Idaho Department of
Environmental Quality

Mason Creek Subbasin Assessment

December 2001

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Executive Summary

The Mason Creek subwatershed drains 62 square miles of rangeland, agricultural land and urban areas. Mason Creek is located in the southern portion of the lower Boise River watershed, which is located in southwest Idaho. Mason Creek largely flows through Canyon County, but the headwaters are located in Ada County. The stream flows in a northwesterly direction from its origin at the New York Canal to its confluence with the lower Boise River in the city of Caldwell.

Section 303(d) of the Federal Clean Water Act requires states to develop a Total Maximum Daily Load (TMDL) allocation plan for water bodies determined to be water quality limited. A TMDL allocation plan documents the amount of a pollutant a water body can assimilate without exceeding a state's water quality standards, and allocates that amount as loads to point and nonpoint sources. TMDLs are defined in 40 CFR Part 130 as the sum of the individual Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for nonpoint sources, including a margin of safety and natural background conditions. If the water body is impaired by a section 303(d) listed pollutant, a TMDL and additional pollution control measures may be necessary. The section 303(d) listed pollutants in Mason Creek are sediment, nutrients and dissolved oxygen.

Mason Creek is not designated for beneficial uses in the water quality standards. For undesignated waters, the presumed uses are cold water biota and secondary contract recreation, unless analysis shows other uses are more appropriate. Using CH2M Hill as a contractor, the Lower Boise River Water Quality Plan performed a detailed beneficial use evaluation for Mason Creek in order to characterize the appropriate beneficial uses for a highly regulated, irrigation driven system. The analysis shows that modified aquatic life and secondary contact recreation represent the best attainable beneficial uses in Mason Creek. The modified aquatic life use describes streams that are limited in aquatic life diversity due to factors such as ephemeral or intermittent flow, naturally occurring pollutant levels or long-standing hydrologic modification. Water quality criteria for dissolved oxygen, pH and temperature were developed to accompany the modified aquatic life use.

Using literature-based algal biomass levels and total suspended sediment concentrations as surrogates to beneficial use support status, the data show that nutrients (total phosphorous) and sediment (total suspended sediment) are not impairing modified aquatic life or secondary contact recreation. Surrogates provide an expression of water quality condition in instances where numeric water quality criteria do not exist, as with nutrients and sediment. Dissolved oxygen concentrations and pH levels are also within the criteria ranges, further indicating that aquatic life beneficial uses are not impaired. Due to the lack of beneficial use impairment, TMDLs for sediment, nutrients and dissolved oxygen are not required for Mason Creek and DEQ will recommend de-listing during the 2002 303(d) listing cycle.

Bacteria are not listed as a pollutant of concern in Mason Creek. However, the data show that E. Coli are exceeding the state standard at all locations in the stream. DEQ recommends listing Mason Creek for bacteria on the 2002 303(d) list and establishing a TMDL schedule.

The Snake River-Hells Canyon TMDL is scheduled to be complete in December 2001. Nutrients and sediment are listed as pollutants of concern in the TMDL and will be addressed by assigning load allocations to the major tributaries to the Snake River, including the lower Boise River. When the Snake River-Hells Canyon TMDL allocates a nutrient load to the lower Boise River, load reductions from the tributaries to the lower Boise River will be necessary to meet the Snake River-Hells Canyon allocation to the lower Boise River. A nutrient load allocation will likely be given to Mason Creek and additional reductions will be necessary.

An implementation plan is currently being developed by the Lower Boise River Watershed Advisory Group and supporting agencies to specify the activities needed to meet the sediment and bacteria load allocations identified in the 2000 sediment and bacteria TMDLs for the river proper. The implementation plan will also have placeholders to address nutrient reductions when they become necessary. Upon completion and implementation of the plan, any necessary reductions from Mason Creek will be achieved.

Subbasin Watershed Characterization

Mason Creek is located in southern portion of the lower Boise River watershed (Hydrologic Unit Code (HUC) 17050114). The lower Boise River watershed is located in southwest Idaho (Figure 1). The Mason Creek subwatershed drains 62 square miles of rangeland, agricultural lands, and urban areas. Mason Creek is a 17.75 mile system that flows through Ada and Canyon counties and the cities of Nampa and Caldwell, Idaho (Figure 2). The creek flows in a northwesterly direction from its origin at the New York Canal to its confluence with the lower Boise River southeast of Caldwell.

Topography in the subwatershed is relatively constant, consisting primarily of gradual drops in elevation as the creek flows down several step-like terraces to its confluence with the lower Boise River. Elevation in the subwatershed ranges from 2770 feet at the New York Canal to 2390 feet at the confluence with the lower Boise River. Relief varies according to topography; the terraces are generally level while the drop down to the next terrace ranges from 3.0% to 0.4% slopes.

Geology

Mason Creek lies within the western Snake River Plain. The multiple terraces that developed throughout the Quaternary period comprise much of the subwatershed. All terrace deposits are pebble to cobble gravel with a coarse sand matrix. Thin wind-blown deposits of loess differentially cover the terrace surfaces. Shield volcanoes, basaltic cones, and lava flows bound and cover the subwatershed. Some basalt flows bury former alluvial surfaces and all flows are differentially covered by thin loess deposits (Othberg, 1994).

Soils are derived predominantly from river and wind born materials. The soils generally have weakly developed profiles, are unleached, alkaline, and have high natural fertility. Soil textures found in the subwatershed are silty and sandy loams in the lower portion and loamy sands and sandy loams in the upper portion (Collett, 1980).

Climate

Climate within the subwatershed is temperate to arid. The summer months are hot and dry while the winters are cold and wet, though generally not severe. The average maximum summer temperature during the period of 1940 - 2000 was 83.9 F in Boise. The average minimum winter temperature in Boise from 1940 -2000 was 25.9 F (Climate Data Center, 2000). The average annual precipitation during the period of 1940 - 2000 in Boise (23 miles east of Caldwell) was 11.9 inches (Climate Data Center, 2000). Most precipitation falls during the colder months. Snow accumulation is typically light and usually melts shortly after it falls.

Surface Hydrology

An intricate system of inputs and withdrawals in combination with the local flood control policies in the lower Boise River watershed have significantly altered the flow regime and

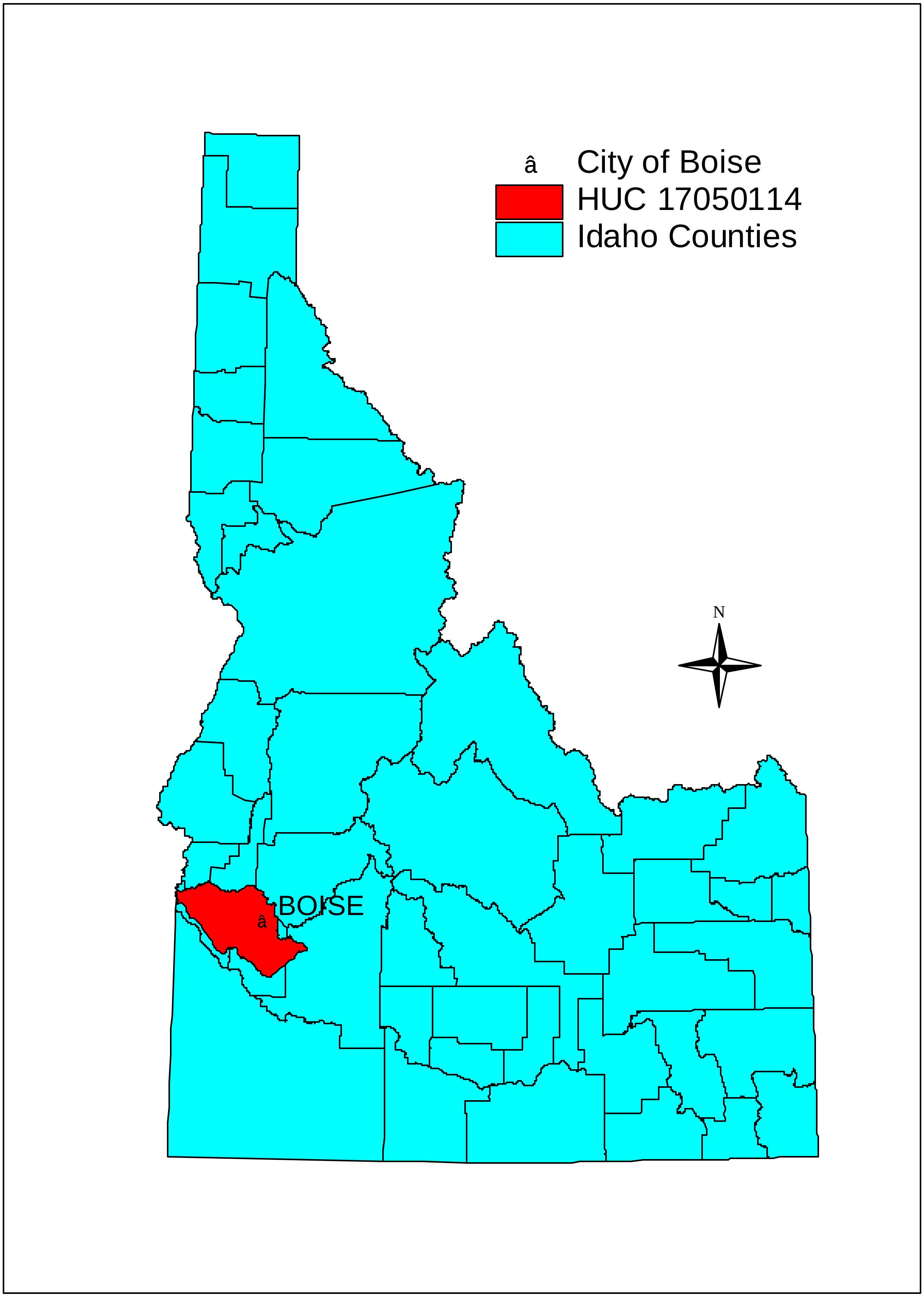


Figure 1. Lower Boise River Watershed

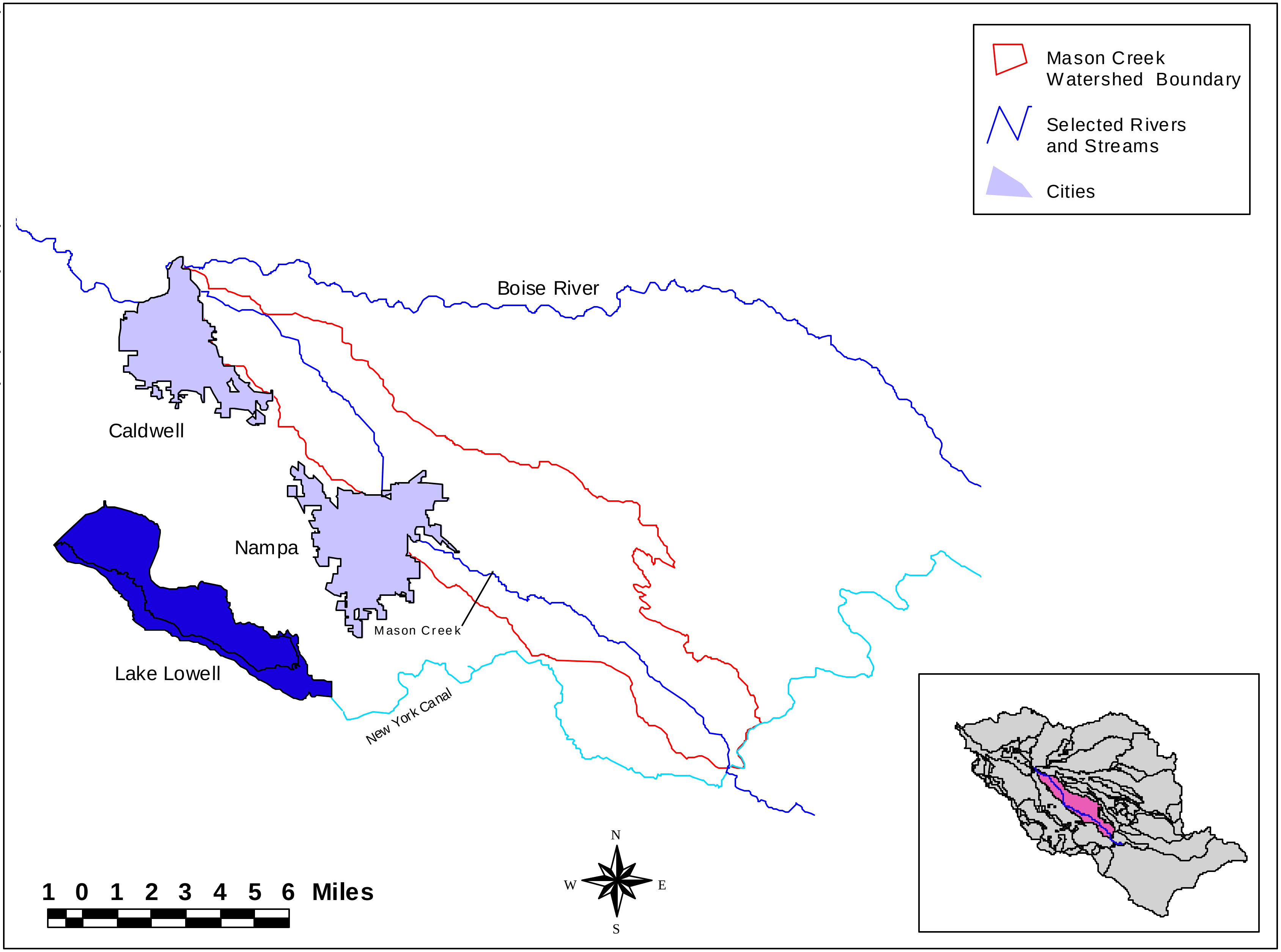


Figure 2. Mason Creek Subwatershed

the physical and biological characteristics of Mason Creek. Historically, Mason Creek did not exist as it does at present time. Around 1891 a reservoir named Lake Ethel was present at the current site of Lakeview Park in Nampa. The reservoir was formed by damming the Mason Creek drainage and was probably a result of the completions of the Phyllis Canal (1890) and the Ridenbaugh Canal (1891).

Lucky Peak Dam, the structure controlling flow at the upstream end of the lower Boise watershed, was constructed and began regulating flow in 1957. Water is released from the reservoir to the lower Boise River just a few miles upstream from Boise. Water releases from the reservoir are managed primarily for flood control and irrigation, which directly effects the hydrology of Mason Creek. Other management considerations that have less of an effect on Mason Creek include power generation, recreation, and maintenance of minimum stream flows during low flow periods and release of water to augment salmon migration flows in the Snake River. Figure 3 shows mean monthly flows for the Boise River below Lucky Peak Dam, United States Geological Survey (USGS) Station 13202000, before construction of Lucky Peak Dam and under current regulated flow conditions. Flow regulation for flood control has replaced natural, short duration (two to three months), flushing peak flows with longer (four to six months), greatly reduced, peak flows. Water management has increased discharge during the summer irrigation season and significantly decreased winter low flows.

The regulated annual hydrograph for Mason Creek below the New York Canal can be divided into two flow regimes. Low flow conditions generally begin in mid-October when the irrigation season ends. The low flow period extends through the winter until the irrigation season flow regime begins again in late April. Figure 4 shows the mean monthly flow in Mason Creek at the mouth and at Lakeview Park in Nampa. The data acquisition process for Mason Creek is relatively new. For that reason, there is very little flow data available for Mason Creek. However, due to the highly regulated nature of Mason Creek, this flow regime is likely static from year to year.

During the irrigation season, the New York Canal diverts water from the Boise River above Boise to irrigate fields along the south side of the river, where Mason Creek is located. The New York Canal directly discharges to the Mason Creek Feeder during the irrigation season. The Mason Creek Feeder flows for approximately 9.3 miles before nearly all of the water is diverted into the Ridenbaugh Canal. A small amount of water seeps through the diversion structure into Mason Creek, but the amount is not measurable. During the non-irrigation season, when the New York Canal is dry, the Mason Creek Feeder is dry as well. The Mason Creek Feeder is a purely man-made structure that is concrete lined in many locations. While the historical records are not conclusive in defining the natural headwaters of Mason Creek, under current management activities, the location at which the New York Canal discharges to the Mason Creek Feeder best describes the stream headwaters.

Dating as far back as 1916 (Paul, 1916), irrigation practices have altered drainage patterns in Mason Creek. In many cases, water does not follow natural drainage paths. The natural drainage area in much of the lower portion of the subwatershed has been deepened, lengthened, straightened, and diverted while drains, laterals, and canals have been constructed. The stream alterations and man-made waterways have created new drainage areas that are significantly different from the natural subwatershed areas. The current drainage area was delineated in 1997 by the Soil Conservation Commission. The drainage area delineated by the commission is used for this assessment because it accurately identifies the lands that drain to Mason Creek.

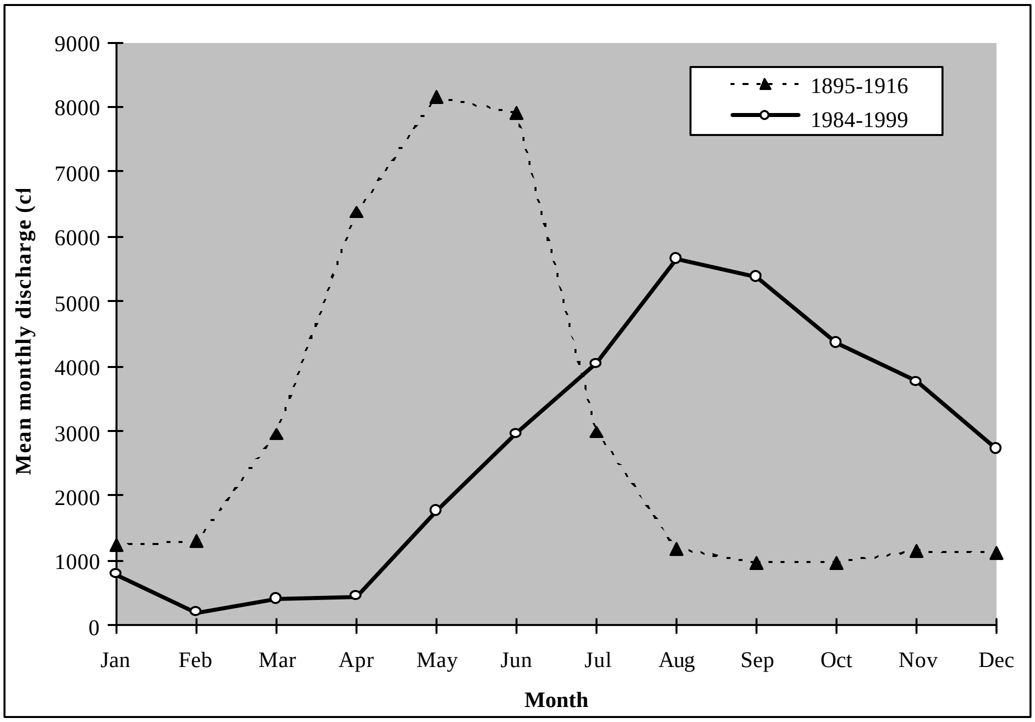


Figure 3. Regulated and unregulated mean monthly discharge in the Boise River near Boise, USGS gaging station 13202000.

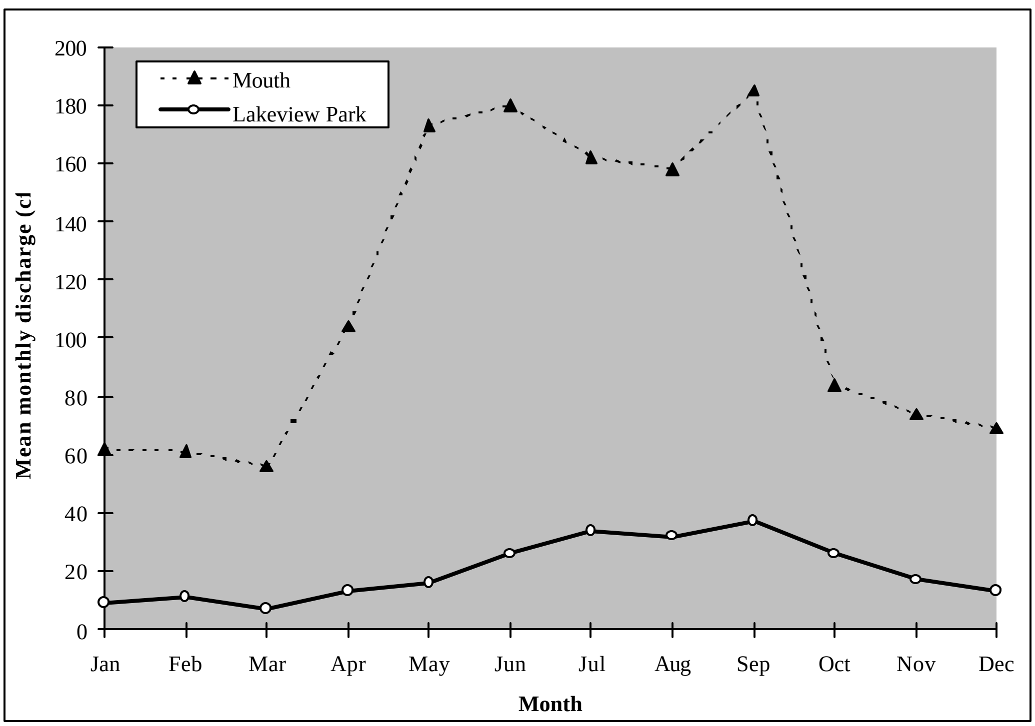


Figure 4. Mean monthly flow in Mason Creek at Lakeview Park and the mouth, 1998-2000

The repeated use and reuse of water in the subwatershed is a complicating factor in determining the fate of pollutants when they are discharged to the stream and the effects of pollutant reductions at different locations. The shear number of canals and laterals in the subwatershed suggest the complexity of interpreting flow conditions and pollutant fate.

From a surface hydrology standpoint, Mason Creek can be divided into two sections. From the New York Canal to the Ridenbaugh Canal (9.3 miles), the stream is intermittent. Water is present in this segment of the stream only during the irrigation season (April – October). From the Ridenbaugh Canal to the Boise River (8.5 miles), the stream is perennial. The high water table in this portion of the watershed and the deep stream channel creates a system that is constantly recharged by ground water, even in the winter. During the irrigation season the flow in Mason Creek at the mouth is nearly triple that of winter base flows, primarily due to an extensive network of agricultural return flows to the creek.

According to IDAPA 58.01.02.070.07 water quality standards apply to intermittent waters during optimal flow periods sufficient to support the uses for which the water body is designated. Mason Creek from the New York Canal to the Ridenbaugh Canal is a man-made structure that exists only to convey water.

Groundwater Hydrology

A deep, semi-confined to confined Idaho Group aquifer underlies the Mason Creek subwatershed. The boundaries of the confined, semi-confined, and unconfined aquifer system are related to changes in the types and occurrence of lake and river sediments, and crustal faulting. Primary water yielding strata are interbedded sand, silt, and claystone of the Idaho Group (Squires and others, 1992). Studies by Dion (1972) and Burnham (1979) show canal seepage and irrigation application as a source of recharge to the shallow aquifer.

Historically, ground water levels in the subwatershed were lower than they are today. Starting as early as the 1860's, farmers in the valley started diverting water from the river for irrigation. As the extent of irrigated area increased, large amounts of water were applied to the surface by flood or furrow irrigation methods and ground water levels rose by tens of feet. High ground water levels began to interfere with soil and crop health. In response, numerous drains were constructed and existing ephemeral drainage ways were deepened and widened in the early 1900's to drain excess ground water.

Ground water levels have been relatively stable or slightly declining since the many drains and wells were dug back in the 1910's and 1920's . Recent studies by Squires and others (1993) and Tungate and Berenbrock (1995) show declining water levels in the Boise City area (~25 miles east). Ground water table maps show an average decline of ten feet in 90% of the Boise City area during the period of 1970-1992 (Tungate and Berenbrock, 1995). A slight increase was noticed in five small areas around the Boise River and Boise Front. These declines have been attributed to increased ground water withdrawals and artificially induced ground water gradients from long-term wells in southeast Boise and to the west (Squires and others, 1993).

From New York Canal to the Ridenbaugh Canal, the Mason Creek Feeder neither gains or loses much ground water. This is due to the mostly armored nature of the feeder. From the Ridenbaugh Canal to the Boise River, the stream primarily gains ground water, even in the winter. This high water table in combination with the deep stream channel allows for a near constant ground water re-charge in Mason Creek.

Channel and Substrate Characteristics

The Mason Creek subwatershed is moderately narrow, sloping gently to the northwest as it flows toward the lower Boise River. The stream channel can largely be classified as a Rosgen type F from its headwaters to the Boise River. The F type channel is deeply entrenched, low gradient (<0.02), has a high width/depth ratio, and a riffle/pool morphology (Rosgen, 1994). The entrenched aspect of the channel has been amplified by the extensive deepening and widening that occurred in the early part of the century.

The streambed from the New York Canal to the Ridenbaugh Canal ranges from sand-size (<2 mm) material to large cobble (128.1-256 mm). From the Ridenbaugh Canal to Boise River the streambed is primarily sand and silt (<2.5 mm) with a few highly dispersed cobble and gravel areas. At most locations, the cobbles and gravels are severely embedded. The banks are typically stable and steeply sloped due to past and current maintenance work by the irrigation districts.

Mason Creek exhibits other characteristics typical of a stream with regulated flow. The numerous man-modified portions of the stream along with the regulated irrigation flow have caused a narrowing and straightening of the stream channel. Braiding and sinuosity caused by divergent and out of bank flow events are largely absent. Regulated flow and the ongoing conversion of riparian areas to residential and commercial uses have essentially eliminated the floodplains in the lower portion of the stream. These factors have resulted in changes in stream morphology, hydrology and water quality. In many locations, the banks have been armored to prevent loss of land during high irrigation flow conditions.

Terrestrial and Aquatic Wildlife Characteristics

Mason Creek and the lands adjacent to it are home to numerous species of wildlife. The stream corridor is home to several species of waterfowl, including ducks and geese. In addition, several mammal species live on or near Mason Creek. These include fox, rabbit, beaver, muskrat, and other mammal and fowl species.

The United States Bureau of Reclamation (USBR) has indicated that numerous game and non-game fish species were historically found in Mason Creek, although no quantitative estimates or observation dates were noted. No fish electrofishing surveys have been conducted in Mason Creek, but antecdotal evidence from local landowners indicates that rainbow trout are present during the fishing season. Idaho Fish and Game has stated that information exists on file that shows rainbow trout resided in the creek before November 28, 1975 (IDFG written communication, 1997).

Cultural Characteristics

The Boise River valley and Mason Creek was first explored in 1811 by overland explorers of John Jacob Astor's Pacific Fur company. The Boise valley was settled in 1863. Gold discoveries in 1862 in the nearby mountains prompted the founding of Boise City.

The subwatershed began to change with the coming of the Oregon Shortline Railroad in 1887 and completion of the Phyllis and Ridenbaugh Canals in 1890 and 1891 respectively. The canals provided water to the southern portion of the Boise River and enabled settlement beyond the river bottomlands. By 1900 it is estimated that 465 miles of canals, ditches, and laterals had been constructed in the Boise Valley, capable of serving 100,000 acres of land (United States Bureau of Reclamation, 1996), many of those within the Mason Creek drainage. The federal Reclamation Act of 1902 allocated funds to support the Boise Project (1904), that allowed further reclamation of the Boise Valley. The Boise Project, overseen by the U.S. Bureau of Reclamation, included construction of the following: Diversion Dam (1908), the New York Canal (1909 and 1912) and others.

The Boise Project, completed in 1915, provided irrigation water to many acres beyond the Boise River floodplain. Additional canals and diversions were added throughout the valley to further supplement irrigation efforts by 1927. However, problems with excessive standing water in the Mason Creek drainage began to arise as early as 1910. To combat the rising water table, ditches were constructed, stream channels were deepened and pumps were installed to drain excess ground water (Nace and others, 1957).

During the summer, many portions of Mason Creek are used for swimming and wading. However, the managing irrigation districts discourage contact recreation due to the dangers of high flow velocities and entrenched channels. Below the Ridenbaugh Canal, where the depths and flow are ample to support contact recreation, the banks are steep and heavily vegetated.

Demographics and Economics

The Mason Creek subwatershed has experienced rapid growth over the past 10 years. Canyon County, in which Mason Creek is largely located, has experienced a population growth slightly slower that Ada county, which was one of the fastest growing counties in the United States from 1990 to 1999. The population in Canyon County has increased from 90,076 to 131,441 (46% increase) in last 10 years. Most of the development on Mason Creek has been in the form of residential subdivisions. This development has come largely at the expense of farmland. However, as Mason Creek moves through Nampa and Caldwell, there are several commercial operations adjacent to the stream.

Land Ownership and Land Use

Figure 5 and Table 1 illustrate the current land use pattern in the Mason Creek subwatershed. Land ownership is a mixture of federal, state, county, municipal and private ownership. The major land uses in the subwatershed are irrigated cropland (54%), urban residential and subdivision (25%), and rural residential (6%). Throughout the watershed, especially in the middle portion between Nampa and Caldwell and south of Meridian, agricultural lands are rapidly being converted to suburban residential and commercial land uses. This land use transition significantly alters the type and complexity of pollutant transport in the subwatershed.

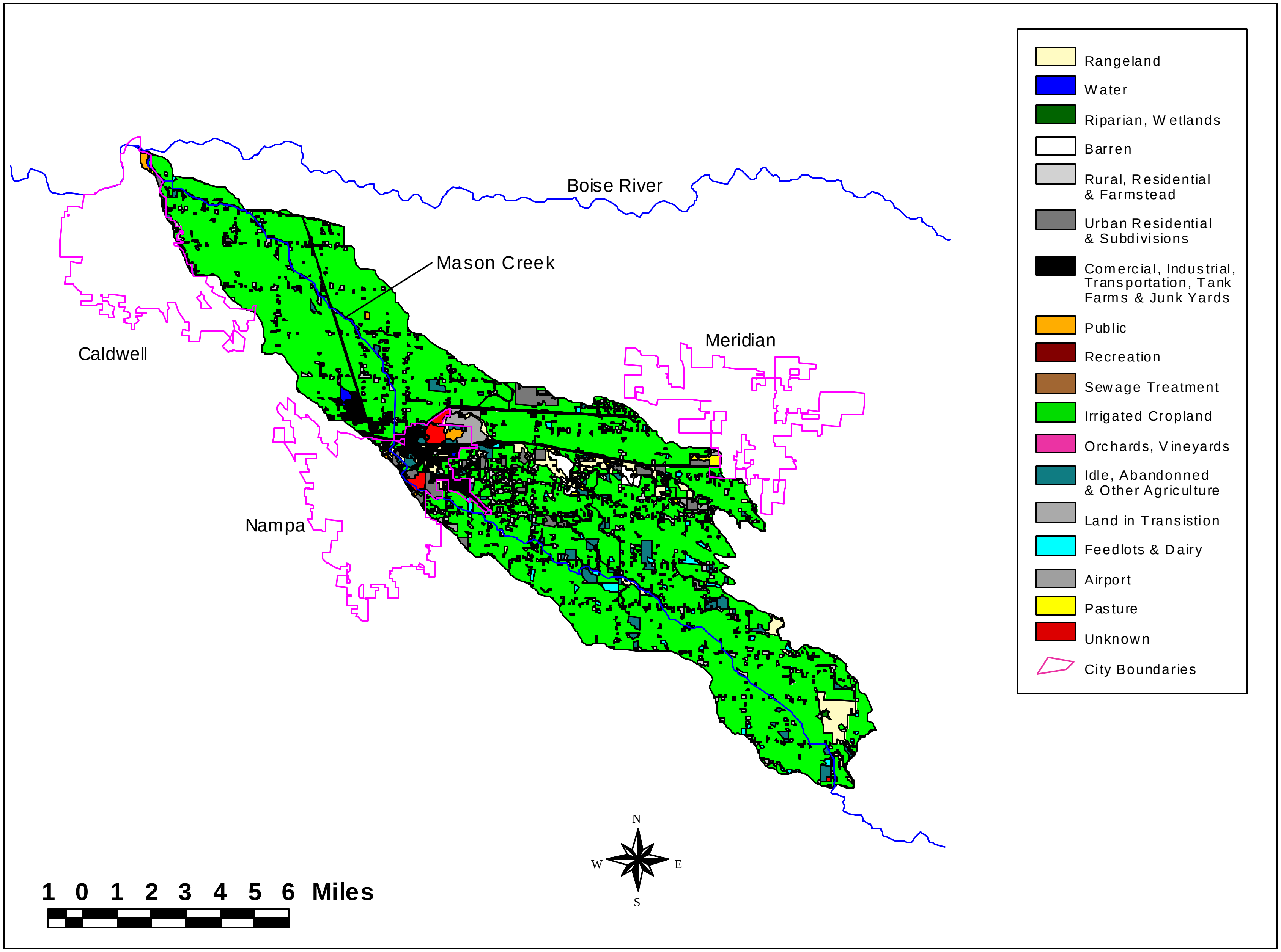


Figure 5. Mason Creek Landuse (modified from IDWR 1994 data)

Table 1. Land use pattern in the Mason Creek subwatershed

Land Use	Acres	Percent of Total
Irrigated Cropland	30577	54
Urban Residential / Subdivisions	10056	25
Rural Residential & Farmstead	2558	6
Commercial, Industrial, Transportation, Tank Farms	1536	4
Rangeland	1363	3
Idle, Abandoned & other Agriculture	1224	3
Feedlots & Dairy	449	2
Land in Transition	416	1
Barren Lands	257	1
Water	229	1
Recreation	246	1

Public Involvement

Idaho Code section 39-3611 states that TMDLs shall be developed in accordance with section 39-3614 (duties of the basin advisory groups), section 39-3616 (duties of each watershed advisory group) and the federal Clean Water Act. Two groups within the lower Boise Valley are actively working to enhance the health and environment of the lower Boise River. The Lower Boise River Water Quality Plan (LBRWQP) was formed in 1992 by stakeholders interested in water quality in the river, and was designated as the Watershed Advisory Group (WAG) for the lower Boise River watershed in July 1996. As the WAG, the group is responsible for advising the DEQ on the development of TMDLs in the watershed as well as preparing the TMDL implementation plan. Additionally, WAGs are to develop and recommend actions needed to effectively control sources of pollution in the watershed. Boise River 2000 focuses on issues related to the management of water quantity and flood control, but focuses primarily in the Boise River proper. Both groups are comprised of representatives from local and state government, environmental and recreation groups, agriculture, industry, flood control and drainage districts and concerned citizens. The primary goal of each group is to help improve and maintain the overall quality of the Boise River system.

Subwatershed Water Quality Concerns and Status

Mason Creek (water quality limited segment 2733) is listed as water quality limited on the 1998 303(d) list for the state if Idaho (Table 2). The 303(d) listed boundaries are the headwaters to the Boise River. The stream is listed for dissolved oxygen, sediment and nutrients throughout.

Table 2. Summary of Section 303(d) listed segments for Mason Creek.

Name	**Boundaries**	**Pollutants** **1998 303(d) list**
Mason Creek	Headwaters to Boise River	Dissolved Oxygen, Sediment, Nutrients

Surface Water Beneficial Use Classifications

Surface water beneficial use classifications are intended to protect the various uses of the state's surface water. Idaho waterbodies that have designated beneficial uses are listed in Idaho's Water Quality Standards and Wastewater Treatment Requirements. They are comprised of five categories: aquatic life, recreation, water supply, wildlife habitat and aesthetics.

Aquatic life classifications are for waterbodies that are suitable or intended to be made suitable for protection and maintenance of viable aquatic life communities of aquatic organisms and populations of significant aquatic species. Aquatic life beneficial uses include cold water biota, warm water biota, seasonal cold water biota, modified communities and salmonid spawning.

Recreation classifications are for waterbodies that are suitable or intended to be made suitable for primary and secondary contact recreation. Primary contact recreation is prolonged and intimate human contact with water where ingestion is likely to occur, such as swimming, water skiing and skin diving. Secondary contact recreation consists of recreational uses where raw water ingestion is not probable, such as wading and boating.

Water supply classifications are for waterbodies that are suitable or intended to be made suitable for agriculture, domestic and industrial uses. Industrial water supply applies to all waters of the state. Wildlife habitat waters are those which are suitable or intended to be made suitable for wildlife habitat. Aesthetics is a use that applies to all waters of the state.

IDAPA 58.01.02.140 designates beneficial uses for selected waterbodies in the Southwest Idaho Basin. Undesignated waterbodies are presumed to support cold water biota and primary or secondary contact recreation unless the Department of Environmental Quality determines that other uses are appropriate. This is typically done by preparing a detailed evaluation of the attainability of uses in the stream.

Beneficial Uses in Mason Creek

Mason Creek is currently undesignated in IDAPA 58.01.02.140. According to IDAPA 58.01.02.101.01, undesignated surface waters of the state shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, wherever attainable. This practical interpretation of this rule is that all undesignated surface waters of the state are presumed to be able to support Cold Water Biota and Secondary or Primary Contact Recreation water quality criteria, unless proven to be otherwise through a detailed use evaluation. In instances where the presumed uses cannot be met or are simply not appropriate, a beneficial use evaluation must be performed to justify the use change. 40 CFR 131.10(g) provides the conditions under which a presumed or designated use may be changed to a less restrictive use. If one or more of the conditions are met, the use may be changed to a less restrictive use. The conditions are:

(1) Naturally occurring pollutant concentrations prevent the attainment of the use; or
(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
(3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or
(5) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
(6) Controls more stringent than those required by Sections 301(b) and 306 of the Clean Water Act would result in substantial and widespread economic and social impact.

Recognizing that the presumed aquatic live beneficial use of Cold Water Biota may not be appropriate in a highly man-modified, irrigation driven stream such as Mason Creek, the lower Boise River WAG chose to perform a beneficial use evaluation for Mason Creek. In doing so, CH2M Hill was tasked with evaluating the historical conditions of the stream, as well as the current physical, chemical and biological conditions as they relate to the potential support status of beneficial uses. After a thorough review of the data and a multitude of other information, CH2M Hill determined that the appropriate beneficial uses for Mason Creek are an aquatic life use of modified (MOD) and a contact recreation use of secondary contact recreation (SCR) (Table 3). Appendix A contains the supporting analysis on how the beneficial uses were determined.

Table 3. Existing beneficial uses for Mason Creek (Dupuis and Doran 2001)

Name	**Existing Uses**
Mason Creek (Headwaters to Boise River)	Modified Secondary Contact Recreation

Applicable Water Quality Criteria

The *Idaho Water Quality Standards and Wastewater Treatment Requirements* contain numeric criteria necessary to protect surface water beneficial uses in the state of Idaho. The numeric criteria are designed such that they are protective of the aquatic life and/or contact recreation beneficial uses to which they apply. For the modified aquatic life use, no statewide numeric criteria have been developed. IDAPA 58.01.02.250.05 indicates that when designated as such, site-specific water quality criteria for the modified aquatic life use will be determined on a case-by-case basis. The criteria should reflect the chemical, physical and biological conditions necessary to fully support the existing aquatic life community. Once developed, the criteria will be adopted into the *Idaho Water Quality Standards and Wastewater Treatment Requirements.*

Following this guidance, CH2M Hill developed site-specific water quality criteria that are protective of the MOD aquatic life community that exists in Mason Creek. Criteria were developed for dissolved oxygen, temperature and pH. These parameters were identified as critical in terms of the water chemistry necessary to maintain the existing aquatic live community in Mason Creek. Other than for these parameters, all other applicable numeric water quality criteria apply to Mason Creek. Appendix A details the rationale for the MOD specific water quality criteria.

The following water quality criteria are applicable to the pollutants of concern listed on the 1998 Section 303(d) list for Mason Creek. The criteria represent water quality conditions that are protective of the existing aquatic life community in Mason Creek. No site-specific criteria were developed for nutrients and sediment, yet IDAPA 58.01.02.200 indicates that the standards for nutrients and sediment apply to all surface waters of the state. To address the lack of numeric criteria, methods to determine whether the narrative nutrient and sediment standards are met have been established and are discussed in the data analysis and interpretation section.

Sediment

Sediment shall not exceed quantities specified in IDAPA §250 and §252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in section 350 (IDAPA 58.01.02.200.08).

Turbidity

For modified communities, there are no existing turbidity criteria. Water quality criteria for modified aquatic life will be determined on a case by case basis reflecting the chemical, physical and biological levels necessary to fully support the existing aquatic live community (IDAPA 58.01.02.250.05).

No site-specific turbidity criteria were developed for Mason Creek. Hence, the cold water biota turbidity criteria apply.

For cold water biota, turbidity below any applicable mixing zone set by the Department of Environmental Quality, shall not exceed background turbidity by more than 50 Nephelometric Turbidity Units (NTU) instantaneously or more than 25 NTU more than 10 consecutive days (IDAPA 58.01.02.250.02.d).

Excess Nutrients

Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (IDAPA 58.01.02.200.06).

pH

Hydrogen Ion Concentration (pH) values within the range of six point five (6.5) to nine point five (9.5) (IDAPA 58.01.02.250.01.a)

This pH criterion reflects the chemical levels necessary to fully support the existing aquatic life community in Mason Creek.

Dissolved Oxygen

For the modified community in Mason Creek, waters are to exhibit the following characteristics:

> Dissolved oxygen concentrations exceeding four (4) mg/l at all times (IDAPA 58.01.02.250.05)

This dissolved oxygen criterion reflects the chemical levels necessary to fully support the existing aquatic live community in Mason Creek.

Summary of Existing Water Quality Data

Numerous sources of data are available within the Mason Creek subwatershed to describe the physical and chemical water quality as the biological communities of the stream. Table 4 summarizes that available data. The DEQ surveyed the stream in 1997 and 2001 following portions of the Beneficial Use Reconnaissance Project (BURP) protocol. The full BURP assessment was not performed due to high water in 1997 and a need for only pebble count data in 2001. Additionally, in 2000 the DEQ collected chemical and benthic and suspended chlorophyll-a data at two locations. The USGS, through a multi-year monitoring plan jointly funded by the DEQ, LBRWQP and USGS also collects chemical data at the mouth of the stream. This effort began in 1994 and is ongoing. In 1998 and 1999 the Idaho Department of Agriculture collected chemical data at five locations in the stream. Numerous other entities such and the City of Boise and Boise State University have collected data at various locations along Mason Creek. These data are valuable in that they can be used to fill data gaps or supplement existing data. Figure 6 illustrates the location of the major sampling locations established by the DEQ, USGS and the Idaho Department of Agriculture (IDA).

Table 4. Available physical, chemical and biological data for Mason Creek.

Name/Agency	Monitoring Dates	Data Type	Current Status
Idaho Department of Environmental Quality	6/00 – 10/00 (3 sites)	Chemical, Biological	Complete
	Partial BURP: 1997, 2001	Biological	Complete
US Geological Survey	12/94 – Current (1 site @ mouth)	Chemical	Ongoing
Idaho Department of Agriculture	4/98 – 4/99 (5 sites)	Chemical	Complete
City of Boise	2/98 – 7/98	Chemical	Complete

Data Analysis and Interpretation

The DEQ used chemical water quality, biological, physical habitat, and current complaint data to assess the support status of beneficial uses in Mason Creek. For chemical water quality, the concentration of listed pollutants in relation to the applicable water quality criteria is used to assess the status of beneficial uses and pollutants contributing to impairment. In any location where the respective criteria are exceeded by a listed pollutant on a chronic basis (>10% of the data exceed the criterion), the associated beneficial uses are likely to be impaired. This method of data analysis is consistent with EPA's 1996 305(b) guidance as well as DEQ's DRAFT water body assessment process for wadable streams. In the case of nutrients and sediment, the state of Idaho does not have numeric water quality standards. Rather, the standards are narrative and open to interpretation by the state. The interpretation of these standards typically occurs on a site-specific basis and is largely based on the sensitivity and reaction of the beneficial uses that require protection. If a Section 303(d) listed pollutant is impairing beneficial uses, a TMDL for that pollutant is required. If beneficial uses appear to be impaired by a non-303(d) listed pollutant the DEQ has the option of preparing a TMDL at the current time or postponing the TMDL until a later date when until additional data can be collected to validate the suspected impairment.

pH

pH is a measure of the concentration of hydrogen ions. Streams that display a very high or very low ionic concentration typically have restricted flora and fauna, in both species richness and abundance (Allan 1995). The effects of excess nutrients on pH levels in lotic

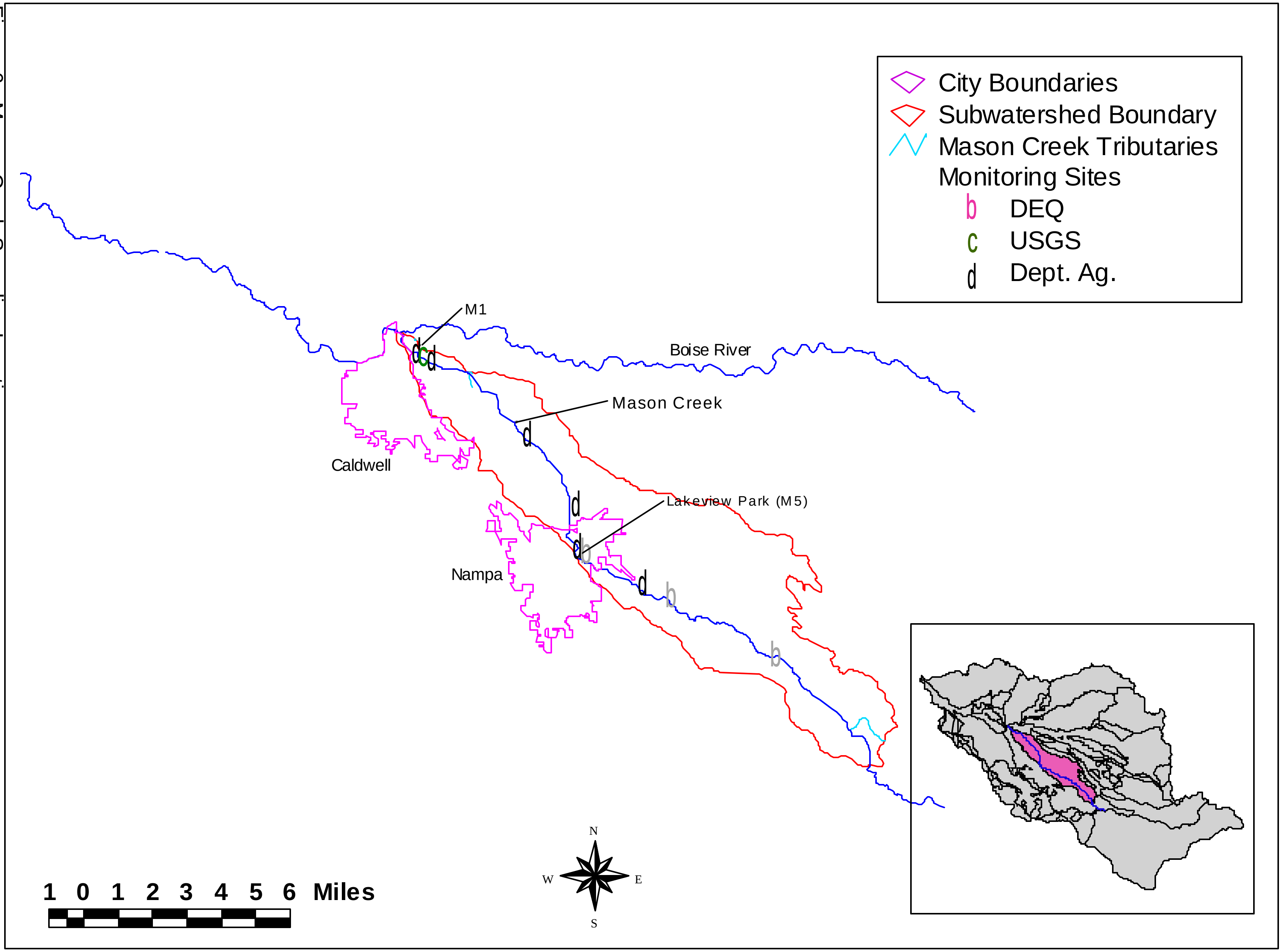
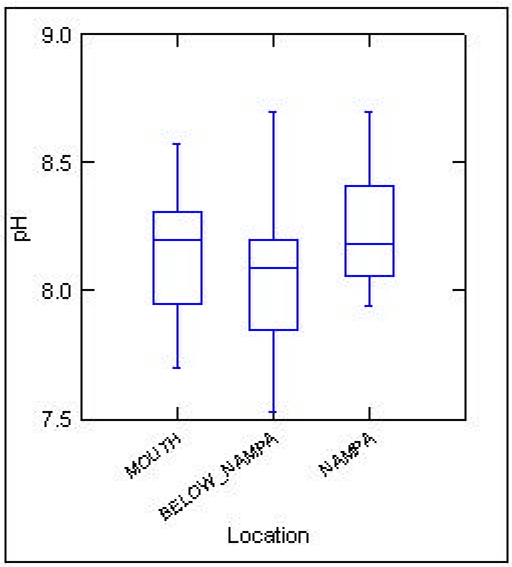


Figure 6. Mason Creek Sampling Locations

waters such as Mason Creek are in part function of the nutrient-algae relationship and ultimately a function of the algal biomass in the system. When algal biomass conditions become excessive, the water body typically experiences an increased volume of carbon dioxide in the water at night due to plant respiration. This increase in carbon dioxide beyond the normal range disrupts the stream's ability to buffer itself. When carbon dioxide levels increase, the pH typically drops.

Figure 7 shows the range of pH values in Mason Creek from the years 1998 to 2000. The data were collected on a monthly basis by the Department of Agriculture and the USGS and include values from the growing season of each year. The mean pH value in the stream is 8.2 above Nampa, 8.0 at Lakeview Park in Nampa and 8.2 at the mouth. At nearly all locations in the stream, the state criteria are met. Only in one case is the criteria exceeded. On November 16, 1999 the pH spiked to 12.6. This is an isolated incident and does not appear to represent current conditions in Mason Creek.



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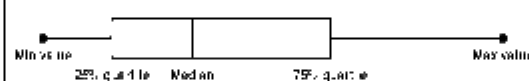


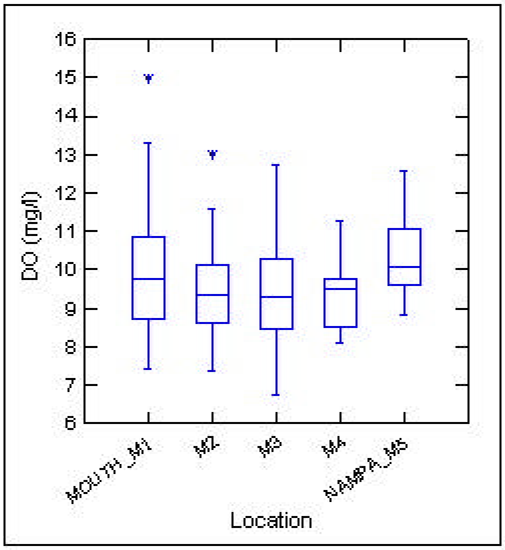
Figure 7. pH values in Mason Creek, 1998 - 2000

Dissolved Oxygen

Dissolved oxygen can be a direct indicator of nuisance aquatic growth in that as aquatic algae biomass increases, the amount of night-time respiration increases as well. As respiration increases, the volume of oxygen removed from the water increases. In excessive algae growth situations, the result is often low DO concentrations that stress or even kill sensitive species of fish and macroinvertebrates.

Dissolved oxygen data acquired from the Idaho Department of Agriculture and the USGS for the years 1994 to 2000 are used to assess the dissolved oxygen conditions in Mason Creek. The entire data set consists of data that were collected at five longitudinally spaced locations along Mason Creek. The Department of Agriculture data were collected approximately twice a month from April 1998 to December 1999. The data were collected at five locations along the length of Mason Creek. The USGS data were collected from one to three times per month from May 1994 to September 2000. All USGS data were collected at the mouth.

Figure 8 shows the dissolved oxygen data for Mason Creek. The sampling location denoted as M1 is located at the mouth of Mason Creek. The sampling location denoted as M5 is located at Lakeview Park in Nampa. All of the other sampling locations are below Nampa, where the cumulative effects of algae growth would be expected.



Guide to interpreting the box and whisker plot:

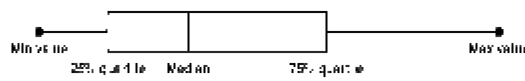


Figure 8. Dissolved Oxygen concentrations in Mason Creek, 1994 – 2000

None of the data points indicate that the dissolved oxygen concentrations in Mason Creek fall below the modified criterion of 4.0 mg/l. However, to address the possibility of a diurnal dissolved oxygen sag in Mason Creek, the DEQ collected pre-dawn dissolved oxygen and pH data at the monitoring locations above Nampa and at Lakeview Park in mid-October 2000. Pre-dawn dissolved oxygen data typically represent the lowest concentrations because of the cumulative plant respiration that has occurred throughout the night. At the upstream monitoring location the dissolved oxygen concentration was 7.80 mg/L. At Lakeview Park the dissolved oxygen concentration was 7.91 mg/L. At both locations the pH was normal, being 7.78 and 7.82, respectively.

Based on these data, dissolved oxygen is not impairing the aquatic live beneficial use. This conclusion includes the pre-dawn measurements, when dissolved oxygen concentrations are typically the lowest.

Sediment

Suspended sediment (TSS) conditions can be used as an indicator of sediment conditions in water bodies in that they provide a direct measure of water column clarity. Suspended sediment is defined as the sediment fraction that is readily suspended in the water column (typically <0.1mm). Total suspended sediment concentrations in Mason Creek fluctuate with the irrigation season flows (Figure 9). At all of the monitoring locations TSS concentrations in the stream increase during the irrigation season and decrease during the non-irrigation season, primarily due to surface erosion from agricultural lands. The peak concentrations typically occur at the beginning of the irrigation season when the system is being charged with water, causing an initial slug of re-suspended sediment to move through the system. Additionally, there is a cumulative increase in TSS concentrations in the lower portion of the stream. The TSS concentrations at the mouth are notably higher than the concentrations upstream, again suggesting that return flow to Mason Creek contributes to the overall TSS load in the stream. Mason Creek also receives water via the Caldwell Highline Canal, which receives a portion of water from Fifteenmile Creek.

As illustrated in Figure 9, the TSS concentrations during the irrigation season are notably higher than the remainder of the year. Table 5 shows the irrigation and non-irrigation season monthly average TSS concentrations in Mason Creek for the years 1998 through 2000. During the irrigation season, the monthly average TSS concentration at the mouth is 149 mg/L. The monthly average concentration steadily drops at the upstream locations, with the upstream most monitoring location (Lakeview Park) monthly average being 17 mg/L. During the non-irrigation season, the monthly average concentration is 60 mg/L at the mouth and 43 mg/L at Lakeview Park, indicating that the TSS concentrations throughout Mason Creek are relatively static throughout the non-irrigation season.

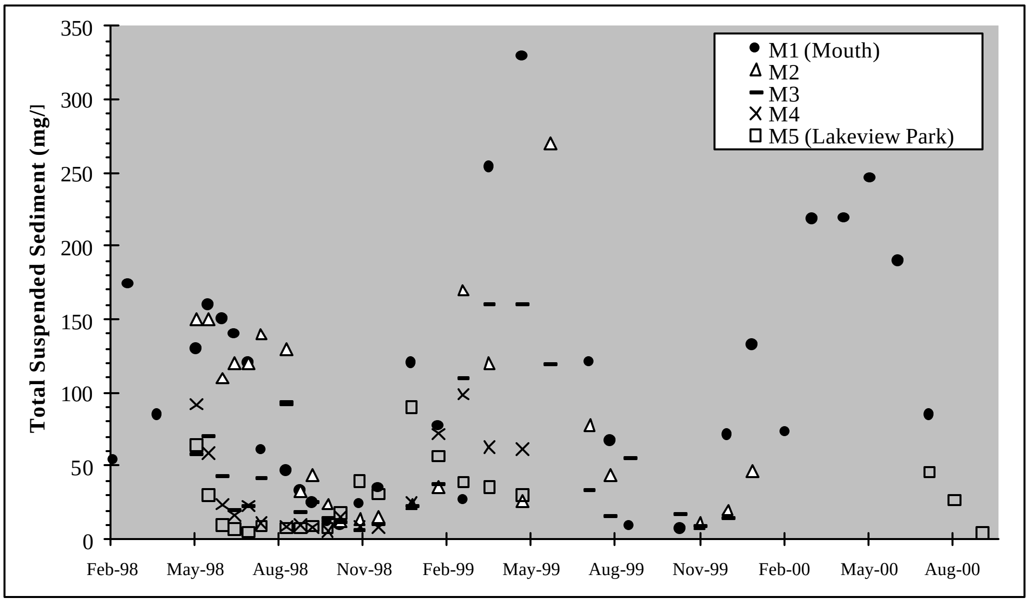


Figure 9. Total Suspended Sediment levels in Mason Creek, 1998-2000

Table 5. Irrigation and non-irrigation season monthly average TSS concentrations (mg/L) in Mason Creek, 1998-2000

Season	M1 (mouth)	M2	M3	M4	M5 (Lakeview Park)
Irrigation Season	149	109	43	26	17
Non-irrigation Season	60	45	55	44	43

The lower Boise River sediment TMDL (2000) established an instream TSS target of 50 mg/L for no longer that 60 days, and 80 mg/L for no longer than 14 days for the lower Boise River proper. These targets are consistent with Newcombe and Jensen's (1996) recommended thresholds for juvenile salmonids. The 50/80 targets were specifically chosen for the lower Boise River because they are protective of juvenile rainbow trout and hence the salmonid spawning designation. Based on this premise, the in-stream targets for the lower Boise River proper are not appropriate for Mason Creek because Mason

Creek is not listed for salmonid spawning, nor do the available data show salmonid spawning to be an existing use.

While salmonid spawning does not occur in Mason Creek, there is evidence that a transient population of adult rainbow trout exists in the stream during the irrigation season. The Idaho Fish and Game reported that adult rainbow trout were present in Mason Creek before 1975 (IDFG, personal communication with D. Allan, 2000), although they do not manage the stream as an active fishery. In adjacent tributaries, such as Indian Creek, that have similar hydrologic regimes from an irrigation standpoint, IDFG and DEQ have documented the presence of adult rainbow trout. The fish are likely flushed into the streams during the irrigation charge in April and reside in the streams until anglers catch them or they move back into the Boise River. Antectotal evidence from landowners within the Mason Creek subwatershed indicates that adult rainbow trout are present in the stream during the fishing season, which corresponds with the irrigation season.

Using Newcombe and Jensen's model as a reference (Appendix B), adult salmonids can tolerate TSS concentrations of 148 mg/L for up to four months without experiencing lethal effects. This target is consistent with the modified nature of the fisheries in Mason Creek and is protective of the existing salmonid population in that it is protective of the fish while they are present in the stream. Further, the target does not allow conditions that would cause physical injury to the fish.

The monthly average TSS concentrations at the monitoring locations upstream of the mouth never exceed 148 mg/L, even during the irrigation season. At the mouth, the TSS concentrations range from about 30 mg/L to 329 mg/L during the irrigation season with an average concentration of 149 mg/L. During the non-irrigation season the concentrations range from about 7 mg/L to 218 mg/L with an average of 60 mg/L. A closer review of the irrigation season data at the mouth reveals yearly irrigation season averages of 111 mg/L for 1998, 192 mg/L for 1999 and 191 mg/L for 2000. These values are based on data from May through August of each year, which is a four-month period. The values from 1998 and 1999 indicate that the four-month threshold of 148 mg/L is exceeded.

The lower Boise River sediment TMDL (1998) calls for a 37% TSS load reduction from each of the tributaries in the watershed to meet TSS targets in the river. The implementation plan that describes how these targets will be met is currently being developed by the Lower Boise River Water Quality Plan and is scheduled for completion by the end of 2001. When the 37% TSS load reduction is achieved in Mason Creek, the current TSS concentrations will decline. A 22% reduction in concentration is needed to meet a 148 mg/L target at the mouth of Mason Creek. The DEQ does not recommend seeking further reductions in TSS beyond those already stipulated in the lower Boise River sediment TMDL. Rather, the DEQ recommends taking an adaptive management approach, whereby the lower Boise River TSS reduction goals would be implemented over time. A 37% reduction from 1995 concentrations, which is the baseline year for the river sediment TMDL, yields a concentration at the 62 mg/L and the mouth of Mason Creek, well below 148 mg/L.

Contact Recreational Response to Sediment

Excess sediment can impair recreational beneficial uses in a number of ways. Excess surface sediment can alter the channel form by increasing deposition or scouring, which creates abrupt and unexpected changes in channel form. Additionally, and over abundance of fine substrate sediment can create unsafe swimming and wading conditions by physically interfering with body movement. It typically takes a very large volume of sediment for this effect to occur. Excess sediment can also decrease the aesthetic appeal of the water by making the water appear muddy and murky.

While the data indicate there is fine material in Mason Creek, the sediment levels do not appear to be impairing secondary contact recreation. During the 2000 monitoring season, DEQ employees walked Mason Creek on a monthly basis and did not note any significant difficulty navigating the channel due to excess sediment. In addition, the DEQ has received no complaints about poor swimming or wading conditions due to sediment. Contact recreation occurs or can potentially occur in Mason Creek at several locations, although the irrigation districts discourage it.

Turbidity

None of the agencies that currently monitor Mason Creek or have monitored Mason Creek in the past have collected turbidity data, hence no current turbidity data exists for Mason Creek.

Nutrients and Aquatic Algae Biomass

Phosphorus

High concentrations of phosphorus have been recorded in Mason Creek from 1998 to 2000 (Figure 10). Based on numerous studies (Bothwell 1988, 1989 and Horner and others 1983), the water column total phosphorus (TP) levels in Mason Creek are more than sufficient to support algae growth. Additionally, EPA's gold book criterion for water column total phosphate phosphorus is 0.10 mg/L, which is the level at which EPA indicates the potential for eutrophication exists. This information, along with the direct effects of nutrients on aquatic life and contact recreation beneficial uses, should be considered when determining the effects of nutrients in a water body.

As with the TSS concentrations, the TP concentrations in Mason Creek fluctuate with the irrigation season. Table 6 shows the irrigation and non-irrigation seasonal average concentrations at the Mason Creek monitoring locations for the years 1998 to 2000. The TP concentrations range from as low as .10 mg/L during the non-irrigation season to as high as 0.71 mg/L during the irrigation season. During the irrigation season, the average TP concentration at the mouth is 0.38 mg/L. The average concentration steadily drops at the upstream locations, with the upstream most monitoring location (Lakeview Park) average being 0.19 mg/L. The exception is between M1 and M2 where the TP concentration increases in the upstream direction.

During the non-irrigation season, the average concentration in Mason Creek is 0.25 mg/L at the mouth and 0.18 mg/L at Lakeview Park. For the most part, the non-irrigation season TP concentrations are similar throughout the stream.

The dissolved-orthophosphate concentrations in Mason Creek are typically 65% - 75% of the total phosphorus concentration, which is consistent with the ratio found in the river proper.

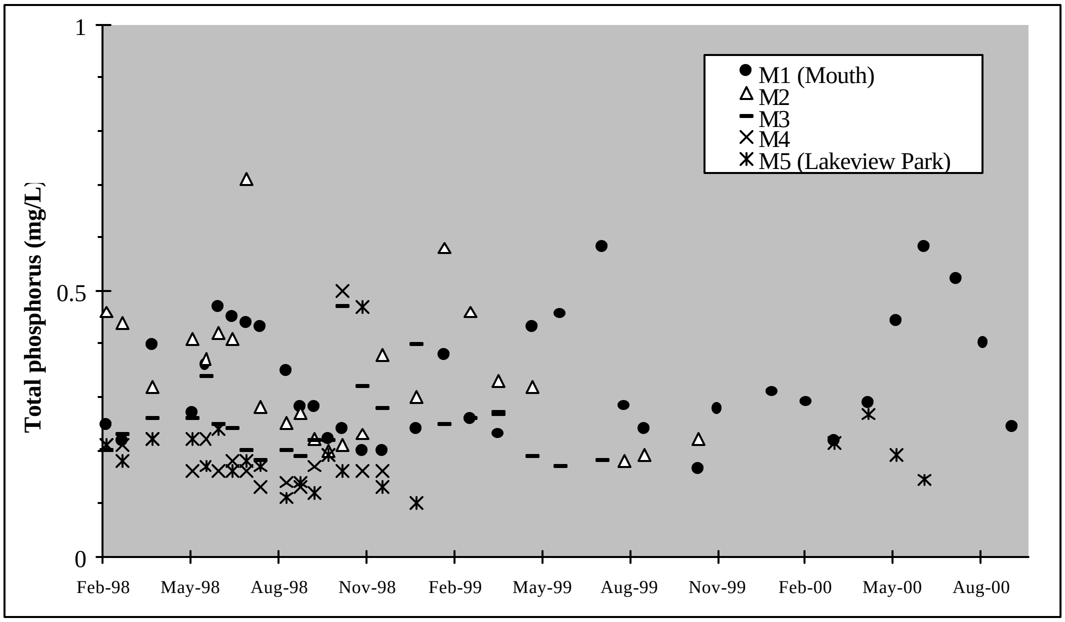


Figure 10. Total phosphorus levels in Mason Creek: 1998-2000.

Table 6. Irrigation and non-irrigation season average TP concentrations (mg/L) in Mason Creek.

Location	Irrigation Season Ave.	Non-Irrigation Season Ave.
M1 (Mouth)	0.38	0.25
M2	0.41	0.27
M3	0.27	0.24
M4	0.19	0.20
M5 (Lakeview Park)	0.19	0.18

The impact of excess nutrients on aquatic life beneficial uses is generally based on abnormalities in dissolved oxygen and pH. When excess nutrients are causing excess algal biomass, dissolved oxygen and pH conditions normally fluctuate as described in the above dissolved oxygen and pH analysis. Dissolved oxygen and pH conditions in Mason Creek are normal, indicating that nutrients are not impairing aquatic life beneficial uses. The impacts of excess nutrients on contact recreation beneficial uses are generally based on algal biomass levels and other associated factors, which are described in the analysis below.

Benthic Chlorophyll –a

Chlorophyll-a is the essential photosynthetic pigment found in aquatic plants. The amount of chlorophyll-a in water column (suspended) algae and in the algae attached to rocks (periphyton) is commonly used to measure algal productivity. While chlorophyll-a concentrations vary from species to species, it remains a viable surrogate for algae biomass (Carlson 1980, Watson et al. 1992). The EPA also suggests that chlorophyll-a is a desirable endpoint because it can usually be correlated to loading conditions (EPA 1999).

Periphytic (benthic) algae grow naturally on pebbles, cobbles and boulders along the streambed. Periphytic algae grow as single celled organisms called diatoms that are kept in check by the grazing of aquatic insects. Periphyton growth is limited by factors such as nutrient and light availability, substrate composition, substrate stability, water velocity and suspended sediment concentration (which causes abrasion). When nutrient availability exceeds the basic needs of diatoms, and other factors do not limit growth, other periphytic species, including bulky, filamentous algae such as Cladophora may grow on the streambed.

The state of Idaho does not have a numeric criterion for periphytic chlorophyll-a. However, several authors have suggested that periphyton chlorophyll-a values from 100 to 200 mg/m^2 constitute a nuisance threshold, above which aesthetics are impaired (Horner and others, 1983, Watson and Gestring, 1996; Welch et al, 1988; Welch, et al., 1989). However, no thresholds have been proposed in relation to the adverse impacts to aquatic life. Impacts to aquatic life are generally based on DO and pH problems and the reduction of living space for aquatic organisms due to excessive algae biomass.

The exact biomass level at which algae growth becomes quantified as "nuisance" is not well defined. The nutrient level and the mass of algae itself that constitutes a nuisance characterization is different in nearly every water body. Nuisance algae growth is often dictated by other limiting factors such as water velocity, substrate composition, ground water nutrient concentration and in the case of attached macrophytes, substrate nutrient concentration.

The benthic chlorophyll-a data for Mason Creek are sparse. However, the data that are available are likely representative of the overall benthic algal conditions in the stream. This assumption is based on the relative similarity in flow regime, substrate condition, water clarity, nutrient enrichment and riparian shading throughout the system, all of which directly effect periphytic algae growth. Samples collected by the DEQ above Nampa and at Lakeview Park in Nampa in September 2000 revealed benthic chlorophyll-a levels of 4.35 mg/m2, and 4.63 mg/m2, respectively. Both are well below the minimum nuisance threshold of 100 mg/m2. The low benthic chlorophyll-a levels in Mason Creek are not surprising given the growth-limiting factors in the stream. The substrate surveys that have been conducted in Mason Creek indicate that the stream bottom is dominated by silt and sand with sporadically distributed areas of gravel and cobble, which is typically highly embedded. Silt and sand is unstable and does not provide a desirable attachment point for benthic algae. In addition, the peak growing season for benthic algae corresponds with the irrigation season (April – September) in the lower Boise River basin. The result is decreased water clarity. This decrease in water clarity is likely in part limiting the growth of benthic algae in Mason Creek. A similar scenario is occurring in the lower Boise River at Parma.

In addition to being well below the literature nuisance threshold values, the periphytic biomass levels in Mason Creek are not such that they are causing unsafe swimming or wading conditions. There continues to be evidence of contact recreation throughout the stream, although the irrigation districts discourage it and consider it to happen in trespass only. In addition, the DEQ has no registered complaints regarding odor or water discoloration caused by algae, both of which could occur when large benthic algae mats die and decompose.

Water Column Chlorophyll –a

While the state of Idaho does not have a numeric criterion for water column chlorophyll-a, Oregon's threshold is 15 ug/l. When the Oregon threshold is exceeded in an average of three samples collected over consecutive months at a representative location, a follow-up is made to ascertain if a beneficial use is adversely impacted. Hence, a value of greater than 15 ug/l does not necessarily indicate impairment. North Carolina has a chlorophyll-a criterion of 40 ug/l, which according to the state of North Carolina indicates impairment. Raschke (1994) proposed a level of 25 ug/l for surface waters used for viewing pleasure, boating, safe swimming and fishing. These thresholds are used as a point of reference for this assessment.

As with benthic chlorophyll-a, the water column chlorophyll-a data for Mason Creek are sparse. However, it is again assumed that the data that are available are representative of the overall water column algal conditions in the stream. This assumption is based on the relative similarity in flow regime, water clarity, nutrient enrichment and riparian shading throughout the system, all of which directly effect water column algae growth. Samples collected by the DEQ above Nampa and at Lakeview Park in Nampa July 2000 revealed water column chlorophyll-a levels of 1.3 µg/L and 7.7 µg/L, respectively. Both are well below the most stringent nuisance threshold value of 15 µg/L. The factor that is probably limiting water column algae the most is water clarity. Again, the peak growing season for benthic algae corresponds with the irrigation season (April – September) in the lower Boise River basin. The result is decreased water clarity, and hence, decreased light penetration in Mason Creek during the irrigation season.

Macrophytes and Other Bulky Species

During the growing season Mason Creek exhibits significant macrophyte growth at many locations. Due to current bank maintenance and the original channelization activity, the stream exhibits very little shade and typically exhibits low point velocities due to the low gradient. Flow measurements conducted by DEQ during the 2000 growing season show that point velocities in Mason Creek are frequently below 1.6 fps, which is the threshold velocity above which most macrophytes and other benthic algae species find it difficult to attach themselves (Thomann and Mueller, 1987). The average point velocity above Nampa for the months of June through August was .36 fps. At Lakeview Park in Nampa, the average point velocity was .54 fps. This factor in combination with shallow depth, which allows for enough light penetration for macrophytes to establish, contribute to the macrophyte growth in Mason Creek. This factor is compounded by the life history of macrophytes in that most species only go dormant during the non-growing season, they do not die off completely. Hence, at the beginning of the new growing season, dormant macrophytes need less light to re-establish. Field surveys conducted from June through October 2000 at locations above Nampa and at Lakeview Park in Nampa identified macrophytes covering between 25% and 85% of the cross-sectioned stream channel. At both locations, the aquatic macrophyte that dominates the population is *Potamogeton pectinatus* L (Sago Pondweed). While these densities are not necessarily directly indicative of beneficial use impairment, they are higher than normal for streams in the Snake River Basin / High Desert ecoregion, which range from 0% to about 15% coverage.

This is based on the observations of DEQ personnel who have worked in the field for the past several years.

Sago Pondweed is adapted to and highly tolerant of a large range of currents and water level fluctuations due to its narrow leaves (McCombie and Wile, 1971). The anatomy of its leaves also allows it to grow well in silty streams because the leaves do not accumulate sediment. Sago growth is frequently noted in nutrient rich waters, particularly in the lower reaches where pollution loads are usually the greatest (Howard-Williams 1981). Sago production is typically associated with elevated levels of phosphorus in the water column (Zaky 1960, Jones and Cullimore 1973, Anderson 1978, Collins et al. 1987, Penuelas and Sabater 1987), although the plant uses its roots and shoots to obtain nutrients from the sediment (Welsh and Denny 1979). While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes (Chambers et al 1999).

Many authors (Welsh and Denny 1979, Chambers et al 1999) suggest that other than harvesting and chemical treatment, the most efficient way of controlling Sago growth is by controlling sedimentation rates. This is substantiated by the United States Department of Agriculture's 1999 report entitled "A Procedure to Estimate the Response of Aquatic Systems to Changes in Phosphorus and Nitrogen Inputs". The report indicates that in terms of management, the best method for controlling macrophyte growth in small macrophyte-dominated streams is to control surface erosion and sedimentation. Based on this premise, a reduction in surface sediment in Mason Creek would reduce the mass of macrophytes. To meet the lower Boise River sediment TMDL requirements (DEQ 2000), Mason Creek must reduce total suspended sediment loads by 37%. While the link between TSS and surface sediment is not well defined, it is inherent. Most of the best management practices (BMPs) that can be used to control TSS are ultimately designed to prevent all surface sediment erosion or sediment transfer. Thus, controlling TSS loads to Mason Creek will inherently result in a reduced level of surface sediment in the stream and reduced macrophyte densities. The DEQ recommends implementing the lower Boise River sediment TMDL before seeking further sediment reductions in Mason Creek to reduce macrophyte density.

Bacteria

The lower Boise River bacteria TMDL allocated a 97% reduction in fecal coliform concentrations in Mason Creek to meet bacteria standards in the river (50 CFU/100 ml). The fecal coliform geometric mean at the mouth was 1407 CFU/100 ml. Since the river TMDL was developed, the state of Idaho has moved to an E. Coli bacteria standard, which is a 30-day geometric mean of 126 organisms/100ml for both primary and secondary contact recreation.

Data collected in 1998 and 1999 at Mason Creek monitoring locations indicate that during the recreation season (May-August), the stream exceeds the E.Coli standard at all locations (Table 7). The data are not represented as a monthly geometric mean, but clearly show that the recreation season concentrations are above the standard.

Table 7. Bacteria concentrations in Mason Creek

Location	Year (May-Aug)	Geo-mean (#/100ml)
M1 (Mouth)	1998	1791
	1999	No Data
M2	1998	1070
	1999	1350
M3	1998	425
	1999	531
M4	1998	437
	1999	No Data
M5 (Lakeview Park)	1998	629
	1999	No Data

DEQ recommends listing Mason Creek for bacteria on the 2002 303(d) list. Upon listing the streams, DEQ will establish a TMDL schedule. It makes more sense to evaluate the need for bacteria TMDLs after the lower Boise River bacteria implementation plan is complete and being implemented. The management practices that are initiated as a result of the implementation plan may reduce the bacteria reductions necessary to meet standard in Mason Creek.

Status of Beneficial Uses

The data indicate that sediment, dissolved oxygen and nutrients are not impairing modified aquatic life or secondary contact recreation beneficial uses in Mason Creek. Consequently, DEQ does not recommend preparing TMDLs for the pollutants and recommends removing sediment, dissolved oxygen and nutrients as pollutants of concern in Mason Creek from the 2002 303(d) list. Table 8 summarizes the beneficial use support status for Mason Creek.

Table 8. Beneficial Use Support Status in Mason Creek.

Segment	Designated Use	Existing Use	Impaired Use	Pollutant(s) Causing Impairment
Headwaters to Boise River	Undesignated	MOD, SCR	SCR	Bacteria

In providing water to their respective clients, the Nampa-Meridian Irrigation District and the Pioneer Irrigation District are the entities that largely control the irrigation season flow regime of Mason Creek. One of the districts' responsibilities is to clean and maintain the stream channel to ensure the flow of water is not significantly impeded. The districts' have the authority to remove any obstructions from the stream channel that is interfering with the delivery of water (IDAPA 37.03.07.025.03). In doing so, it is not necessary that they secure a stream channel alteration permit provided no equipment is working in the channel. This historical and current stream channel maintenance has resulted in deep, straight, narrow channels with little riparian vegetation and little in-stream habitat complexity. While the districts' work is authorized, it does contribute to the overall reduction in aquatic life diversity. This habitat modification and stream channel maintenance does not fall under TMDL authority. It is DEQ's position that habitat modification and flow alteration, which may adversely affect beneficial uses, are not pollutants under Section 303(d) of the Clean Water Act. There are no water quality standards for habitat or flow, nor are they suitable for estimation of load capacity or load allocations. Because of these practical limitations, TMDLs will not be developed to address habitat modification or flow alteration.

While this assessment indicates that secondary contact recreation and modified aquatic life are not impaired by nutrients in Mason Creek, the high nutrient concentrations imply that nutrients are a potential threat to aquatic life and recreational uses in the lower Boise River. However, recent nutrient analysis for the river proper indicates that beneficial uses in river are not impaired by nutrients. Current analysis that is part of the Lower Snake-Hells Canyon TMDL sub-basin assessment, however, indicates that nutrient reductions will likely be needed from the lower Boise River and hence, Mason Creek in order to restore impaired beneficial uses in the Snake River and Brownlee Complex. These reductions will be recognized through the development of an implementation plan that addresses nutrient load allocations to the mouth of each tributary as part of the lower Boise nutrient TMDL, which is being driven by the Snake River-Hells Canyon TMDL process. A similar scenario exists for sediment. While TSS is not impairing the MOD aquatic life communities in Mason Creek, TSS reductions still need to be achieved for the lower Boise River sediment TMDL.

Data Gaps

This assessment has identified several data gaps that limit full assessment of the effects of the listed pollutants on beneficial uses. While the best available data was used to develop the current assessment, DEQ acknowledges there are unresolved questions, as outlined in Table 9.

Efforts to gather additional bacteria, sediment and nutrient data either are underway or have been planned by DEQ, the WAG and various stakeholders. The USGS, through a jointly funded plan by the DEQ, LBRWQP and USGS collects data on the tributaries to the river as well as the river itself. The Department of Agriculture also collects data on selected tributaries, including Mason Creek. In 2001, the Nampa-Meridian Irrigation District, in cooperation with many of the water-users in the valley, embarked on a large-scale monitoring effort on all of the tributaries to the river and the river itself. The information developed through these efforts may be used to revise the appropriate portions of the assessment, and determine and adjust appropriate implementation methods and control measures. Changes in the assessment will not result in the production of a new document. Minor changes will be handled through a letter amending the existing document(s), more extensive changes will be handled through supplementary documentation or replacing sections or appendices. The goal will be to build upon rather than replace the original work wherever practical. The schedule and criteria for reviewing new data is more appropriately addressed in the final implementation plan, due 18 months after approval of the TMDLs (where written). The revision of this assessment is consistent with current and developing EPA guidance that emphasizes an iterative approach to TMDL development and implementation. Any additional effort on the part of DEQ to revise the SBA or implementation plan must be addressed on a case-by-case basis, as additional funding becomes available.

Table 9. Data gaps identified during development of the Mason Creek Subbasin Assessment

Pollutant or other Factor	Data Gap
Sediment	Only instantaneous suspended sediment data available; cannot evaluate duration of concentrations
	Bedload data
	Discrete substrate and water column particle size distribution data throughout the stream
	Stream bank erosion rates
Nutrients	Only instantaneous data available; cannot evaluate duration of concentrations
Biological	Benthic and suspended algae data for hot summer drought conditions as well throughout the growing season for multiple years
	A quantified determination of macrophyte density throughout the stream
Other	Additional diurnal dissolved oxygen data

Pollution Source Inventory

Sediment and nutrients enter Mason Creek primarily from nonpoint sources. There are no NPDES permitted point sources that currently discharge to Mason Creek.

Nonpoint sources of sediment and nutrients include agricultural activities, stormwater runoff, runoff from construction activities, drain maintenance and bank erosion. An unknown amount of internal re-suspension also occurs at any given location. The most significant sources of sediment from agricultural practices are likely surface irrigated cropland and streambank trampling due to unrestricted use of streamside areas by livestock. Construction in the stream channel is subject to stream alteration permits issued by the Idaho Department of Water Resources. These permits generally include requirements for best management practices to reduce sediment releases to the stream. Agricultural activities are exempt from stream alteration permits. Agricultural activities that generate sediment include surface irrigated row crops and surface irrigated pastures. A substantial amount of the sediment that erodes from agricultural lands is deposited in the multiple drains, canals and laterals and is liberated during the irrigation charge in April. Sediment is also liberated from the stream substrate when irrigators alter instream structures to improve diversions.

Most large confined animal feeding operations (CAFOs), confined feeding areas (CFAs) and dairies are subject to discharge limits under general NPDES permits. To be regulated under a general NPDES permit, CAFOs and CFAs must meet size criteria and be considered significant contributors of pollutants. All dairies that have a permit to sell milk are subject to the Idaho Department of Agriculture dairy inspection program. Dairies are required to have adequate waste management practices subject to the Rules Governing Dairy Waste, IDAPA 58.01.02350.03.g and IDAPA 02.04.14. Smaller animal feeding operations and pasture grazing are not regulated. Animal waste that is removed from dairies, CAFOs and CFAs in liquid or solid form may be applied to agricultural lands as a soil amendment. Operators subject to an NPDES permit are required to land apply waste at agronomic rates and maintain adequate record keeping of waste management. The IDA has rules in place to ensure proper management of land applied animal waste at other facilities, but these activities are currently unregulated. The extent to which land application of animal waste is a source of bacteria is unknown.

Nonpoint sources of nutrients include runoff from agricultural operations, including irrigated row crops, pasture, animal management operations, stormwater runoff and ground water. Nutrients that enter the stream from ground water generally have their source in the same land use activities that contribute nutrients directly to surface water. A notable exception is septic systems. In areas that lack sewering and wastewater treatment, septic systems may contribute nutrients to ground water that eventually reach the stream directly or via drains.

Pollution Control Efforts

Nonpoint Sources

In both Ada and Canyon Counties, there are existing water quality programs for nonpoint source pollutant reductions. Most of the agricultural programs are federally funded through the Natural Resource Conservation Service (NRCS), through past and present Farm Bills authorized by the United States Congress. These programs are targeted at the agricultural community to assist with conservation practices. For example, the Ada and Canyon County Soil Conservation Districts (SCD) have Water Quality Programs for Agriculture (WQPA) money available to address on-the-farm pollutant reductions. WQPA is a State of Idaho water quality program to provide cost share incentives to local operators for pollutant reductions. The agricultural community, through local SCDs and other funding sources has demonstrated a willingness to protect water quality in the lower Boise River valley. Ada and Canyon SCD works with agricultural operators in the respective counties to provide technical assistance for implementation of BMPs.

Other state and federal funding sources include the federal 319 program, the Agricultural Water Quality Program for Idaho, the Resource Conservation and Rangeland Development Program, and the Federal Environmental Quality Incentive Program (EQIP). Current federal funding from EQIP is targeted at all farming and ranching activities. Participation from local operators has been competitive and is based on the availability of funds from the program. Other sources of funding include private sources such as Ducks Unlimited, The Nature Conservancy and colleges and universities.

Based on the rapidly growing populations in Cities of Nampa and Caldwell, they likely meets the criteria for a Phase II stormwater permit beginning in 2002. The permit(s) will likely require implementation of BMPs to control stormwater runoff within the affected area.

The Idaho OnePlan web site (www.oneplan.org) is an on-line tool to help farmers and ranchers create their own farm and ranch conservation plans. Developed as a cooperative effort between multiple state and federal agencies, the OnePlan will assist producers in meeting the ongoing demands for sustainable agriculture. As an example, a

OnePlan Nutrient Management Plan could assist an Idaho dairy farmer to meet the rigorous demands of Idaho's new dairy regulations. In the future, the OnePlan web site will offer many additional on-line tools such as crop nutrient demands and crop water consumption charts.

Point Sources

There are no discrete point sources that currently discharge to Mason Creek. Without a TMDL in place new point sources will be required to meet the existing in-stream water quality criteria that apply to Mason Creek and will also be subject to the antidegradation provisions set forth in IDAPA 58.01.02.051.

Reasonable Assurance

The state has responsibility under Sections 401, 402 and 404 of the Clean Water Act to provide water quality certification. Under this authority, the state reviews dredge and fill, stream channel alteration and NPDES permits to ensure that the proposed actions will meet the Idaho's water quality standards.

Under Section 319 of the Clean Water Act, each state is required to develop and submit a nonpoint source management plan. Idaho's most recent Nonpoint Source Management Program was finalized in September 1999. The plan was submitted to and approved by the EPA. Among other things, the plan identifies programs to achieve implementation of nonpoint source BMPs, includes a schedule for program milestones, outlines key agencies and agency roles and is certified by the state attorney general to ensure that adequate authorities exist to implement the plan and identifies available funding sources.

Idaho's nonpoint source management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs describe in the plan is the provision for public involvement, such as the formation of Basin Advisory Groups (BAGs) and Watershed Advisory Groups (IDAPA 58.01.02.052). The WAGs are to be established in high priority watersheds to assist DEQ and other state agencies in formulating specific actions needed to control point and nonpoint sources of pollution affecting water quality limited waterbodies. The Lower Boise River Water Quality Plan is the designated WAG for the lower Boise River watershed, which includes Mason Creek. Upon EPA approval of a TMDL, the WAG, with the assistance of appropriate federal and state agencies, will begin development of an implementation plan to meet water quality goals.

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 10.

Table 10. State of Idaho's regulatory authority for nonpoint pollution sources

Authority	IDAPA Citation	Responsible Agency
Rules Governing Solid Waste Management	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Rules Governing Subsurface and Individual Sewage Disposal Systems	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Rules and Standards for Stream-channel Alteration	58.01.02.350.03(d)	Idaho Department of Water Resources
Rules Governing Exploration and Surface Mining Operations in Idaho	58.01.02.350.03(f)	Idaho Department of Lands
Rules Governing Placer and Dredge Mining in Idaho	58.01.02.350.03(g)	Idaho Department of Lands
Rules Governing Dairy Waste	58.01.02.350.03.(h)	Idaho Department of Agriculture

The state of Idaho uses a voluntary approach to control agricultural nonpoint sources. However, regulatory authority can be found in the water quality standards (IDAPA 58.01.02.350.01 through 58.01.02.350.03). IDAPA 58.01.02.054.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan) (IDHW and SCC, 1993) which provides direction to the agricultural community. A portion of the Ag Plan outlines responsible agencies or elected groups (SCDs) that will take the lead if nonpoint source pollution problems need to be addressed. For agricultural activity, it assigns the local SCDs to assist the landowner/operator with developing and implementing BMPs to abate nonpoint pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations that may be determined to be an imminent and substantial danger to public health or environment (IDAPA 58.01.02.350.02(a)).

The *Idaho Water Quality Standards and Wastewater Treatment Requirements* specify that if water quality monitoring indicates that water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate and/or modify the BMPs to protect beneficial uses. If necessary the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with the Director of the Department of Environmental Quality's authority provided in Section 39-108, Idaho Code (IDAPA 58.01.02.350).

The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs; the Soil Conservation Commission for grazing and agricultural activities; the Department of Transportation for public road construction; the Department of Agriculture for aquaculture; and DEQ for all other activities (IDAPA 58.01.02.003).

IDAPA 58.01.02.054.06 indicates that pollutant trading is an appropriate mechanism for restoring water quality limited water bodies to compliance with water quality standards. In the lower Boise River proper, nutrients do not appear to exceed the narrative water quality standard and hence are not impairing beneficial uses. However, the nutrients in the river are contributing to the impairment of beneficial uses in the Snake River. For this reason, effluent trading will be a cost-effective way for helping improve water quality in the river. With inherent nutrient reduction requirements for point and non-point sources serving as the impetus, an effluent trading demonstration project was initiated in January 1998. The effluent trading framework revolved around developing a conceptual framework for activating trades between the multiple sources in the valley.

References

Allen, J.D. 1995. Stream Ecology: Structure and function of running waters. Chapman and Hall. New York City, NY. USA.

Anderson, M. G. 1978. Distribution and production of sago pondweed (Potamogeton pectinatus L.) on a northern prairie marsh. Ecology 59:154-160.

Bothwell, M.L. 1988. Growth rate responses of lotic periphyton diatoms to experimental phosphorus enrichment: The influence of temperature and light. Canadian Journal of Fisheries and Aquatic Science 45, pp.261 - 269.

Burnham, W.L. 1979. Groundwater report - Southwest community waste management study. Ada County Planning Association Technical Memorandum 308.04g.

Carlson, RE. 1980. More complications in the chlorophyll-Secci disk relationship. Limnology and Oceanography. 25:378-382.

Chambers, P.A., R.E. DeWreede, E.A. Irlandi, and H. Vandermuelen. 1999. Management issues in aquatic macrophyte ecology: A Canadian perspective. Can. J. Bot. 77:471-487.

Collett, R.A. 1972. Soil survey of Ada County area Idaho. United States Department of Agriculture, Soil Conservation Service, 327 p., maps.

Collins, C. D., R. B. Sheldon, and C. W. Boylen. 1987. Littoral zone macrophyte community structure: distribution and association of species along physical gradients in Lake George, New York, U.S.A. Aquat. Bot. 29:177-194.

Denny, P. 1980. Solute movement is submerged angiosperms. Biol. Rev. 55:65-92.

Dion, N P. 1972. Some effects of land use on the ground water system in the Boise-Nampa area, Idaho. Idaho Department of Water Administration Water Information Bulletin 26, 47 p.

Dupuis T., and S. Doran. 2001. Beneficial use evaluation for selected tributaries in the Lower Boise River, Draft Technical Memorandum. CH2M Hill, Boise, Idaho.

EPA. 1999. National Nutrient Assessment Strategy: An overview of available endpoints and assessment tools.

Horner, R.R., E.B. Welch and R.B. Veenstra. 1983. Development of nuisance periphytic algae in laboratory streams in relation to enrichment and velocity. In Periphyton of Freshwater Ecosystems, Wetzel, R. G. (ed.), Dr. W. Junk Publishers, The Hague.

Howard-Williams, C., and B. R. Allanson. 1981. Phosphorus cycling in a dense Potamogetonpectinatus L. bed. Oecologia 49:56-66.

Idaho Department of Agriculture. 2001. Personal communication with Kirk Cambell (IDA). Idaho Department of Agriculture. May 2001.

Idaho Department of Environmental Quality. 2000. Lower Boise River TMDL Subbasin assessment and Total Maximum Daily Loads. September 1998.

Idaho Department of Fish and Game. 2000. Personal communication with Dale Allan (IDFG). Idaho Department of Environmental Quality. March, 2000.

Idaho Department of Fish and Game. 1997. Written communication from Tracey Trent (IDFG) with Idaho Department of Environmental Quality. February 18, 1997.

IDHW and SCC. 1993. Idaho Agricultural Pollution Abatement Plan, 1991. Idaho Soil Conservation Commission, Boise, Idaho.

Jones, C., and D. R. Cullimore. 1973. Influence of macronutrients on the relative growth of water plants in the Qu'Appelle lakes. Environ. Pollut. 4:283-290.

McCombie, A. M., and I. Wile. 1971. Ecology of aquatic vascular plants in southern Ontario impoundments. Weed Sci. 19:225-228.

Nace, R.L., S.W. West, and R.W. Mower. 1957. Feasibility of ground-water features of the alternate plan for the Mountain Home Project, Idaho. U. S. Geological Survey Water Supply Paper 1376, 121 p.

Newcombe, C.P. and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16, No. 4, pp. 693-727.

Othberg, K.L. 1994. Geology and geomorphology of the Boise Valley and adjoining areas, western Snake River Plain, Idaho. Idaho Geological Survey, Bulletin 29, 54 p.

Paul, D.J. 1916. Report on drainage investigation of Pioneer and Nampa-Meridian districts in Boise Valley for the year 1916. U.S. Bureau of Reclamation.

Penuelas, J., and F. Sabater. 1987. Distribution of macrophytes in relation to environmental factors in the Ter River, N.E. Spain. Int. Rev. Hydrobiol. 72:41-58.

Raschke, R.L. 1994. Phytoplankton bloom frequencies in population of small southeastern impoundments. Lake and Reservoir Management. 8(2):205-210.

Richards, C., and K.L. Bacon. 1994. Influence of fine sediment on macroinvertebrate colonization of surface and hyporheic stream substrates. Great Basin Naturalist 54:106-113.

Rosgen, D.L. 1994. A Classification of Natural Rivers. Catena, Vol. 22, pp. 169-199.

Squires, E., S.H. Wood, and J.L. Osiensky. 1992. Hydrogeologic framework of the Boise aquifer system, Ada County, Idaho. Idaho Water Resources Institute, University of Idaho, Moscow, Idaho, Research Technical Completion Report 14-08-0001-G1559-06, 114 p.

Squires, E., S.H. Wood, and J.L. Osiensky, and R.D. Dittus. 1993. Groundwater conditions and hydraulic testing of the Boise-fan aquifer of southeast Boise River Valley, Ada County, Idaho. A Report for Boise Water Corporation, 76 p.

Thomann, R.V. and J.A. Mueller, 1987. Principles of Surface Water Quality Modeling and Control. Harper & Row, New York.

Tungate, A. M. and C. Berenbrock. 1995. Configuration of the water table, 1970 and 1992, and water-table change between 1970 and 1992 in the Boise area, Idaho. U.S. Geological Survey Water Resources Investigations Report 94-4116, 1 plate.

United States Bureau of Reclamation. 1996. A description of Bureau of Reclamation system operation of the Boise and Payette Rivers: Bureau of Reclamation, Boise, Idaho Office, 40 p., appendices.

United States Department of Agriculture. 1999. A procedure to estimate the response of aquatic systems to changes in phosphorous and nitrogen inputs: Department of Agriculture.

Waters, T.F. 1995. Sediment in Streams: Sources, Biological Effects and Control. American Fisheries Society 2, 251p.

Watson, S., E. McCauley, and J.A. Downing. 1992. Sigmoid relationships between phosphorous, algal biomass, and algal community structure. Canadian Journal of Fish and Aquatic Science. 49:2605-2610.

Watson, V. and B. Gestring. 1996. Monitoring algae levels in the Clark Fork River. Intermountain Journal of Sciences 2, No. 2, pp. 17-26.

Welsh, R. P. H., and P. Denny. 1979. The translocation of 32p in two submerged aquatic angiosperm species. New Phytol. 82 645-656.

Welch, E. B., R. R. Horner and C. R. Patmont. 1989. Prediction of nuisance periphytic biomass: A management approach. Water Resources 23, No. 4, pp. 401 - 405.

Welch, E. B., J. M. Jacoby, R. R. Horner and M. S. Seeley. 1988. Nuisance biomass levels of periphytic algae in streams. Hydrobiologia 157, pp. 161 - 166.

Wisseman, B. 1996. Benthic invertebrate biomonitoring and bioassessment in western montane streams. Aquatic Biology Associates Inc. Corvallis, Oregon.

Zaky, S. 1960. The effect of wind on the distribution and density of Potamogeton pectinatus in Nozha Hydrodrome. Notes and Memoires 44. Alexandria Inst. Hydrobiol. 33 pp.

Acronyms

(BAG)	Basin Advisory Group
(BMP)	Best Management Practices
(BURP)	Beneficial Use Reconnaissance Project
(CAFO)	Confined Animal Feeding Operation
(CFA)	Confined Feeding Areas
(CFR)	Code of Federal Regulation
(CWB)	Cold Water Biota
(DEQ)	Idaho Division of Environmental Quality
(DO)	Dissolved Oxygen
(EPA)	Environmental Protection Agency
(EQIP)	Environmental Quality Incentive Program
(HUC)	Hydrologic Unit Code
(IDA)	Idaho Department of Agriculture
(IDAPA)	Idaho Administrative Procedures Act
(IDFG)	Idaho Fish and Game
(IDHW)	Idaho Department of Health and Welfare
(IDWR)	Idaho Department of Water Resources
(LA)	Load Allocation
(LBRWQP)	Lower Boise River Water Quality Plan
(MOD)	Modified Aquatic Life (beneficial use)
(MOU)	Memorandum of Understanding
(NRCS)	Natural Resource Conservation Service
(NPDES)	National Pollutant Discharge Elimination System
(NTU)	Nephelometric Turbidity Units
(SCC)	Soil Conservation Commission
(SCD)	Soil Conservation District
(SCR)	Secondary Contact Recreation
(SBA)	Subbasin Assessment
(TP)	Total Phosphorus
(TSS)	Total Suspended Sediment
(TMDL)	Total Maximum Daily Load
(USBR)	United States Bureau of Reclamation
(USGS)	United States Geological Survey
(WAG)	Watershed Advisory Group
(WLA)	Wasteland Allocation
(WQPA)	Water Quality Programs for Agriculture
(WWTP)	Wastewater Treatment Plants

Glossary of Terms

Algal bloom - Rapid growth of algae on the surface of lakes, streams, or ponds; stimulated by nutrient enrichment.

Average flow - The average of annual volumes converted to a rate of flow for a single year; (measured in cubic feet per second cfs).

Base flow - Streamflow derived primarily from groundwater contributions to the stream.

Basin - A physiographic region bounded by a drainage divide; consists of a drainage system comprised of streams and often natural or man-made lakes. Also called drainage basin or watershed.)

Bed load - The larger or heavier particles of the stream load moved along the bottom of a stream by the moving water and not continuously in suspension or solution.

Beneficial use - Any water use that enables the user to derive economic or other benefit from such use.

Benthic fauna - Organisms attached to or resting on the bottom or living in the bottom sediments of a water body.

Biological community - All of the living things in a given environment.

Biota - The plant and animal life of a region.

Channelization - The artificial enlargement or realignment of a stream channel.

Climate - Meteorological elements that characterize the average and extreme conditions of the atmosphere over a long period of time at any one place or region of the earth's surface.

Confluence - The place where streams meet.

Dissolved oxygen (DO) – The amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials.

Diversion - The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system.

Diversity - The distribution and abundance of different kinds of plant and animal species and communities in a specified area.

Ecology - The study of the interrelationships of living things to one another and to the environment.

Effluent - The sewage or industrial liquid waste that is released into natural waters by sewage treatment plants, industry, or septic tanks.

Growing season - The number of consecutive days having a minimum temperature above 32^{o}F.

Habitat – The native environment where a plant or animal naturally grows or lives.

Headwaters - The source and upper reaches of a stream; also the upper reaches of a reservoir.

Hydrograph - A graph showing the changes in discharge of a stream or river with the passage of time.

Hydrology - The science of waters of the earth; water's properties, circulation, principles, and distribution.

Impairment - A detrimental effect on the biological integrity of a water body caused by impact that prevents attainment of the designated or existing use.

Irrigation - The controlled application of water to cropland, hayland, and/or pasture to supplement that supplied through nature.

Irrigation return flow - Nonconsumptive irrigation water returned to a surface or ground water supply.

National Pollutant Discharge Elimination System (NPDES) - A permit program under Section 402 of the Clean Water Act that imposes discharge limitations on point sources by basing them on the effluent limitation capabilities of a control technology or on local water-quality standards.

Nonpoint source pollution - Pollution discharged over a wide land area, not from one specific location or discrete source.

Nutrients - Elements or compounds essential to life, including carbon, oxygen, nitrogen, phosphorus, and many others.

Organic matter - Plant and animal residues, or substances made by living organisms.

Perennial stream - A stream that flows from source to mouth throughout the year.

pH - An expression of both acidity and alkalinity on a scale of 0-14, with 7 representing neutrality; numbers less than 7 indicate increasing acidity and numbers greater than 7 indicate increasing alkalinity.

Point-source pollution - Pollution discharged through a pipe or some other discrete source from municipal water-treatment plants, factories, confined animal feedlots, or combined sewers.

Riparian area - Land areas directly influenced by a body of water. Usually have visible vegetation or physical characteristics showing this water influence. Stream sides, lake borders, and marshes are typical riparian areas.

Sediment - Fragmented organic or inorganic material derived from the weathering of soil, alluvial, and rock materials; removed by erosion and transported by water, wind, ice, and gravity.

Sedimentation - The deposition of sediment from a state of suspension of water or air.

Silt - Sedimentary particles smaller than sand particles, but larger than clay particles.

Subbasin - Subdivision of a major river basin, drained by tributaries or groups of tributaries, including associated closed basins.

Total maximum daily load (TMDL) - The total allowable pollutant load to a receiving water such that any additional loading will produce a violation of water-quality standards.

Tributary - A stream that contributes its water to another stream or body of water.

Turbidity - Cloudiness caused by the presence of suspended solids in water; an indicator of water quality.

Waste water treatment - Any of the mechanical, chemical or biological processes used to modify the quality of waste water in order to make it more compatible or acceptable to man and his environment.

Water quality - A term used to describe the chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

Water quality standard - Recommended or enforceable maximum contaminant levels of chemical parameters (e.g., BOD, TDS, iron, arsenic, and others) of water. These parameters are established for water used by municipalities, industries, agriculture, and recreation.

Watershed - Area of land that contributes surface runoff to a given point in a drainage system.

Appendices

Appendix A

Beneficial Use Evaluation for Selected Tributaries in the Lower Boise River, CH2M Hill, 2000

Appendix B

Derivation of a TSS target for Modified (MOD) waters in the Lower Boise River Basin, based on Newcombe and Jensen (1996).

Idaho Department of
Environmental Quality

Sand Hollow Creek Subbasin Assessment

December 2001

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Executive Summary

The Sand Hollow Creek subwatershed drains 93 square miles of rangeland, agricultural land and mixed rural farmstead. Sand Hollow Creek is located in the northwest portion of the lower Boise River watershed (although is drains to the Snake River), which is located in southwest Idaho. Sand Hollow Creek largely flows through Canyon County, but the headwaters are located in Gem and Payette Counties. The stream flows in a southwesterly direction from its origin to Interstate 84, then in a northwesterly direction from the interstate to its confluence with the Snake River below Parma, Idaho.

Section 303(d) of the Federal Clean Water Act requires states to develop a Total Maximum Daily Load (TMDL) allocation plan for water bodies determined to be water quality limited. A TMDL allocation plan documents the amount of a pollutant a water body can assimilate without exceeding a state's water quality standards, and allocates that amount as loads to point and nonpoint sources. TMDLs are defined in 40 CFR Part 130 as the sum of the individual Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for nonpoint sources, including a margin of safety and natural background conditions. If the water body is impaired by a section 303(d) listed pollutant, a TMDL and additional pollution control measures may be necessary. The section 303(d) listed pollutants in Sand Hollow Creek are sediment, nutrients and dissolved oxygen.

Sand Hollow Creek is not designated for beneficial uses in the water quality standards. For undesignated waters, the presumed uses are cold water biota and secondary contact recreation, unless analysis shows other uses are more appropriate. Using CH2M Hill as a contractor, the Lower Boise River Water Quality Plan performed a detailed beneficial use evaluation for Sand Hollow Creek to characterize the appropriate beneficial uses for a highly regulated, irrigation driven system. The analysis shows that modified aquatic life and secondary contact recreation are appropriate beneficial uses. The modified aquatic life use describes streams that are limited in aquatic life diversity due to factors such as ephemeral or intermittent flow, naturally occurring pollutant levels or long-standing hydrologic modification. Water quality criteria for dissolved oxygen, pH and temperature were developed to accompany the modified aquatic life use.

Using literature-based algal biomass levels and total suspended sediment concentrations as surrogates to beneficial use support status, the data show that nutrients (total phosphorous) is not impairing modified aquatic life or secondary contact recreation. Dissolved oxygen concentrations and pH levels are also within the criteria ranges, further indicating that aquatic life beneficial uses are not impaired by nutrients. TMDLs for nutrients and dissolved oxygen are not recommended for Sand Hollow Creek and DEQ will recommend de-listing during the 2002 303(d) listing cycle. When the data are compared to the total suspended sediment (TSS) surrogate they indicate that TSS is in excess above Parma and further reductions need to be made. However, DEQ does not recommend a sediment TMDL. Rather, an adaptive management approach is recommended by dovetailing with an ongoing management plan being implemented by the Canyon Soil Conservation Commission. Until the surrogate target is met, DEQ does not recommend removing sediment from the 303(d) list.

Bacteria are not listed as a pollutant of concern in Sand Hollow Creek. However, the data show that E. Coli are exceeding the state standard at all locations in the stream. DEQ recommends listing Sand Hollow Creek for bacteria on the 2002 303(d) list and establishing a TMDL schedule.

The Snake River-Hells Canyon TMDL is scheduled for completion in December 2001. Nutrients and sediment are listed as pollutants of concern in the TMDL and will be addressed by assigning load allocations to the major tributaries to the Snake River. The Snake River-Hells Canyon TMDL will also outline a need for nutrient and sediment reductions from agricultural drains and other small tributaries that discharge directly to the Snake River, but is not expected to allocate explicit loads to Sand Hollow Creek. The extent of sediment and nutrient reductions necessary from Sand Hollow Creek to meet the Snake River-Hells Canyon TMDL is currently unknown.

An implementation plan is currently being developed by the Lower Boise River Watershed Advisory Group and supporting agencies to specify the activities needed to meet any potential load allocations for Sand Hollow Creek as a result of the Snake River-Hells Canyon TMDL. Upon completion and implementation of an approved plan, any necessary reductions from Sand Hollow Creek will be achieved.

Subbasin Watershed Characterization

Sand Hollow is located in the northwest portion of the lower Boise River watershed (Hydrologic Unit Code (HUC) 17050114), although it drains to the Snake River. The lower Boise River watershed located in southwest Idaho (Figure 1). The Sand Hollow Creek subwatershed drains 93 square miles of rangeland and agricultural lands with mixed rural farmsteads. Sand Hollow Creek is a 23.7 mile system that flows primarily through Canyon county and the community of Parma (Figure 2). The creek flows in a southwesterly direction from its origin to where it crosses Highway 26. The stream then parallels the lower Boise River in a northwesterly direction to its confluence with the Snake River.

Topography above Highway 26 consists of moderate drops in elevation as the stream follows the topography down to the valley. Below Highway 26, the topography is relatively constant with slight changes in elevation as the stream flows towards the Snake River. Elevation in the subwatershed ranges from 2540 feet at the C-Line Canal (headwaters) to 2200 feet at the confluence with the Snake River.

Geology

Sand Hollow Creek lies within the western Snake River Plain. The multiple terraces that developed throughout the Quaternary period comprise much of the subwatershed. All terrace deposits are pebble to cobble gravel with a coarse sand matrix. Thin wind-blown deposits of loess differentially cover the terrace surfaces. Shield volcanoes, basaltic cones, and lava flows bound and cover the subwatershed. Some basalt flows bury former alluvial surfaces and all flows are differentially covered by thin loess deposits (Othberg, 1994).

Soils are derived predominantly from river and wind born materials. The soils generally have weakly developed profiles, are unleached, alkaline, and have high natural fertility. Soil textures found in the subwatershed are silty and sandy loams in the lower portion and loamy sands and sandy loams in the upper portion (Collett, 1972).

Climate

Climate within the subwatershed is temperate to arid. The summer months are hot and dry while the winters are cold and wet, though generally not severe. The average maximum summer temperature during the period of 1940 - 2000 was 83.9 F in Boise (23 miles east of Parma). The average minimum winter temperature in Boise from 1940 - 2000 was 25.9 F (Climate Data Center, 2000). The average annual precipitation during the period of 1940 - 2000 in Boise was 11.9 inches (Climate Data Center, 2000). Most precipitation falls during the colder months.

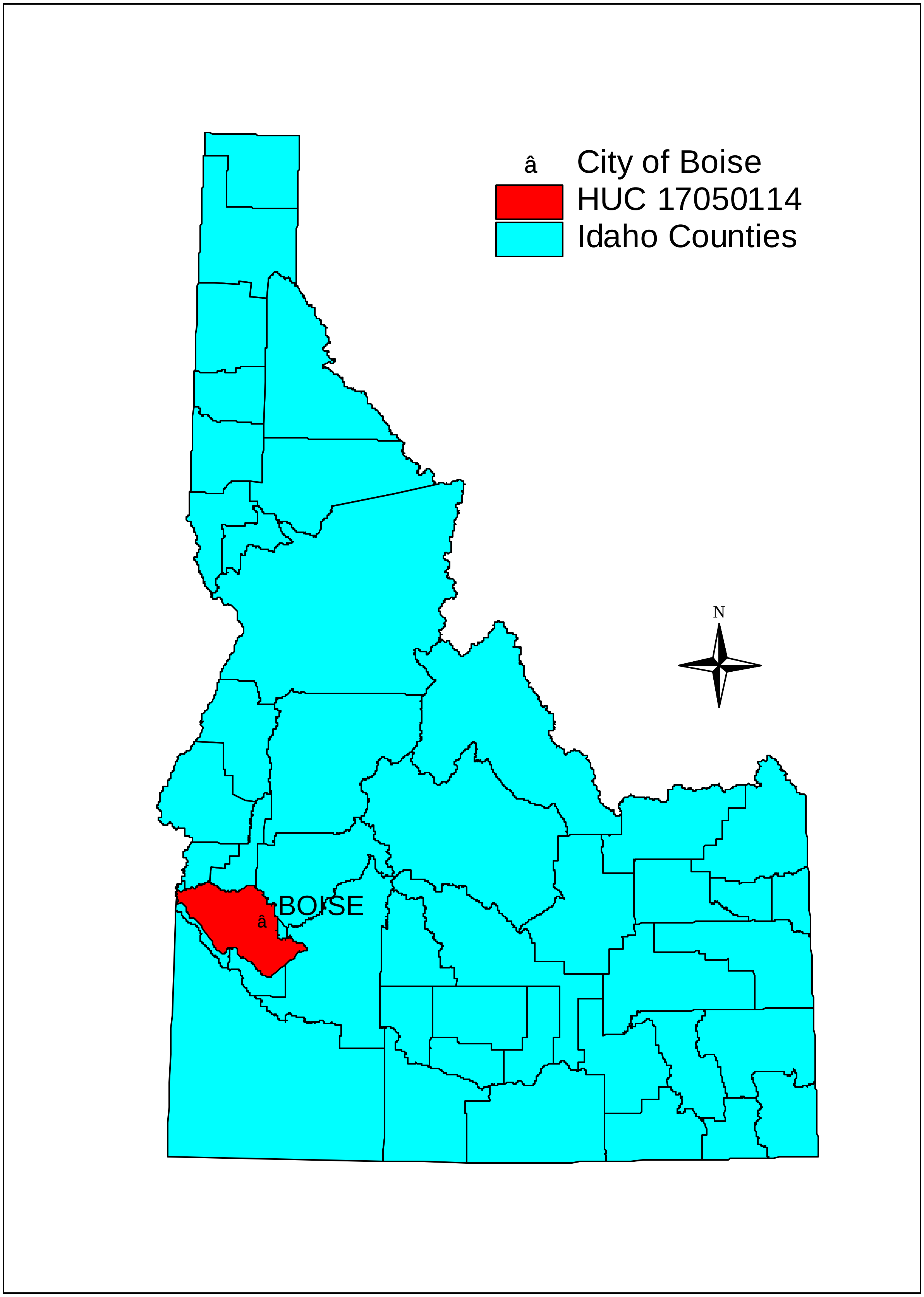


Figure 1. Lower Boise River Watershed

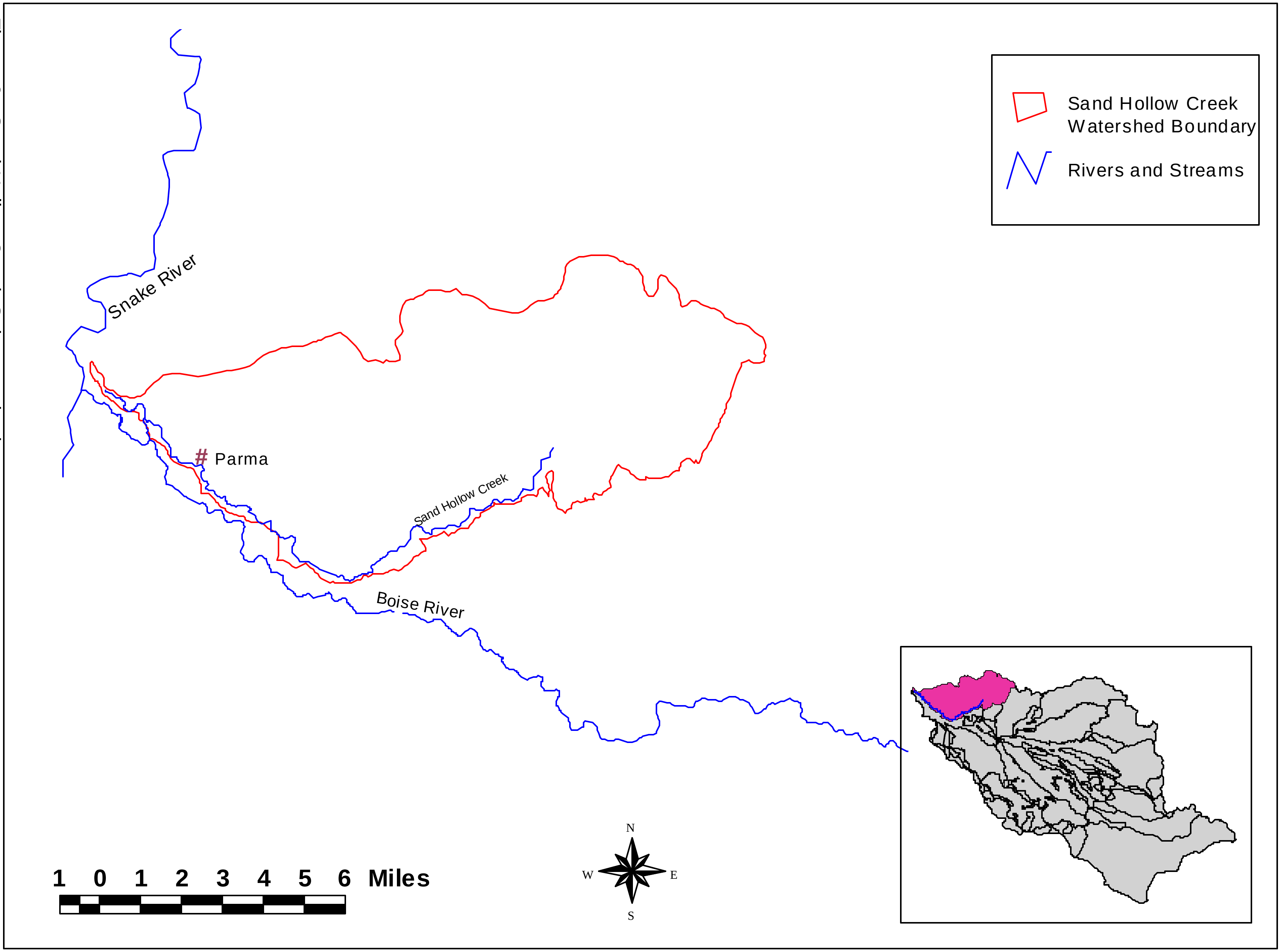


Figure 2. Sand Hollow Creek Subwatershed

Surface Hydrology

An intricate system of inputs and withdrawals in combination with the local flood control policies in the lower Boise River watershed have significantly altered the flow regime and the physical and biological characteristics of Sand Hollow Creek. The flow regime for Sand Hollow Creek can be divided into two segments. From the C-Line Canal to the Sand Hollow Wasteway the stream is intermittent. This 4.6 mile segment typically flows for a short time during the spring, but in some years may flow throughout the irrigation season, which ends in September. Following the irrigation season, the stream above the Sand Hollow Wasteway commonly goes dry. Below the Sand Hollow Wasteway (19.1 miles in length) the stream is perennial, although the volume of water is significaly less in the non-irrigation season. Low flow conditions generally begin in mid-October when the irrigation season ends. The low flow period extends through the winter until the irrigation season flow regime begins again in late April. During the irrigation season the flow in Sand Hollow Creek at the mouth is nearly triple that of winter base flows, primarily due to an extensive network of agricultural flows to the creek. Figure 3 shows the mean monthly flow in Sand Hollow Creek below Parma at the Sebree Canal and North of Interstate 84. The data acquisition process for Sand Hollow Creek is relatively new. For that reason, there is very little flow data available. However, due to the regulated nature of Sand Hollow Creek, this flow regime is likely static from year to year.

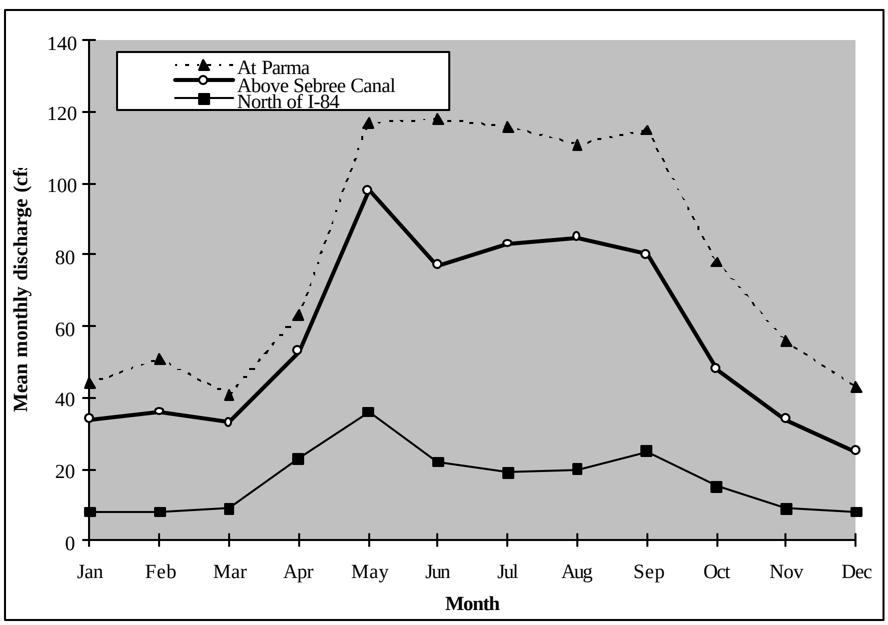


Figure 3. Mean monthly flow in Sand Hollow Creek near Parma, at the Sebree Canal and North of I-84, 1998-2000

During the irrigation season, Black Canyon Canal diverts water from the Payette River. Water is then pumped over the ridge in a southerly direction to the C-Line Canal, which is used to irrigate lands north of the lower Boise River. Sand Hollow Creek is hydrologically connected to the C-Line Canal via a headgate and spillway structure, but the diversion is rarely used (Personal communication with K. Griswold (ISCC), 2000). Below the Sand Hollow Wasteway, inputs include the C-Line Canal, D-Line Canal, Farmers Cooperative

Sebree Canal, Notus Canal and Boise River diversions. From the Sand Hollow Wasteway to the Snake River the stream steadily gains water, as illustrated in Figure 3.

Dating as far back as 1916 (Paul, 1916), irrigation practices have altered drainage patterns in Sand Hollow Creek. In many cases, water does not follow natural drainage paths. The natural drainage area in much of the subwatershed has been deepened, lengthened, straightened, and diverted while drains, laterals, and canals have been constructed. The stream alterations and man-made waterways have created new drainage areas that are significantly different from the natural subwatershed areas. The headwaters historically originated in the foothills south of the Black Canyon Canal. Construction of the C-Line Canal intersected the Sand Hollow Creek drainage and provided two areas where the C-Line Canal can input water into the stream, although it rarely does. Figure 4 depicts the current drainage area of the Sand Hollow Creek subwatershed (David Ferguson, unpub. data, 1997). The drainage area delineated by Ferguson is used for this assessment because it accurately identifies the lands that drain to Sand Hollow Creek.

The repeated use and reuse of water in the subwatershed is a complicating factor in determining the fate of pollutants when they are discharged to the stream and the effects of pollutant reductions at different locations. The shear number of canals and laterals in the subwatershed suggest the complexity of interpreting flow conditions and pollutant fate.

According to IDAPA 58.01.02.070.07 water quality standards apply to intermittent waters during optimal flow periods sufficient to support the uses for which the water body is designated. Sand Hollow Creek from the headwaters to the Sand Hollow Wasteway is an intermittent segment.

Groundwater Hydrology

A deep, semi-confined to confined Idaho Group aquifer underlies the Sand Hollow Creek subwatershed. The boundaries of the confined, semi-confined, and unconfined aquifer system are related to changes in the types and occurrence of lake and river sediments, and crustal faulting. Primary water yielding strata are interbedded sand, silt, and claystone of the Idaho Group (Squires and others, 1992). Studies by Dion (1972) and Burnham (1979) show canal seepage and irrigation application as a source of recharge to the shallow aquifer.

Historically, ground water levels in the subwatershed were lower than they are today. Starting as early as the 1860's, farmers in the valley started diverting water from the river for irrigation. As the extent of irrigated area increased, large amounts of water were applied to the surface by flood or furrow irrigation methods and ground water levels rose by tens of feet. High ground water levels began to interfere with soil and crop health. In response, numerous drains were constructed and existing ephemeral drainage ways were deepened and widened in the early 1900's to drain excess ground water. Ground water levels have been relatively stable or slightly declining since the many drains and wells were dug back in the 1910's and 1920's.

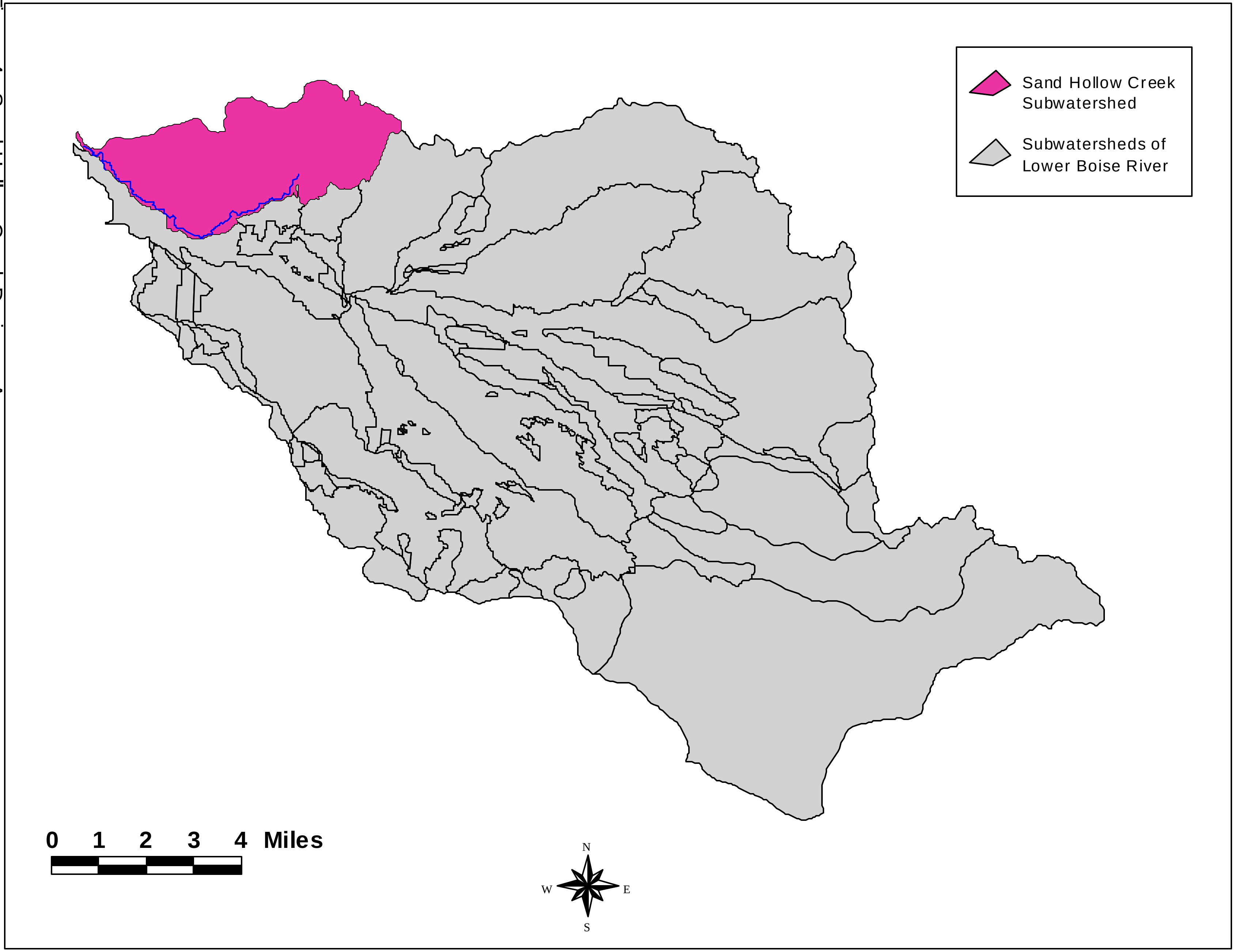


Figure 4. Sand Hollow Creek Drainage Area

Channel and Substrate Characteristics

The Sand Hollow Creek subwatershed is a broad watershed, sloping gently to the southwest and northwest as it flows toward the Snake River. The stream channel can largely be classified as a Rosgen type F from its headwaters to the Snake River. The F type channel is deeply entrenched, low gradient (<0.02), has a high width/depth ratio, and a riffle/pool morphology (Rosgen, 1994). The entrenched aspect of the channel has been amplified by the extensive deepening and widening that occurred in the early part of the century.

The streambed in Sand Hollow Creek ranges from silt-size (<1 mm) material to large cobble (128.1-256 mm), although silt and sand material comprise most of the substrate. Larger substrate material is highly dispersed cobble and gravel areas and typically embedded. The banks are typically stable with vegetation.

Sand Hollow Creek exhibits other characteristics typical of a stream with regulated flow. The numerous man-modified portions of the stream along with the regulated irrigation flow have caused a narrowing and straightening of the stream channel. Braiding and sinuosity caused by divergent and out of bank flow events are largely absent. These factors have resulted in changes in stream morphology, hydrology and water quality.

Terrestrial and Aquatic Wildlife Characteristics

Sand Hollow Creek and the lands adjacent to it are home to numerous species of wildlife. The stream corridor is home to several species of waterfowl, including ducks and geese. In addition, several mammal species live on or near Sand Hollow Creek. These include fox, rabbit, beaver, muskrat, and other mammal and fowl species.

The Department of Environmental Quality has recently collected data indicating that numerous game and non-game fish species are present in Sand Hollow Creek. Clark and Bauer (1983) also collected rainbow trout in the stream.

Cultural Characteristics

The Boise River valley and Sand Hollow Creek was first explored in 1811 by overland explorers of John Jacob Astor's Pacific Fur company. The Boise valley was settled in 1863. Gold discoveries in 1862 in the nearby mountains prompted the founding of Boise City.

Passage of the Clean Water Act in 1972 brought about reductions in point source discharges of pollutants through the National Pollutant Discharge Elimination System (NPDES) permitting program. The permit program is used to control and monitor point sources that discharge into waters of the United States. The City of Parma discharges to Sand Hollow Creek under the NPDES permitting program. The plant design flow is 0.31 mgd.

During the hunting season, Sand Hollow Creek is a popular destination for duck and goose hunting. The adjacent lands are used for pheasant and grouse hunting.

Demographics and Economics

The Sand Hollow Creek subwatershed has experienced minor growth over the past 10 years. The population has risen 10.9% from 1597 people in 1990 to 1771 people in 2000. Small pockets of residential subdivisions and rural ranchettes have been developed south of Parma and near the community of Sand Hollow, but for the most part the lands adjacent to the stream have remained in agricultural use. As Sand Hollow Creek moves through Parma there are minor commercial operations adjacent to the stream, but very little has changed in recent time.

Land Ownership and Land Use

Figure 5 and Table 1 illustrate the current land use pattern in the Sand Hollow Creek subwatershed. Land ownership is a mixture of federal, state, county, municipal and private ownership, with the majority of the lands being privately held. The stream largely flows through Canyon County, although a small portion of the stream is in Gem and Payette Counties. The major land uses in the subwatershed are irrigated cropland (40%) and rangeland (45%)

Table 1. Land use pattern in the Sand Hollow Creek subwatershed

Land Use	**Acres**	**Percent of Total**
Rangeland	26,672	45
Irrigated Cropland	23,814	40
Urban Residential & Subdivisions	3264	5
Idle, Abandoned & other Agriculture	1400	2
Rural Residential & Farmstead	1223	2
Riparian Wetland	952	2
Transportation, Tank Farms, Junkyards	663	1
Water	471	1
Barren Lands	415	1
Pasture	411	1

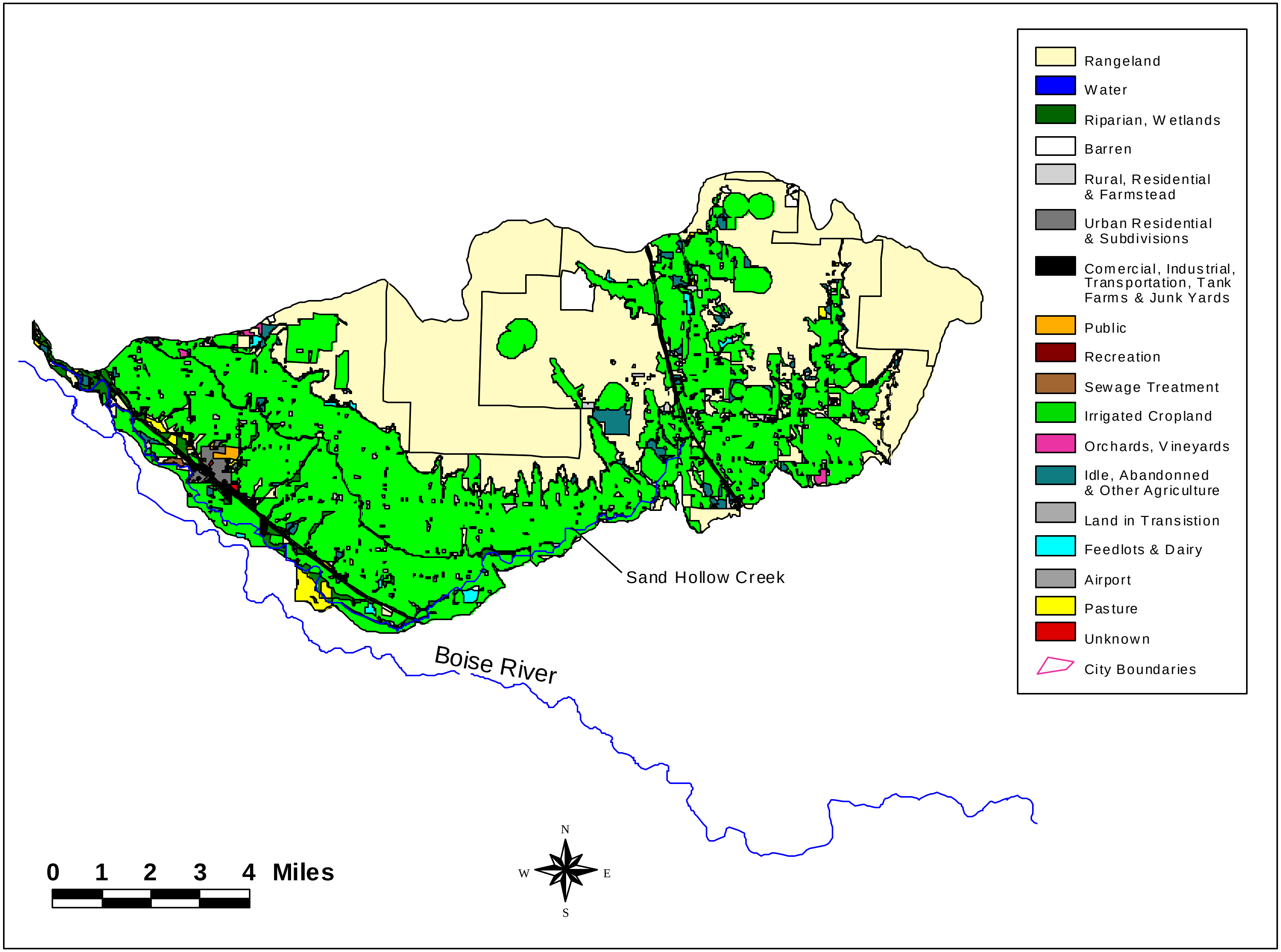


Figure 5. Sand Hollow Creek Landuse (modified from IDWR 1994 data)

Public Involvement

Idaho Code section 39-3611 states that TMDLs shall be developed in accordance with section 39-3614 (duties of the basin advisory groups), section 39-3616 (duties of each watershed advisory group) and the federal Clean Water Act. Two groups within the lower Boise Valley are actively working to enhance the health and environment of the lower Boise River. The Lower Boise River Water Quality Plan (LBRWQP) was formed in 1992 by stakeholders interested in water quality in the river, and was designated as the Watershed Advisory Group (WAG) for the lower Boise River watershed in July 1996. The group is responsible for advising the DEQ on the development of TMDLs in the watershed as well as preparing the TMDL implementation plan. Additionally, WAGs are to develop and recommend actions needed to effectively control sources of pollution in the watershed. Boise River 2000 focuses on issues related to the management of water quantity and flood control, but focuses primarily in the Boise River proper. Both groups are comprised of representatives from local and state government, environmental and recreation groups, agriculture, industry, flood control and drainage districts and concerned citizens. The primary goal of each group is to help improve and maintain the overall quality of the Boise River system.

Subwatershed Water Quality Concerns and Status

Sand Hollow Creek (water quality limited segment 2730) is listed as water quality limited on the 1998 303(d) list for the state of Idaho (Table 2). The 303(d) listed boundaries are the headwaters to the Snake River. The stream is listed for dissolved oxygen, sediment and nutrients throughout.

Table 2. Summary of Section 303(d) listed segments for Sand Hollow Creek.

Name	**Boundaries**	**Pollutants** **1998 303(d) list**
Sand Hollow Creek	Headwaters to Snake River	Dissolved Oxygen, Sediment, Nutrients

Surface Water Beneficial Use Classifications

Surface water beneficial use classifications are intended to protect the various uses of the state's surface water. Idaho waterbodies that have designated beneficial uses are listed in *Idaho's Water Quality Standards and Wastewater Treatment Requirements*. They are comprised of five categories: aquatic life, recreation, water supply, wildlife habitat and aesthetics.

Aquatic life classifications are for waterbodies that are suitable or intended to be made suitable for protection and maintenance of viable aquatic life communities of aquatic organisms and populations of significant aquatic species. Aquatic life beneficial uses include cold water biota, warm water biota, seasonal cold water biota, modified communities and salmonid spawning.

Recreation classifications are for waterbodies that are suitable or intended to be made suitable for primary and secondary contact recreation. Primary contact recreation is prolonged and intimate human contact with water where ingestion is likely to occur, such as swimming, water skiing and skin diving. Secondary contact recreation consists of recreational uses where raw water ingestion is not probable, such as wading and boating.

Water supply classifications are for waterbodies that are suitable or intended to be made suitable for agriculture, domestic and industrial uses. Industrial water supply applies to all waters of the state. Wildlife habitat waters are those which are suitable or intended to be made suitable for wildlife habitat. Aesthetics is a use that applies to all waters of the state.

IDAPA 58.01.02.140 designates beneficial uses for selected waterbodies in the Southwest Idaho Basin. Undesignated waterbodies are presumed to support cold water biota and primary or secondary contact recreation unless the Department of Environmental Quality determines that other uses are appropriate. This is typically done by preparing a detailed evaluation of the attainability of uses in the stream.

Beneficial Uses in Sand Hollow Creek

Sand Hollow Creek is currently undesignated in IDAPA 58.01.02.140. According to IDAPA 58.01.02.101.01, undesignated surface waters of the state shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, wherever attainable. This practical interpretation of this rule is that all undesignated surface waters of the state are presumed to be able to support Cold Water Biota and Secondary or Primary Contact Recreation water quality criteria, unless proven to be otherwise through a detailed use evaluation. In instances where the presumed uses cannot be met or are simply not appropriate, a beneficial use evaluation must be performed to justify the use change. Code of Federal Regulations 40 131.10(g) provides the conditions under which a presumed or designated use may be changed to a less restrictive use. If one or more of the conditions are met, the use may be changed to a less restrictive use. The conditions are:

(1) Naturally occurring pollutant concentrations prevent the attainment of the use; or
(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
(3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or
(5) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
(6) Controls more stringent than those required by Sections 301(b) and 306 of the Clean Water Act would result in substantial and widespread economic and social impact.

Recognizing that the presumed aquatic live beneficial use of Cold Water Biota may not be appropriate in a highly man-modified, irrigation driven stream such as Sand Hollow Creek, the lower Boise River WAG chose to perform a beneficial use evaluation for Sand Hollow

Creek. In doing so, CH2M Hill was tasked with evaluating the historical conditions of the stream, as well as the current physical, chemical and biological conditions as they relate to the potential support status of beneficial uses. After a thorough review of the data and a multitude of other information, CH2M Hill determined that the appropriate beneficial uses for Sand Hollow Creek are an aquatic life use of Modified (MOD) and a contact recreation use of secondary contact recreation (SCR) (Table 3). Appendix A contains the supporting analysis on how the beneficial uses were determined.

Table 3. Existing beneficial uses for Sand Hollow Creek (Dupuis and Doran, 2001)

Name	**Existing Uses**
Sand Hollow Creek (Headwaters to Snake River)	Modified Secondary Contact Recreation

Applicable Water Quality Criteria

The *Idaho Water Quality Standards and Wastewater Treatment Requirements* contain numeric criteria necessary to protect surface water beneficial uses in the state of Idaho. The numeric criteria are designed such that they are protective of the aquatic life and/or contact recreation beneficial uses to which they apply. For the Modified (MOD) aquatic life use, no statewide numeric criteria have been developed. IDAPA 58.01.02.250.05 indicates that when designated as such, site-specific water quality criteria for the modified aquatic life use will be determined on a case-by-case basis. The criteria should reflect the chemical, physical and biological conditions necessary to fully support the existing aquatic life community. Once developed, the criteria will be adopted into the *Idaho Water Quality Standards and Wastewater Treatment Requirements.*

Following this guidance, CH2M Hill developed site-specific water quality criteria that are protective of the MOD aquatic life community that exists in Sand Hollow Creek. Criteria were developed for dissolved oxygen, temperature and pH. These parameters were identified as critical in terms of the water chemistry necessary to maintain the existing aquatic life community in Sand Hollow Creek. Other than for these parameters, all other applicable numeric water quality criteria apply to Sand Hollow Creek. Appendix A details the rationale of the MOD specific water quality criteria.

The following water quality criteria are applicable to the pollutants of concern listed on the 1998 Section 303(d) list for Sand Hollow Creek. The criteria represent water quality conditions that are protective of the existing aquatic life community in Sand Hollow Creek. No site-specific criteria were developed for nutrients and sediment, yet IDAPA 58.01.02.200 indicates that the standards for nutrients and sediment apply to all surface waters of the state. To address the lack of numeric criteria, methods to determine whether the narrative nutrient and sediment standards are met have been established and are discussed in the data analysis and interpretation section.

Sediment

Sediment shall not exceed quantities specified in 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses.

Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in section 350 (IDAPA 58.01.02.200.08).

Turbidity

For modified communities, there are no existing turbidity criteria. Water quality criteria for modified aquatic life will be determined on a case by case basis reflecting the chemical, physical and biological levels necessary to fully support the existing aquatic life community (IDAPA 58.01.02.250.05).

No site-specific turbidity criteria were developed for Sand Hollow Creek. Hence, the cold water biota turbidity criteria apply.

For cold water biota, turbidity below any applicable mixing zone set by the Department of Environmental Quality, shall not exceed background turbidity by more than 50 Nephelometric Turbidity Units (NTU) instantaneously or more than 25 NTU more than 10 consecutive days (IDAPA 58.01.02.250.02.d).

Excess Nutrients

Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (IDAPA 58.01.02.200.06).

pH

Hydrogen Ion Concentration (pH) values within the range of six point five (6.5) to nine point five (9.5) (IDAPA 58.01.02.250.01.a)

This pH criterion reflects the chemical levels necessary to fully support the existing aquatic life community in Sand Hollow Creek.

Dissolved Oxygen

For the modified community in Sand Hollow Creek, waters are to exhibit the following characteristics:

> Dissolved oxygen concentrations exceeding four (4) mg/l at all times (IDAPA 58.01.02.250.05)

This dissolved oxygen criterion reflects the chemical levels necessary to fully support the existing aquatic life community in Sand Hollow Creek.

Summary of Existing Water Quality Data

Numerous sources of data are available within the Sand Hollow Creek subwatershed to describe the current physical and chemical water quality and the biological communities of the stream. Table 4 summarizes that available data. The DEQ surveyed the stream in 1996 and 1997 following the Beneficial Use Reconnaissance Project (BURP) protocol. Additionally, in 2000 the DEQ collected chemical and benthic and suspended chlorophyll-a data at three locations. In 1998 and 1999 the Idaho Department of Agriculture collected chemical data at three locations in the stream. The City of Parma waste water treatment plant (WWTP) also discharges to Sand Hollow Creek. As part of their NPDES permitting requirements, the plant collects chemical data from their effluent. They do not currently collect ambient stream data. Figure 6 shows the location of the sampling sites established by the DEQ and the Idaho Department of Agriculture.

Table 4. Available physical, chemical and biological data for Sand Hollow Creek.

Name/Agency	**Monitoring Regime**	**Data Type**	**Current Status**
Idaho Department of Environmental Quality	6/00 – 10/00 (3 sites)	Chemical, Biological	Complete
	BURP: 1996, 1997	Biological	Complete
Idaho Department of Agriculture	4/98 – 12/99 (3 sites)	Chemical	Complete
City of Parma WWTP	Current at plant	Chemical	Ongoing

Data Analysis and Interpretation

The DEQ used chemical water quality, biological, physical habitat, and current complaint data to assess the support status of beneficial uses in Sand Hollow Creek. For chemical water quality, the concentration of listed pollutants in relation to the applicable water quality criteria is used to assess the status of beneficial uses and pollutants contributing to impairment. In any location where the respective criteria are exceeded by a listed pollutant on a chronic basis (>10% of the data exceed the criterion), the associated beneficial uses are likely to be impaired. This method of data analysis is consistent with EPA's 1996 305(b) guidance as well as DEQ's DRAFT water body assessment process for wadable streams. In the case of nutrients and sediment, the state of Idaho does not have numeric water quality standards. Rather, the standards are narrative and open to interpretation by the state. If a Section 303(d) listed pollutant is impairing beneficial uses, a TMDL for that pollutant is required. If beneficial uses appear to be impaired by a non-303(d) listed pollutant the DEQ has the option of preparing a TMDL at the current time or postponing the TMDL until a later date when until additional data can be collected to validate the suspected impairment.

pH

pH is a measure of the concentration of hydrogen ions. Streams that display a very high or very low ionic concentration typically have restricted flora and fauna, in both species richness and abundance (Allan 1995). The effects of excess nutrients on pH levels in lotic waters such as Sand Hollow Creek are in part function of the nutrient-algae relationship and ultimately a function of the algal biomass in the system. When algal biomass conditions become excessive the water body typically experiences an increased volume of carbon dioxide in the water at night due to plant respiration. This increase in carbon dioxide beyond the normal range disrupts the streams ability to buffer itself. When carbon dioxide levels increase, the pH typically drops.

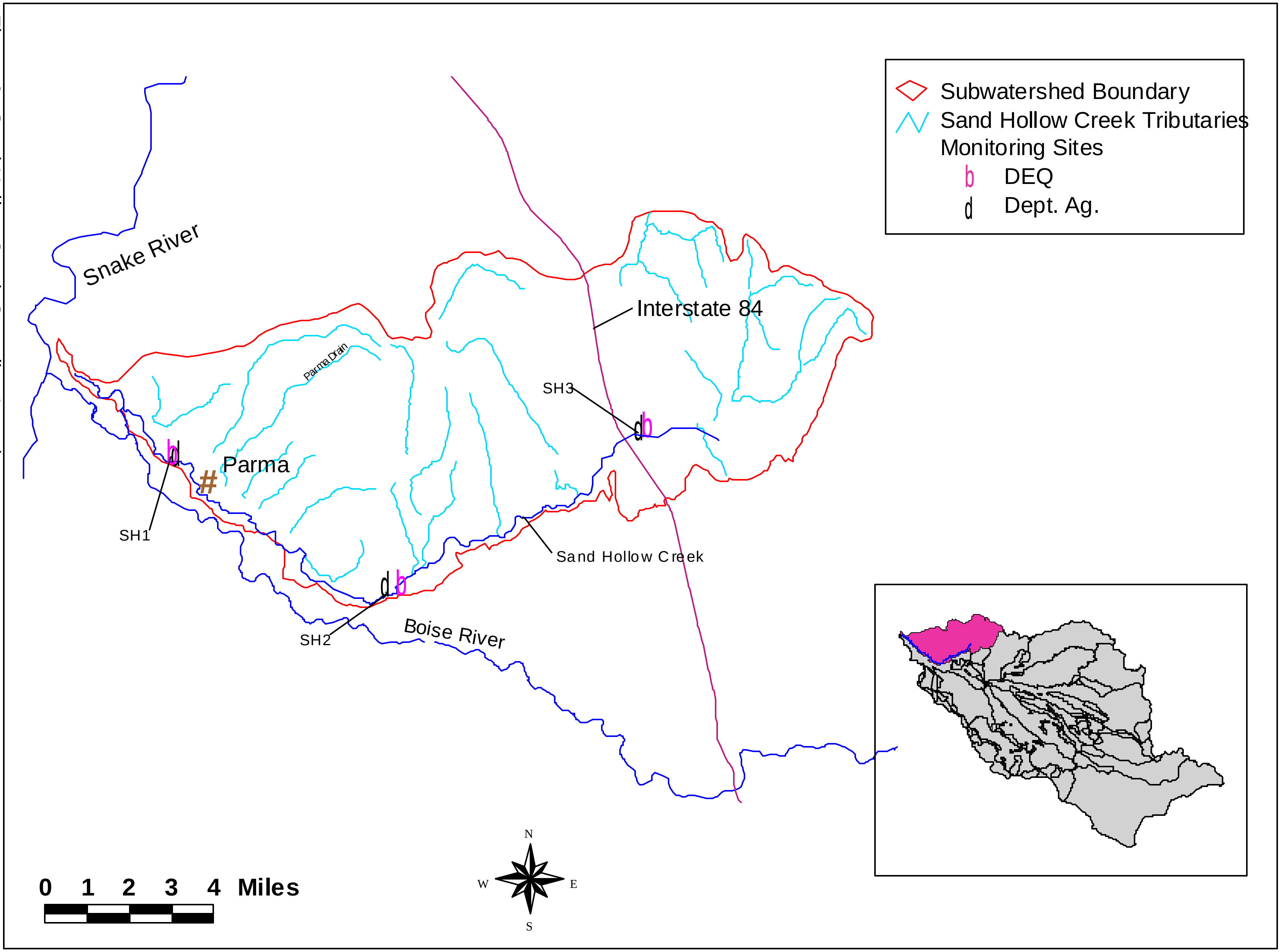
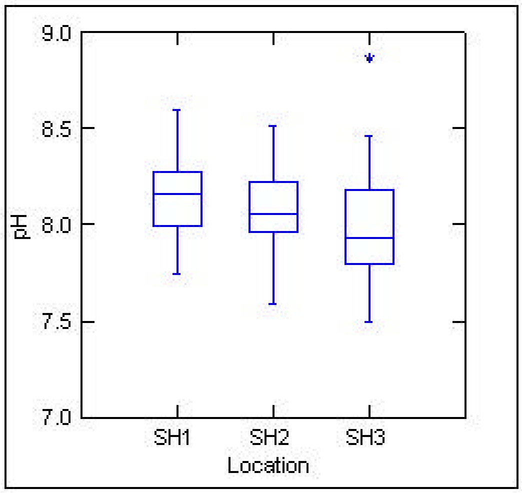


Figure 6. Sand Hollow Creek Sampling Locations

Figure 7 shows the range of pH values in Sand Hollow Creek from the years 1998 to 2000. The data were collected on a monthly basis by the Department of Agriculture and DEQ and include values from the growing season of each year. The mean pH value in the stream is 8.14 near Parma (SH1), 8.0 above Parma (SH2) and 7.9 below Interstate 84 (SH3). At all locations in the stream, even considering the values in the stream during the growing season, the modified criterion is met.



Guide to interpreting the box and whisker plot:

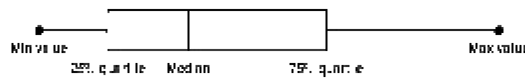
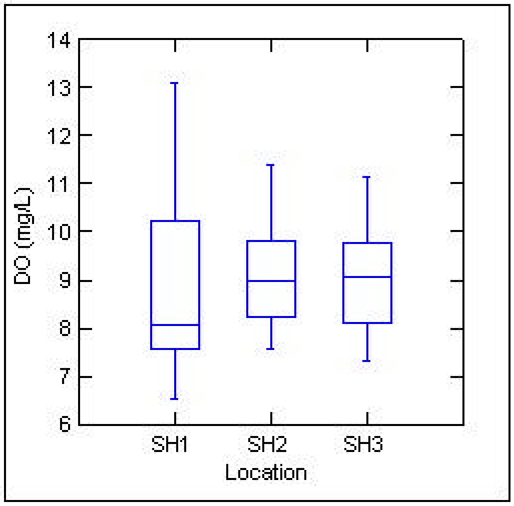


Figure 7. pH values in Sand Hollow Creek, 1998 - 2000

Dissolved Oxygen

Dissolved oxygen can be a direct indicator of nuisance aquatic growth in that as aquatic algae biomass increases, the amount of night-time respiration increases as well. As respiration increases, the volume of oxygen removed from the water increases. In excessive algae growth situations, the result is often low DO concentrations that stress or even kill sensitive species of fish and macroinvertebrates.

Dissolved oxygen data acquired from the Idaho Department of Agriculture and DEQ for the years 1998 to 2000 are used to assess the dissolved oxygen conditions in Sand Hollow Creek. The entire data set consists of data that were collected at three longitudinally spaced locations along Sand Hollow Creek. The Department of Agriculture data were collected approximately twice a month from April 1998 to December 1999. The data were collected at five locations along the length of Sand Hollow Creek. The DEQ data were collected once per month from June 2000 to September 2000. Figure 8 shows the dissolved oxygen data for Sand Hollow Creek.



Guide to interpreting the box and whisker plot:

Figure 8. Dissolved Oxygen concentrations in Sand Hollow Creek, 1994 – 2000

The data show that dissolved oxygen concentrations in Sand Hollow Creek do not fall below the modified criterion of 4.0 mg/l. Based on these data, dissolved oxygen is not impairing the aquatic life beneficial use.

Sediment

Suspended sediment (TSS) conditions can be used as an indicator of sediment conditions in water bodies in that it provides a direct measure of water column clarity. Suspended sediment is defined as the sediment fraction that is readily suspended in the water column (typically <0.1mm). Total suspended sediment concentrations in Sand Hollow Creek fluctuate with the irrigation season flows (Figure 9). At all of the monitoring locations TSS concentrations in the stream increase during the irrigation season and decrease during the non-irrigation season, primarily due to surface erosion from agricultural lands. The peak concentrations often occur at the beginning of the irrigation season when the system is being charged with water, causing an initial slug of re-suspended sediment to move through the system. The concentrations then decrease for a short period while the system is charged. Once charged and the producers begin to irrigate, the concentrations increase again. Additionally, there is a cumulative increase in TSS concentration in the lower portion of the stream. The TSS concentrations at the SH1 and SH2 are notably higher than the concentration upstream at SH3. This suggests that return flows to Sand Hollow Creek above SH2 contribute to the overall TSS load in the stream.

As illustrated in Figure 9, the TSS concentrations during the irrigation season are notably higher than the remainder of the year. Table 5 shows the irrigation and non-irrigation season average TSS concentrations in Sand Hollow Creek for the years 1998 through 2000. The average TSS concentration at Parma (SH1) during the irrigation season is 155 mg/L. The average concentration upstream of Parma (SH2) increases slightly to 164 mg/L. This suggests that there are few if any substantial agricultural inputs between the two sites. Upstream of Interstate 84 (SH3) the monthly average concentration during the irrigation season is 49 mg/L. During the non-irrigation season, the TSS concentrations in the stream remain relatively constant with only a slight downstream increase in concentration.

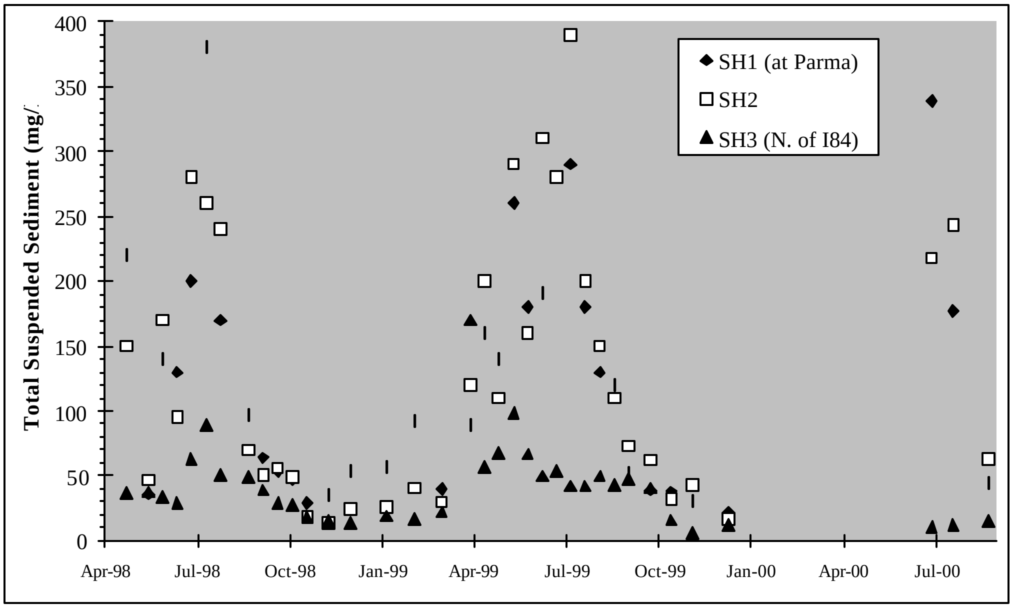


Figure 9. Total Suspended Sediment levels in Sand Hollow Creek, 1998-2000

Table 5. Irrigation and non-irrigation season average TSS concentrations (mg/L) in Sand Hollow Creek, 1998-2000

Season	SH1	SH2	SH3
Irrigation Season	155	164	49
Non-irrigation Season	44	30	17

The lower Boise River sediment TMDL (2000) established an instream TSS target of 50 mg/L for no longer that 60 days, and 80 mg/L for no longer than 14 days for the lower Boise River proper. These targets are consistent with Newcombe and Jensen’s (1996) recommended thresholds for juvenile salmonids (trout). The 50/80 targets were specifically chosen for the lower Boise River because they are protective of juvenile rainbow trout and hence the salmonid spawning designation. Based on this logic, the in-stream targets for the lower Boise River proper are not appropriate for Sand Hollow Creek because Sand Hollow Creek is not listed for salmonid spawning, nor do the available data show salmonid spawning to be an existing use.

While salmonid spawning does not occur in Sand Hollow Creek, there is evidence that a transient population of adult rainbow trout exists in the stream during the irrigation season. In 1997, the DEQ collected fish data approximately one-half mile below Interstate 84. Multiple species were identified during the survey, including leopard dace, redside shiners, bridgelip suckers, mountain suckers and three adult rainbow trout. All of the trout were greater than 100 mm in length.

Using Newcombe and Jensen’s sediment threshold matrix as a reference (described in Appendix B), adult salmonids can tolerate TSS concentrations of 148 mg/L for up to four months without experiencing lethal effects. This target is consistent with the modified nature of the fisheries in Sand Hollow Creek in that it is protective of the adult salmonid population while they are present in the stream. In fact, the target of 148 mg/L for up to four months is conservative and adds a margin of safety when the recommendations outlined by the European Inland Fisheries Advisory Commission (EIFAC) are considered. EIFAC (1964) indicated that suspended solid concentrations (which are typically less than suspended sediment in the same sample) should remain between 25-80 mg/L to maintain good fisheries and between 80-400 mg/L for moderate to poor fisheries. Given the EIFAC ranges, 148 mg/L suspended sediment falls in the lower end of 'moderate' fisheries assignment. Again, the connecting Sand Hollow Creek to 'moderate' protection is consistent with the modified nature of the fisheries in Sand Hollow Creek in that it is protective of adult fish while they are present in the stream.

Upstream of Interstate 84 the TSS concentrations are significantly below the target of 148 mg/L, even during the irrigation season. As indicated in Figure 5, the monthly irrigation season average is 49 mg/L. The standard deviation is 32, suggesting that even considering the variance of concentrations, the concentration remains below 148 mg/L at nearly all times. Below the interstate, the data are not as conclusive. Upstream of Parma (SH2) the irrigation season average is 164 mg/L with a standard deviation of 98, suggesting the variance of concentrations is large. Conditions below Parma (SH1) are similar, with an irrigation season average of 155 mg/L and a standard deviation of 95.

A closer review of the data (Table 6) shows in 1999, when TSS concentration are at their highest for the period of record, the target of 148 mg/L is exceeded for four consecutive months (120 days) at SH2, but not at SH1. At SH1, the concentration begins to exceed 148 mg/L on 4/20 and remains above 148 mg/L until 7/27 (3 months). The interval average for this period is 213 mg/L. At SH2 the concentration begins to exceed 148 mg/L on 4/20 and continues to exceed through 8/10. The interval average for this 4-month period is 235 mg/L. The brief decrease that occurs on 5/4 at both locations is because the irrigation system has been charged, but producers have not started or are only beginning to irrigate.

Table 6. Irrigation season TSS concentrations (mg/L) at SH1 and SH2 for April-August 1999

Date	**Irrigation Season TSS Concentration (mg/L)**	
	SH1	**SH2**
4-06-99	89	120
4-20-99	160	200
5-04-99	140	110
5-18-99	260	290
6-01-99	180	160
6-15-99	191	310
6-29-99	280	280
7-13-99	290	390
7-27-99	180	200
8-10-99	130	150
8-24-99	120	110

Due to the exceedence of the four-month TSS target at SH2, TSS reductions in Sand Hollow Creek are necessary to meet the water quality goals. The question becomes, is a TMDL for Sand Hollow Creek the best means by which to address the need for reductions? Based on the current sediment reduction activities in the watershed and the fact that the Snake River-Hells Canyon TMDL is implicating sediment reductions from a lumped conglomerate of smaller systems that flow to the Snake River (of which Sand Hollow is included), the DEQ does not recommend a sediment TMDL for Sand Hollow Creek. Rather, DEQ recommends continuing with the current Canyon SCD coordinated Sand Hollow Water Quality Project and taking an adaptive management approach to reducing suspended sediment in Sand Hollow Creek. This approach is described further in Appendix C. The Canyon SCD works with agricultural operators in the respective counties to provide technical assistance for implementation of BMPs. The Sand Hollow Water Quality Project currently being implemented in the Sand Hollow Creek subbasin. Within the Sand Hollow watershed, $399,751 in state matching funds and $321,695 in landowner personal funds have been spent to carry out conservation practices such as filter strips, sediment basins, conservation tillage, sprinkler systems, surge irrigation systems and other water conservation practices. At one time, the Canyon SCD was matching 33 active contracts and providing conservation treatment to 3,700 acres. These current and future sediment reduction efforts are consistent with the activities that would occur with a TMDL implementation plan in place. No regulatory authority currently exists over individual producers. Therefore, the nonpoint source incentive for implementing best management practices is the availability of expertise and money, of which the Canyon SCD is currently offering.

Contact Recreational Response to Sediment

Excess sediment can impair recreational beneficial uses in a number of ways. Excess surface sediment can alter the channel form by increasing deposition or scouring, which creates abrupt and unexpected changes in channel form. Additionally, over abundance of fine substrate sediment can create unsafe swimming and wading conditions by physically interfering with body movement. It typically takes a very large volume of sediment for this effect to occur. Excess sediment can also decrease the aesthetic appeal of the water by making the water appear muddy and murky.

While the data indicate there is fine material in Sand Hollow Creek, the sediment levels do not appear to be impairing secondary contact recreation. During the 2000 monitoring season, DEQ employees walked Sand Hollow Creek on a monthly basis and did not note any significant difficulty navigating the channel due to excess sediment. In addition, the DEQ has received no complaints about poor swimming or wading conditions due to sediment. Contact recreation occurs or can potentially occur in Sand Hollow Creek at several locations, although the irrigation districts discourage it.

Turbidity

None of the agencies that currently monitor Sand Hollow Creek or have monitored Sand Hollow Creek in the past have collected turbidity data, hence no current turbidity data exist for Sand Hollow Creek.

Nutrients and Aquatic Algae Biomass

Phosphorus

High concentrations of phosphorus have been recorded in Sand Hollow Creek from 1998 to 2000 (Figure 10). Based on numerous studies (Bothwell, 1988 and Horner and others 1983), the water column total phosphorus (TP) levels in Sand Hollow Creek are more than sufficient to support algae growth. Additionally, EPA's gold book criterion for water column total phosphate phosphorus is 0.10 mg/L, which is the level at which EPA indicates the potential for eutrophication exists. This information, along with the direct effects of nutrients on aquatic life and contact recreation beneficial uses, should be considered when determining the effects of nutrients in a water body.

As with the TSS concentrations, the TP concentrations in Sand Hollow Creek fluctuate with the irrigation season. Table 7 shows the irrigation and non-irrigation seasonal average concentrations at the Sand Hollow Creek monitoring locations for the years 1998 to 2000. The TP concentrations range from as low as 0.11 mg/L during the non-irrigation

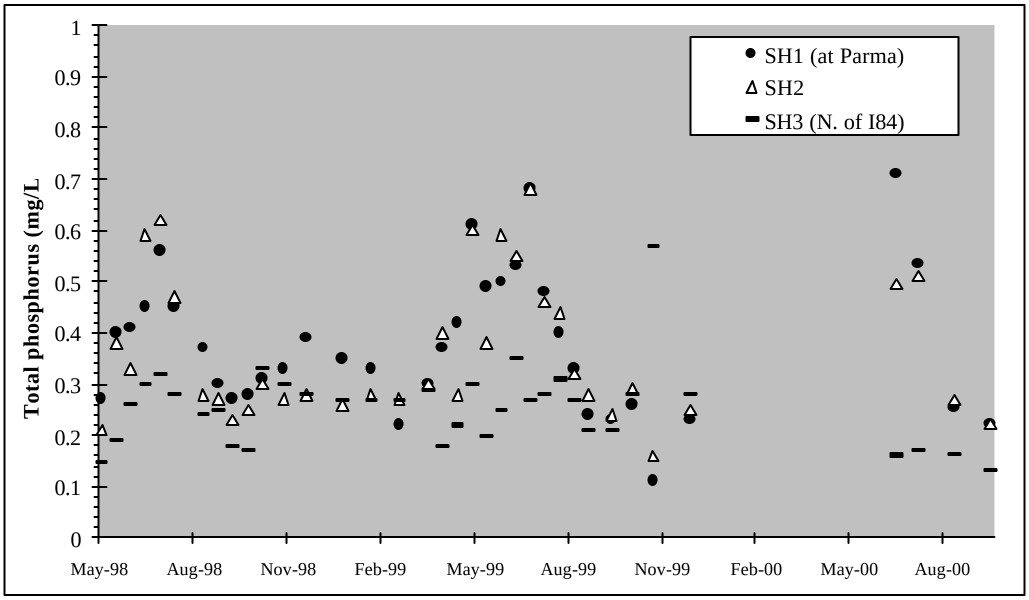


Figure 10. Total phosphorus levels in Sand Hollow Creek, 1998-2000.

season to as high as 0.71 mg/L during the irrigation season. During the irrigation season, the average TP concentration below Parma is 0.42 mg/L. The average concentration steadily drops at the upstream locations, with the most upstream monitoring location (upstream of Interstate 84) average being 0.24 mg/L.

During the non-irrigation season, the average concentration in Sand Hollow Creek below Parma is 0.28 mg/L at the mouth and 0.30 mg/L above the interstate. For the most part, the non-irrigation season TP concentrations are similar throughout the stream.

The dissolved-orthophosphate concentrations in Sand Hollow Creek are typically 65% - 75% of the total phosphorus concentration, which is consistent with the ratio found in the river proper.

Table 7. Irrigation and non-irrigation season average TP concentrations (mg/L) in Sand Hollow Creek.

Location	**Irrigation Season Ave.**	**Non-Irrigation Season Ave.**
SH1 (at Parma)	0.42	0.28
SH2	0.40	0.26
SH3 (North of I-84)	0.24	0.30

The impact of excess nutrients on aquatic life beneficial uses is generally based on abnormalities in dissolved oxygen and pH. When excess nutrients are causing excess algal biomass, dissolved oxygen and pH conditions normally fluctuate as described in the above dissolved oxygen and pH analysis. Dissolved oxygen and pH conditions in Sand Hollow Creek are normal, indicating that nutrients are not impairing aquatic life beneficial uses. The impacts of excess nutrients on contact recreation beneficial uses are generally based on algal biomass levels and other associated factors, which are described in the analysis below.

Benthic Chlorophyll –a

Chlorophyll-a is the essential photosynthetic pigment found in aquatic plants. The amount of chlorophyll-a in water column (suspended) algae and in the algae attached to rocks (periphyton) is commonly used to measure algal productivity. While chlorophyll-a concentrations vary from species to species, it remains a viable surrogate for algae biomass (Carlson 1980, Watson et al. 1992). The EPA also suggests that chlorophyll-a is a desirable endpoint because it can usually be correlated to loading conditions (EPA 1999).

Periphytic (benthic) algae grow naturally on pebbles, cobbles and boulders along the streambed. Periphytic algae grow as single celled organisms called diatoms that are kept in check by the grazing of aquatic insects. Periphyton growth is limited by factors such as nutrient and light availability, substrate composition, substrate stability, water velocity and suspended sediment concentration (which causes abrasion). When nutrient availability exceeds the basic needs of diatoms, and other factors do not limit growth, other periphytic species, including bulky, filamentous algae such as *Cladophora* may grow on the streambed.

The state of Idaho does not have a numeric criterion for periphytic chlorophyll-a. However, several authors have suggested that periphyton chlorophyll-a values from 100 to 200 mg/m^2 constitute a nuisance threshold, above which aesthetics are impaired (Horner and others, 1983, Watson and Gestring, 1996; Welch, and others, 1988; Welch, et al., 1989). However, no thresholds have been proposed in relation to the adverse impacts to aquatic life. Impacts to aquatic life are generally based on DO and pH problems and the reduction of living space for aquatic organisms due to excessive algae biomass.

The exact biomass level at which algae growth becomes quantified as “nuisance” is not well defined. The nutrient level and the mass of algae itself that constitutes a nuisance characterization is different in nearly every water body. Nuisance algae growth is often dictated by other limiting factors such as water velocity, substrate composition, ground water nutrient concentration and in the case of attached macrophytes, substrate nutrient concentration.

The benthic chlorophyll-a data for Sand Hollow Creek are sparse. However, the data that are available likely represent the overall benthic algal conditions in the stream. This assumption is based on the relative similarity in flow regime, substrate condition, water clarity, nutrient enrichment and riparian shading throughout the system, all of which directly affect periphytic algae growth. Samples collected by the DEQ at Parma, above Parma and above the interstate crossing in September 2000 revealed benthic chlorophyll-a levels of 121 mg/m2, 8.0 mg/m2 and <0.32 mg/m2 respectively. The sites above the interstate and above Parma are well below the minimum nuisance threshold of 100 mg/m2. The benthic biomass at Parma increases substantially from the upstream site, but remains below the nuisance threshold. The low benthic chlorophyll-a levels in Sand Hollow Creek are not surprising given the growth-limiting factors in the stream. The substrate surveys that have been conducted in Sand Hollow Creek indicate that the stream bottom is dominated by silt and sand with sporadically distributed areas of gravel and cobble, which is typically highly embedded. Silt and sand are unstable and do not provide a desirable attachment point for benthic algae. In addition, the peak growing season for benthic algae corresponds with the irrigation season (April – September) in the lower Boise River basin. The result is decreased water clarity. This decrease in water clarity is likely in part limiting the growth of benthic algae in Sand Hollow Creek. A similar scenario is occurring in the lower Boise River at Parma.

In addition to being below the literature nuisance threshold values, the periphytic biomass levels in Sand Hollow Creek are not such that they are causing unsafe swimming or wading conditions. There continues to be evidence of contact recreation throughout the stream in the form of swimming holes and hunting access. In addition, the DEQ has no registered complaints regarding odor or water discoloration caused by algae, both of which could occur when large benthic algae mats die and decompose.

Water Column Chlorophyll –a

While the state of Idaho does not have a numeric criterion for water column chlorophyll-a, Oregon's threshold is 15 ug/l. When the Oregon threshold is exceeded in an average of three samples collected over consecutive months at a representative location, a follow-up is made to ascertain if a beneficial use is adversely impacted. Hence, a value of greater than 15 ug/l does not necessarily indicate impairment. North Carolina has a chlorophyll-a criterion of 40 ug/l, which according to the state of North Carolina indicates impairment. Raschke (1994) proposed a level of 25 ug/l for surface waters used for viewing pleasure, boating, safe swimming and fishing. These thresholds are used as a point of reference for this assessment.

As with benthic chlorophyll-a, the water column chlorophyll-a data for Sand Hollow Creek are sparse. However, it is again assumed that the data that are available are representative of the overall water column algal conditions in the stream. This assumption is based on the relative similarity in flow regime, water clarity, nutrient enrichment and riparian shading throughout the system, all of which directly effect water column algae growth. . Samples collected by the DEQ at Parma, above Parma and above the interstate during the 2000 growing season revealed suspended chlorophyll-a levels of 5.2 ug/l, 2.0 ug/l and 0.9ug/l respectively. All are well below the most stringent nuisance threshold value of 15 µg/L. The factor that is probably limiting water column algae is water clarity. Again, the peak growing season for benthic algae corresponds with the irrigation season

(April – September) in the lower Boise River basin. The result is decreased water clarity, and hence, decreased light penetration in Sand Hollow Creek during the irrigation season.

Macrophytes and Other Bulky Species

Sand Hollow Creek exhibits very little macrophyte growth in relation to the other 303(d) listed tributaries in the lower Boise River Basin. Excess macrophyte growth was not observed in the stream at any location during the 2000 growing season. While macrophytes were noted in the upper portions of the stream, they were sporadically distributed and were not dense. The low macrophyte densities are not surprising given the factors that limit macrophyte growth in Sand Hollow Creek.

As opposed to many of the tributaries in the southeastern portion of the lower Boise River watershed, the stream banks in Sand Hollow Creek are not managed as heavily for irrigation purposes. There are more water demands in most of the southeasterly located subwatersheds than in the Sand Hollow Creek subwatershed. Thus, fewer input and withdrawal structures that require maintenance have been placed in Sand Hollow Creek. The result is a riparian area that has remained partially intact. Additionally, Sand Hollow Creek has experienced very little riparian disturbance due to development. In many portions of Sand Hollow Creek the riparian canopy is dense enough to provide suitable shade to the stream, this is uncommon in the southeastern subwatersheds. Department of Environmental Quality monitoring performed in 1996 and 1997 showed the stream's canopy provided shade to nearly 50% of the stream channel at sites just upstream and downstream of Interstate 84. This percentage of canopy cover remains relatively constant throughout the system, with a few exceptions where more or less shade is available. The result is reduced light infiltration to the stream and reduced algal biomass.

Another factor that limits macrophyte growth in Sand Hollow Creek is flow velocity. Thomann and Mueller (1987) showed that due to a scouring effect, point velocities greater than 1.6 fps decreased the capability of benthic periphyton and macrophytes to effectively attach themselves to the substrate. Flow measurements conducted by the Department of Agriculture during the 1999 growing season show that point velocities in Sand Hollow Creek slightly upstream of Parma frequently exceed 1.6 fps. Near Interstate 84 where there is even less water than near Parma, the velocities are less, but still near 1.6 fps (Figure 11).

The average point velocity above Parma for the months of April through September 1999 was 2.73 fps. Near Interstate 84, the average point velocity was 1.56 fps. This factor in combination with the presence of riparian shade, which decreases light penetration, appears to be limiting the establishment of dense macrophyte beds.

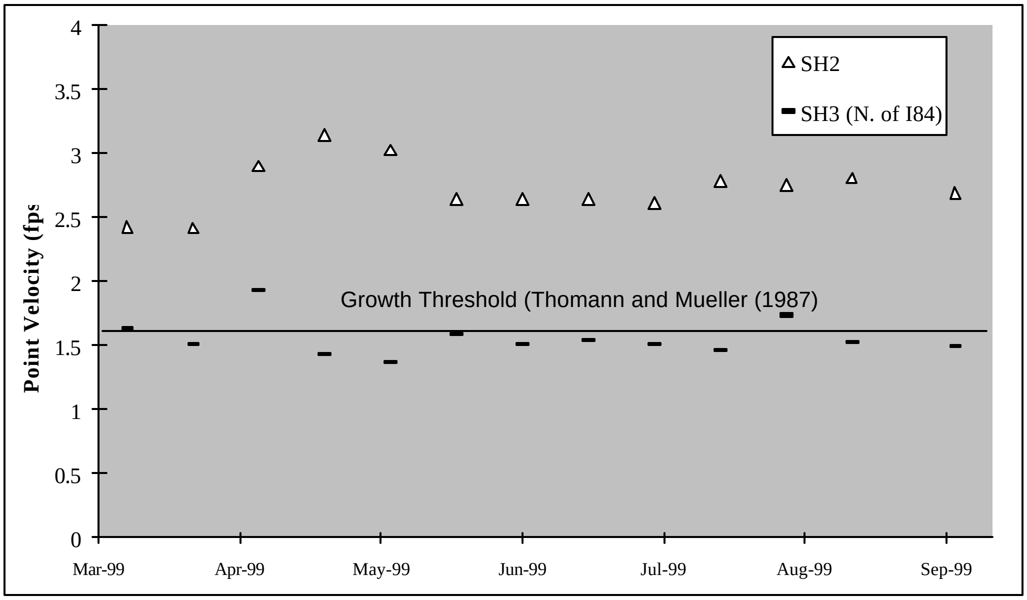


Figure 11. Point Velocities in Sand Hollow Creek, 1999 growing season.

Bacteria

The state of Idaho's bacteria standard say that waters designated for secondary contact recreation are not to contain E. Coli bacteria exceeding a 30-day geometric mean of 126 organisms/100ml.

Data collected in 1998 and 1999 at Sand Hollow Creek monitoring locations indicate that during the recreation season (May-August), the stream exceeds the E.Coli standard at all locations (Table 8). The data are not represented as a monthly geometric mean, but clearly show that the recreation season concentrations are above the standard.

Table 8. Bacteria concentrations in Sand Hollow Creek

Location	Year (May-Aug)	Geo-mean (#/100ml)
SH1 (at Parma)	1998	954
	1999	802
SH2	1998	1217
	1999	613
SH3 (North of I-84)	1998	956
	1999	942

DEQ recommends listing Sand Hollow Creek for bacteria on the 2002 303(d) list. Upon listing the streams, DEQ will establish a TMDL schedule.

Status of Beneficial Uses

The data indicate that dissolved oxygen and nutrients are not impairing modified aquatic life or secondary contact recreation beneficial uses in Sand Hollow Creek. Consequently, DEQ does not recommend preparing TMDLs for those pollutants and recommends removing them as pollutants of concern in Sand Hollow Creek from the 2002 303(d) list. The data also indicate that irrigation season suspended sediment concentrations above Parma are slightly over the surrogate TSS value. However, DEQ does not recommend preparing a TMDL to achieve reductions. DEQ recommends implementing an adaptive management approach, as described in the sediment analysis section and Appendix C. Due to the exceedence of the TSS target, DEQ does not recommend de-listing sediment from the 2002 303(d) list at this time. Table 9 summarizes the beneficial use support status for Sand Hollow Creek.

Table 9. Beneficial Use Support Status in Sand Hollow Creek.

Segment	**Designated Use**	**Existing Use**	**Impaired Use**	**Listed Pollutant(s) Causing Impairment**
Headwaters to Snake River	Undesignated	MOD, SCR	MOD, SCR	Sediment, Bacteria

This assessment indicates that secondary contact recreation and modified aquatic life beneficial uses in Sand Hollow Creek are not impaired by nutrients. However, the high nutrient concentrations found in Sand Hollow Creek imply that nutrients are a contributing factor to nutrient loading in the Snake River. The Snake River-Hells Canyon nutrient TMDL will outline a general need for nutrient reductions from adjacent agricultural lands, but will not assign explicit load allocations to small tributaries such as Sand Hollow Creek.

Data Gaps

This assessment has identified several data gaps that limit full assessment of the effects of the listed pollutants on beneficial uses. While the best available data were used to develop the current assessment, DEQ acknowledges there are unresolved questions, as outlined in Table 10.

New information developed through monitoring efforts may be used to revise the appropriate portions of the SBA, and determine and adjust appropriate implementation methods and control measures. Changes in the assessment will not result in the production of a new document. Minor changes will be handled through a letter amending the existing document(s), more extensive changes will be handled through supplementary documentation or replacing sections or appendices. The goal will be to build upon rather than replace the original work wherever practical. The revision of this assessment is consistent with current and developing EPA guidance that emphasizes an iterative approach to TMDL development and implementation. Any additional effort on the part of DEQ to revise the SBA or implementation plan must be addressed on a case-by-case basis, as additional funding becomes available.

Table 10. Data gaps identified during development of the Sand Hollow Creek Subbasin Assessment

Pollutant or other Factor	Data Gap
Sediment	Only instantaneous suspended sediment data available; cannot evaluate duration of concentrations
	Bedload data
	Discrete substrate and water column particle size distribution data throughout the stream
	Stream bank erosion rates
Nutrients	Only instantaneous data available; cannot evaluate duration of concentrations
Biological	Benthic and suspended algae data for hot summer drought conditions as well throughout the growing season for multiple years
Other	Diurnal dissolved oxygen data

Pollution Source Inventory

Sediment and nutrients enter Sand Hollow Creek from point and nonpoint sources. The City of Parma WWTP currently discharges to Sand Hollow Creek. The WWTP, which has a design flow of 0.31 mgd, is located west of town.

Nonpoint sources of sediment primarily include agricultural activities and bank erosion, although drain maintenance may produce large amounts of sediment while it is occurring. Stormwater runoff and runoff from construction activities are not as significant sources as in tributaries in the upper portion of the watershed, but may be a minor source. An unknown amount of internal re-suspension also occurs at any given location. The most significant sources of sediment from agricultural practices are likely surface irrigated cropland and streambank trampling due to unrestricted use of streamside areas by livestock. Construction in the stream channel is subject to stream alteration permits issued by the Idaho Department of Water Resources. These permits generally include requirements for best management practices (BMPs) to reduce sediment releases to the stream. Agricultural activities are exempt from stream alteration permits. Agricultural activities that generate sediment include surface irrigated row crops and surface irrigated pastures. A substantial amount of the sediment that erodes from agricultural lands is deposited in the multiple drains, canals, and laterals and is liberated during the irrigation charge in April. Sediment is also liberated from the stream substrate when irrigators alter instream structures to improve diversions.

Most large confined animal feeding operations (CAFOs), confined feeding areas (CFAs) and dairies are subject to discharge limits under general NPDES permits. To be regulated under a general NPDES permit, CAFOs and CFAs must meet size criteria and be considered significant contributors of pollutants. All dairies that have a permit to sell milk are subject to the Idaho Department of Agriculture (IDA) dairy inspection program. Dairies are required to have adequate waste management practices subject to the Rules Governing Dairy Waste, IDAPA 58.01.02350.03.g and IDAPA 02.04.14. Smaller animal feeding operations and pasture grazing are not regulated. Animal waste that is removed from dairies, CAFOs and CFAs in liquid or solid form may be applied to agricultural lands as a soil amendment. Operators subject to an NPDES permit are required to land apply waste at agronomic rates and maintain adequate record keeping of waste management. The IDA has rules in place to ensure proper management of land applied animal waste at other facilities, but these activities are currently unregulated. The extent to which land application of animal waste is a source of bacteria is unknown.

Nonpoint sources of nutrients include runoff from agricultural operations, including irrigated row crops, pasture, animal management operations, stormwater runoff and ground water. Nutrients that enter the stream from ground water generally have their source in the same land use activities that contribute nutrients directly to surface water. A notable exception is septic systems. In areas that lack sewering and wastewater treatment, septic systems may contribute nutrients to ground water that eventually reach the stream directly or via drains.

Pollution Control Efforts

Nonpoint Sources

Most of the agricultural programs are federally funded through the Natural Resource Conservation Service (NRCS), through past and present Farm Bills authorized by the United States Congress. These programs are targeted at the agricultural community to assist with conservation practices. For example, the Canyon County Soil Conservation Districts (SCD) have State Agricultural Water Quality Program (SAWQP) money available to address on-the-farm pollutant reductions. SAWQP is a state of Idaho water quality program to provide cost share incentives to local operators for pollutant reductions. The agricultural community, through local SCDs and other funding sources has demonstrated a willingness to protect water quality in the lower Boise River valley.

Other state and federal funding sources include the federal 319 program, the Agricultural Water Quality Program for Idaho, the Resource Conservation and Rangeland Development Program, and the Federal Environmental Quality Incentive Program (EQIP). Current federal funding from EQIP is targeted at all farming and ranching activities. Participation from local operators has been competitive and is based on the availability of funds from the program. Other sources of funding include private sources such as Ducks Unlimited, The Nature Conservancy and colleges and universities.

The Idaho OnePlan web site (www.oneplan.org) is an on-line tool to help farmers and ranchers create their own farm and ranch conservation plans. Developed as a cooperative effort between multiple state and federal agencies, the OnePlan will assist producers in meeting the ongoing demands for sustainable agriculture. As an example, a OnePlan Nutrient Management Plan could assist an Idaho dairy farmer to meet the rigorous demands of Idaho's new dairy regulations. In the future, the OnePlan web site will also offer additional on-line tools such as crop nutrient demands and crop water consumption charts.

Point Sources

The Parma wastewater treatment plant is the only discrete point source in the Sand Hollow Creek subwatershed. The plant, which provides treatment of wastewater from the city of Parma, discharges to Sand Hollow Creek. As part of the discharge monitoring portion of their NPDES permit, the WWTP is required to monitor their effluent to determine compliance with their permit. The monthly discharge monitoring reports are sent to EPA and DEQ as well as kept on file at the facility.

In 1996, EPA reissued the Idaho general NPDES permit for CAFOs. This new general permit allows permitted facilities to discharge animal waste only during unusual climatic events. The new permit also requires permitted facilities to land apply animal waste at agronomic rates, and requires record keeping of animal waste management practices. It is believed these provisions will reduce discharges to surface waters, and reduce impacts to ground water.

Reasonable Assurance

The state has responsibility under Sections 401, 402 and 404 of the Clean Water Act to provide water quality certification. Under this authority, the state reviews dredge and fill, stream channel alteration and NPDES permits to ensure that the proposed actions will meet the Idaho's water quality standards.

Under Section 319 of the Clean Water Act, each state is required to develop and submit a nonpoint source management plan. Idaho's most recent Nonpoint Source Management Program was finalized in September 1999. The plan was submitted to and approved by the EPA. Among other things, the plan identifies programs to achieve implementation of nonpoint source BMPs, includes a schedule for program milestones, outlines key agencies and agency roles and is certified by the state attorney general to ensure that adequate authorities exist to implement the plan and identifies available funding sources.

Idaho's nonpoint source management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, such as the formation of Basin Advisory Groups (BAGs) and Watershed Advisory Groups (WAGs) (IDAPA 58.01.02.052). The WAGs are to be established in high priority watersheds to assist DEQ and other state agencies in formulating specific actions needed to control point and nonpoint sources of pollution affecting water quality limited waterbodies. The Lower Boise River Water Quality Plan (LBRWQP) is the designated WAG for the lower Boise River watershed, which includes Sand Hollow Creek. Upon EPA approval of a TMDL, the WAG, with the assistance of appropriate federal and state agencies, will begin development of an implementation plan to meet water quality goals.

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 11.

Table 11. State of Idaho's regulatory authority for nonpoint pollution sources

Authority	IDAPA Citation	Responsible Agency
Rules Governing Solid Waste Management	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Rules Governing Subsurface and Individual Sewage Disposal Systems	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Rules and Standards for Stream-channel Alteration	58.01.02.350.03(d)	Idaho Department of Water Resources
Rules Governing Exploration and Surface Mining Operations in Idaho	58.01.02.350.03(f)	Idaho Department of Lands
Rules Governing Placer and Dredge Mining in Idaho	58.01.02.350.03(g)	Idaho Department of Lands
Rules Governing Dairy Waste	58.01.02.350.03.(h)	Idaho Department of Agriculture

The state of Idaho uses a voluntary approach to control agricultural nonpoint sources. However, regulatory authority can be found in the water quality standards (IDAPA 58.01.02.350.01 through 58.01.02.350.03). IDAPA 58.01.02.054.07 refers to the *Idaho Agricultural Pollution Abatement Plan* (Ag Plan) (IDHW and SCC, 1993) which provides direction to the agricultural community approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (SCDs) that will take the lead if nonpoint source pollution problems need to be addressed. For agricultural activity, it assigns the local SCDs to assist the landowner/operator with developing and implementing BMPs to abate nonpoint pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations that may be determined to be an imminent and substantial danger to public health or environment (IDAPA 58.01.02.350.02(a)).

The *Idaho Water Quality Standards and Wastewater Treatment Requirements* specify that if water quality monitoring indicates that water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate and/or modify the BMPs to protect beneficial uses. If necessary the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with the Director of the Department of Environmental Quality's authority provided in Section 39-108, Idaho Code (IDAPA 58.01.02.350).

The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs; the Soil Conservation Commission for grazing and agricultural activities; the Department of Transportation for public road construction; the Department of Agriculture for aquaculture; and DEQ for all other activities (IDAPA 58.01.02.003).

References

Allen, J.D. 1995. Stream Ecology: Structure and function of running waters. Chapman and Hall. New York City, NY. USA.

Bothwell, M.L. 1988. Growth rate responses of lotic periphyton diatoms to experimental phosphorus enrichment: The influence of temperature and light. Canadian Journal of Fisheries and Aquatic Science 45, pp.261 - 269.

Burnham, W.L. 1979. Groundwater report - Southwest community waste management study. Ada County Planning Association Technical Memorandum 308.04g.

Carlson, RE. 1980. More complications in the chlorophyll-Secci disk relationship. Limnology and Oceanography. 25:378-382.

Clark, W.H and S.B. Bauer. 1983. Water Quality Status Report Lower Boise River Drains Canyon County, Idaho. Idaho Department of Health and Welfare: Water Quality Series #50.

Collett, R.A. 1972. Soil survey of Ada County area Idaho. United States Department of Agriculture, Soil Conservation Service, 327 p., maps.

Dion, N P. 1972. Some effects of land use on the ground water system in the Boise-Nampa area, Idaho. Idaho Department of Water Administration Water Information Bulletin 26, 47 p.

Dupuis T., and S. Doran. 2001. Beneficial use evaluation for selected tributaries in the Lower Boise River, Draft Technical Memorandum. CH2M Hill, Boise, Idaho.

EPA. 1991. Guidance for water quality-based decisions: The TMDL process. U.S. Environmental Protection Agency 440/4-91-001, Washington, D.C., 58 p.

EPA. 1999. National Nutrient Assessment Strategy: An overview of available endpoints and assessment tools.

Griswold, K. 2000. Personal communication from Keith Griswold, Idaho Soil Conservation Commission.

European Inland Fisheries Advisory Commission. 1964. Water quality criteria for European freshwater fish. Report on Finely Divided Solids and Inland Fisheries. European Inland Fisheries Advisory Comission. Food and Agriculture Organization of the United Nations. Rome. EIFAC/1. 21p.

Horner, R.R., E.B. Welch and R.B. Veenstra. 1983. Development of nuisance periphytic algae in laboratory streams in relation to enrichment and velocity. In Periphyton of Freshwater Ecosystems, Wetzel, R. G. (ed.), Dr. W. Junk Publishers, The Hague.

IDHW and SCC. 1993. Idaho Agricultural Pollution Abatement Plan, 1991. Idaho Soil Conservation Commission, Boise, Idaho.

Newcombe, C.P. and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16, No. 4, pp. 693-727.

Othberg, K.L. 1994. Geology and geomorphology of the Boise Valley and adjoining areas, western Snake River Plain, Idaho. Idaho Geological Survey, Bulletin 29, 54 p.

Paul, D.J. 1916. Report on drainage investigation of Pioneer and Nampa-Meridian districts in Boise Valley for the year 1916. U.S. Bureau of Reclamation.

Raschke, R.L. 1994. Phytoplankton bloom frequencies in population of small southeastern impoundments. Lake and Reservoir Management. 8(2):205-210.

Rosgen, D.L. 1994. A Classification of Natural Rivers. Catena, Vol. 22, pp. 169-199.

Squires, E., S.H. Wood, and J.L. Osiensky. 1992. Hydrogeologic framework of the Boise aquifer system, Ada County, Idaho. Idaho Water Resources Institute, University of Idaho, Moscow, Idaho, Research Technical Completion Report 14-08-0001-G1559-06, 114 p.

Thomann, R.V. and J.A. Mueller, 1987. Principles of Surface Water Quality Modeling and Control. Harper & Row, New York.

United States Department of Agriculture. 1999. A procedure to estimate the response of aquatic systems to changes in phosphorous and nitrogen inputs: Department of Agriculture.

Watson, S., E. McCauley, and J.A. Downing. 1992. Sigmoid relationships between phosphorous, algal biomass, and algal community structure. Canadian Journal of Fish and Aquatic Science. 49:2605-2610.

Watson, V. and B. Gestring. 1996. Monitoring algae levels in the Clark Fork River. Intermountain Journal of Sciences 2, No. 2, pp. 17-26.

Welch, E. B., R. R. Horner and C. R. Patmont. 1989. Prediction of nuisance periphytic biomass: A management approach. Water Resources 23, No. 4, pp. 401 - 405.

Welch, E. B., J. M. Jacoby, R. R. Horner and M. S. Seeley. 1988. Nuisance biomass levels of periphytic algae in streams. Hydrobiologia 157, pp. 161 - 166.

Acronyms

(BAG)	Basin Advisory Group
(BMP)	Best Management Practices
(BURP)	Beneficial Use Reconnaissance Project
(CAFO)	Confined Animal Feeding Operation
(CFA)	Confined Feeding Areas
(CFR)	Code of Federal Regulation
(CWB)	Cold Water Biota
(DEQ)	Idaho Division of Environmental Quality
(DO)	Dissolved Oxygen
(EPA)	Environmental Protection Agency
(EQIP)	Environmental Quality Incentive Program
(HUC)	Hydrologic Unit Code
(IDA)	Idaho Department of Agriculture
(IDAPA)	Idaho Administrative Procedures Act
(IDFG)	Idaho Fish and Game
(IDHW)	Idaho Department of Health and Welfare
(IDWR)	Idaho Department of Water Resources
(LA)	Load Allocation
(LBRWQP)	Lower Boise River Water Quality Plan
(MOD)	Modified Aquatic Life (beneficial use)
(MOU)	Memorandum of Understanding
(NRCS)	Natural Resource Conservation Service
(NPDES)	National Pollutant Discharge Elimination System
(NTU)	Nephelometric Turbidity Units
(SCC)	Soil Conservation Commission
(SCD)	Soil Conservation District
(SCR)	Secondary Contact Recreation
(SBA)	Subbasin Assessment
(TP)	Total Phosphorus
(TSS)	Total Suspended Sediment
(TMDL)	Total Maximum Daily Load
(USBR)	United States Bureau of Reclamation
(USGS)	United States Geological Survey
(WAG)	Watershed Advisory Group
(WLA)	Wasteland Allocation
(WQPA)	Water Quality Programs for Agriculture
(WWTP)	Wastewater Treatment Plants

Glossary of Terms

Algal bloom - Rapid growth of algae on the surface of lakes, streams, or ponds; stimulated by nutrient enrichment.

Average flow - The average of annual volumes converted to a rate of flow for a single year; (measured in cubic feet per second cfs).

Base flow - Streamflow derived primarily from groundwater contributions to the stream.

Basin - A physiographic region bounded by a drainage divide; consists of a drainage system comprised of streams and often natural or man-made lakes. Also called drainage basin or watershed.)

Bed load - The larger or heavier particles of the stream load moved along the bottom of a stream by the moving water and not continuously in suspension or solution.

Beneficial use - Any water use that enables the user to derive economic or other benefit from such use.

Benthic fauna - Organisms attached to or resting on the bottom or living in the bottom sediments of a water body.

Biological community - All of the living things in a given environment.

Biota - The plant and animal life of a region.

Channelization - The artificial enlargement or realignment of a stream channel.

Climate - Meteorological elements that characterize the average and extreme conditions of the atmosphere over a long period of time at any one place or region of the earth's surface.

Confluence - The place where streams meet.

Dissolved oxygen (DO) – The amount of oxygen freely available in water and necessary for aquatic life and the oxidation of organic materials.

Diversion - The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system.

Diversity - The distribution and abundance of different kinds of plant and animal species and communities in a specified area.

Ecology - The study of the interrelationships of living things to one another and to the environment.

Effluent - The sewage or industrial liquid waste that is released into natural waters by sewage treatment plants, industry, or septic tanks.

Growing season - The number of consecutive days having a minimum temperature above 32^{o}F.

Habitat – The native environment where a plant or animal naturally grows or lives.

Headwaters - The source and upper reaches of a stream; also the upper reaches of a reservoir.

Hydrograph - A graph showing the changes in discharge of a stream or river with the passage of time.

Hydrology - The science of waters of the earth; water's properties, circulation, principles, and distribution.

Impairment - A detrimental effect on the biological integrity of a water body caused by impact that prevents attainment of the designated or existing use.

Irrigation - The controlled application of water to cropland, hayland, and/or pasture to supplement that supplied through nature.

Irrigation return flow - Nonconsumptive irrigation water returned to a surface or ground water supply.

National Pollutant Discharge Elimination System (NPDES) - A permit program under Section 402 of the Clean Water Act that imposes discharge limitations on point sources by basing them on the effluent limitation capabilities of a control technology or on local water-quality standards.

Nonpoint source pollution - Pollution discharged over a wide land area, not from one specific location or discrete source.

Nutrients - Elements or compounds essential to life, including carbon, oxygen, nitrogen, phosphorus, and many others.

Organic matter - Plant and animal residues, or substances made by living organisms.

Perennial stream - A stream that flows from source to mouth throughout the year.

pH - An expression of both acidity and alkalinity on a scale of 0-14, with 7 representing neutrality; numbers less than 7 indicate increasing acidity and numbers greater than 7 indicate increasing alkalinity.

Point-source pollution - Pollution discharged through a pipe or some other discrete source from municipal water-treatment plants, factories, confined animal feedlots, or combined sewers.

Riparian area - Land areas directly influenced by a body of water. Usually have visible vegetation or physical characteristics showing this water influence. Stream sides, lake borders, and marshes are typical riparian areas.

Sediment - Fragmented organic or inorganic material derived from the weathering of soil, alluvial, and rock materials; removed by erosion and transported by water, wind, ice, and gravity.

Sedimentation - The deposition of sediment from a state of suspension of water or air.

Silt - Sedimentary particles smaller than sand particles, but larger than clay particles.

Subbasin - Subdivision of a major river basin, drained by tributaries or groups of tributaries, including associated closed basins.

Total maximum daily load (TMDL) - The total allowable pollutant load to a receiving water such that any additional loading will produce a violation of water-quality standards.

Tributary - A stream that contributes its water to another stream or body of water.

Turbidity - Cloudiness caused by the presence of suspended solids in water; an indicator of water quality.

Waste water treatment - Any of the mechanical, chemical or biological processes used to modify the quality of waste water in order to make it more compatible or acceptable to man and his environment.

Water quality - A term used to describe the chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

Water quality standard - Recommended or enforceable maximum contaminant levels of chemical parameters (e.g., BOD, TDS, iron, arsenic, and others) of water. These parameters are established for water used by municipalities, industries, agriculture, and recreation.

Watershed - Area of land that contributes surface runoff to a given point in a drainage system.

Appendices

Appendix A

Beneficial Use Evaluation for Selected Tributaries in the Lower Boise River, CH2M Hill, 2000

Appendix B

Derivation of a TSS target for Modified (MOD) waters in the Lower Boise River Basin, based on Newcombe and Jensen (1996).

Appendix C

An adaptive management approach for reducing TSS concentrations in Sand Hollow Creek, 17050114