in others. Two of the wells were used to pump about 800 acre-feet in 1980, whereas all five of the wells were used to pump more than 29,000 acre-feet in 1992, over 27,000 acre-feet in 2001, and nearly 25,000 acre-feet in 2002 (Reclamation 2004).

Domestic, Municipal, and Industrial Water Use

The average county population of the Basin Study area has increased by about 34 percent since 2000, with Fremont County population increasing 7.4 percent, Madison County increasing 39.9 percent, and Teton County increasing 55.7 percent (Census 2011). To meet the needs of the growing population, farms and ranches have been subdivided into housing developments, many of which were platted on lands formerly irrigated for agriculture (Figure 10). The water rights of these lands may have been retained by the seller, sold to the developer, or sold to another user in the same canal company. In any case, the water is still diverted and used in either adjoining land or applied as landscaping water to the new homes. Generally domestic water supply comes from groundwater (Van Kirk 2010a).

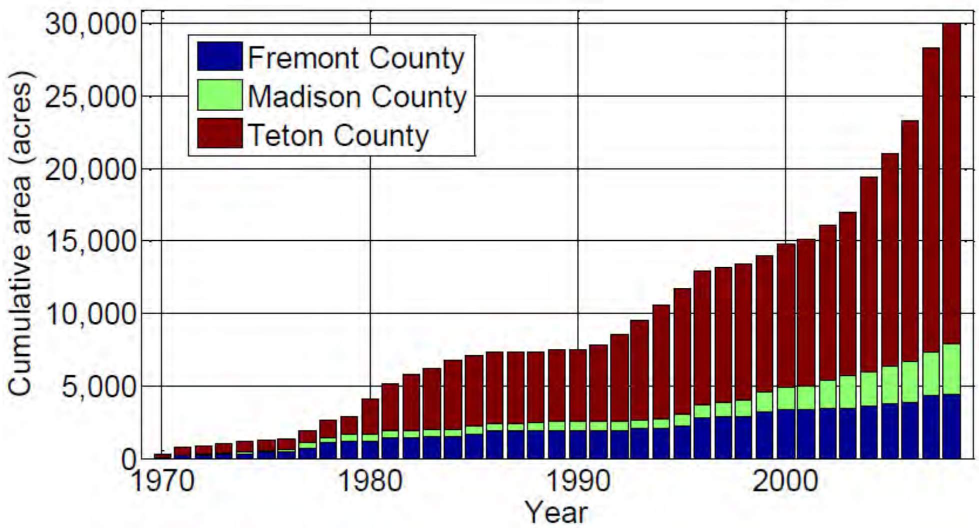


Figure 10. Cumulative area of subdivisions platted since 1970, excluding Island Park. Total irrigated land area in the Henrys Fork watershed is about 275,000 acres (Van Kirk 2010a).

Community water sources are defined as systems that serve at least 25 people or must have 15 service connections (IDEQ 2011a). All but one of the incorporated towns in the Basin Study area relies on ground water to supply their populations, drawing water from the ESPA and the Teton Basin Aquifer (Table 4).

Table 4. Estimated population and water sources of incorporated towns in the three-county area (Census 2011, IDEQ 2011b).

County	Incorporated Towns	Estimated Population in 2009	Change since 2000 Census	Water Source	Aquifer
Fremont	St. Anthony	3,447	+105	ground water	ESPA
	Ashton	1,089	-40	ground water	Teton Basin Aquifer
	Drummond	14	-1	ground water	NA
	Island Park	281	+66	Non-community system; ground water	NA
	Newdale	351	-7	ground water	ESPA
	Parker	317	-2	ground water	ESPA
	Teton	671	+102	ground water	ESPA
	Warm River	10	0	NA	NA
Madison	Rexburg	28,856	+11,599	ground water	ESPA
	Sugar City	1,677	+435	ground water	ESPA
Teton	Driggs	1,439	+339	Surface water and ground water	Teton Basin Aquifer and local watershed
	Tetonia	244	-3	ground water	Teton Basin Aquifer
	Victor	1,883	+1,043	ground water and springs	Teton Basin Aquifer and local watershed
Estimated Totals		40,279	+13,583		

Water for use industrial activities is relatively small when compared to water used for agriculture, but is essential for economic growth and development (Table 5). Madison County is the only county in the Basin Study area that currently has industrial water use (approximately 5.52 acre-feet per day) (USGS 2011b).

Table 5. Estimated domestic, municipal, and industrial uses of water in the Henrys Fork River basin, county-level data for 2005 (USGS 2011b).

		Fremont	Madison	Teton	Totals
Public Supply, total withdrawals from groundwater	Mgal/day	1.93	4.71	1.06	7.70
	acre-feet/year	2,161	5,307	1,186	8,654
Public Supply, total withdrawals from surface water	Mgal/day	0	0	0	0
	acre-feet/year	0	0	0	0
Total industrial water use, self-supplied	Mgal/day	0	1.80	0	1.80
	acre-feet/year	0	2,015	0	2,015
Total withdrawals for irrigation of golf courses	Mgal/day	1.11	0.46	0	1.57
	acre-feet/year	1,245	515	0	1,760
Total withdrawal for livestock	Mgal/day	0.24	0.23	0.20	0.67
	acre-feet/year	270	259	22	551
Total withdrawal for aquaculture	Mgal/day	4.52	0	0	4.52
	acre-feet/year	5,063	0	0	5,063
Total withdrawals for mining	Mgal/day	0.06	0.22	0.01	0.29
	acre-feet/year	66	241	11	318
Total withdrawals	Mgal/day	7.86	7.42	1.27	16.55
	acre-feet/year	8,805	8,337	1,219	18,361

Ecosystem Water Use

Aquatic Species

The Idaho Department of Fish and Game operates the Henrys Lake Hatchery near the town of Island Park. The facility is an egg-taking station only so fish are onsite during the mid-February through April spawning period. During this time, approximately 13 acre-feet a day are required for hatchery operations (Table 5).

The Henrys Fork River basin is renowned for its fisheries of Yellowstone cutthroat trout, rainbow trout, and nonnative brown trout (Figure 11 and Figure 12). While cutthroat trout can be found in all of the locations indicated on the map (Figure 11), most of these occurrences constitute individual fish migrating downstream from headwater populations and do not constitute viable populations. The Idaho Department of Fish and Game, the FMID, and Reclamation work cooperatively to provide winter releases from reservoirs that promote high trout densities and quality fish habitat.

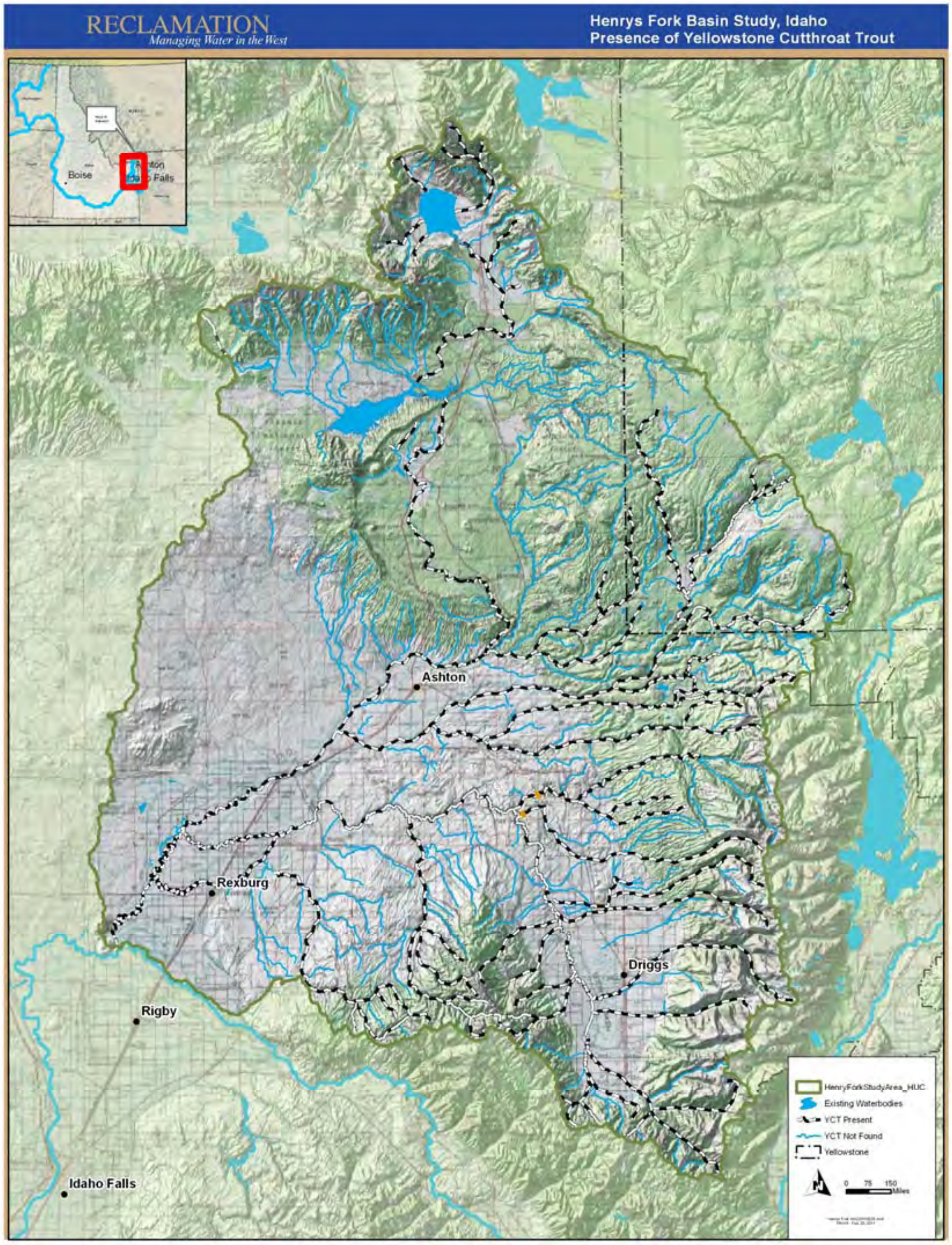


Figure 11. Map showing the presence of Yellowstone cutthroat trout in the Henrys Fork watershed.

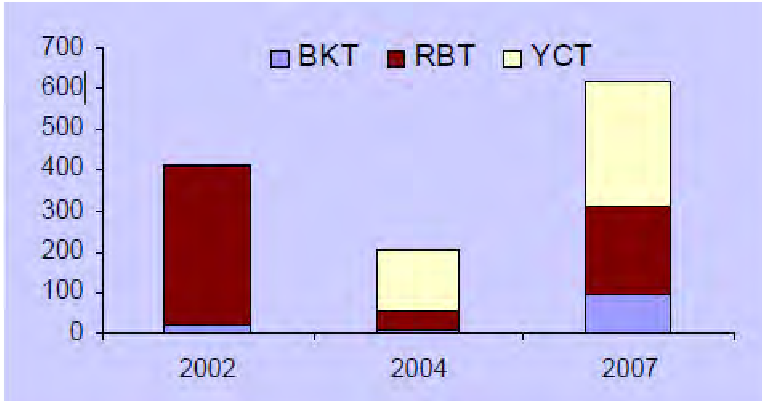


Figure 12. Estimated Abundance (fish per mile) of age-1 and older rainbow (RBT), brook (BKT), and cutthroat (YCT) trout in the Mack's Inn reach of the Henrys Fork River in 2007 (IDFG 2007).

Within the upper Teton watershed, the native Yellowstone cutthroat trout population has decreased in the past 15 years while the nonnative rainbow trout population has grown (Van Kirk 2005). While the causes of the decline in Yellowstone cutthroat trout populations are unclear, anthropogenic activities, the introduction of nonnative fish populations, the prevalence of whirling disease in the lower reaches, loss of habitat, and drought are suspected of contributing to the decline (IDFG 2007). Hydrologic alteration of the rivers by the diversion of flows during the spawning times of the Yellowstone cutthroat trout may have also contributed to their reduced numbers (Van Kirk 2005).

Figure 13 shows the timing of rainbow and cutthroat trout spawning and fry emergence in relation to the peak flows in the South Leigh Creek, Henrys Fork River, and the South Fork Snake River. Nonnative rainbow trout cannot successfully reproduce in streams that have a high peak flow immediately before and during fry emergence because the peak flow displaces eggs and fry. The Yellowstone cutthroat trout fry generally emerge in late summer and early fall when they are not displaced by high flows. The Henrys Fork River hydrograph is representative of ground-water dominated streams throughout the Henrys Fork River watershed upstream of St. Anthony. Peak flows are low during rainbow trout egg incubation and fry emergence; consequently, rainbow trout have displaced cutthroat trout throughout this watershed. Hydrographs for the South Fork Snake River and Teton River at South Leigh are representative of snowmelt-dominated streams throughout the Snake River watershed upstream of Palisades Reservoir. Peak flows are high during rainbow trout egg incubation and fry emergence. It is assumed that this is why rainbow trout have been less successful in invading those rivers.

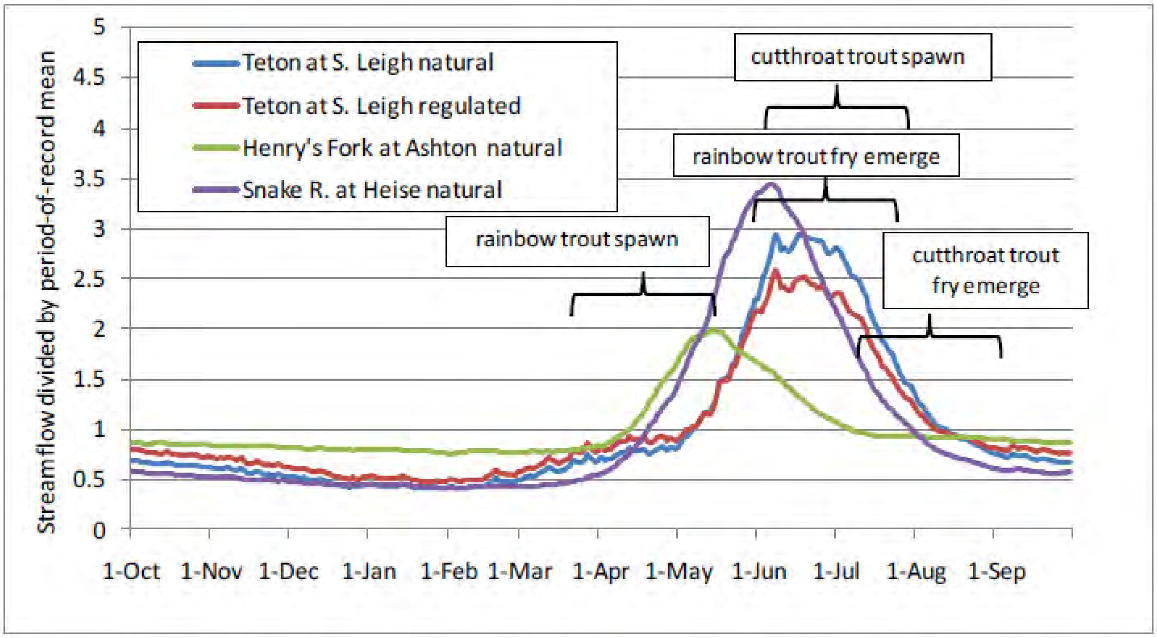


Figure 13. Mean hydrograph over water years 1972-2003 for Henrys Fork River basin streams (natural and unregulated), with spawning and fry emergence timings for rainbow trout and cutthroat trout shown (Van Kirk 2010a).

The minimal stream flow is the amount of flow necessary to preserve desired stream values such as fish and wildlife habitat, aquatic life, recreation, water quality, and aesthetic beauty. In the Henrys Fork basin, the Idaho Water Resource Board holds minimum stream flow water rights on the Henrys Fork, the Warm River, Bitch Creek and the Teton River. Recommended minimum flow amounts have been planned by the Idaho Department of Fish and Game (IDFG 1999 and IDFG 1978) and the Snake River Resources Review panel (SR3 2001).

Fisheries in the Henrys Fork River basin may suffer from drought-induced drawdowns of Island Park Reservoir which eliminates most of the summer benthic invertebrate production in that pool; low fall-winter flows in the river below Island Park Dam and below Henrys Lake; and late summer flows in the Henrys Fork River below St. Anthony and in the lower Falls River as irrigation water is diverted. Reclamation cooperates with the Idaho Department of Fish and Game to minimize these impacts.

Avian Species

The Henrys Fork River basin is located along a portion of the Pacific waterfowl flyway. Over a million waterfowl migrate through the area in spring and in fall, with large concentrations of ducks and geese around Island Park Reservoir and Henrys Lake. Trumpeter swans utilize the open waters of the Henrys Fork River basin, which is the primary wintering area for most of Canada's trumpeter swan population. While no longer listed as endangered or threatened, their populations are still rebuilding (IDWR 1992).

Releases from Island Park Dam are sometimes made for the fish and swan habitat at the request of the Idaho Department of Fish and Game and the Henrys Fork Foundation. If stored water is available in the reservoir, the water may be released to break up ice if low temperatures freeze the river. Reclamation consults with the Idaho Department of Fish and Game to determine the ramping rates during those releases to limit damage to fish and swan habitat. In years with low autumn flows, releases from the dam may be reduced to 180 cfs to increase the possibility early freezing of the river to encourage the swans to migrate elsewhere while they have the energy reserves to do so. Meetings between the FMID, Idaho Department of Fish and Game, Reclamation, Henrys Fork Foundation, and other interested entities are held to determine the flow needs for the Henrys Fork River in relation to fish and swam habitat needs and the availability water supplies (PFC 2002).

Surface and Groundwater Interactions

The Henrys Fork River watershed exhibits a high degree of interaction between surface water and ground water, both spatially and temporally. A localized shallow aquifer system connects to the Henrys Fork River above its confluence with the Snake River. There is also limited interaction between surface and shallow ground water flows in the Henrys Fork River and the ESPA. Peak water flows generally occur in early summer (Figure 14).

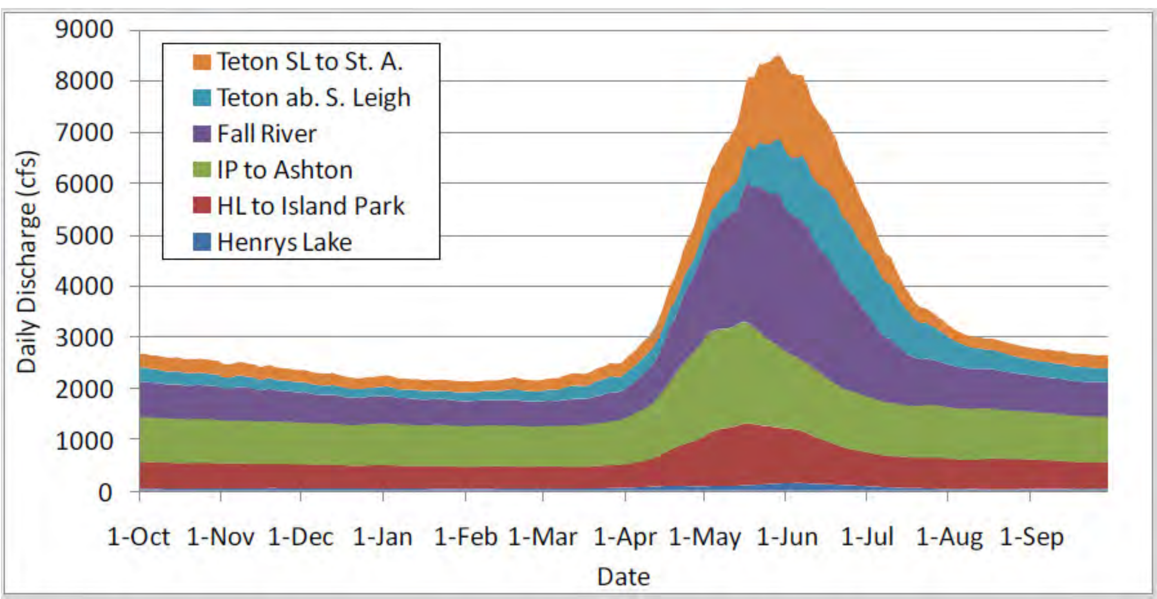


Figure 14. 30-year mean water supply hydrograph, 1979-2008 (Van Kirk 2011).

Van Kirk (2005) estimates that during the irrigation season, 10 to 100 percent of the tributary flows into Teton Valley are diverted for irrigation use. Ground water discharge that results from irrigation recharge increases river flows during the winter; however, with the advent of sprinkler irrigation practices, the winter flows have declined (Van Kirk 2005).

More than 10 percent of all tributary underflow to the ESPA comes from irrigation activity within the Henrys Fork basin. Some estimates (Johnson, Sullivan, Cosgrave, Schmidt 1999) are as high as 58 percent. Recharge from the Henrys Fork enters the upper end of the ESPA, upstream from nearly all points of use. In addition to the ESPA recharge from irrigation, the Henrys Fork River basin contributes to the recharge of regional aquifers from precipitation, percolation from streambeds, and ground water underflow from neighboring highlands (Reclamation 1991).

Summary of Current Water Use

As shown in Table 5, over 3,335 acre-feet of ground water and surface water are used daily in Fremont, Madison, and Teton counties for a wide range of purposes; however, not included in that table are the requirements for sustaining fish species and other aquatic life in the river systems. Table 6 summarizes the estimated water use, including the environmental uses in the basin.

Table 6. Summary of estimated current water use in the Henrys Fork watershed.

	Volume per year (acre-feet)
Agriculture	1,417,320
Domestic, commercial, municipal, & industrial water	18,361
Environmental uses	Various recommendations

4.0 FUTURE WATER NEEDS

Looking 40 years in the future, economic issues relating to irrigation, recreation, and associated businesses will require dependable water supplies. Socially, the Henrys Fork watershed has world-renowned rainbow trout streams that are of national importance. A more reliable water supply should increase Island Park hydroelectric output, provide irrigation benefits during periods of drought, provide a stable water supply for municipal/domestic and industrial needs, maintain current (near natural) peak flows in the Henrys Fork River, and protect fisheries habitat.

Potential Climate Change Impacts

Reclamation, the Bonneville Power Administration, and the Corps of Engineers collaborated to adopt climate change and hydrologic datasets to better understand how potential changes in water supply due to climate change may affect reservoir operations in the Columbia River Basin. Output (e.g., temperature, precipitation) from Global Climate Models (GCMs) was spatially downscaled and bias corrected, then used in a hydrologic model that generated supply or flow values at various locations in the CRB. Those supply data were provided to the stakeholders for use in their long-term planning models for several basins, including the Snake River basin where the Henrys Fork watershed is located. This section focuses on the climate change study that was completed for the Snake River above Brownlee Reservoir. The entire Snake River basin above Brownlee Reservoir, including the Payette and Boise rivers, was modeled; however, the only location at which detailed calibration occurred was at Brownlee Reservoir. While the Henrys Fork watershed was modeled, it would need to be calibrated and climate change projections reevaluated for results specific to the watershed.

The climate projections were selected at the Columbia River Basin scale based on a desired range of precipitation and temperature change. However, when those same projections were viewed at the Snake River basin scale, most of them were skewed toward wetter conditions in the future. Based on the GCMs selected, the Upper Snake River basin is projected to experience warmer (0.5 to about 2 degrees Fahrenheit (˚F) warmer in the 2020s scenarios and 1˚F to 3˚F in the 2040s scenarios) and wetter conditions in some cases (5 percent decrease to 10 percent increase in the 2020s and a 5 percent decrease and 15 percent increase in the 2040s) as compared to historical conditions (Reclamation 2011).

Several metrics were evaluated to better understand the potential impacts of the selected GCMs on the Upper Snake River basin. These metrics included inflow to reservoir groups, surface water delivery, and flow augmentation among others. Inflow was summed for all of the reservoirs in the Upper Snake River above Brownlee Reservoir. The model indicated a shift in the timing of the peak flow and an increase in volume in most locations. The timing of peak inflow generally shifted a month earlier and flow volume increased above historical flows in the earlier, cool season part of the year (October or November to April) and decreased in the summer and fall seasons (May through September or October). This shift in timing and increase in inflow volume earlier in the year resulted in an increase in the end-of-month storage earlier in the year and a greater need to draft reservoirs to provide irrigation water later in the summer months (Reclamation 2011).

A decrease in surface water delivery also occurred in the latter part of the irrigation season or warmer months (Reclamation 2011). A decrease in instream flow in the late summer to early fall months would result in less water available for natural flow diversions and an increased need for stored water.

Environmental objectives for both anadromous and resident fish species were evaluated as well. In some of the reservoirs that require minimum pools or flows, it was found that in some cases it may be more difficult to meet these objectives in some of the reservoirs in the driest conditions (Reclamation 2011).

Agricultural Water Needs Assessment

Analysis of actual irrigation diversions in recent years indicates that irrigators in the Henrys Fork River basin do not have a sufficient water supply during average and less than average water years. The extent of shortages varies between individual canal companies that make up the FMID. About half of the district lands currently experience shortages during drought periods; shortages vary from 20 to 80 percent for individual canal companies. The Teton Exchange wells are located at the lower end of the basin; therefore, supplemental water from the wells is not available in the areas with the greatest unmet irrigation demand. Since no increase in irrigated acreage is likely, the current needs are expected to be the same as the future needs.

About half of the irrigated lands currently experience shortages during drought periods; shortages vary from 20 to 80 percent for individual canal companies (Table 7). The Teton Exchange wells are located at the lower end of the basin; therefore, supplemental water is from the wells is only available to the downstream-most areas.

Table 7. Current unmet irrigation needs of the four canal-irrigated regions (Van Kirk 2011)

Region	Crop Demand ET acre-feet	Average Applied ET acre-feet	Unmet Irrigation Demand acre-feet
Egin Bench	68,670	68,120	550
Lower Bench	163,123	158,053	5,070
North Fremont	76,267	17,938	58,329
Teton Valley	106,596	39,222	67,374
Totals	414,656	283,333	131,323

Assuming that water use is the same as in the four irrigated regions mentioned in Table 3, an extrapolated estimation would be that there are 170,549 acre-feet (131,323 divided by 0.77) of unmet irrigation demand for the irrigated lands in the Henrys Fork River basin.

Domestic, Municipal, and Industrial Water Needs Assessment

According to USGS (2011), each person uses 80 to 100 gallons of water per day for normal household activities. Assuming a continued 2 percent annual population growth over the next 40 years, the population and subsequent municipal and household demands would double to 36,722 acre-feet annually (Table 8).

Table 8. Historic growth in the three-county area.

County	Population Growth Rate 1980-2006	Annualized Growth Rate 26 Years	Percent of Population in Henrys Fork Basin	Basin - Prorated Population Growth Rate
Freemont	14.4%	0.5%	24	0.12%
Madison	61.2%	1.85%	61	1.13%
Teton	170.6%	3.9%	15	0.59%
Estimated Basin Population – Annual Growth Rate 1980-2006				1.84%

Conversion of irrigated lands to housing developments or other non-agricultural uses could reduce diversions from streams, which could also reduce recharge amounts from canal seepage. Idaho State Water Law does not address or provide a mechanism for leasing excess flow in order to restore instream habitat or provide other benefits (Van Kirk 2010b).

The Henrys Fork River basin lies in the "non-trust water area" as designated by the Idaho Department of Water Resources. Water rights from the Snake River in the non-trust area are not fully satisfied at certain times. For any new consumptive use of water, applicants must demonstrate to the State of Idaho that their new diversion and consumptive use of water will not injure other rights or that mitigation can be done during times that injury would otherwise occur. The interconnection between surface and ground water in the area must be considered and addressed in any proposal. These criteria may limit new water supplies in the future for municipalities and industry.

Environmental Needs Assessment

Fish Species

As mentioned in Section 3.0, there are several recommendations for minimum flows in the Henrys Fork River basin for the benefit of aquatic species and their habitats.

Avian Species

Trumpeter swans feed on the macrophytes found in the Henrys Fork River below Island Park Dam. Idaho Department of Fish and Game suggests that between 5,000 and 10,000 acre-feet of water in Island Park Reservoir storage, if available, could benefit the downstream trumpeter swan habitat during the winter. Managed winter flows could reduce ice formation and dewatering of macrophyte beds; however, ice could still form in very cold temperatures. Storage releases between late-January and April 1 may also benefit the trumpeter swans in the river below the dam by breaking up ice on the river in late winter (PFC 2002).

Other Future Needs in the Upper Snake River Basin

Eastern Snake Plain Aquifer (ESPA)

Of the 2.1 million acres on the ESPA, 871,000 are irrigated by surface water, 889,000 acres are irrigated from ground water, and 348,000 acres are irrigated from both sources. Additionally, municipalities, food processing facilities, aquaculture facilities, hydroelectric power generation, recreation, and fisheries are dependent on surface and ground waters within the Eastern Snake Plain (IDWR 2009).

Declining aquifer levels and spring discharges, changing flows in the Snake River and actions that have placed new demands on already scarce water supplies (e.g., flow augmentation for anadromous fish survival) have resulted in insufficient supplies to satisfy existing beneficial uses across the Upper Snake River basin. A series of water use conflicts that had the potential to severely disrupt the economy of the Eastern Snake Plain region led to the development of the ESPA Comprehensive Aquifer Management Plan (CAMP) which was approved as a component of the State Water Plan by the 2009 Idaho Legislature. The CAMP recognized an annual water budget deficit in the ESPA of 600,000 acre-feet, and established a long-term goal to adjust this deficit by implementing a mix of management strategies over a 20-year period at an estimated cost of $600 million. The following management strategies were identified in the ESPA CAMP:

- Ground water to surface water conversions: the Phase 1 target (1 to 10 years) was 100,000 acre-feet
- Aquifer recharge: the Phase 1 target was 100,000 acre-feet
- Demand reduction: the Phase 1 target was 95,000 acre-feet
- Pilot weather modification program: the targeted Phase 1 volume was 50,000 acre-feet

The ESPA CAMP and the long-term objective to adaptively manage and improve the conditions of the aquifer was developed collaboratively by the ESPA Advisory Committee following several years of detailed technical analysis and review.

The Idaho Water Resource Board (IWRB) operates a Managed Aquifer Recharge Program in the ESPA. Since 2008, IWRB-sponsored managed recharge in the ESPA totaled almost 191,000 acre-feet at a cost of approximately $477,000.

FMID and its member canals participate in the IWRB's Managed Aquifer Recharge Program. Under contract with the IWRB, FMID recharges prior to and after the irrigation season. Recharge occurs as a result of seepage from water diverted into canals and by direct delivery to the Egin Lakes recharge site. In both situations, water passively infiltrates into the ESPA. Since 2008, FMID has recharged an estimated 91,081 acre-feet (Table 9; IDWR 2010).

Table 9. Annual ground water recharge volumes since 2008 (IDWR 2010).

	2008 (acre-feet)	2009 (acre-feet)	2010(acre-feet)
FMID recharge	4,860	36,755	49,466

The IWRB's Managed Aquifer Recharge Program provides a mechanism to evaluate and support the development of new projects with the potential to provide basin-wide and localized benefits. The program seeks to balance the effects of recharge across the ESPA based on hydrologic data, regulatory requirements, and funding constraints.

Summary of Estimated Water Needs

The impacts of future climate change are uncertain. On-going research indicates that the Henrys Fork River basin may experience warmer temperatures and slightly higher precipitation amounts. There may be a shift in the timing of peak/low flows to earlier in the year and the predicted warmer temperatures could extend the irrigation season to later in the year.

Table 10. Summary of future water needs.

	Current Water Use (acre-feet)	Projected Future Use (acre-feet)	Future Unmet Water Needs
Agriculture	1,417,320*	1,587,869	170,549
Domestic, commercial, municipal, & industrial needs**	18,361	36,722	18,361
Environmental needs	Various Recommendations	Various Recommendations	Various Recommendations
ESPA (long-term target to be met through a mix of strategies)			600,000

*this is the current irrigation water diversion. The estimated future unmet need is the same as the current unmet need.

**estimated doubling over 40 years based on past population growth and current water use.

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