Idaho Department of
Environmental Quality

Fivemile and Tenmile Creek Subbasin Assessment

Fivemile Creek

December 2001

Tenmile Creek

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Executive Summary

The Fivemile and Tenmile Creek subwatersheds drain 83 and 74 square miles of rangeland, agricultural land and urban areas, respectively. Both streams are located in the southeast portion of the lower Boise River watershed, which is located in southwest Idaho. Fivemile and Tenmile Creek flow in a northwesterly direction through Ada and Canyon Counties before they join together to form Fifteenmile Creek, which discharges to the lower Boise River four miles upstream of the town of Middleton.

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 Fivemile and Tenmile Creek are sediment, nutrients and dissolved oxygen.

Fivemile and Tenmile Creek are designated in the Idaho Water Quality Standards for cold water biota and secondary contact recreation. Recognizing that cold water biota and secondary contact recreation may not be appropriate beneficial uses for highly regulated and irrigation driven systems, Nampa-Meridian and Pioneer Irrigation Districts performed a beneficial use evaluation for Fivemile and Tenmile Creek to characterize the appropriate beneficial uses and submitted it to DEQ. The analysis shows that a modified aquatic life use accurately defines the best attainable conditions in both streams. 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. The use evaluation also recommends removing all contact recreation designations. However, the secondary contact recreation use will not be removed.

Modified aquatic life and secondary contact recreation are fully supported in Fivemile and Tenmile Creek. Using dissolved oxygen, pH, suspended sediment and algal biomass concentrations as indicators and surrogates of sustainable water quality conditions, the data do not indicate impairment by nutrients, sediment or dissolved oxygen. 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 Fivemile and Tenmile Creek and DEQ will recommend de-listing during the 2002 303(d) listing cycle.

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

The Snake River-Hells Canyon TMDL is scheduled to be completed 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. The load allocation will likely be given to Fifteenmile Creek, but reductions from Fivemile and Tenmile Creek may be necessary to meet the allocation.

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 the Fifteenmile Creek Subwatershed will be achieved.

Subbasin Watershed Characterization

Fivemile Creek and Tenmile Creek are located in the southeast portion of the lower Boise River watershed (Hydrologic Unit Code (HUC) 17050114), which is located in southwest Idaho (Figure 1). The Fivemile Creek subwatershed drains 83 square miles of rangeland, agricultural lands and urban areas. Fivemile Creek is 28.92 miles long and flows through Ada and Canyon counties and the cities of Boise and Meridian, Idaho (Figure 2). Fivemile Creek flows in a northwesterly direction from its origin near the I-84 Blacks Creek off-ramp east of Boise to its confluence with Tenmile Creek, where the two creeks join to form Fifteenmile Creek. Fifteenmile Creek flows for approximately 3.5 miles before it joins the lower Boise River. The Tenmile Creek subwatershed drains 74 square miles of rangeland, agricultural lands and urban areas. Tenmile Creek is 27.15 miles long and flows through Ada and Canyon counties and the city of Meridian, Idaho (Figure 3). Tenmile Creek flows in a northwesterly direction from its origin at Blacks Creek Reservoir to its confluence with Fivemile Creek.

Topography in both subwatersheds is relatively flat, with gradual drops in elevation as they flow down several step-like terraces to where they form Fifteenmile Creek. Elevation in the Fivemile Creek subwatershed ranges from 3,360 feet at the I-84 rest stop to 2,450 feet at Fifteenmile Creek. Elevation in the Tenmile Creek subwatershed ranges from 3,169 feet at Black Creek Reservoir to 2,450 feet at Fifteenmile Creek. Relief varies according to topography; the terraces are generally level while the drop down to the next terrace ranges from 0.4% to 3.0% slopes.

Geology

Fivemile and Tenmile Creek lie within the western Snake River Plain. The multiple terraces that developed throughout the Quaternary period comprise much of the subwatersheds. 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 below the New York Canal and loamy sands and sandy loams above the New York Canal (Collett, 1972).

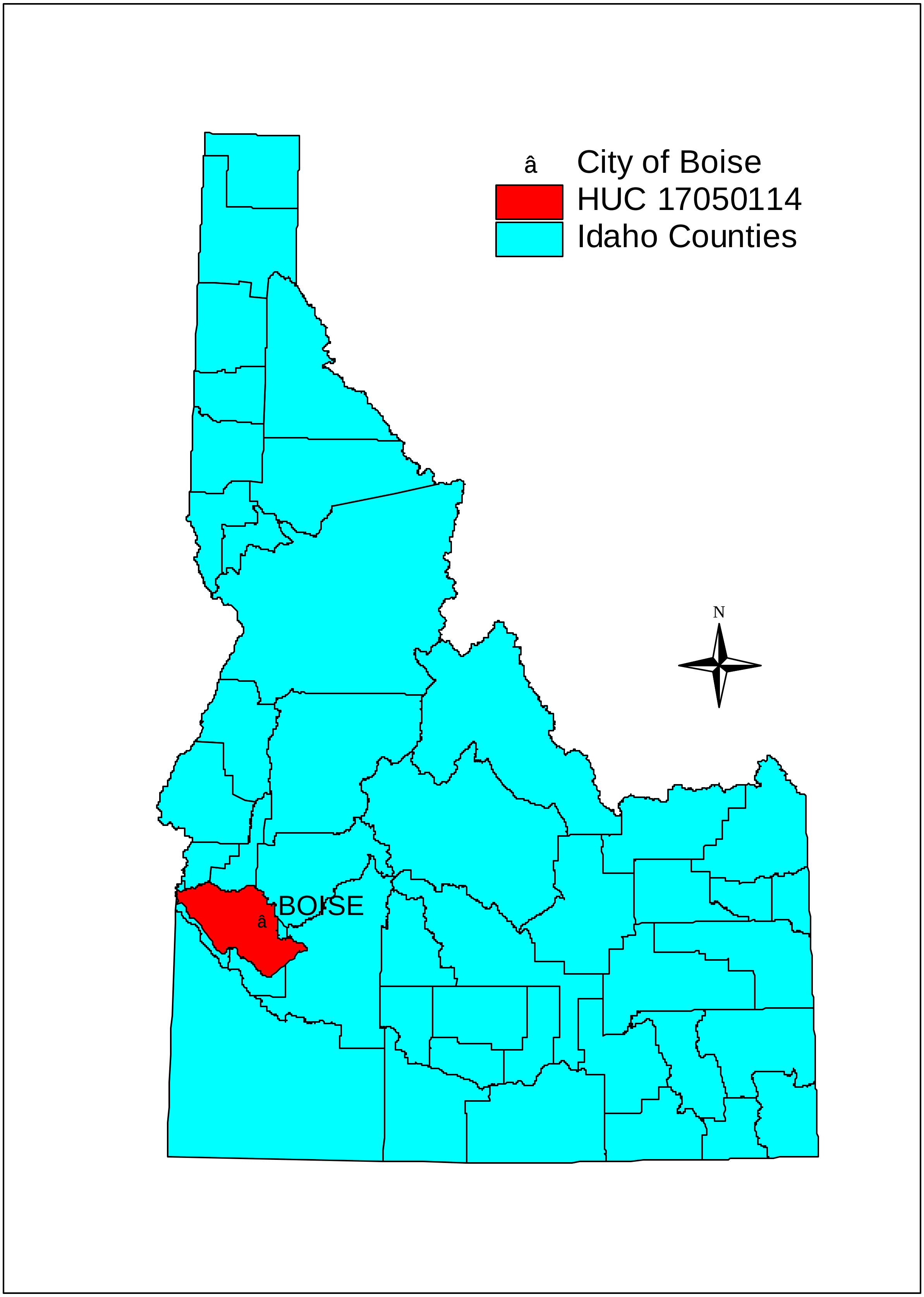


Figure 1. Lower Boise River Watershed

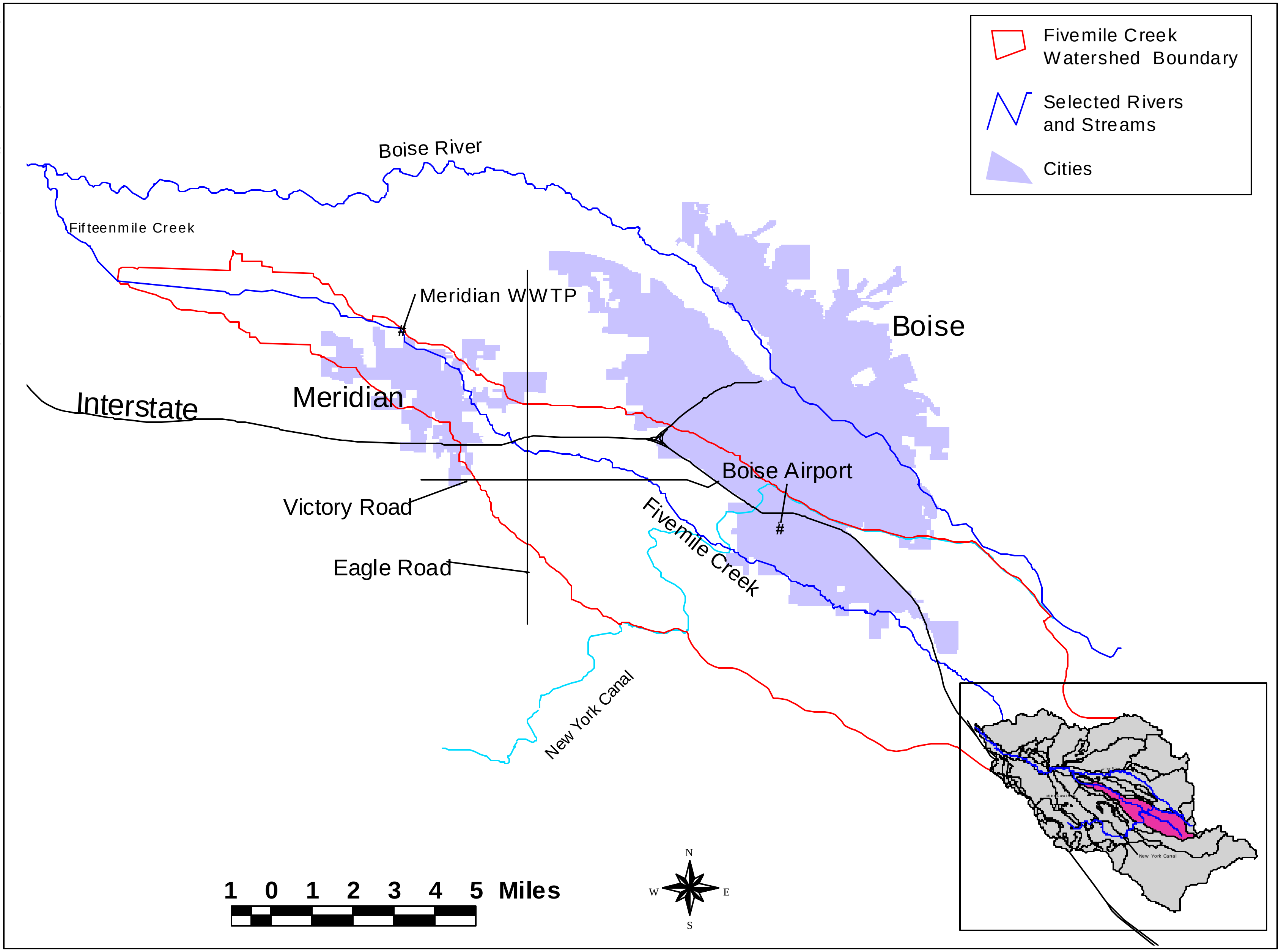


Figure 2. Fivemile Creek Subwatershed

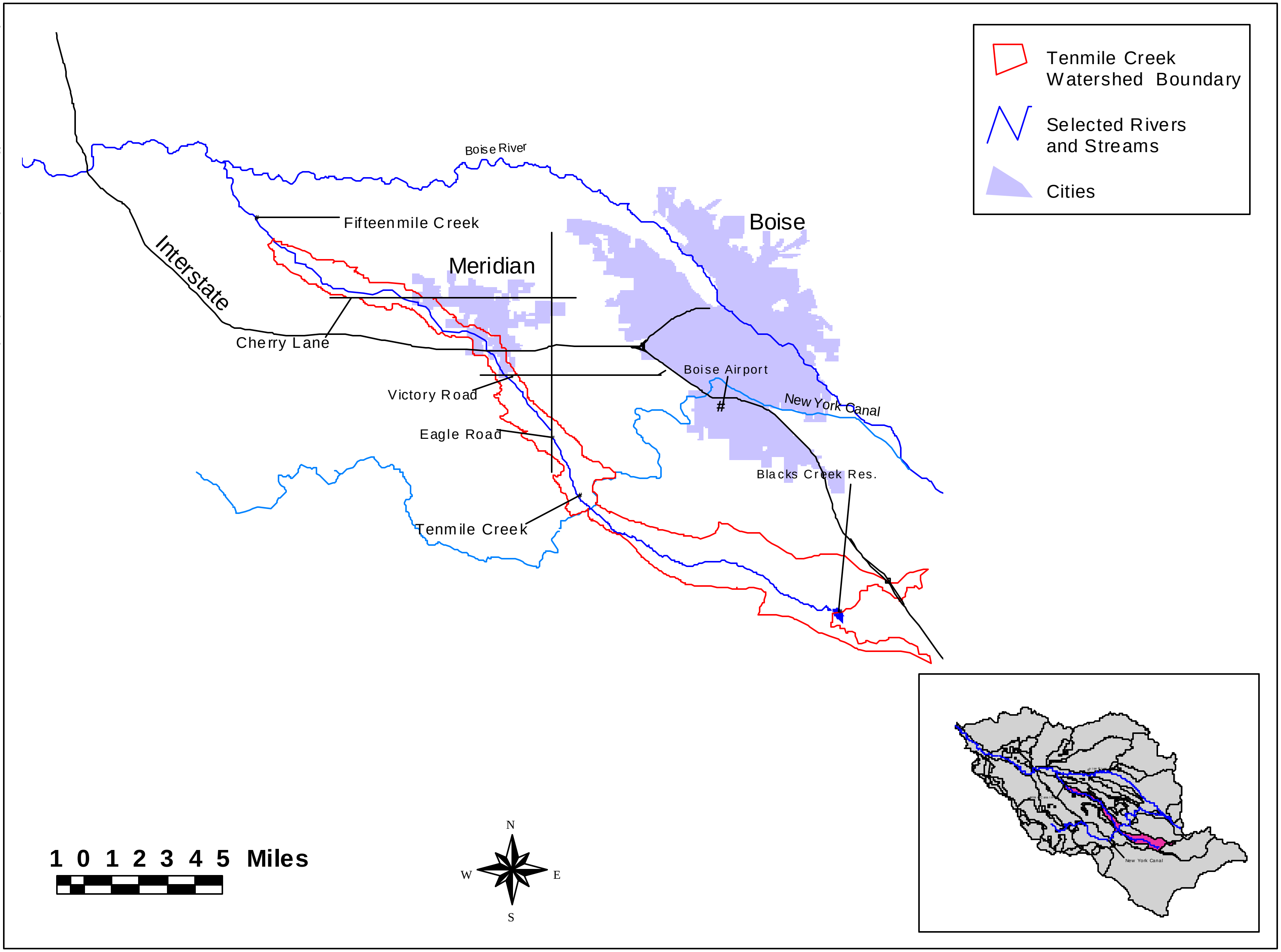


Figure 3. Tenmile Creek Subwatershed

Climate

Climate within the subwatersheds 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 83.9º Fahrenheit (F) in Boise. The average minimum winter temperature in Boise from 1940 -2000 was 25.9º 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. 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 the physical and biological characteristics of Fivemile and Tenmile Creek. Historically, both creeks were intermittent from their headwaters to about one mile prior to where they form Fifteenmile Creek. From that point on downstream they were perennial. At present day, Fivemile Creek is intermittent from its headwaters to the Evans Drain and perennial from Evans Drain to its confluence with Tenmile Creek. Tenmile Creek is intermittent from its headwaters to Meridian Road and perennial from Meridian Road to its confluence with Fivemile Creek. Both streams remain perennial in the lower portions due to elevated groundwater levels. Flows increase during the irrigation season (April – September) due to irrigation related return flows.

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 effect the hydrology of Fivemile and Tenmile Creek by raising the water table during the irrigation season. Other management considerations that have less of an effect 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 4 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 the perennial portions of Fivemile and Tenmile Creek can be divided into two flow regimes. Low flow conditions generally begin in mid-October after the irrigation season ends. The low flow period extends through the winter until the irrigation season begins again April. Figures 5 and 6 show the mean monthly flows for Fivemile and Tenmile Creek. Due to the highly regulated nature of both systems, these flow regimes are relatively static from year to year.

Dating as far back as 1916 (Paul, 1916), irrigation practices have altered drainage patterns in Fivemile and Tenmile 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

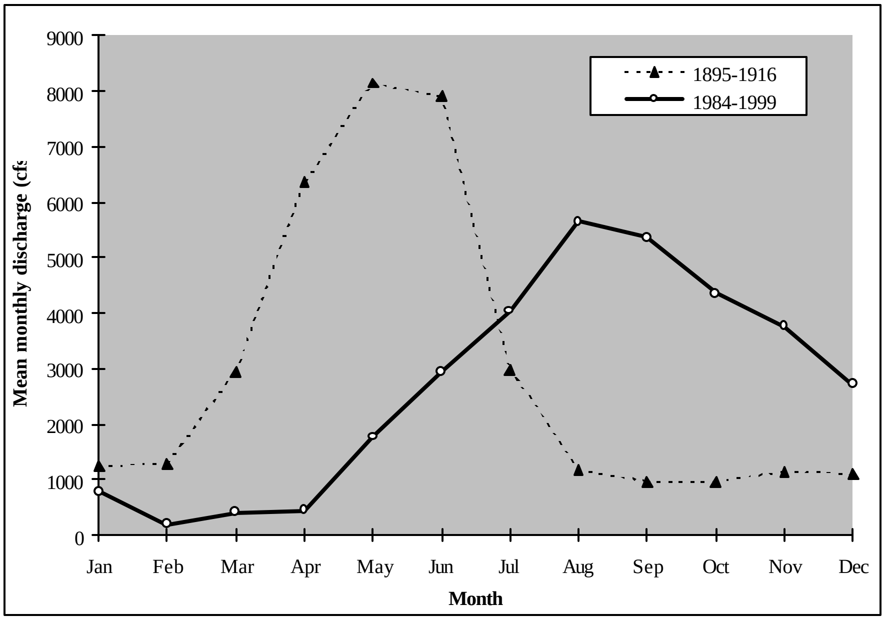


Figure 4. Regulated and unregulated mean monthly discharge in the Boise River near Boise, USGS gaging station 13202000.

waterways have created new drainage areas that are significantly different from the natural subwatershed areas. Figures 7 and 8 depict the current drainage areas of the Fivemile and Tenmile Creek subwatersheds (David Ferguson, unpub. data, 1997). The drainage areas delineated by Ferguson are used for this assessment because they accurately identify the lands that drain to both systems.

Very little flow data exists for Fivemile or Tenmile Creek above the New York Canal. The data that has been located indicates that water is only present for a few weeks during the spring and in some years water is never present. DEQ beneficial use reconnaissance project (BURP) data collected July 10, 1996, south of the Boise airport and June 11, 1998 southeast of the Boise airport found dry channels in Fivemile Creek. Additional surveys in May and June 1999 and 2000 and February 2001 at the same locations also revealed dry channels. Because there are no major diversions above the New York Canal, it was assumed that the creek was also dry above these locations during these years. BURP data collected for Tenmile Creek on July 10 1996, south of the Boise airport, and June 10 1997, below Blacks Creek Reservoir found a dry channel near the airport and a flow of 9.0 cfs below the reservoir. Additional surveys in May and June 1999 and 2000 and February 2001 at the same locations also revealed dry channels. These data verify that Fivemile and Tenmile Creek above the New York Canal are intermittent. 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, which is 5.0 cfs for contact recreation and 1.0 cfs for aquatic life.

The data indicate that the lower segments of Fivemile and Tenmile Creek are perennial. While the New York Canal does not directly discharge to either system, the water table below the New York canal is substantially higher than above the New York Canal. The high water table and deep stream channel creates a system that is constantly recharged by ground water, even in the winter. During the irrigation season the flows in Fivemile and Tenmile Creek are nearly triple that of winter base flows, primarily due to an extensive network of nonpoint source return flows to the creeks.

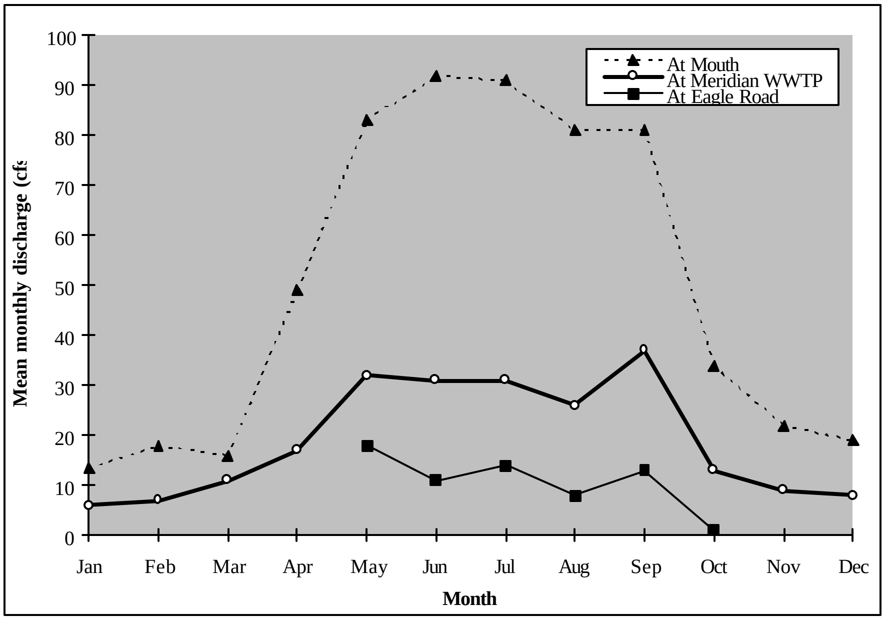


Figure 5. Mean monthly flow in Fivemile Creek at the mouth, at the Meridian WWTP and near Eagle Road, 1998-2000

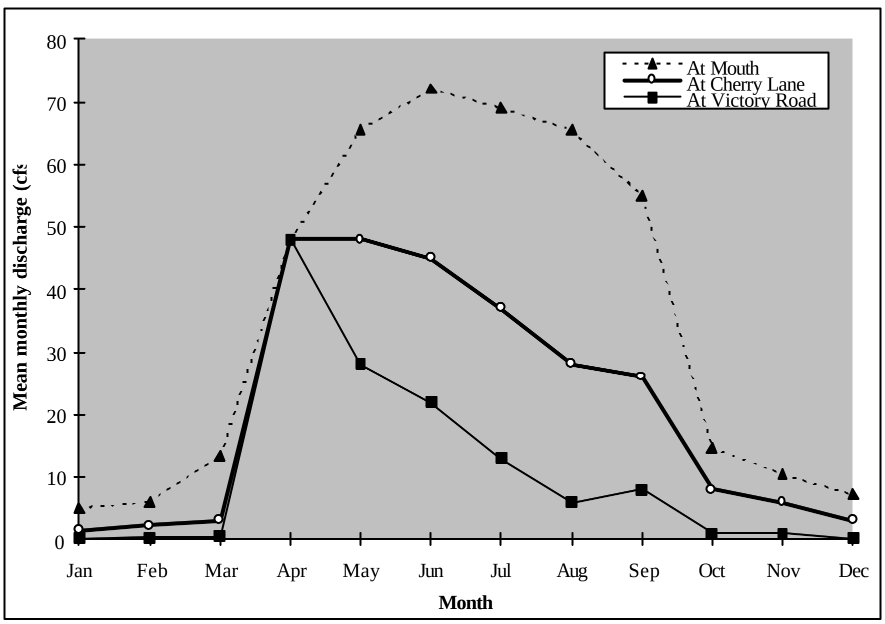


Figure 6. Mean monthly flow in Tenmile Creek at the mouth, at Cherry Lane and near Victory Road, 1998-2000

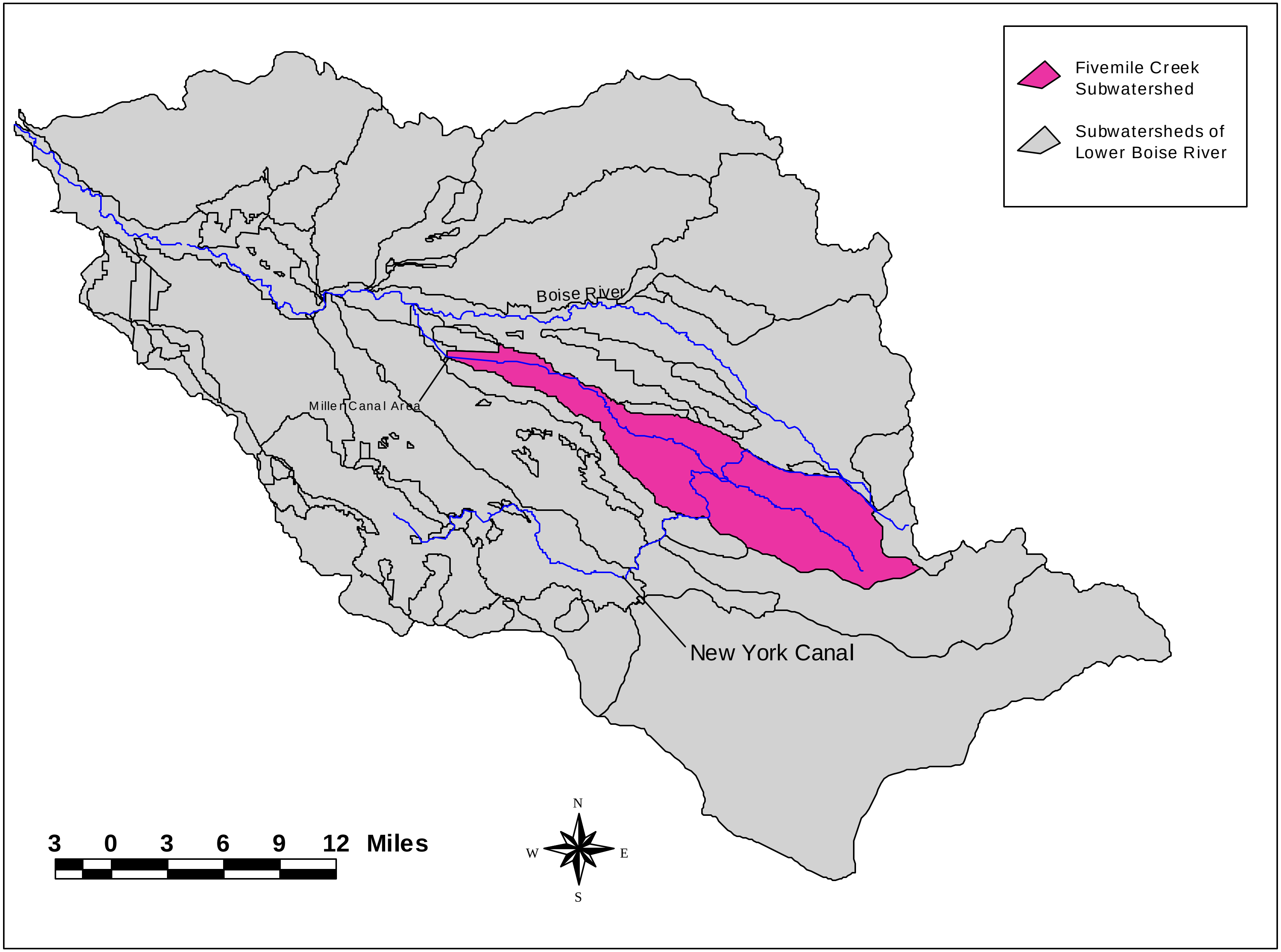


Figure 7. Fivemile Creek Drainage Area

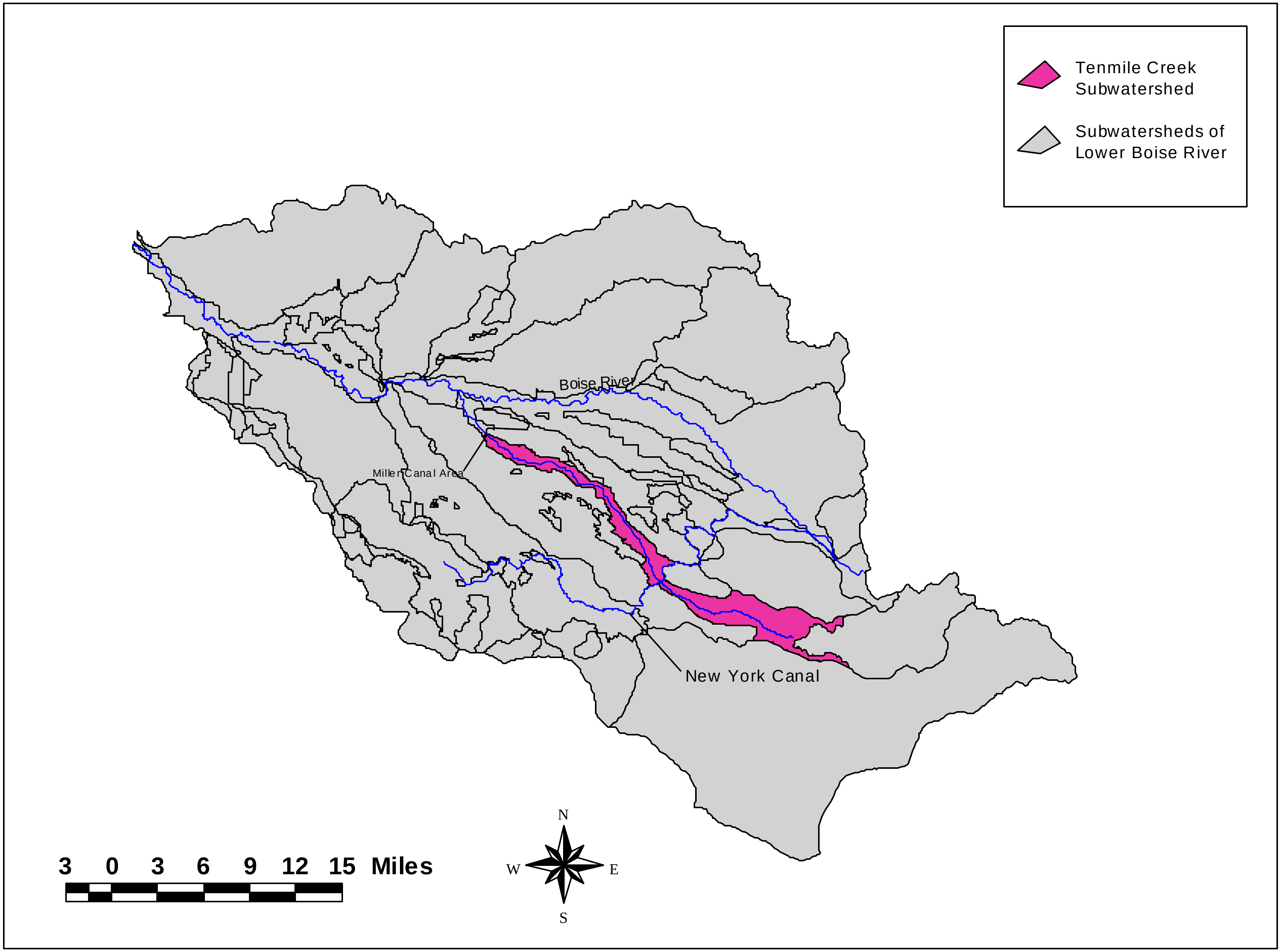


Figure 8. Tenmile Creek Drainage Area

Groundwater Hydrology

A deep, semi-confined to confined Idaho Group aquifer underlies the Fivemile and Tenmile Creek subwatersheds. 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 sands, silts, and claystones 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 were lower than they are today. Starting as early as the 1860's, farmers in the valley began 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 historic drains and wells were dug in the 1910's and 1920's. Recent studies by Squires and others (1992) and Tungate and Berenbrock (1995) show declining water levels in the Boise City area. 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 well production in southeast Boise and to the west (Squires and others, 1992).

Fivemile and Tenmile Creek both gain and lose ground water depending on the location and season. Generally, the streams lose to ground water above the New York Canal. Below the New York Canal, they generally gain water due to the artificially high water table.

Channel and Substrate Characteristics

The Fivemile Creek subwatershed is a moderately narrow, gently sloping northwest trending stream that flows toward the lower Boise River. The stream channel can largely be classified as a Rosgen type F from its headwaters to Fifteenmile Creek although, above the New York Canal, the stream displays some type C characteristics (Rosgen, 1996). The F type channel is deeply entrenched, low gradient (<0.02), has a high width/depth ratio, and a riffle/pool morphology. 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 C type channel is characterized as low gradient (<0.02) and meandering with a riffle/pool morphology, high width/depth ratio, and a broad, well-defined floodplain. The Tenmile Creek subwatershed is similar to Fivemile in that it slopes to the northwest, is moderately narrow in width and displays the same type of Rosgen stream channel classifications.

The streambeds of both systems from their headwaters to the New York Canal range from sand-size (<2 mm) material to small cobble (64.1-128 mm). From the New York Canal to Fifteenmile Creek the streambeds are primarily sand and silt (<2.5 mm) with a few highly dispersed cobble and gravel areas. In 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.

Fivemile and Tenmile Creek exhibit other characteristics typical of a stream with regulated flow. The numerous man-modified portions of the streams along with the regulated irrigation flows have caused a narrowing and straightening of the stream channels. 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 streams. 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

The lands adjacent to Fivemile and Tenmile Creek are home to numerous species of wildlife. The stream corridor is home to several species of waterfowl, including ducks and geese. Several mammal species also live on or near the streams, including fox, rabbit, beaver, muskrat, and other mammal and fowl species.

Fivemile Creek is currently home to numerous non-game fish species (CH2M Hill, 1996). Fish surveys conducted by CH2M Hill in 1996 above and below the Meridian wastewater treatment plant located redside shiner, northern pike minnow, speckled dace, bridglip sucker, Chinese winter loach, carp, smallmouth bass and chub. While no recent data exists to show salmonids reside in Fivemile Creek, the Idaho Fish and Game has indicated that information exists on file that shows rainbow trout resided in the creek before November 28, 1975 (IDFG written correspondence, 1997).

A fish survey was performed in Tenmile Creek at Amity Road in May 2000. While only one Chinese winter loach was found at this location, it is likely that additional fish species are present in the lower portion of the stream. Idaho Fish and Game has indicated that rainbow trout have been documented in the lower segment of Tenmile Creek (IDFG written correspondence, 1997)

Cultural Characteristics

The Boise River valley and Fivemile and Tenmile Creek were first explored in 1811 by overland explorers of the Pacific Fur company. Gold discoveries in 1862 in the nearby mountains prompted the founding of Boise City and the Boise valley was settled in 1863.

The subwatersheds began to change with the coming of the Oregon Shoreline Railroad in 1887 and the completion of the Phyllis and Ridenbaugh Canals in 1890 and 1891 respectively. These canals provided water to the southern portion of the Boise River watershed 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 delivering water to 100,000 acres of land (United States Bureau of Reclamation, 1996), many of those within the Fivemile and Tenmile Creek drainways. The Federal Reclamation Act of 1902 allocated funds to support the Boise Project (1904), that allowed further development 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 Fivemile and Tenmile Creek drainages 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).

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 only NPDES permitted point source currently discharging to the Fivemile Creek is the Meridian wastewater treatment plant. The design/permit flow of the plant is 7 million gallons per day (MGD).

During the summer, many portions of Fivemile and Tenmile 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 New York Canal, where the depths and flows could support contact recreation, the banks are often steep, heavily vegetated and difficult to navigate.

Demographics and Economics

The upper portions of Fivemile and Tenmile Creek (headwaters to New York Canal) have seen little new growth in the past 10 years. The lower portions have experienced rapid growth. Ada County, in which Fivemile and Tenmile Creek are largely located, was one of the fastest growing counties in the United States from 1990 to 1999 with population increases of more than 37%. Most of the development on both systems has been in the form of residential subdivisions. However, as they move through Meridian there are several commercial operations adjacent to the stream.

Land Ownership and Land Use

Figures 9 and 10 and Table 1 illustrate the current land use patterns in the Fivemile and Tenmile Creek subwatersheds. Land ownership is a mixture of federal, state, county, municipal and private ownership in both subwatersheds. The major land uses in Fivemile Creek are rangeland (43%), irrigated cropland (17%) and urban residential (10%). The major land uses in Tenmile Creek are rangeland (80%) and irrigated cropland (14%). Throughout both subwatersheds, especially in the lower portions, agricultural lands are rapidly being converted to suburban residential and commercial land uses. This land use transition will significantly alter the type and complexity of pollutant transport in the subwatersheds.

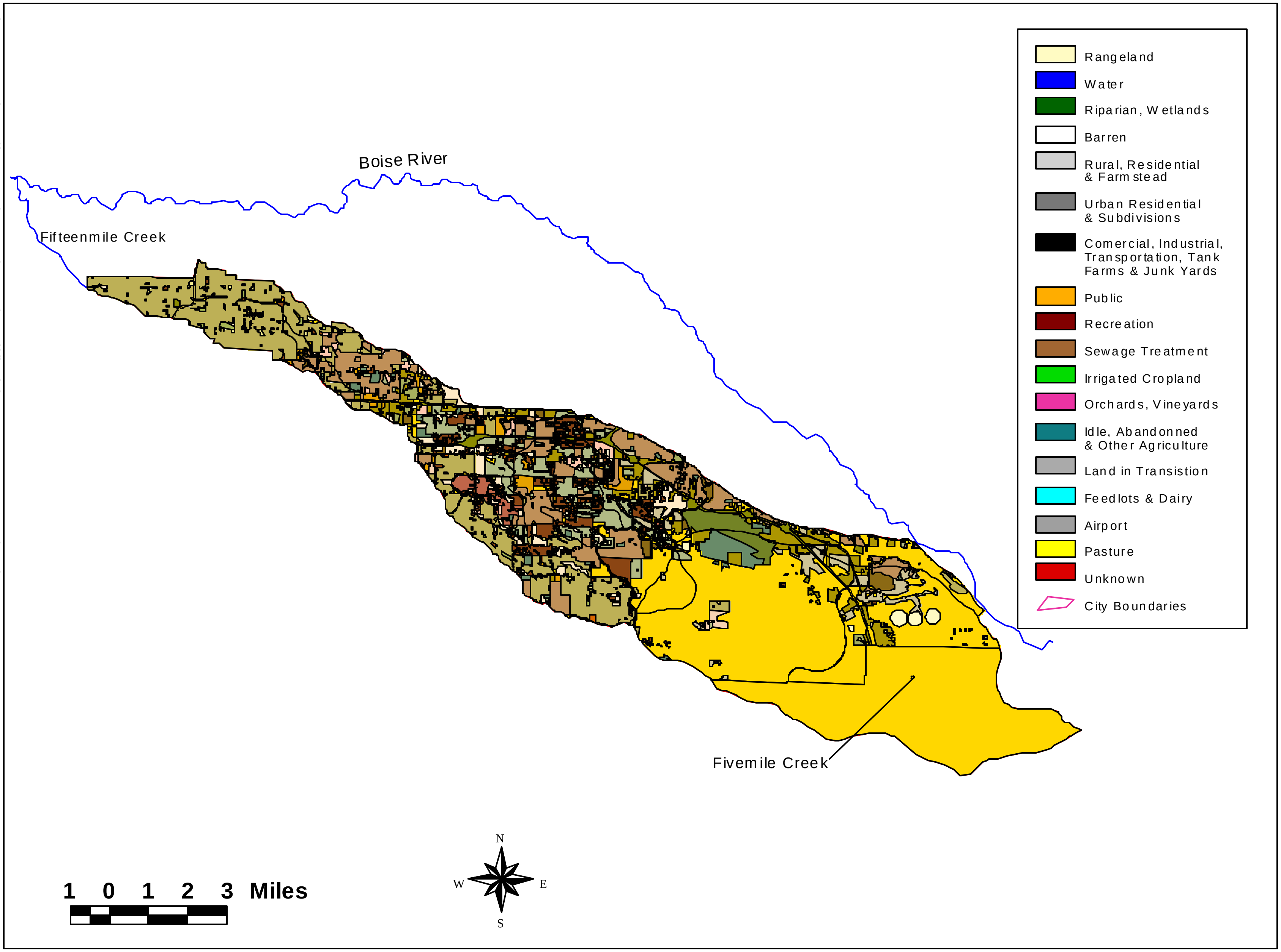


Figure 9. Fivemile Creek Landuse (modified from IDWR 1994 data)

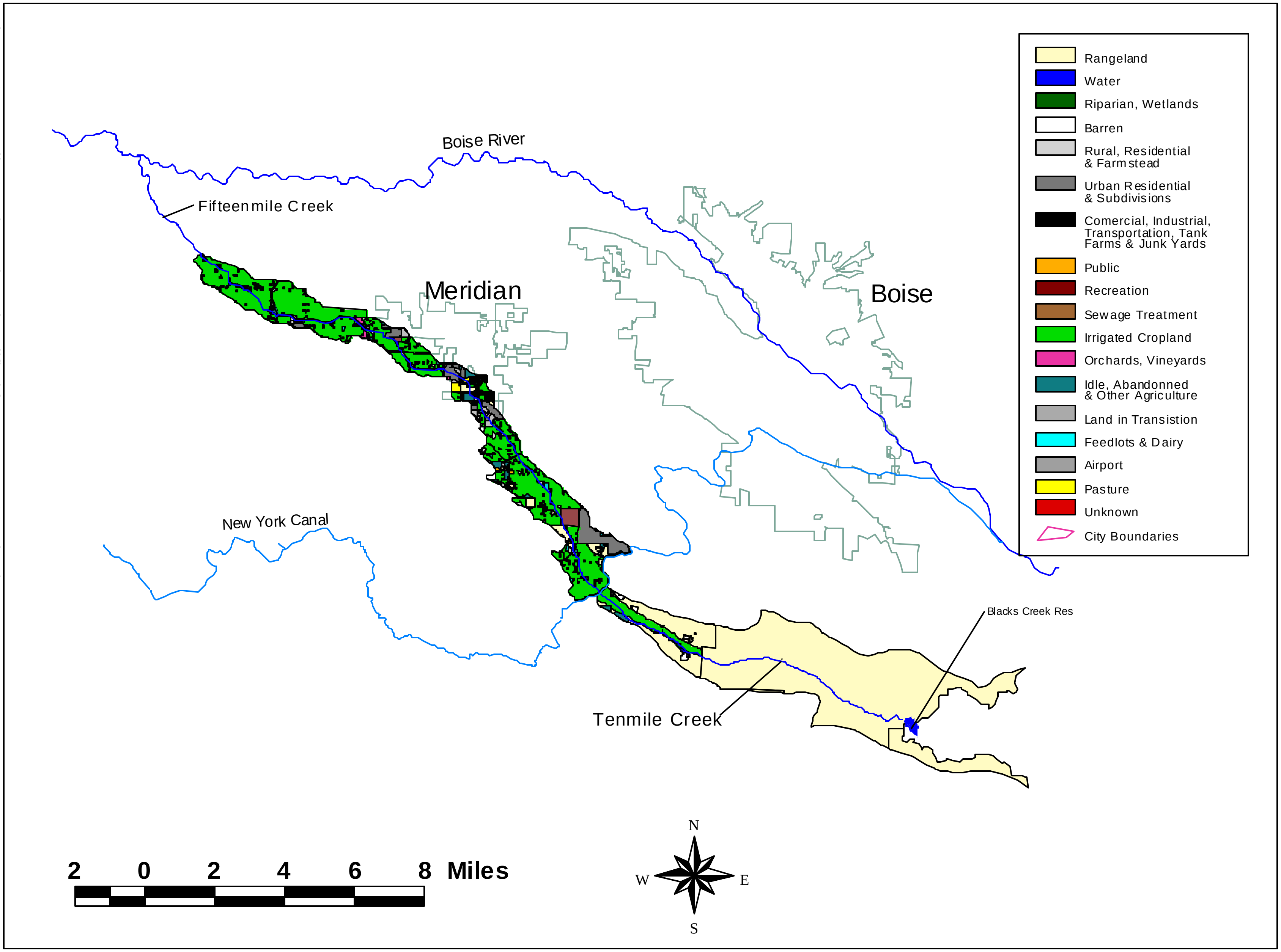


Figure 10. Tenmile Creek Landuse (modified from IDWR 1994 data)

Table 1. Land use pattern in the Fivemile and Tenmile Creek subwatersheds

	Fivemile Creek		**Tenmile Creek**	
Land Use	**Acres**	**Percent of Total**	**Acres**	**Percent of Total**
Rangeland	23,220	43	37,828	80
Irrigated Cropland	9089	17	6882	14
Urban Residential / Subdivisions	5195	10	784	2
Barren Lands	1235	2	132	1
Commercial, Industrial, Transportation, Tank Farms	3226	6	217	1
Idle, Abandoned & other Agriculture	2291	4	333	1
Land in Transition	434	1		
Pasture	3014	6		
Public Lands	952	2		
Recreation	461	1		
Rural Residential & Farmstead	2812	4	630	1
Sewage Treatment	306	1		
Airport	807	2		
Water	299	1		

Public Involvement

Idaho Code Section 39-3611 states that TMDLs shall be developed in accordance with Idaho Code Section 39-3614 (duties of the basin advisory groups), 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

Fivemile and Tenmile Creek (water quality limited segments 2734 and 2736) are 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 Fifteenmile Creek for both streams. Both streams are listed for dissolved oxygen, sediment and nutrients throughout.

Table 2. Summary of §303(d) listed segments for Fivemile and Tenmile Creek.

Name	**Boundaries**	**Pollutants** **1998 §303(d) list**
Fivemile Creek	Headwaters to Fifteenmile Creek	Dissolved Oxygen, Sediment, Nutrients
Tenmile Creek	Headwaters to Fifteenmile Creek	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 the Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02) and 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.

Beneficial Uses in Fivemile and Tenmile Creek

Beneficial uses are designated in IDAPA 58.01.02.140 for Fivemile Creek from the headwaters to the Miller Canal, which is different than the 303(d) listed boundaries. The Miller Canal runs adjacent to Fivemile Creek where it combines with Tenmile Creek to form Fifteenmile Creek. Beneficial uses are also designated for Tenmile Creek from the Blacks Creek Reservoir Dam to the Miller Canal. The designated uses for Fivemile and Tenmile Creek are shown in Table 3.

Table 3. Designated beneficial uses for Fivemile and Tenmile Creek.

Stream Name	**Designated Beneficial Uses**
Fivemile Creek (Headwaters to Miller Canal)	Cold Water Biota Secondary Contact Recreation
Tenmile Creek (Blacks Creek Reservoir Dam to Miller Canal)	Cold Water Biota Secondary Contact Recreation

In instances where the designated 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 designated beneficial uses of cold water biota and secondary contact recreation may not be appropriate in highly man-modified, irrigation driven systems such as Fivemile and Tenmile Creeks, the Nampa-Meridian Irrigation District and Pioneer Irrigation District chose to perform a beneficial use evaluation for both systems. After a review of the physical, chemical and biological data and a multitude of other information, and in consultation with DEQ and the WAG, the aquatic life beneficial use of modified was recommended. 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. It was also recommended that the contact recreation beneficial use be completely removed. Appendix A details the analysis describing how these proposed changes were reached. After reviewing the proposed use recommendations, and after receiving comments from EPA and others, the DEQ determined that the change to modified aquatic life was appropriate, but that removing the contact recreation designation altogether was not appropriate at this time. Appendix B outlines DEQ's rationale for not removing the contact recreation designation from Fivemile and Tenmile Creeks. A recent (November 2001) DEQ board decision directed DEQ to develop a 'contact' beneficial use specific to agricultural drains. Upon development of this use, DEQ will reconsider requests to change secondary contact recreation. Table 4 outlines the beneficial use changes as they remain.

Table 4. Existing beneficial uses for Fivemile and Tenmile Creek

Stream Name	**Existing Uses**
Fivemile Creek (headwaters to Miller Canal)	Modified Secondary Contact Recreation
Tenmile Creek (Blacks Creek Reservoir Dam to Miller Canal)	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, the DEQ determined that the site specific water criteria for the modified community in Fivemile and Tenmile Creek should be consistent with the seasonal cold water biota criteria, except that they will apply throughout the year. This is because a mix of cool water fish, including incidentally located rainbow trout during the summer, has been documented in recent investigations. The only seasonal cold water biota specific criterion that pertains to this analysis is dissolved oxygen. Other than for dissolved oxygen, all other applicable cold water biota criteria apply.

The following water quality criteria are applicable to the pollutants of concern listed on the 1998 Section 303(d) list for Fivemile and Tenmile Creek. The criteria represent water quality conditions that are protective of the existing aquatic life community in the stream. 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

Turbidity below any applicable mixing zone set by the Department of Health and Welfare, Idaho Division 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)

Dissolved Oxygen

For the modified communities in Fivemile and Tenmile 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)

Summary of Existing Water Quality Data

Numerous sources of data are available within the Fivemile and Tenmile Creek subwatersheds to describe the physical and chemical water quality and the biological communities in the streams. Table 5 summarizes that available data. The DEQ surveyed Fivemile Creek in 1996, 1997 and 1998 using the Beneficial Use Reconnaissance Project

(BURP) process. Tenmile Creek was surveyed in 1996, 1997 and 2000. Additionally, in 2000, the DEQ collected chemical and benthic and suspended chlorophyll-a data at two locations in both streams. The USGS, through a multi-year monitoring plan jointly funded by the DEQ, LBRWQP and USGS collected chemical data at the mouths of the streams in 2000. In 1998 and 1999, the Idaho Department of Agriculture collected chemical data at three locations in the lower portion (below the New York Canal) of Fivemile Creek. They also collected similar data at three locations on Tenmile Creek. The Meridian WWTP, pursuant to their 1999 NPDES permit requirements have and continue to collect chemical water quality data above and below the Fivemile Creek discharge point. In 1996 CH2M Hill prepared a report that characterized the integrity of Fivemile Creek above and below the Meridian WWTP. Physical, chemical, and biological data were collected. The effort was funded by the Meridian WWTP. Figure 11 illustrates the locations of the major sampling sites established by the DEQ, USGS and the Idaho Department of Agriculture.

Table 5. Available physical, chemical and biological data for Fivemile and Tenmile Creek

Name/Agency	**Monitoring Regime**	**Data Type**	**Current Status**
Idaho Department of Environmental Quality	6/00 – 10/00 (2 sites per stream)	Chemical, Biological	Complete
	BURP: 1996-98, 2000	Biological	Complete
US Geological Survey	4/00 – Current (1 site @ mouth of Five and Tenmile)	Chemical	Ongoing
Idaho Department of Agriculture	4/98 – 4/99 (3 sites per stream)	Chemical	Complete
Meridian WWTP	Current at plant, Fivemile Creek	Chemical	Ongoing
CH2M Hill	1995, Fivemile Creek	Physical, Chemical, Biological	Complete

Data Analysis and Interpretation

The DEQ used chemical water quality, biological and physical habitat data to assess the support status of beneficial uses in Fivemile and Tenmile Creek. The concentration of listed pollutants in comparison to the applicable water quality criteria are 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%), the associated beneficial uses are likely to be impaired. In the case of nutrients and sediment, the state of Idaho does not have numeric water quality standards in place. Rather, the standards for nutrients and sediment 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

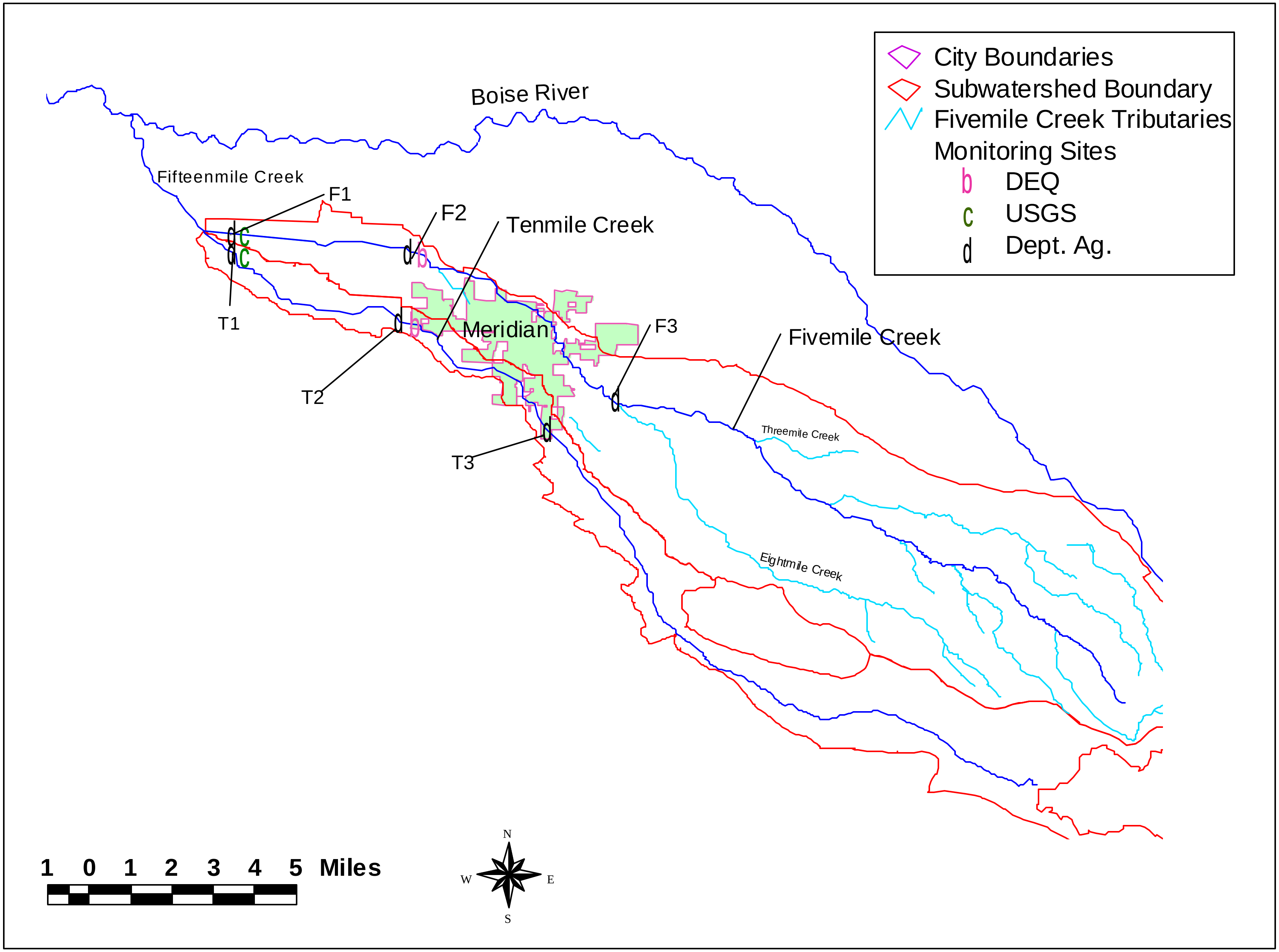


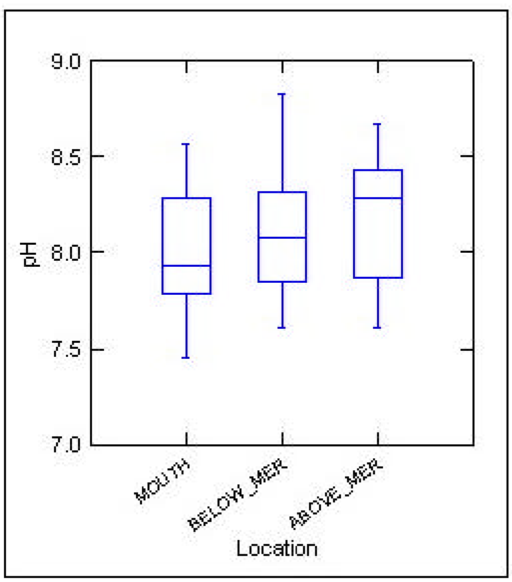
Figure 11. Fivemile and Tenmile Creek Sampling Locations

pollutant the DEQ has the option of preparing a TMDL at the current time or postponing the TMDL until a later date when 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 are in part a 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 to abnormal levels.

Figure 12 shows the range of pH values in Fivemile Creek from the years 1998 to 2000. The data were collected on a monthly basis by the Idaho State Department of Agriculture and the USGS and include values from the growing season of each year when pH sags would occur. The mean pH value in the stream drops slightly from 8.16 above Meridian to 7.9 at the mouth, but all locations in the stream, even considering the minimum values, the state criteria are met.



Guide to interpreting the box and whisker plot:

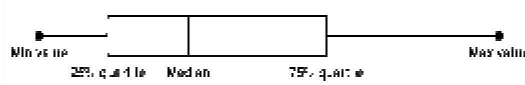
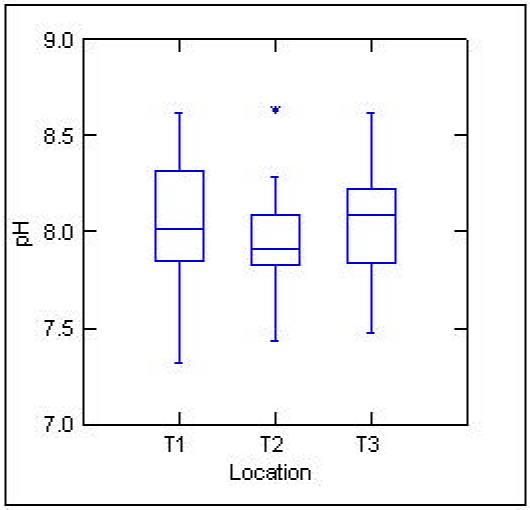


Figure 12. pH values in Fivemile Creek, 1998 – 2000

Figure 13 shows the range of pH values in Tenmile Creek from the years 1998 to 2000. The data were collected on a monthly basis by the Idaho State Department of Agriculture and the USGS and include values from the growing season of each year. The mean pH in the stream remains essentially the same, with the values being 8.1 above Meridian and 8.05 at the mouth. At all locations in the stream, even considering the minimum values, the state criteria are met.



Guide to interpreting the box and whisker plot:

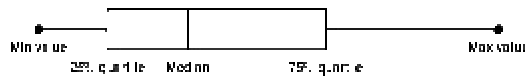


Figure 13. pH values in Tenmile Creek, 1998 – 2000

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.

For Fivemile Creek, a very robust dissolved oxygen data set is available from the Meridian WWTP, spanning the years 1990-1999. In all, 5,134 data points are available for analysis. The data is from the facility's monthly discharge monitoring reports (DMR). From 1990 to 1997 the measurements were collected daily at locations upstream and downstream of the discharge point. One-half of the 90-97 data were collected upstream of the discharge point. The remaining one-half were collected downstream of the discharge point. The 1998 and 1999 measurements are monthly averages taken upstream of the discharge point.

Of the 90-97 upstream data, 79 values (3%) are below 6.0 mg/l. Of the 90-97 downstream data, 145 points (5%) are below 6.0 mg/l. None of the 98-99 data are below 6.0 mg/l, most likely because in 1998 the Meridian WWTP upgraded their post-aeration facilities to meet the NPDES DO requirements. Of the values that are below 6.0 mg/L, 76% occurred in 1992, which is the lowest water year on record for the Lower Boise River watershed. A review of the 1992 daily effluent DO concentrations from the Meridian WWTP revealed only one criteria violation. This suggests that the 1992 low flow in Fivemile Creek is the primary reason such a large number of criteria violations occurred that year, not increased BOD in the Meridian WWTP discharge.

To address the possibility of a diurnal dissolved oxygen crash in Fivemile Creek, the DEQ collected pre-dawn dissolved oxygen and pH data at the monitoring locations above and below the City of Meridian 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 at 6:30 a.m. was 5.89 mg/L. At the downstream location the dissolved oxygen concentration at 7:02 a.m. was 8.13 mg/L. At both locations the pH was normal, being 7.48 and 7.83, respectively.

EPA's 1996 Guidelines for Preparing State Water Quality Assessments indicate that for conventional pollutants, of which dissolved oxygen is included, not more than 10% of the measurements should exceed the criterion. If the number of criteria exceedences is less than 10% of the total number of measurements, the water body in question can be classified as Fully Supporting. This essentially means the pollutant is not impairing the associated beneficial use(s). Following this guidance, the dissolved oxygen levels in Fivemile Creek are not such that they are impairing beneficial uses.

For Tenmile Creek, the dissolved oxygen data were collected by the Idaho Department of Agriculture, USGS and DEQ. The data span the years 1998-2000 and were collected at locations upstream (T3) and downstream (T1 and T2) of the City of Meridian. Figure 14 displays the data. The concentration does not fall below 6.0 mg/L on any occasion.

To address the possibility of a diurnal dissolved oxygen crash in Tenmile Creek, the DEQ collected pre-dawn dissolved oxygen and pH data at the monitoring locations above and below the City of Meridian 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 7.75 mg/L. At the downstream location the dissolved oxygen concentration 5.89 mg/L. At both locations the pH was normal, being 7.64 and 7.35, respectively.

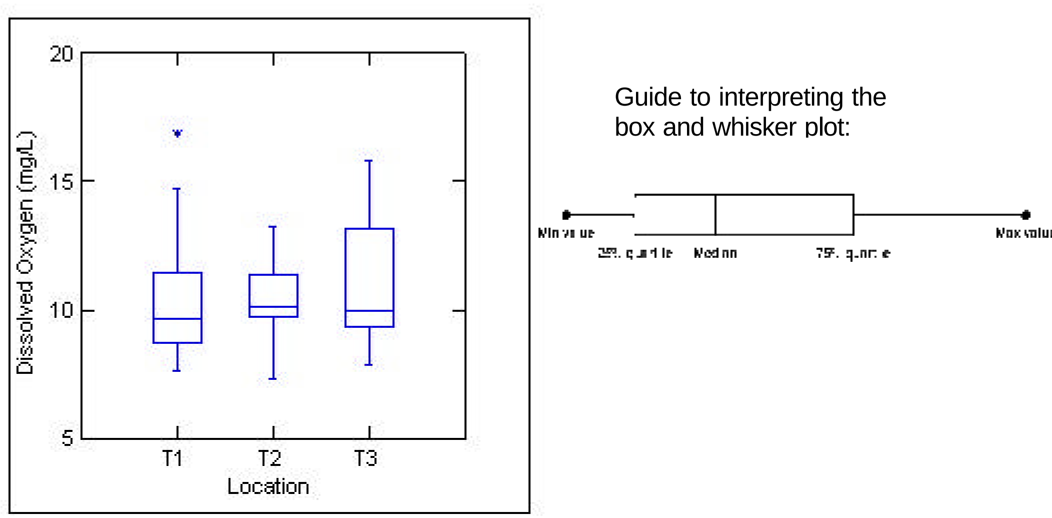


Figure 14. Dissolved oxygen concentrations in Tenmile Creek, 1998 – 2000

Sediment

Suspended sediment (TSS) concentrations can be used as an indicator of sediment conditions in water bodies in that they can provide a direct measure of water column clarity. Suspended sediment is defined as the sediment fraction that is suspended in the water column (typically <0.1mm). Excessive suspended sediment can adversely effect aquatic life in a number of ways. Most fish species can tolerate acutely high levels of suspended sediment. However, when suspended sediment levels become chronically high, sensitive salmonid and macroinvertebrate species show negative affects.

Newcombe and Jensen (1996) reported that for juvenile rainbow trout, concentrations of 50 to 100 mg/L suspended sediment for 14 to 60 days yielded significantly reduced growth rates or lethal effects. Thruston et al (1979) concluded that 25 mg/L TSS would provide high protection, 80 mg/L would provide moderate protection and >400 mg/L would provide low protection for juvenile rainbow trout. From an acute exposure standpoint, adult rainbow trout can withstand significantly higher levels of TSS than juvenile trout. Newcombe and Jensen's 1996 model suggests that adult salmonids can withstand TSS levels of 1097 mg/L for up to six days without experiencing mortality.

Total suspended sediment concentrations in Fivemile and Tenmile Creek fluctuate with the irrigation season flows (Figures 15 and 16). At the monitoring locations in both streams suspended sediment concentrations in the stream increase during the irrigation season and decrease during the non-irrigation season, primarily due to surface erosion from agricultural lands. Additionally, there is a cumulative increase in suspended sediment concentrations in the lower portions of the streams. The TSS concentrations at the mouths are notably higher than the upstream concentrations, suggesting that irrigation return flows contribute to the overall suspended sediment load in the stream.

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. 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 Fivemile and Tenmile Creek because neither stream is listed for salmonid spawning, nor do the available data show salmonid spawning to be an existing use. Electrofishing surveys conducted by CH2M Hill (1996) and DEQ in Fivemile Creek did not locate any salmonid species. Table 6 identifies the fish species identified during these efforts.

No salmonids were present in the electrofishing surveys and they likely do not reside in the streams on an annual basis. However, it is likely that salmonids (and other species for that matter) temporarily enter the streams via the canal system. Based on the flow related operational regime of Fivemile and Tenmile Creek and fisheries data from similarly operated adjacent watersheds, it is reasonable to assume that a small adult rainbow trout population resides in Fivemile and Tenmile Creek during the irrigation season. This is partially substantiated by Idaho Fish and Game (IDFG) reports, which indicate that adult rainbow trout were present in Fivemile Creek prior to 1975. 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. Antecdotal evidence from landowners within the Fivemile Creek subwatershed indicates that adult rainbow trout are present in the stream during the fishing season.

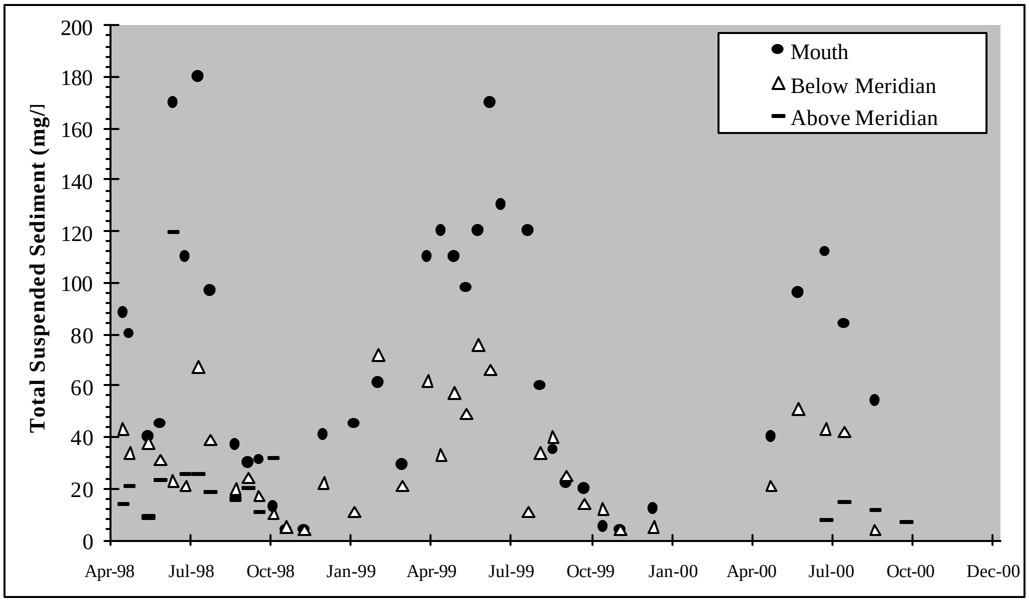


Figure 15. Total Suspended Sediment levels in Fivemile Creek above Meridian, below Meridian and at the mouth: 1998-2000.

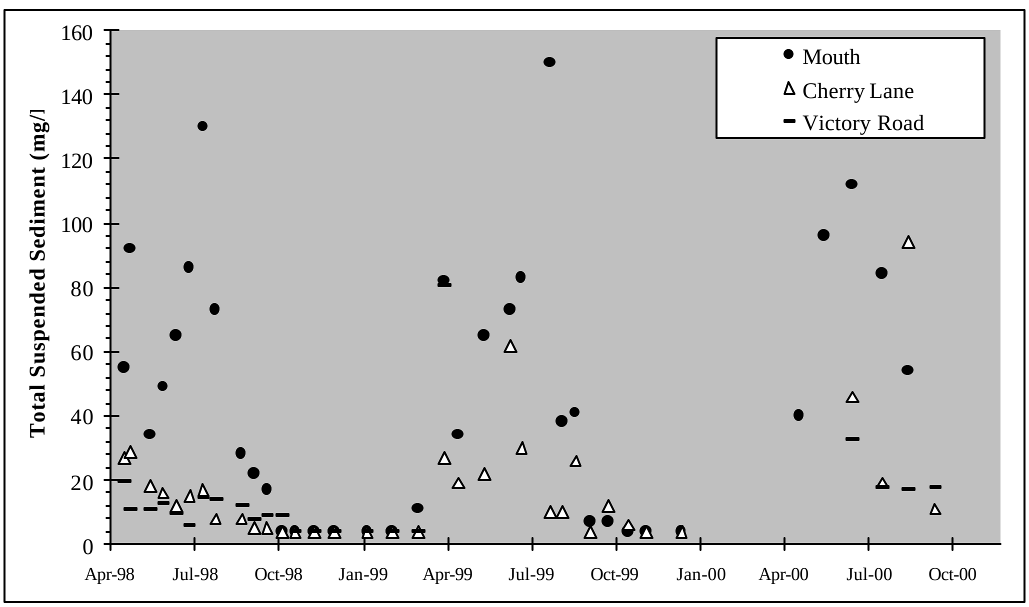


Figure 16. Total Suspended Sediment levels in Tenmile Creek at Cherry Lane, Victory Road and at the mouth: 1998-2000.

While a population of transient adult rainbow trout likely resides in Fivemile and Tenmile Creek, further protection from water column sediment is not necessary. The existing TSS concentrations at the monitoring sites above the mouths of both streams rarely exceed 50 mg/L, which is a threshold for juvenile fish, and hence overly stringent for adult fish. At the mouth of Fivemile Creek, the TSS concentrations range from about 80 mg/L to 180 mg/L during the irrigation season with an average concentration of 86 mg/L. During the non-irrigation season the concentrations range from about 5 mg/L to 65 mg/L with an average of 22 mg/L. At the mouth of Tenmile Creek the TSS concentrations range from about 7 mg/L to 150 mg/L during the irrigation season with an average concentration of 62 mg/L. During the non-irrigation season the concentrations range from about 4 mg/L to 11 mg/L with an average of 5 mg/L. Using Newcombe and Jensen's TSS threshold model as a guide (Appendix C), adult salmonids can withstand TSS concentrations of 148 mg/L for up to four months without experiencing lethal effects. The TSS levels in Fivemile and Tenmile Creek are well below this threshold. This suggests that the current TSS concentrations do not need to be reduced to protect the transient salmonid populations.

Table 6. Fish species identified in Fivemile Creek during 1996 and 2000 electrofishing efforts.

Name	**Common Name**
1996 Effort, CH2M Hill At Meridian WWTP	Redside shiner, Northern squawfish, Speckled dace, Bridgelip sucker, Chinese winter loach, Carp, Smallmouth bass, Chub
2000 Effort, IDEQ Above Meridian	Chinese winter loach, Speckled Dace

Contact Recreational Response to Surface 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 Fivemile and Tenmile Creek, the sediment levels do not appear to be impairing secondary contact recreation. During the 2000 monitoring season, DEQ employees walked both streams 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 at several locations in Fivemile and Tenmile Creek, although the irrigation districts discourage it.

Turbidity

None of the agencies that have collected data for Fivemile and Tenmile Creek have collected turbidity data. Furthermore, ambient turbidity monitoring is not part of the Meridian wastewater treatment plants monitoring requirements. No current turbidity data exists for Fivemile or Tenmile Creek.

Nutrients and Aquatic Algae Biomass

Phosphorus

High concentrations of phosphorus have been recorded in Fivemile and Tenmile Creek from 1998 to 2000 (Figures 17 and 18). Based on numerous studies (Bothwell 1988 and Horner and others 1983), the water column total phosphorus (TP) concentrations in both streams are more than sufficient to support algae growth, which when at nuisance levels, is typically the surrogate for contact recreation support status. Additionally, EPA's gold book criterion for water column total phosphate phosphorus is 0.10 mg/L. EPA indicates the potential for eutrophication exists at this level, although in many systems it does not occur. 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 Fivemile Creek fluctuate with the irrigation season. Table 7 shows the irrigation and non-irrigation seasonal average concentrations at the three monitoring locations for the years 1998 to 2000. The TP concentrations range from as low as 0.09 mg/L to as high as 0.67 mg/L. These data show that the EPA gold book criterion is exceeded in nearly every sampling event, however the data do not directly indicate beneficial use impairment. As they relate to nutrients, aquatic life beneficial use impairment is generally based on surrogate measures such as dissolved oxygen concentrations and pH levels.

TP concentrations in Tenmile Creek do not fluctuate with the irrigation season as closely as Fivemile Creek. Table 6 shows the irrigation and non-irrigation seasonal average concentrations at the three monitoring locations for the years 1998 to 2000. The TP concentrations range from as low as 0.05 mg/L to as high as 0.41 mg/L.

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

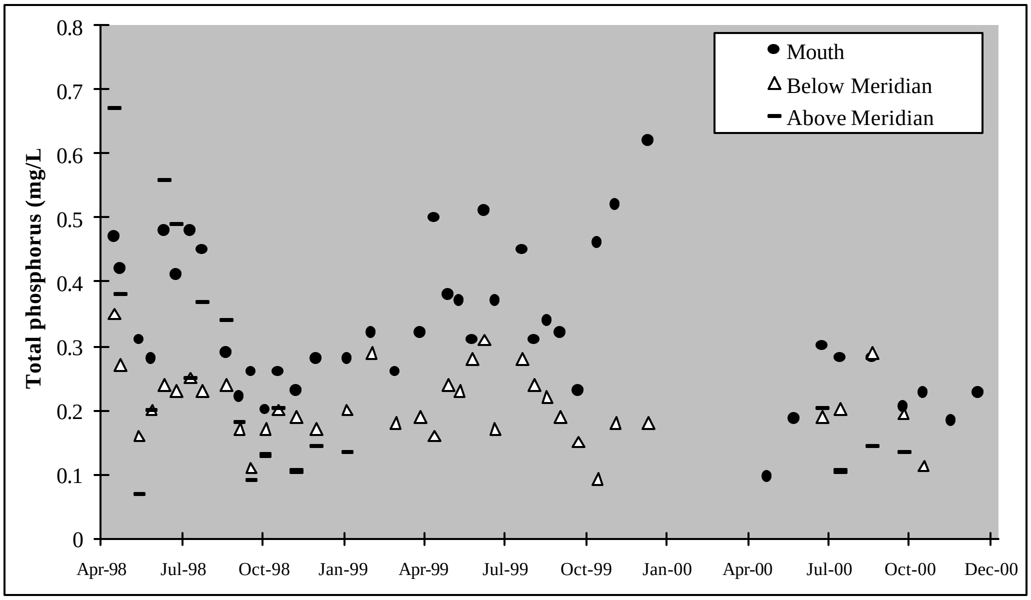


Figure 17. Total phosphorus levels in Fivemile Creek above Meridian, below Meridian and at the mouth: 1998-2000.

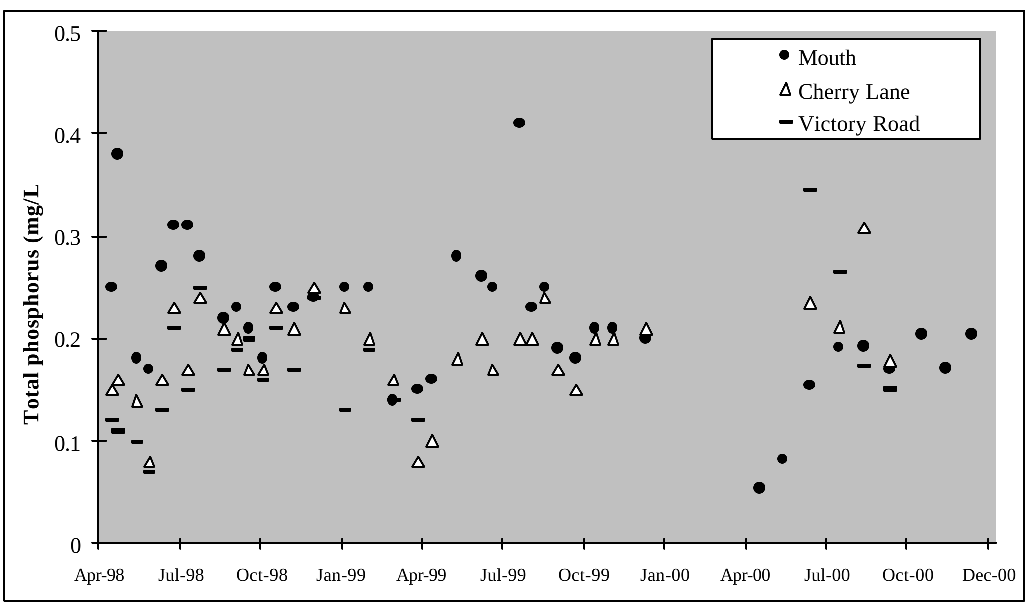


Figure 18. Total phosphorus levels in Tenmile Creek at Cherry Lane, Victory Road and at the mouth: 1998-2000.

Table 7. Irrigation and non-irrigation season TP concentration averages in Fivemile and Tenmile Creek.

Stream Name / Location	Irrigation Season Ave	Non-Irrigation Season Ave.
Fivemile Creek - Above the confluence with Tenmile Creek (mouth)	0.35 mg/L	0.29 mg/L
Fivemile Creek - Below Meridian	0.22 mg/L	0.18 mg/L
Fivemile Creek - Above Meridian	0.28 mg/L	0.14 mg/L
Tenmile Creek - Above the confluence with Fivemile Creek (mouth)	0.22 mg/L	0.21 mg/L
Tenmile Creek - Below Meridian	0.18 mg/L	0.21 mg/L
Tenmile Creek - Above Meridian	0.17 mg/L	0.17 mg/L

Benthic Chlorophyll –a

Periphytic (benthic) algae grow on pebbles, cobbles and boulders along the streambed. In streams that do not experience an over abundance of nutrients, periphytic algae grow as single celled organisms called diatoms that are limited in biomass by the grazing of aquatic insects. When nutrient availability exceeds the basic needs of diatoms, other periphytic species, including bulky, filamentous algae such as *Cladophora* may grow on the streambed. When the filamentous algae become excessive they can impede intergravel flow which decreases intergravel dissolved oxygen necessary for young fish and macroinvertebrates.

The state of Idaho does not have a numeric criterion for periphytic chlorophyll-a. 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, and others, 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 Fivemile and Tenmile Creek are sparse. However, the data that are available are likely representative of the overall benthic algal conditions in the streams. This assumption is based on the relative similarity in flow regime, substrate condition, water clarity, nutrient enrichment and riparian shading throughout the systems, all of which directly effect periphytic algae growth.

Fivemile Creek

Two samples collected by the DEQ above and below Meridian in September 2000 revealed benthic chlorophyll-a levels of 8.4 mg/m2, and 9.2 mg/m2, respectively. Both are well below the minimum nuisance threshold of 100 mg/m2.

Tenmile Creek

Two samples collected by the DEQ above and below Meridian in September 2000 revealed benthic chlorophyll-a levels of 2.13 mg/m2, and 11.5 mg/m2, respectively. Both are well below the minimum nuisance threshold of 100 mg/m2.

The low benthic chlorophyll-a levels in Fivemile and Tenmile Creek are not surprising given the growth limiting factors in the stream. The substrate surveys that have been conducted in both streams below the New York Canal show that the stream bottoms are 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. Additionally, the peak growing season for benthic algae corresponds with the irrigation season (April – September) in the lower Boise River basin, when TSS concentrations are elevated. The result is decreased light penetration during the growing season. This decrease in light penetration inhibits photosynthesis and limits the mass of algae that can grow.

Water Column 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). While the state of Idaho does not have a numeric criterion for 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. Additionally, North Carolina has a chlorophyll-a criterion of 40 ug/l, which according to the state of North Carolina indicates impairment.

As with benthic chlorophyll-a, the water column chlorophyll-a data for Fivemile and Tenmile 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 water clarity, nutrient enrichment and riparian shading throughout the systems, all of which directly effect water column algae growth.

Fivemile Creek

Two samples collected by the DEQ above and below Meridian in July 2000 revealed water column chlorophyll-a levels of 0.5 µg/L and 2.4 µg/L, respectively. Both are well below the most stringent nuisance threshold value of 15 µg/L.

Tenmile Creek

Two samples collected by the DEQ above and below Meridian in July 2000 revealed water column chlorophyll-a levels of 2.9 µg/L and 1.9 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 in Fivemile and Tenmile Creek the most is water clarity. 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 during the irrigation season.

Macrophytes and Other Bulky Species

During the growing season Fivemile and Tenmile Creek exhibit significant macrophyte growth in the upper perennial segments. Macrophytes are not as significant in the lower segments. Both streams lack a shade-providing riparian canopy. Thus, emergent macrophytes have ample light with which to grow. Additionally, the upper segments exhibit low point velocities due to the low gradient and low flow. Flow measurements conducted by DEQ during the 2000 growing season show that point velocities in Fivemile Creek above Meridian 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 Meridian for the months of June through August was .63 fps. Below Meridian, the velocities are closer to 1.6 fps. This factor in combination with shallow depth above Meridian, which allows for more light penetration when macrophyte buds are re-generating, contribute to the macrophyte growth in Fivemile Creek. Field surveys conducted from June through October 2000 at locations above Meridian identified macrophytes covering between 50% and 90% of the cross-sectioned stream channel. The aquatic macrophyte that dominates the population is *Potamogeton pectinatus* L (Sago Pondweed).

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 pondweed growth is frequently noted in nutrient-rich waters, particularly in the lower reaches where pollution loads are usually the greatest (Howard-Williams 1981). Sago pondweed 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 pondweed 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 Fivemile and Tenmile Creek would reduce the mass of macrophytes. To meet the lower Boise River sediment TMDL requirements (DEQ 2000), both streams must reduce total suspended sediment loads by 37%. While the link between TSS and surface sediment in the lower Boise River basin is not well defined, it is inherent. Most of the management practices (BMPs) that are used to control TSS are ultimately designed to prevent all surface erosion and sediment delivery to receiving water bodies. Thus, attempts to control TSS loading to Fivemile and Tenmile Creek will inherently result in a reduced level of surface sediment loading.

Bacteria

The lower Boise River bacteria TMDL allocated a 95% reduction in fecal coliform concentrations in Fifteenmile Creek to meet bacteria standards in the river (50 CFU/100 ml). The fecal coliform geometric mean at the mouth was 992 CFU/100 ml. Reductions will also have to be made in Fivemile and Tenmile Creek to meet this target. 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 Fivemile and Tenmile Creek monitoring locations indicate that during the recreation season (May-August), both streams exceed 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 Fivemile and Tenmile Creek

Location	**Year (May-Aug)**	**Geo-mean (#/100ml)**
T1 (mouth)	1998	650
	1999	518
T2 (below Meridian)	1998	757
	1999	544
T3 (above Meridian)	1998	687
	1999	No Data
F1 (mouth)	1998	779
	1999	511
F2 (below Meridian)	1998	581
	1999	656
F3 (above Meridian)	1998	516
	1999	No Data

DEQ recommends listing Fivemile and Tenmile Creek for bacteria on the 2002 303(d) list from the New York Canal to the mouth. 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 standards in Fivemile and Tenmile Creek.

Status of Beneficial Uses

The data indicate that sediment, nutrients and dissolved oxygen are not impairing modified aquatic life or secondary contact recreation uses in Fivemile and Tenmile Creek. Consequently, DEQ does not recommends preparing TMDLs for the pollutants and recommends removing sediment, dissolved oxygen and nutrients as pollutants of concern from the 2002 303(d) list. Table 9 summarizes the beneficial use support status for both streams.

Table 9. Beneficial Use Support Status in Fivemile and Tenmile Creek.

Segment	Designated Use	Existing Use	Impaired Use	Pollutant(s) Causing Impairment
Headwaters to Fifteenmile Creek	CWB, SCR	MOD, SCR	SCR	Bacteria
Headwaters to Fifteenmile Creek	CWB, SCR	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 flow regime of Fivemile and Tenmile 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, they do not need to secure a stream channel alteration permit provided no equipment is working in the channel proper. This routine stream channel maintenance has resulted in deep, straight, narrow channels with little riparian growth and little in-stream habitat complexity. While the districts' work is authorized, it does contribute to the overall reduction of aquatic life diversity. Habitat modification and stream channel authorization 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 the available data do not indicate nutrient induced beneficial use impairment in Fivemile and Tenmile Creek, high nutrient concentrations imply that nutrients are a potential threat to aquatic life and recreational uses in the lower Boise River. However, recent analysis in the river indicates that beneficial uses are not impaired by nutrients. The DEQ does not recommend developing nutrient TMDLs for Fivemile or Tenmile Creek with the intention of restoring beneficial uses in streams. However, nutrient reductions will likely be needed from Fivemile and Tenmile Creek in order to meet the Snake River-Hells Canyon TMDL nutrient load allocation to the Boise River. The load allocation will most likely be given to Fifteenmile Creek, but reductions from Fivemile and Tenmile Creek may be necessary to meet the allocation. A similar scenario exists for sediment. While TSS is not impairing the MOD aquatic life communities in Fivemile and Tenmile Creeks, 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 10.

Efforts to gather additional 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 Fivemile and Tenmile 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); changes that are more extensive 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 assessment must be addressed on a case-by-case basis, as additional funding becomes available.

Table 10. Data gaps identified during development of the Fivemile and Tenmile Creek SBA

Pollutant or other Factor	Data Gap
Sediment	Only instantaneous suspended sediment data available; cannot evaluate duration of concentrations
	Additional surface sediment data at multiple locations; cannot establish an annual trend
	Discrete substrate and water column particle size distribution data
	Stream bank erosion rates
	Surface and suspended sediment data for all flow regimes (low, average, high)
Nutrients	Only instantaneous data available; cannot evaluate duration of concentrations
	Nutrient data for all flow regimes (low, average, high)
Biological	Benthic and suspended algae (biomass) data for hot summer drought conditions as well throughout the growing season
	A quantified determination of macrophyte density throughout the stream
	A quantifiable method of interpreting macroinvertebrate data for modified (MOD) waters
Other	Additional diurnal dissolved oxygen data

Pollution Source Inventory

Sediment and nutrients enter Fivemile and Tenmile Creek primarily from nonpoint sources. The Meridian wastewater treatment plant, which discharges to Fivemile Creek below the City of Meridian, is subject to relatively strict effluent limits in their NPDES permit. The reasonable assurance analysis that is associated with the NPDES permitting process typically ensures that the effluent discharge will not contribute to the degradation of water quality.

Nonpoint sources of sediment include agricultural activities, stormwater runoff, runoff from construction activities 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 activities on sites that exceed five acres are subject to a general NPDES permit that requires best management practices to limit sediment releases. 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 that can generate sediment include surface irrigated row crops and surface irrigated pastures. Sediment that erodes from agricultural lands has the potential to be delivered to the multiple drains, canals and laterals and may be liberated during the irrigation charge in April. Sediment can also be 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 58.01.02.350.03.g and IDAPA 02.04.14. Smaller CAFOs 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 nutrients is unknown.

Nonpoint sources of nutrients include runoff from agricultural 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 either state or federally funded through the Idaho Soil Conservation Commission (ISCC) or the Natural Resource Conservation Service (NRCS). These programs are targeted at the agricultural community to assist with conservation practices. For example, the Ada Soil & Water Conservation District and the Canyon Soil Conservation District (SCD) have Water Quality Program 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 the local conservation districts and other funding sources has demonstrated a willingness to protect water quality in the lower Boise River valley. Ada SWCD and Canyon SCD work 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 Resource Conservation and Rangeland Development Program, and the Federal Environmental Quality Incentive Program (EQIP). Participation from local operators has been competitive and is based on the availability of funds from the programs. Other sources of funding include private sources such as Ducks Unlimited, The Nature Conservancy and colleges and universities.

Stormwater within the City of Boise is subject to a stormwater NPDES permit. Ada County Highway District, Drainage District 3, the City of Boise, Idaho Department of Transportation, District 3, and Boise State University are all co-applicants for the permit, which was recently issued. The permit requires implementation of BMPs to control stormwater runoff within the affected area. In the future, the City of Meridian will likely be subject to Phase II NPDES storm water requirements. Based on the City of Meridian's rapidly growing population and its proximity to the City of Boise, it likely meets the criteria for a Phase II stormwater permit. The Phase II requirements take effect in 2002.

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. The OnePlan web site offers many additional on-line tools such as crop nutrient demands and crop water consumption charts.

Point Sources

The Meridian wastewater treatment plant is the only discrete point source in the Fivemile Creek subwatershed. No point sources are located in the Tenmile Creek subwatershed. The Meridian plant, which provides tertiary treatment of wastewater from Meridian, can discharge to Fivemile Creek or the Boise River, but uses Fivemile Creek as its primary discharge water.

As part of the discharge monitoring element of their NPDES permit, the Meridian 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 Fivemile and Tenmile Creek subwatersheds have a combination of point and nonpoint sources. However, the pollution distribution is such that potential nutrient reduction goals can only be achieved by including a degree of nonpoint source reductions. The overall reductions must incorporate reasonable assurance that nonpoint source reductions will be implemented and effective in achieving the Snake River- Hells Canyon load allocation (EPA, 1991). If the appropriate load reductions are not achieved from nonpoint sources through existing regulatory and voluntary programs, then additional reductions must come from point sources. The cost effectiveness of additional point source reductions would be closely evaluated before this would occur.

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 decrease pollutant loading from point and nonpoint sources that affect water quality limited waterbodies. The Lower Boise River Water Quality Plan (LBRWQP) is the designated WAG for the lower Boise River watershed, which includes Fivemile and Tenmile Creek.

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 Health and Welfare
Rules Governing Subsurface and Individual Sewage Disposal Systems	58.01.02.350.03(c)	Idaho Department of Health and Welfare
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(e)	Idaho Department of Lands
Rules Governing Placer and Dredge Mining in Idaho	58.01.02.350.03(f)	Idaho Department of Lands
Rules Governing Dairy Waste	58.01.02.350.03.(g)	Idaho Department of Agriculture

The state of Idaho uses a voluntary approach to address 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 Health and Welfare'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. The Meridian WWTP is a candidate for nutrient trading.

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.

CH2M Hill. 1996. Field assessment of biological, physical and chemical conditions of Fivemile Creek in the vicinity of the City of Meridian's Wastewater Treatment Facility: Prepared for City of Meridian, USEPA and IDEQ.

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.

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.

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 Environmental Quality. 2000. Lower Boise River TMDL Subbasin assessment and Total Maximum Daily Loads. September 1999.

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.

Maguire, T. 1997. Environmental planning tools and techniques. 1997. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise.

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.

Nampa-Meridian, and Pioneer Irrigation Districts. 2001. Use attainability analysis for Fivemile, Tenmile and Fifteenmile drains.

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.

Rosgen, D.L. 1996. 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.

Thruston, R.V., R.C. Russo, C.M. Fetterrolf, T.A. Edsall, and T.M. Barber Jr., editor. 1979. Review of EPA Red Book: Quality Criteria for Water. Water Quality Section, American Fisheries Society, Bethesda, MD. 313 pg.

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.

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.

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

Use Attainability Analysis for Fivemile, Tenmile and Fifteenmile Drains, Nampa-Meridian Irrigation and Pioneer Irrigation District, 2001

Appendix B

DEQ Response to Public Comment for Proposed Beneficial Use Changes

Appendix C

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

Indian Creek Subbasin Assessment

December 2001

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Executive Summary

The Indian Creek subwatershed drains 295 square miles of rangeland, agricultural land and urban areas. Indian Creek is 55.68 mile long and is located in the southern portion of the lower Boise River watershed, which is located in southwest Idaho. The headwaters of Indian Creek are in Elmore County, but most of the stream flows through Ada and Canyon Counties. The stream flows in a southwesterly direction from its origin to where it intersects Interstate 84. From Interstate 84 to its confluence with the lower Boise River it flows in a northwesterly direction.

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 Indian Creek are sediment, nutrients, dissolved oxygen, temperature and oil/grease. Temperature is not addressed in this document because the state is currently developing a temperature assessment protocol and the TMDL is not due until 2006.

Indian Creek is designated for cold water biota, salmonid spawning and primary contact recreation from the headwaters to Sugar Avenue (Nampa), and for cold water biota and secondary contact recreation from Sugar Avenue to the mouth. Recognizing that these designations were not appropriate for the stream segments above the New York Canal, the Lower Boise River Water Quality Plan, which acts as the watershed advisory group, performed a detailed beneficial use evaluation to characterize the appropriate beneficial uses. The analysis showed that from the headwaters to Indian Creek Reservoir the appropriate uses are seasonal cold water biota and secondary contact recreation. From the reservoir to the Callopy Gates (New York Canal-Indian Creek split) the appropriate uses are modified aquatic life and secondary contact recreation. 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. From the Callopy Gates to the mouth the beneficial uses remain the same as those designated in the standards.

Using literature-based algal biomass levels as a surrogate to beneficial use support status, the data show that nutrients (phosphorus) are not assimilated by algae to the extent necessary to impair beneficial uses. 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 (DO) concentrations and pH levels were also evaluated to determine nutrient impairment. pH levels were within the criteria range at all locations in the stream. Dissolved oxygen concentrations above the City of Nampa sagged below the standard during the summer months of 1996-1998, but were well above the standard in the remainder of the stream. The cause of the sag above Nampa has not been determined, but potential sources may include natural biological oxygen demand (BOD) caused by submergent macrophytes or sediment oxygen demand (SOD). DEQ does not recommend a DO TMDL because conditions have not sagged below the criteria in the last three years. Rather, DEQ recommends continuing to monitor DO concentrations to track the current conditions.

Total suspended sediment concentrations and the percentage of substrate surface fines (< 6 mm in diameter) relative to the remaining substrate material were used as sediment surrogates. While the data show that total suspended sediment concentrations are within the range necessary to support salmonid spawning and cold water biota, the percentage of surface fines below the Callopy Gates are in excess (62%) and are contributing to the impairment of aquatic life, particularly salmonid spawning. However, a closer review of the Rosgen stream channel classification shows that the expected level of surface fines in Indian Creek is 66%, which is within 3% of current conditions. This is substantiated by a 2001 United States Geologic Survey (USGS) report indicating that based on the geological framework of the valley, the bulk of the material transported by the lower Boise river tributaries is sand and silt. Furthermore, a sediment source survey revealed relatively few sources of sediment above the City of Nampa, where salmonid spawning is a designated use. Based on these data, DEQ is not recommending sediment TMDL, but rather, recommends implementing the 37% sediment reductions stipulated in the lower Boise River TMDL (DEQ 2000) and assessing sediment conditions according to the schedule to be developed in the implementation plan.

Nutrients and oil & grease are not impairing beneficial uses in Indian Creek. Therefore, DEQ does not recommend TMDLs and recommends delisting nutrients and oil & grease as pollutants of concern from the 2002 303(d) list. Surface sediment (substrate) fine material is in excess below the New York Canal, but DEQ does not recommend a TMDL for sediment at this time. Further investigation into the sediment sources revealed that much of the surface fines are due to the natural functioning conditions of the stream. While no TMDL is required for sediment, DEQ does not recommend de-listing sediment from Indian Creek until the 37% suspended sediment reductions stipulated in the lower Boise River TMDL are implemented. The cause of the low dissolved oxygen conditions above the city of Nampa in the years of 1996-1998 is undetermined. While the sags did not occur in 1999-2001, DEQ does not recommend de-listing dissolved oxygen until sufficient data exists to show that the sags no longer exist.

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

The Snake River-Hells Canyon TMDL is scheduled to be completed 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 Indian 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 Indian Creek will be achieved.

Subbasin Watershed Characterization

Indian Creek is located in the mid-southern portion of the lower Boise River watershed (Hydrologic Unit Code (HUC) 17050114), which is located in southwest Idaho (Figure 1). The entire Indian Creek subwatershed drains 295 square miles of rangeland, agricultural lands, and urban areas. Indian Creek is 55.68 miles long and flows through Elmore, Ada and Canyon counties and the cities of Kuna, Nampa and Caldwell, Idaho (Figure 2). Indian Creek flows in a southwesterly direction from its origin above Mayfield, ID to where it crosses Interstate 84 (I-84) and flows into Indian Creek Reservoir. South I-84, the stream flows in a northwesterly direction to its confluence with the lower Boise River.

The topography South of I-84 is relatively constant, with gradual drops in elevation as the creek flows down several step-like terraces to its confluence with the lower Boise River., Changes in topography north of I-84 are less gradual, particularly above Mayfield, where the stream exits the Danskin Mountains. Elevation in the subwatershed ranges from 3500 feet at its headwaters 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 0.4% to 3.0% slopes.

Geology

Indian Creek lies within the western Snake River Plain. The multiple terraces that developed throughout the Quaternary period comprise much of the subwatershed below I-84. 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).

Below I-84, 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 are silty and sandy and loamy sands and sandy loams (Collett and Priest et al., 1972). Above I-84 the soils remain loamy sands and sandy loams until the base of the Danskin Mountain, where they become unconsolidated course quartz and orthoclase sand.

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 83.9º Fahrenheit (F) in Boise. The average minimum winter temperature in Boise from 1940 -2000 was 25.9º 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. Snow accumulation is typically light in the lower portion of the watershed and usually melts shortly after it falls. In the upper portion of the watershed, snow typically accumulates during the winter, but most often does not last throughout the winter.

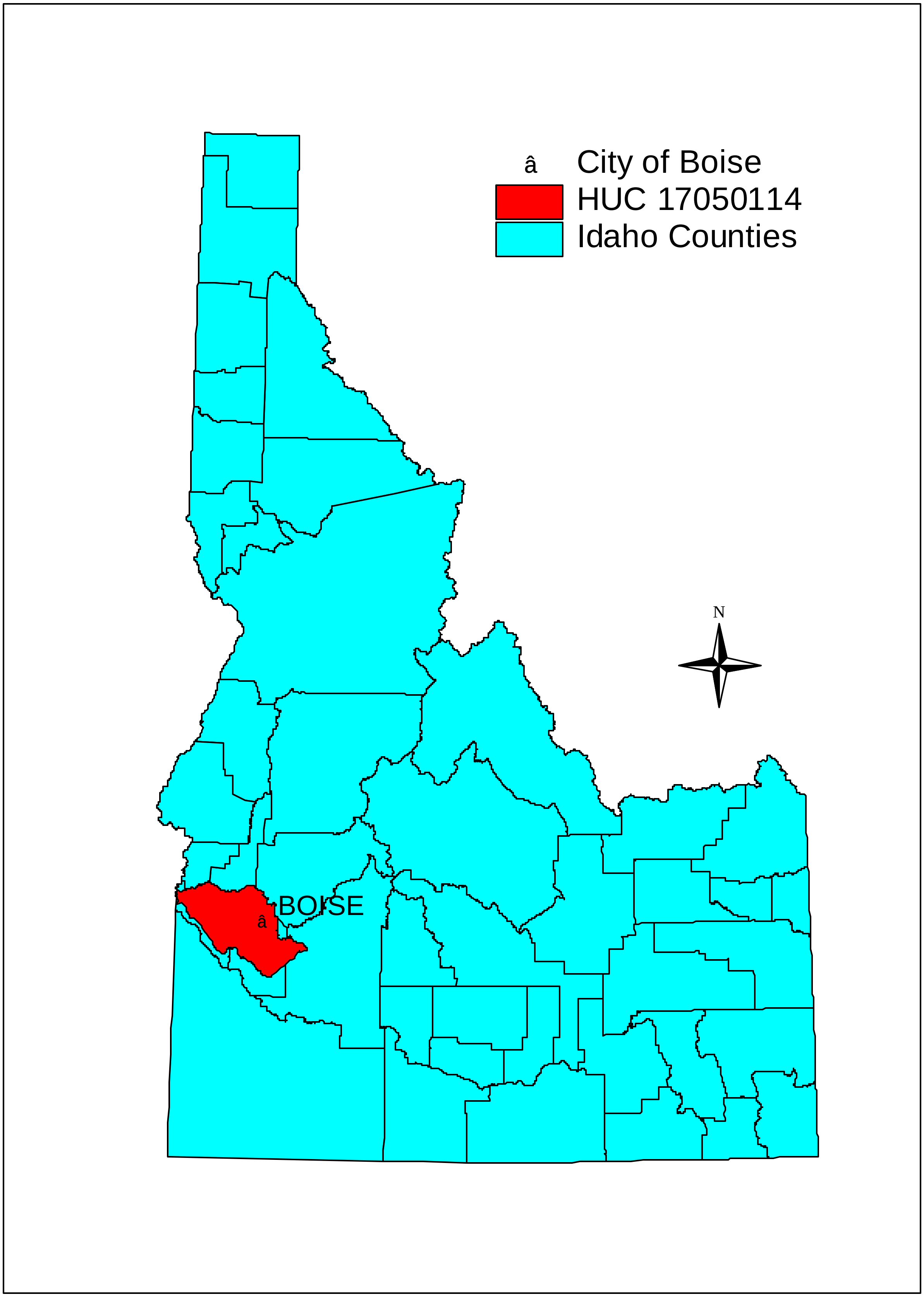
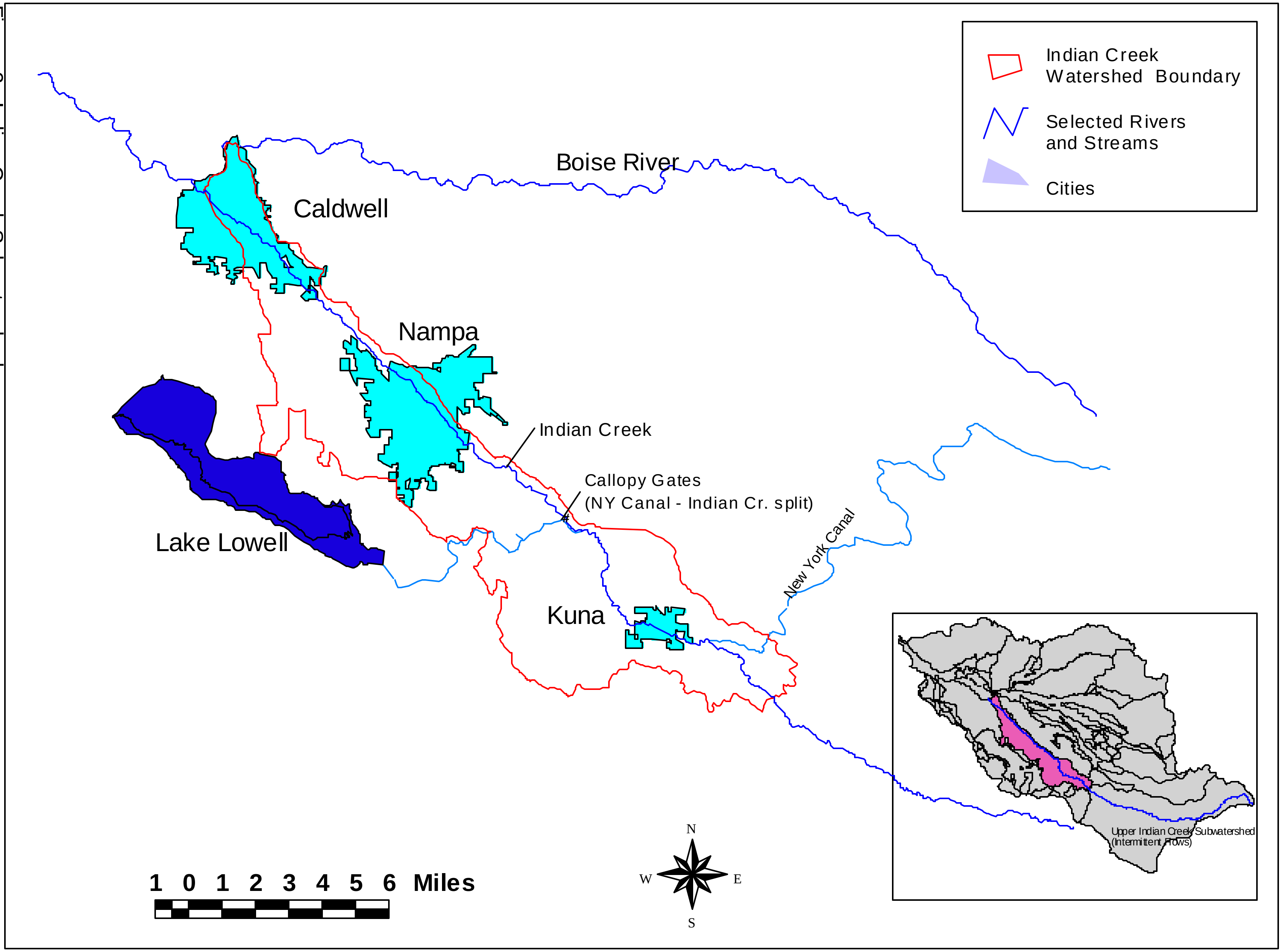


Figure 1. Lower Boise River Watershed

Figure 2. Indian Creek Subwatershed



Surface Hydrology

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 Indian Creek. Other management considerations that have less of an effect on Indian 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 hydrology of Indian Creek can be broken into three flow regimes: Headwaters to New York Canal, New York Canal to Callopy Gates (where Indian Creek splits from the New York Canal), Callopy Gates to the mouth. The headwaters to the New York Canal can be further delineated by the presence of Indian Creek Reservoir, which is located slightly south of I-84. From the headwaters to Indian Creek Reservoir, the stream flows in the early spring due to snowmelt and runoff, but is nearly always dry by early June. The flow data that has been located indicates that water is only present for a few weeks during the spring snow melt period, and at some locations, the presence of water has not been documented in recent time. The sandy nature of the substrate and an unconfined channel allows for the creation of a mirage of sandy channels when the spring melt occurs. This feature, in combination with deep groundwater levels, causes water to percolate into the ground very rapidly. Below Indian Creek Reservoir, the stream rarely contains moving water. Other than isolated swampy areas and small pools that form in the spring, this portion of the stream is dry. At several locations below the reservoir, the stream channel is difficult to locate. In one location just above Kuna, motorcycles and other recreational vehicles use in the stream channel as a track. Along with the available flow data, this information shows that Indian Creek from the headwaters to the New York Canal, with the exception of Indian Creek Reservoir, is intermittent. DEQ beneficial use reconnaissance project (BURP) data collected May 25, 1995 near Mayfield and August 13, 1996 south of the Boise airport revealed dry channels. Data collected June 6, 1997 north of Mayfield revealed a flow of 1.1 cfs in the main channel with several dry braids. The stream was dry within the month.

The analysis performed in this assessment assumes that Indian Creek above the New York Canal, with the exception of Indian Creek Reservoir, is intermittent. Thus, water quality standards apply only during optimal flow periods when beneficial uses can be supported, or when water is present. (IDAPA 58.01.02.070.07).

From the New York Canal to the Callopy Gates Indian Creek is also intermittent. The Callopy Gates are where the New York Canal has the capability of overflowing into Indian Creek, although it rarely happens. In this portion of the stream, the New York Canal (built in the 1890's) and the Indian Creek drainage were merged into one continuos trapezoidal channel. Water is diverted from the lower Boise River at the Diversion Dam into the New York Canal to provide water to numerous irrigation districts and farmers throughout the Boise Valley. During the irrigation season (April - September) the New York Canal averages >600 cfs. However, no water from the New York Canal is directly discharged into Indian Creek. During the non-irrigation season, the New York Canal slowly dries as water is no longer diverted from the river.

The analysis performed in this assessment will again assume that Indian Creek from the New York Canal to the Callopy gates is intermittent. Thus, water quality standards apply only during optimal flow periods when beneficial uses can be supported, or when water is present. (IDAPA 58.01.02.070.07).

Below the New York Canal Indian Creek is perennial, although, an intricate system of inputs and withdrawals in combination with the local flood control policies in the lower Boise River watershed have altered the flow regime and the physical and biological characteristics of the stream. The stream remains perennial below the New York Canal primarily due to infiltration from elevated groundwater levels.

The annual hydrograph for Indian Creek below the Callopy Gates 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 begins again in April. Figure 4 shows mean monthly flow for Indian Creek at the mouth from the years 1994 through 2000. Due to the regulated nature of Indian Creek, this flow regime is relatively static from year to year. During the irrigation season, the New York Canal and the Ridenbaugh canals divert water from the Boise River east of Boise to irrigate fields along the south side of the river, where Indian Creek is largely located. The high water table and deep stream channel creates a system that is constantly recharged by ground water, even in the winter.

Dating as far back as 1916 (Paul 1916), irrigation practices and urban development have altered drainage patterns in Indian 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. Figure 5 depicts the current drainage areas of the Indian 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 Indian Creek.

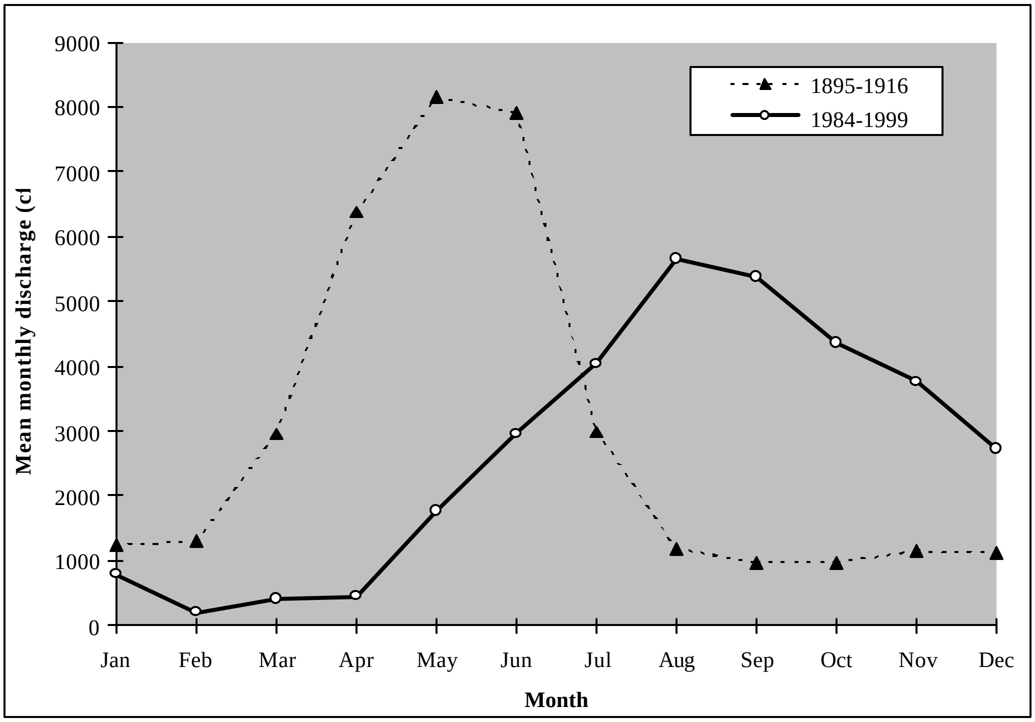


Figure 3. Regulated and unregulated mean monthly discharge in the Boise River near Boise, USGS gaging station 13202000.

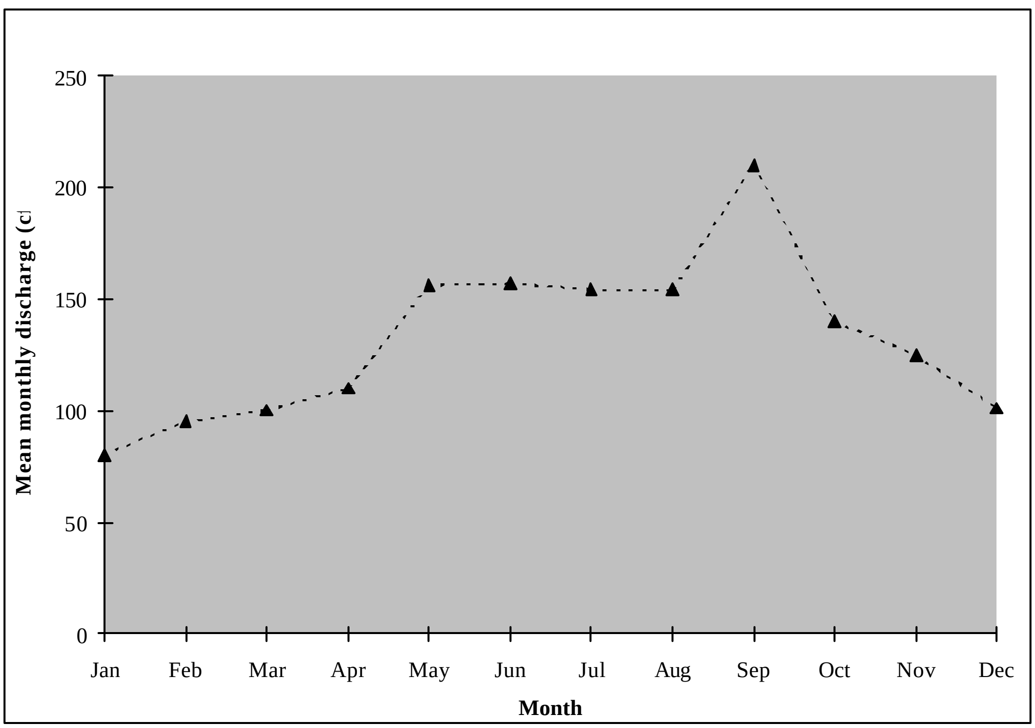
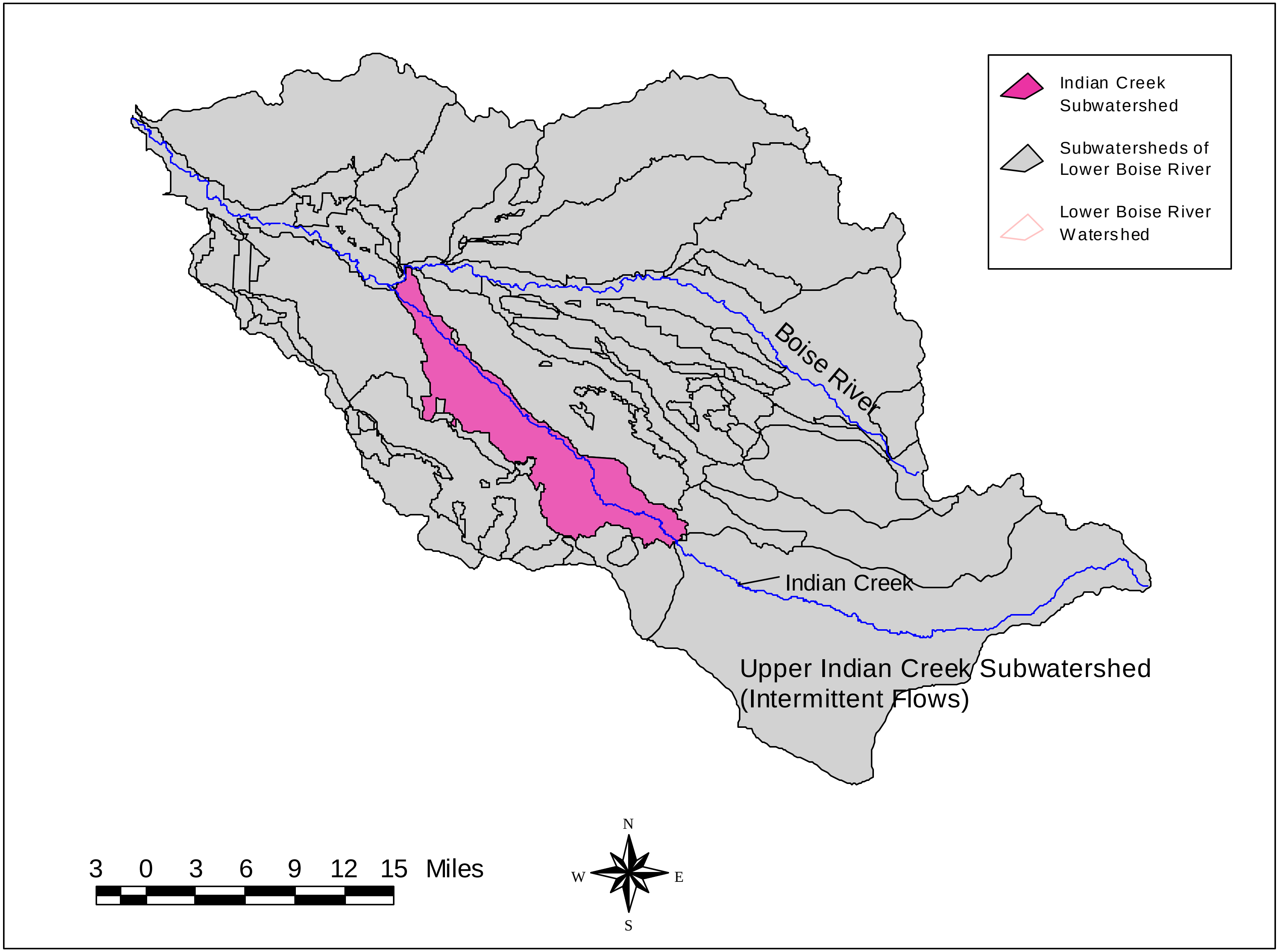


Figure 4. Mean monthly flow in Indian Creek at the mouth, 1994-2000

Figure 5. Indian Creek Drainage Area



Groundwater Hydrology

A deep, semi-confined to confined Idaho Group aquifer underlies the Indian 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 sands, silts, and claystones 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.

The groundwater level above the New York Canal has been classified as being at least 100 ft below the surface. There is no ground water recharge in Indian Creek above the New York Canal. Ground water levels below the New York Canal were historically lower than they are today. Starting as early as the 1860's, farmers in the valley began 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 many of the 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 historic drains and wells were dug 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. 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 well production in southeast Boise and to the west (Squires and others, 1993).

Indian Creek both gains and loses ground water depending on its location and season. Generally, the stream loses to ground water above the New York Canal. From Callopy Gates to the lower Boise River, the stream generally gains due to the high water table.

Channel and Substrate Characteristics

The lower portion of the Indian Creek subwatershed is a moderately narrow, gently sloping northwest trending stream that flows toward the lower Boise River. The upper portion of the watershed is southwesterly flowing in the headwaters with an eventual shift to the northwest. The stream channel can largely be classified as a Rosgen type F from the New York Canal to the lower Boise River. However, above the New York Canal the stream displays some type C and type D characteristics (Rosgen, 1996). The F type channel is deeply entrenched, low gradient (<0.02), has a high width/depth ratio, and a riffle/pool morphology. 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 C type channel is characterized as low gradient (<0.02) and meandering with a riffle/pool morphology, high width/depth ratio, and a broad, well-defined floodplain. Braids with longitudinal and transverse bars characterize the D type channel. The D type channel is typically wide with eroding banks.

The streambed from the headwaters to the New York Canal ranges from sand-size (<2 mm) material to small cobble (64.1-128 mm), although greater that 80% of the substrate is sand and fine pebble (2.51-6 mm). From the Callopy Gates to the lower Boise River the streambed ranges from sand and silt (<2.5 mm) to large cobble (128 -256 mm). Spawning size gravels are highly dispersed and are typically embedded. The banks are typically stable and steeply sloped due to past and current maintenance work by the irrigation districts. In locations where the stream flows through urban development, the stream banks are often rip-rapped or stabilized in another way so as to prevent the loss of land during high flow conditions. Very little bank erosion occurs in Indian Creek.

Indian Creek exhibits other characteristics typical of a stream with regulated flow. The 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 eliminated many portions of the floodplains in the lower portion of the stream. These factors have resulted in changes in stream morphology, hydrology and water quality.

Terrestrial and Aquatic Wildlife Characteristics

Indian 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 Indian Creek. These include fox, rabbit, beaver, muskrat, and other mammal and fowl species.

Indian Creek is currently home to numerous game and non-game fish species. Clark (1979) noted an abundance of non-game fish above the Nampa Wastewater Treatment Plant (WWTP). Idaho Fish and Game has stated that information exists on file that showed before November 28, 1975 rainbow trout resided in the creek. Greater than 1,100 rainbow trout were killed at Kings Corner in Nampa following an accidental discharge from the Armour Fresh Meats Company on January 31, 1986. Other than in 1998, when DEQ electrofished the stream and found a mix of cool water species and two adult rainbow trout, no recent fish surveys have been conducted on Indian Creek below the New York Canal. However, in mid-March 1996 DEQ investigated a localized whey product discharge into Indian Creek that resulted in the death of several fish. Along with several non-game species, DEQ personnel located nine rainbow trout between 12 and 16 inches long. No rainbow trout smaller than 12 inches were located.

Cultural Characteristics

The Boise River valley and Indian Creek were first explored in 1811 by overland explorers of the Pacific Fur Company. Gold discoveries in 1862 in the nearby mountains prompted the founding of Boise City and the Boise valley was settled in 1863.

The subwatershed began to change with the coming of the Oregon Shoreline Railroad in 1887 and the 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 delivering water to 100,000 acres of land (United States Bureau of Reclamation, 1996), many of those within the Indian Creek drainage. The Federal Reclamation Act of 1902 allocated funds to support the Boise Project (1904), that allowed further development 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 Indian 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).

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. Two NPDES permitted facilities currently discharge to Indian Creek. Con-Agra Beef (formerly Armour Fresh Meats), located in southeast Nampa has a design/permit flow of 0.74 million gallons per day (MGD). The City of Nampa WWTP has a design flow of 11.76 MGD.

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

Demographics and Economics

The upper portion of Indian Creek (headwaters to New York Canal) has seen little new growth in the past 10 years. The lower portion of the creek has experienced rapid growth. Canyon County, in which the lower portion of Indian Creek is largely located, has experienced rapid growth in areas south of Nampa and Caldwell. Most of the development has been in the form of residential subdivisions. However, as Indian Creek moves through Kuna, Nampa and Caldwell there are several commercial operations adjacent to the stream.

Land Ownership and Land Use

Figure 6 and Table 1 illustrate the current land use pattern in the Indian Creek subwatershed. Land ownership is a mixture of federal, state, county, municipal and private ownership. The major land type in the upper portion of the subwatershed (above the New York Canal) is rangeland (98%). The remaining portion is irrigated cropland and other types of abandon agricultural lands. In the lower portion of the stream (below the New York Canal) the major land uses are irrigated cropland (62%), urban residential and subdivisions (10%) and rural residential and ranchettes (7%). Throughout the watershed, especially in the lower portion, agricultural lands are rapidly being converted to suburban residential and commercial land uses. This land use transition may significantly alter the type and complexity of pollutant transport in the subwatershed.

Figure 6. Indian Creek Landuse (modified from IDWR 1994 data)

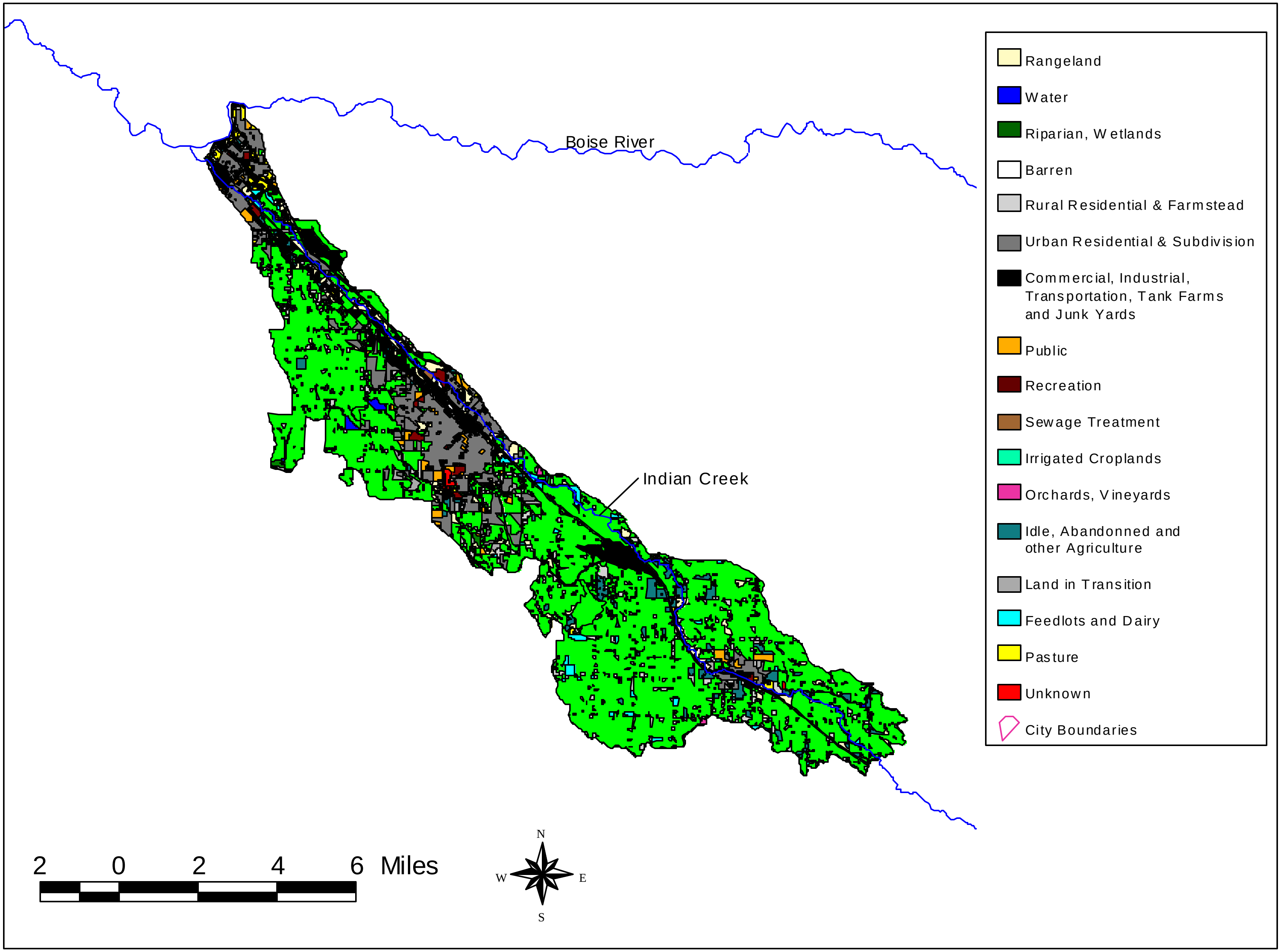


Table 1. Land use pattern in the Indian Creek subwatershed (delineated by upper and lower)

Land Use	**Acres Above NY Canal**	**Percent of Total Above NY Canal**	**Acres Below NY Canal**	**Percent of Total Below NY Canal**
Rangeland	141,987	98	1,619	4
Irrigated Cropland	946	1	27,809	62
Urban Residential / Subdivisions			4,546	10
Barren Lands			98	
Commercial, Industrial, Transportation, Tank Farms	56		3,213	7
Idle, Abandoned & other Agriculture	1151	1	1,323	3
Land in Transition			358	1
Pasture	1		388	1
Public Lands			529	1
Recreation			255	1
Rural Residential & Farmstead	65		3,160	7
Sewage Treatment			25	
Airport				
Riparian, Wetland	23		250	1
Feedlots & Dairy	9		504	1
Orchards & Vineyards			31	
Water	7		434	1
Unknown			54	

Public Involvement

Idaho Code Section 39-3611 states that TMDLs shall be developed in accordance with Idaho Code Section 39-3614 (duties of the basin advisory groups), 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

Indian Creek (water quality limited segment 2731 and 2732) 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 New York Canal (segment 2731) and New York Canal to Boise River (segment 2732). The stream is listed for sediment, nutrients and temperature from the headwaters to the New York Canal and sediment, nutrients, dissolved oxygen, temperature and oil/grease from the New York Canal to the Boise River.

Table 2. Summary of §303(d) listed segments for Indian Creek.

Name	**Boundaries**	**Pollutants 1998 §303(d) list**
Indian Creek	Headwaters to New York Canal	Sediment, Nutrients, Temperature
	New York Canal to Boise River	Sediment, Nutrients Dissolved Oxygen, Oil/Grease, Temperature

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 the *Idaho Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02) and 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 Indian Creek

Beneficial uses are designated in IDAPA 58.01.02.140 for two segments of Indian Creek, which account for the entire length of the stream. From it's headwaters to the Sugar Avenue (Nampa), Indian Creek is designated for Cold Water Biota, Salmonid Spawning and Primary Contact Recreation. From Sugar Avenue to the mouth, Indian Creek is designated for Cold Water Biota and Secondary Contact Recreation. These segment delineations are different than the 303(d) listed boundaries described above. The designated uses for Indian Creek are shown in Table 3.

Table 3. Designated beneficial uses for Indian Creek

Segment	**Designated Uses**
Indian Creek (headwaters to Sugar Avenue)	Cold Water Biota, Salmonid Spawning, Primary Contact Recreation
Indian Creek (Sugar Avenue to mouth)	Cold Water Biota, Secondary Contact Recreation

In instances where the designated 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 designated aquatic live beneficial uses of salmonid spawning and cold water biota and the contact recreation use of primary contact recreation are not appropriate for Indian Creek above the New York Canal, where the stream is intermittent, the lower Boise River WAG chose to perform a beneficial use evaluation for this segment of Indian 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 numeric data and a multitude of other information, CH2M Hill concluded that Indian Creek above the New York Canal, with the exception of Indian Creek Reservoir, is intermittent. Hence, water quality standards apply only during optimal flow periods when beneficial uses can be supported, or when water is present. (IDAPA 58.01.02.070.07). Indian Creek Reservoir is the exception to this segment because it remains wet throughout the year. CH2M Hill concluded that the appropriate beneficial uses for Indian Creek Reservoir are warm water biota and primary contact recreation. The beneficial uses that were determined to be appropriate for the other segments are seasonal cold water biota and secondary contact recreation above the reservoir and modified and secondary contact recreation below the reservoir to the Callopy Gates. From the Callopy Gates to Sugar Avenue CH2M Hill concluded the appropriate beneficial uses are aquatic life uses of cold water biota and salmonid spawning and a contact recreation use of secondary contact recreation, which is consistent with the current designations. CH2M Hill also recommended no change in beneficial uses below Sugar Avenue. Table 4 outlines these recommendations. Appendix A contains the analysis that supports how the beneficial uses were determined.

Table 4. Recommended beneficial uses for Indian Creek (Dupuis and Doran, 2001)

Segment	**Recommended Uses**
Headwaters to Indian Creek Reservoir	Seasonal Cold Water Biota, Secondary Contact Recreation
Indian Creek Reservoir	Warm Water Biota, Primary Contact Recreation
Indian Creek Reservoir to Callopy Gates	Modified, Secondary Contact Recreation
Callopy Gates to Sugar Avenue (no change)	Salmonid Spawning, Cold Water Biota, Secondary Contact Recreation
Sugar Avenue to Mouth (no change)	Cold Water Biota, Secondary Contact Recreation

In coordination with the LBRWQP and CH2M Hill, DEQ is preparing to add these beneficial use changes to a rules change package that will be finalized in 2001.

This assessment will be performed using the recommended beneficial uses developed by CH2M Hill. The recommended uses are more accurate than the current designated uses because they accurately represent the attainable conditions in the stream.

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 modified aquatic life community that exists in Indian Creek from the reservoir to the Callopy Gates. 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 this section of Indian Creek. Other than for these parameters, all other applicable water quality criteria apply to this segment and to Indian Creek below the Callopy Gates. Appendix A details the rationale for the modified 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 Indian Creek. The criteria represent water quality conditions that are protective of the designated and existing aquatic life community in Indian Creek. For the section of stream determined by CH2M Hill to be modified, 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 Sections 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 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)

Dissolved Oxygen

For cold water biota, waters are to exhibit the following characteristic:

> Dissolved oxygen concentrations exceeding six (6) mg/L at all times (IDAPA 58.01.02.250.02.a).
>
> For Salmonid Spawning, waters are to exhibit the following characteristic:
>
>> Intergravel Dissolved Oxygen:
>>
>> One (1) day minimum of not less that five point zero (5.0) mg/L and a seven (7) day average mean of not less than six point zero (6.0) (IDAPA 58.01.02.250.02.e.i.(1)(a),(b)).
>>
>> Water Column Dissolved Oxygen:
>>
>> One (1) day minimum of not less that six point zero (6.0) mg/L or ninety percent (90%) of saturation, whichever is greater (IDAPA 58.01.02.250.02.e.i.(2)(a)).
>>
>> The Salmonid Spawning Dissolved Oxygen Criteria apply during the spawning and incubation period for the particular species inhabiting those waters (58.01.02.250.02.e). During the non-spawning period the Cold Water Biota criteria apply.

For seasonal cold water biota, waters are to exhibit the following characteristics between the summer solstice and the autumn equinox:

> Dissolved oxygen concentrations exceeding six (6) mg/L at all times (IDAPA 58.01.02.250.03.a).

For warm water biota, waters are to exhibit the following characteristic:

> Dissolved oxygen concentrations exceeding five (5) mg/L at all times (IDAPA 58.01.02.250.03.a).

For modified communities, there are no existing dissolved oxygen 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).

As per IDAPA 58.01.02.250.05, Indian Creek from below the reservoir to the Callopy Gates is to exhibit dissolved oxygen concentrations exceeding four (4) mg/L at all times.

This dissolved oxygen criterion reflects the chemical levels necessary to fully support the existing aquatic life community in this segment of Indian Creek.

Oil and Grease

The state of Idaho does not have an ambient water quality standard for oil and grease. In an attempt to identify a preliminary maximum allowable oil and grease target in lotic waters, the Portneuf River TMDL (IDEQ-Pocatello Regional Office) performed a search for state water quality standards or targets for oil and grease (Rowe 1998). The search identified a standard of 10 mg/L in the state of Wyoming. To account for a lack of data and to add an explicit margin of safety, the Portneuf River TMDL decreased the 10 mg/L standard by half and used 5 mg/L as a preliminary oil and grease target in the Portneuf River.

For this evaluation, an oil and grease target of 5 mg/L oil will be used. Hence, the degree of conservatism applied in the Portneuf River TMDL is applicable here. Any chronic exceedence of 5 mg/L in Indian Creek should warrant further investigation into preparing a TMDL for oil and grease.

Summary of Existing Water Quality Data

Numerous sources of data are available within the Indian Creek subwatershed to describe the physical and chemical water quality and the biological communities of the stream. Table 5 summarizes the data used in this assessment. The DEQ surveyed the stream in 1995, 1996 and 1997 using the Beneficial Use Reconnaissance Project process. Additionally, in 2000, the DEQ collected chemical and benthic and suspended chlorophyll-a data in the stream. The USGS, through a multi-year monitoring plan jointly funded by the DEQ, LBRWQP and USGS collected chemical data at the mouth of the stream in 2000. In 1998 and 1999, the Idaho Department of Agriculture collected chemical data at four locations in the lower portion (below the New York Canal) of the stream. The Nampa WWTP and Con-Agra Beef, pursuant to their NPDES permit requirements have and continue to collect chemical water quality data above and below their Indian Creek discharge points. Multiple reports have been prepared for a variety of reasons throughout the years that are useful in describing the physical and biological conditions of Indian Creek (Clark and Martin 1979, Idaho Fish & Game written communication 1997). Figure 7 illustrates the location of the major sampling locations established by the DEQ, USGS and the Idaho Department of Agriculture as well as the location of the Nampa WWTP and Con-Agra Beef.

Table 5. Available physical, chemical and biological data for Indian Creek

Name/Agency	Monitoring Dates	Data Type	Current Status
Idaho Department of Environmental Quality	6/00 – 10/00 (1 site)	Chemical, Biological	Complete
	BURP: 1996-98	Biological	Complete
US Geological Survey	4/00 – Current (1 site at mouth)	Chemical	Ongoing
Idaho Department of Agriculture	4/98 – 4/99 4 sites (I1 - I4)	Chemical	Complete
Nampa WWTP	Current at plant	Chemical	Ongoing
Con-Agra Beef	Current at plant	Chemical	Ongoing

Data Analysis and Interpretation

The DEQ used chemical water quality, biological, physical habitat, current complaint and written and verbal communication data to assess the support status of beneficial uses in Indian Creek. 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 subject 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 additional data can be collected to validate the suspected impairment.

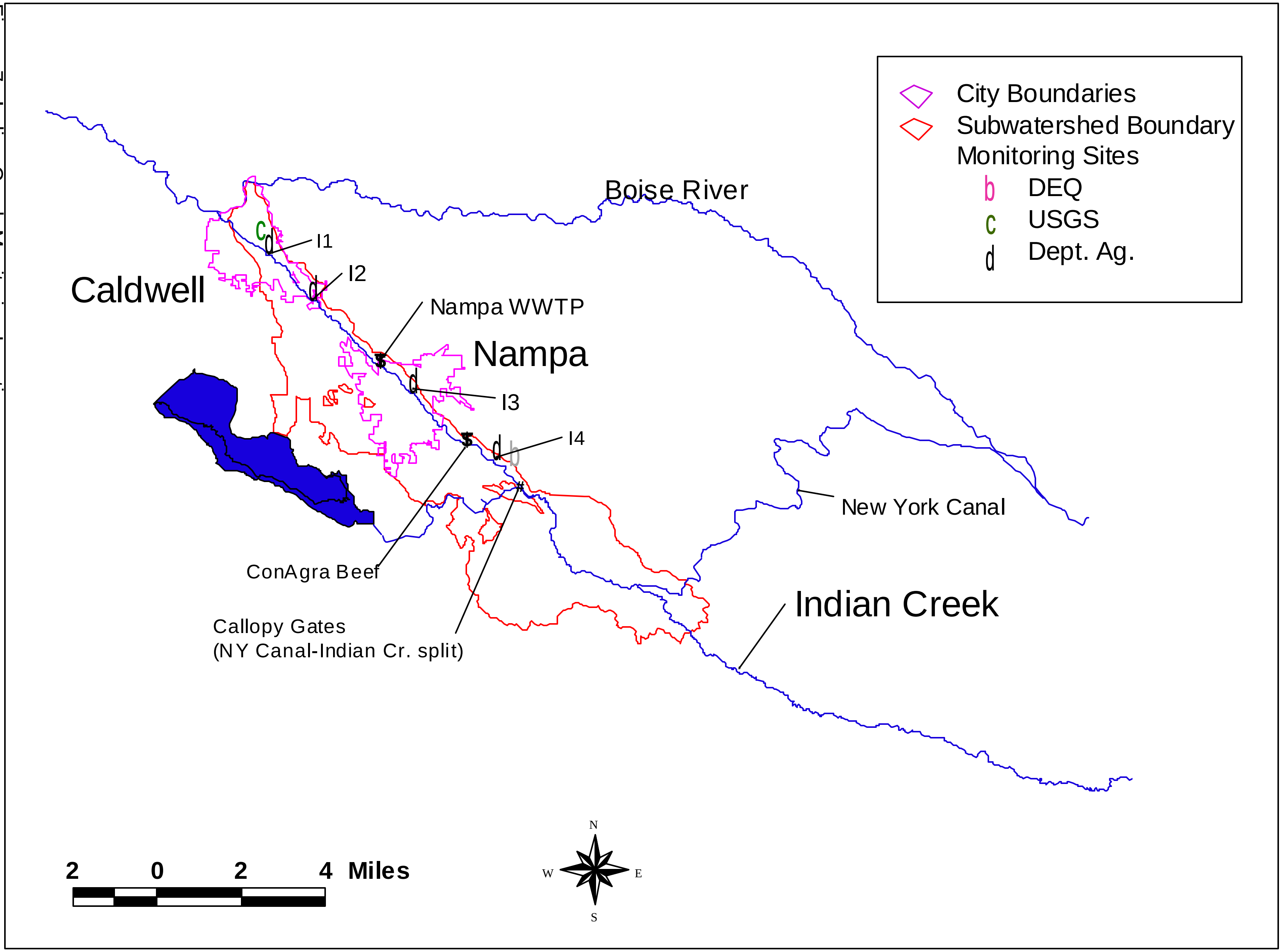
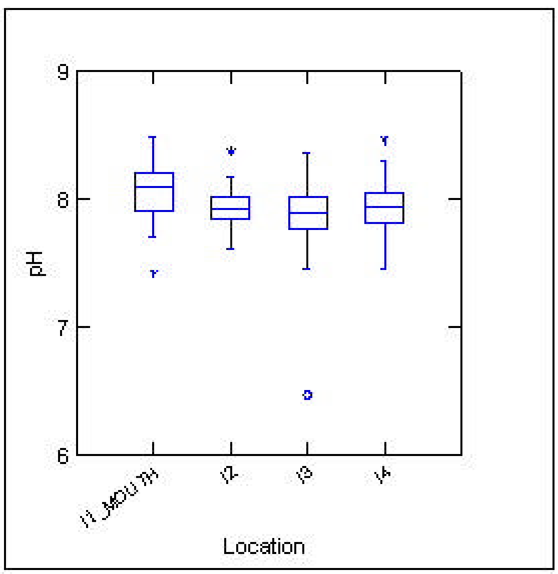


Figure 7. Indian Creek Monitoring Locations

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 are in part a 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 8 shows the range of pH values in Indian Creek from the years 1998 to 2000. The data were collected on a monthly basis by the Idaho State Department of Agriculture and the USGS and include values from the growing season of each year. The mean pH value in the stream is essentially the same at all locations, being 7.9 at I4, 7.8 at I3, 7.9 at I2 and 8.0 at I1. At all locations in the stream, even considering the maximum and minimum values, the state criteria are met. No pH data are available for the segment above Indian Creek Reservoir, where the stream is intermittent.



Guide to interpreting the box and whisker plot:

Figure 8. pH values in Indian Creek, 1998 - 2000

Dissolved Oxygen

Dissolved oxygen can be a direct indicator of nuisance aquatic growth because as aquatic algae biomass increases, the amount of night-time respiration that occurs increases as well. As respiration increases, the volume of oxygen removed from the water increases, thereby lowering dissolved oxygen concentrations. 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 from the USGS and the Department of Agriculture spanning the years 1994-2000 are used to evaluate conditions at the mouth. Data spanning the years 1994-1997 are used to evaluate conditions at the Nampa WWTP and data spanning the years 1992-2000 are used to evaluate conditions at Con-Agra Beef. The USGS and Department of Agriculture were collected during the day using standard field sampling procedures. The Nampa WWTP and Con-Agra Beef data are from the facilities' monthly discharge monitoring reports (DMR). No dissolved oxygen data are available for the segment above Indian Creek Reservoir, where the stream is intermittent.

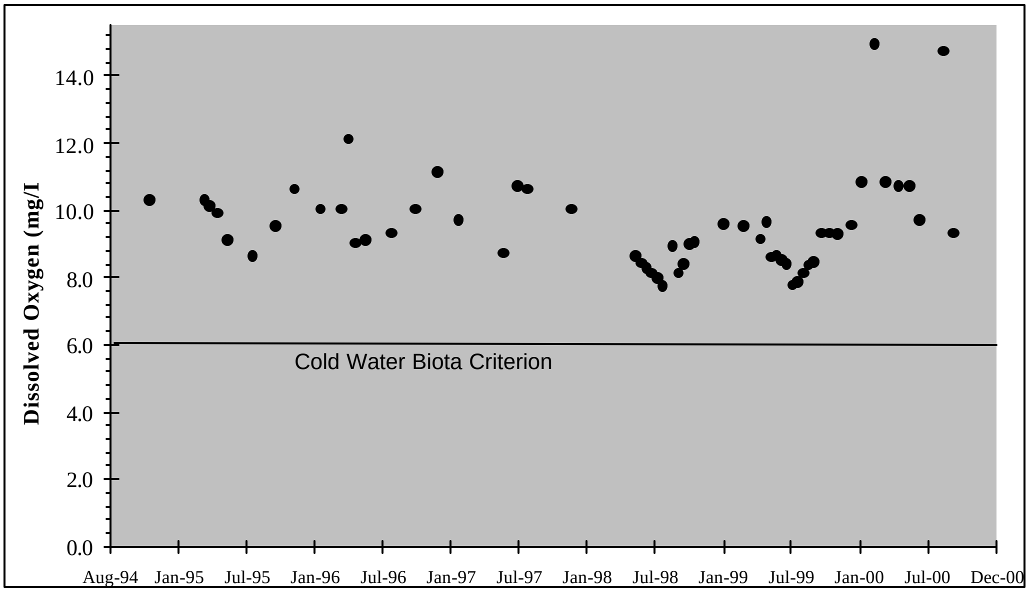


Figure 9. Dissolved Oxygen levels in Indian Creek at the mouth: 1994-2000.

Figure 9 shows the water column dissolved oxygen concentrations at the mouth of Indian Creek. The data indicate that the concentration does not fall below 6.0 mg/L during the sampling period. A review of the percent saturation data shows similar conditions. Figure 10 shows the water column dissolved oxygen concentrations at the Nampa WWTP. The concentrations are similar to those at the mouth. The data indicate that the concentration does not fall below 6.0 mg/L during the sampling period. Figure 11 shows the concentrations at Con-Agra Beef. Unlike the mouth and at the Nampa WWTP, the dissolved oxygen concentrations upstream of Con-Agra Beef occasionally fall below 6.0 mg/L, particularly during the summer months. Twenty-two percent (22%) of the values at this location fall below 6.0 mg/L. The sags occur during the hot summer months of nearly every year. Figure 12 shows the months in which the dissolved oxygen concentrations fall below 6.0 mg/L. Of the total percentage of exceedances, 65% occur in July, August and September, which are the typically the hottest months of the year.

To address the possibility of additional diurnal dissolved oxygen sags in Indian Creek, the DEQ collected pre-dawn dissolved oxygen and pH data above the city of Nampa 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. The pre-dawn dissolved oxygen concentration was 7.55 mg/L. The pH was normal at 7.75.

EPA's 1996 Guidelines for Preparing State Water Quality Assessments indicate that for conventional pollutants, of which dissolved oxygen is included, not more than 10% of the measurements should exceed the criterion. If the number of criteria exceedences is less than 10% of the total number of measurements, the water body in question can be classified as Fully Supporting. This essentially means the pollutant is not impairing the

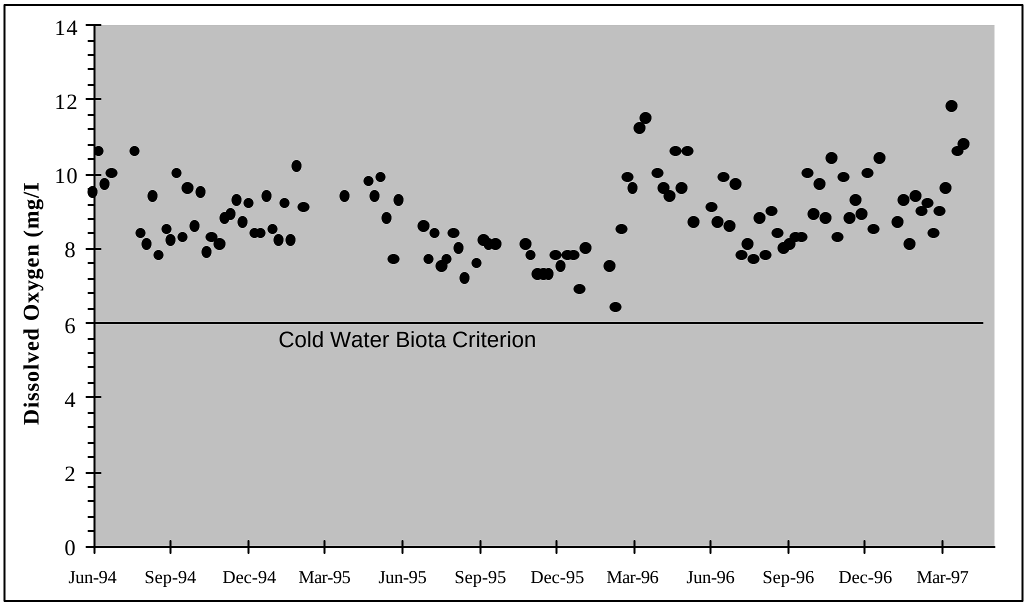


Figure 10. Dissolved Oxygen levels in Indian Creek at the Nampa WWTP: 1994-1997.

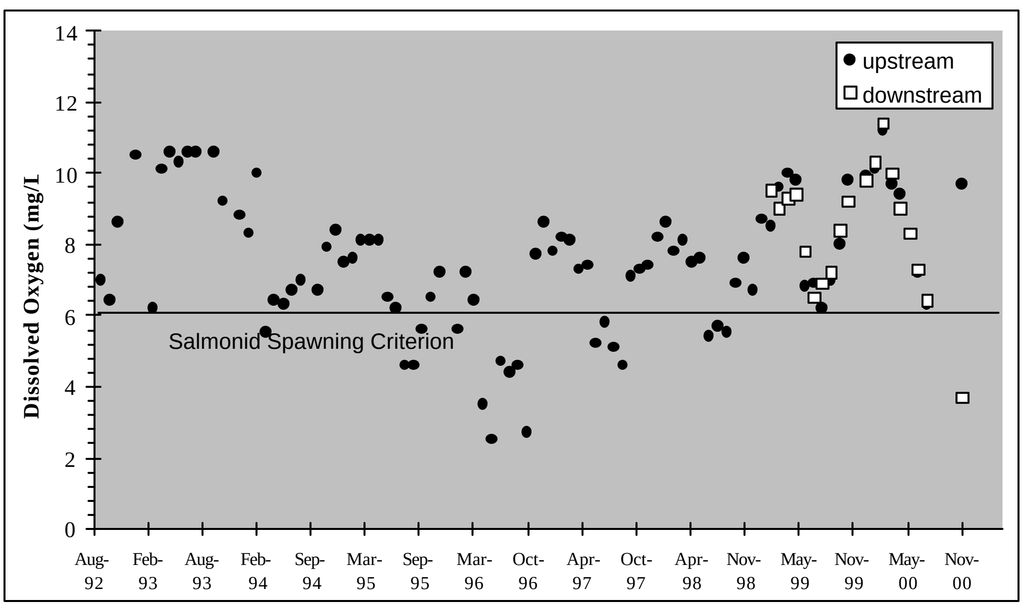


Figure 11. Dissolved Oxygen levels In Indian Creek at Con-Agra Beef, upstream and downstream of discharge point: 1992-2000.

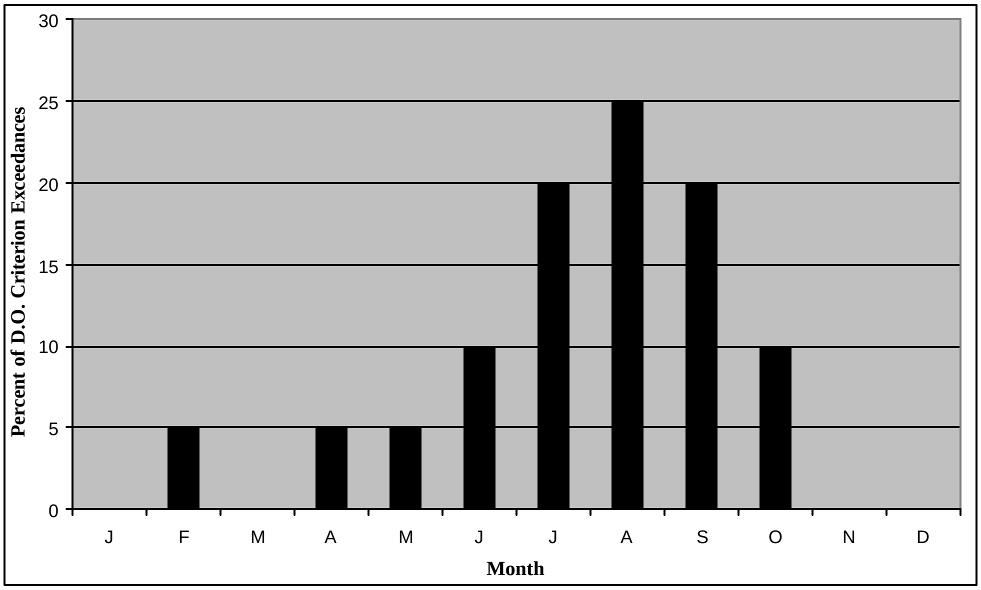


Figure 12. Percent of dissolved oxygen criterion exceedances above Con-Agra Beef, by month.

associated beneficial use(s). This guidance is consistent with DEQ's current water body assessment strategy. Following this assessment strategy, the data suggest that above Con-Agra Beef, cold water biota is impaired by low dissolved oxygen concentrations. The low dissolved oxygen concentrations are not impairing salmonid spawning because relatively few exceedances (4 of 20) occur during the salmonid spawning period, which is March through June.

To determine whether the low dissolved oxygen concentrations above Con-Agra Beef are a function of water temperature, the expected natural dissolved oxygen concentration in this segment of the stream given the current temperature conditions in the stream was calculated. During the months of July through September 1998 and August and September 2000, the average water temperature at the Department of Agriculture monitoring station upstream of Con-Agra Beef was 15.9° C. Following the dissolved oxygen principles proved by Henry's Law[1] and a barometric pressure of 700 torr (typical for the Treasure valley during the summer months), the 100% dissolved oxygen saturation level of water at 15.9° C is 9.14 mg/L. Eighty-percent dissolved oxygen saturation is generally accepted as the level needed to support salmonid spawning (Reiser and Bjornn, 1979), although the IDAPA 58.01.02.250.02.e.i.(2)(a) indicates that saturation should remain above 90%. Using 9.14 mg/L as a baseline, 90% saturation in this segment of Indian Creek during the summer months, at typical Treasure Valley climatic conditions, is 8.2 mg/L. The average dissolved oxygen concentration during the summer months is also 8.2 mg/L, which is 90% of saturation. Assuming 15.9° C represents the typical summer temperature conditions in Indian Creek above Con-Agra Beef, this analysis shows that water temperature is not causing the low dissolved oxygen levels in Indian Creek.

Other causes of reduced dissolved oxygen concentrations in Indian Creek may include an excess of oxygen-demanding course organic matter such as macrophytes or an excess of oxygen demanding sediments. The low flows that often occur in Indian Creek above Con-

[1] The solubility of oxygen in water is a function of the partial pressure of oxygen in the air and water temperature. [DO=(P-p)0.678/35+t] P is the barometric pressure in torr, p is the water vapor pressure in torr, and t is the water temperature in degrees Celsius.

Agra Beef allow for a settling of biological material, which amplifies the sediment oxygen demand. DEQ surveys of Indian Creek during the summer of 2000 show that above Con-Agra Beef the cross sectioned stream channel is typically between 40 and 60% covered with submergent macrophytes of the *Potamogeton* species (Sago Pondweed). Additional causes may be the incidental discharge of oxygen demanding material from a couple of feedlots that are located adjacent to the stream above Nampa. Animal feeding operations posed a significant threat to the stream if they are not operated properly. However, it is unlikely that the lots above Nampa are chronic threats and warrant TMDL development because the DO concentrations in the stream have not remained low, particularly since 1998.

With the current data set, it is not possible to develop an explicit link between the aquatic plant community or the sediment oxygen demand and the reduced dissolved oxygen levels in Indian Creek above Con-Agra Beef. However, based on the aforementioned information, it appears that water temperature and human caused sources are not the cause of low dissolved oxygen in the stream, leaving oxygen consumption by plants and sediment demand as the two most viable causes. The potential for reducing sediment oxygen demand and macrophyte densities will be discussed later.

Oil and Grease

Oil and grease are commonly found in urban/suburban runoff such as storm water (Horner et.al. 1994). Oil and grease data from the Federal Highway administration indicate that typical runoff concentrations range from 6 to 16 mg/L. Furthermore, a report from the Watershed >96 Conference in Washington, D.C., indicated that oil and grease in storm water derived from roads and parking lots may range from 0.7 to 6.6 mg/L. Agricultural runoff can also be a source of petroleum hydrocarbons (Maguire 1997). In terms of concentration, the values are highly variable.

The concentrations of oil and grease that cause negative impacts on aquatic life are widely variable depending upon the specific petroleum hydrocarbon of interest. Under the appropriate conditions, high concentrations can cause lethal effects in all or most of the organisms within a particular area. If exposure is chronic and the concentration is high enough, the pollutant can enter the food chain, thereby detrimentally effecting more than just the initially exposed organisms (Trimbell 1989).

The available oil and grease data were collected by Con-Agra Beef (Table 6) and the City of Nampa WWTP (Table 7), pursuant to the requirements in their NPDES permits. To date, this is the only data for oil and grease in Indian Creek that has been unearthed. Each permit requires the facility to collect weekly samples. The data are summarized each month in a discharge monitoring report (DMR) with the average value being reported. The average value is used for this analysis. The data are not numerous because the requirement to monitor Indian Creek for ambient oil and grease concentrations has only recently been initiated as part of each facility NPDES permit. It should be noted that the data from Con-Agra and the data from Nampa are not comparable. The laboratory analysis used to generate each respective data set uses a different detection limit. The data should only be compared to the preliminary target of 5.0 mg/L.

Table 6. Concentrations of total recoverable oil and grease at Con-Agra Beef

Month	Average Effluent Concentration (mg/L)	Average Upstream Concentration (mg/L)	Average Downstream Concentration (mg/L)
Dec 1998	0.5	No Data	No Data
Jan 1999	0.5*	No Data	No Data
Feb 1999	0.5*	0.5*	0.5*
Mar 1999	0.5*	1.1 (max)	0.5*
April 1999	0.5*	0.5*	0.5*
May 1999	0.5*	1.2 (max)	1.0 (max)
June 1999	0.5*	0.5*	0.5*
July 1999	0.5*	0.5*	0.5*
Aug 1999	0.5*	0.5*	0.5*

*½ of 1.0 mg/L detection limit

The laboratory analysis procedure used by Con-Agra to analyze their oil and grease samples has a detection limit of 1.0 mg/L. In the discharge monitoring report any value less than 1.0 mg/L is reported as 0. For this evaluation, and so that calculating monthly averages is possible, one-half of the detection limit, or 0.5 mg/L, is used. This approach is consistent with that used in the Portneuf River TMDL.

The data indicate that the ambient oil and grease concentrations in Indian Creek above the effluent discharge point are below the target of 5.0 mg/L. The data also show that after the effluent enters Indian Creek and is mixed, the ambient concentrations remain well below 5.0 mg/L downstream of the plant.

Table 7. Concentrations of total recoverable oil and grease from at Nampa WWTP.

Month	Average Effluent Concentration (mg/L)	Average Upstream Concentration (mg/L)
Aug 1999	2.5*	2.5*
Sept 1999	2.5*	2.5*
Oct 1999	9.8	2.5*
Nov 1999	15.1	2.5*
Mar 2000	2.5*	2.5*
April 2000	2.5*	10
May 2000	2.5*	2.5*
June 2000	2.5*	2.5*
July 2000	2.5*	2.5*
Aug 2000	2.5*	2.5*
Oct 2000	2.5*	2.5*
Nov 2000	2.5*	2.5*
Feb 2001	2.5*	2.5*
Mar 2001	No Data	2.5*

*½ of 5.0 mg/L detection limit

The laboratory analysis procedure used by the Nampa WWTP to analyze their oil and grease samples has a detection limit of 5.0 mg/L. In the discharge monitoring report any value less than 5.0 mg/L is reported as <5.0. For this evaluation, and so that calculating monthly averages is possible, one-half of the detection limit, or 2.5 mg/L, is used. This approach is consistent with that used in the Portneuf River TMDL.

Nampa has only recently (July 1999) initiated monitoring for oil and grease. Thus far, data from the upstream monitoring location do not indicate a chronic exceedence in the 5.0 mg/L target.

The data indicate that the ambient oil and grease concentrations in Indian Creek are well below the target of 5.0 mg/L. No data are available at the mouth, where the cumulative effects of stormwater discharges from the City of Nampa and the City of Caldwell would be recognized. It is reasonable to assume that oil and grease concentrations at the mouth are higher than the upstream concentrations, although it is difficult to determine how much. With Phase II stormwater requirements scheduled to take effect in 2002, Nampa and Caldwell will likely be subject to strict storm water controls that presumably will mitigate much of the current load to Indian Creek. These forthcoming requirements along with the fact that in-stream oil and grease concentrations are largely below 5.0 mg/L, suggest that no further action should be taken for reducing oil and grease levels in Indian Creek.

Sediment

Suspended sediment (TSS) and surface sediment characteristics can be used as direct indicators of sediment conditions in water bodies. Suspended sediment is defined as the sediment fraction that is suspended in the water column (typically <0.1mm). Surface sediment is defined as the sediment fraction that resides on the bottom of the stream, but is not buried to a great extent, as with subsurface fines. Surface sediment levels are commonly associated with bedload conditions. Excessive suspended sediment and surface sediment can adversely effect aquatic life in a number of ways. Most fish species can tolerate acutely high levels of suspended sediment. However, when suspended sediment levels become chronically high, sensitive salmonid and macroinvertebrate species show negative affects. Newcombe and Jensen (1996) reported that for juvenile rainbow trout, concentrations of 50 to 100 mg/L suspended sediment for 14 to 60 days yielded significantly reduced growth rates or lethal effects. Thruston et al (1979) concluded that 25 mg/L TSS would provide high protection, 80 mg/L would provide moderate protection and >400 mg/L would provide low protection for juvenile rainbow trout. From an acute exposure standpoint, adult rainbow trout can withstand significantly higher levels of TSS than juvenile trout. Newcombe and Jensen's 1996 model suggests that adult salmonids can withstand TSS levels of 1097 mg/L for up to six days without experiencing mortality.

Excessive surface sediment (particles less than 6.0 mm in diameter) can adversely affect aquatic life by smothering fish nesting areas and filling pools that provide critical holding habitat. Surface sediment can also decrease inter-gravel dissolved oxygen concentrations by reducing the flow of water through the substrate matrix. This affects juvenile fish as well as macroinvertebrates. The result is often a less than desirable fishery and macroinvertebrate community. Excess surface sediment can also reduce the value of contact recreation by reducing visibility, making the stream bottom muddy and difficult to wade and by clogging the stream channel. In agricultural watersheds and/or watersheds that contain nutrient-rich soils, surface sediment often contributes to excessive macrophyte growth if the nutrient-rich sediment is not sufficiently flushed through or internally recycled by the system.

Suspended Sediment

While total suspended sediment concentrations in Indian Creek fluctuate somewhat according to location, the fluctuations are not as closely linked to the irrigation season as some of the other tributaries in the basin (Figure 13). In fact, during the 1998 water year the average concentration in the stream was higher during the non-irrigation season than during the irrigation season. This can likely be attributed to the fact that Indian Creek is not used as an agricultural return drain to the same extent as the adjacent tributaries. Very few agricultural return drains actually discharge to Indian Creek.

While the TSS concentrations do not fluctuate according to irrigation season as apparently, there is a cumulative increase in suspended sediment concentrations in the lower portion of the stream. The TSS concentrations at the mouth (I1) are notably higher than the concentrations above Nampa (I4). This suggests that between the upper and lower monitoring locations there are sources such as occasional irrigation return flows and storm water inputs from the cities of Nampa and Caldwell that likely contribute to the overall suspended sediment load in the stream.

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 protection of juvenile rainbow trout in the lower Boise River proper. These targets are consistent with Newcombe and Jensen's (1996) recommended thresholds mentioned above. 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, and knowing that the segment of Indian Creek from the Callopy Gates to Sugar Avenue will remain designated for salmonid spawning, the in-stream targets for the lower Boise River proper are applicable to this segment of Indian Creek. Electrofishing surveys conducted by DEQ in 1998 above and below Con-Agra beef showed that adult rainbow

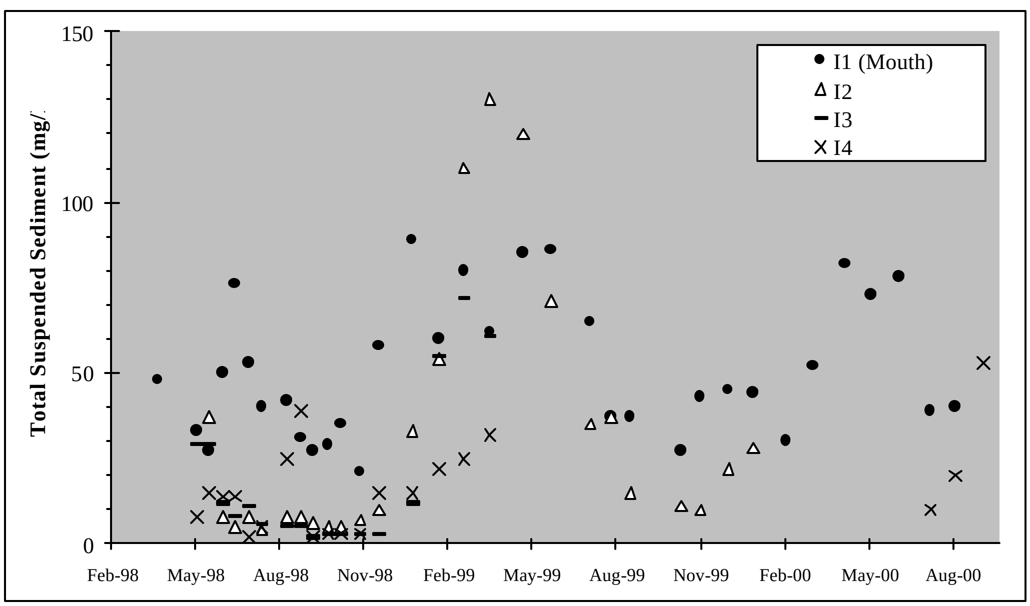


Figure 13. Total Suspended Sediment levels in Indian Creek, 1998-2000

trout are common in Indian Creek. However, no young-of-the-year fish were located. Additional fish data was generated during a complaint investigation performed near Kuna in 1996, where several fish were killed due to an accidental milk / whey product spill. Nine adult rainbow trout between 12 and 16 inches long were located, but no juvenile fish were found.

The available fisheries data show that adult trout reside in Indian Creek, but do not appear to be spawning. The TSS data show that if fish were spawning in the stream, the concentrations at I4, which is upstream of Sugar Avenue, are not high enough to stress juvenile fish (Newcombe and Jensen 1996). During the irrigation season the average monthly concentration at I4, which in part corresponds with the spawning season (Jan-July), is 15 mg/L. During the non-irrigation season, the monthly average concentration is 14 mg/L. The concentration peaks at 53 mg/L in August 2000, but returns below 50 mg/L shortly thereafter. These data show that during the salmonid spawning period and throughout the year in fact, TSS concentrations in the segment of the stream designated for salmonid spawning are well below the threshold of 50 mg/L.

No TSS data are available for Indian Creek above the Callopy Gates. In the segment of the stream above the reservoir, visual observations by DEQ personnel indicate that when water is present it is clear enough to see the bottom of the stream. The unconsolidated granite that typifies the geology of the upper segment is not conducive to producing high TSS concentrations. From the reservoir to the New York Canal the stream is nearly always dry. In the New York Canal segment, the water that is present is water diverted from the Boise River at the Diversion Dam, where TSS concentrations are typically less than 5 mg/L. There are no irrigation inputs into the New York Canal and the banks are well armored to prevent water loss. Hence, it is unlikely that TSS concentrations increase substantially.

Surface Sediment

DEQ performed a particle size characterization in Indian Creek above Indian Creek Reservoir in 1997 and found that 82% of the stream channel is composed of course sand and pebble size material. Very little silt was noted. The geology of Indian Creek above the reservoir is conducive to this type of substrate and it appears that these are the natural conditions. Weathered, unconsolidated granite outcroppings line the stream as it exits the Danskin Mountains, which facilitate seasonal influxes of course granite sand and fine gravel from the adjacent land. Larger substrate types such as large cobbles and boulders are present, but are sporadically distributed.

Below Indian Creek Reservoir, the stream substrate is largely sand and small pebble with sporadically distributed large cobble. This portion of the stream rarely contains water or flushing flows, hence the composition of the substrate is of little consequence to the overall aquatic life community in Indian Creek.

At most locations, substrate in the New York Canal to the Callopy gates is composed of small and large cobble, and gravel. At several locations, the banks have been armored and the armor material has sloughed into the channel. Additionally, below Kuna where the canal flows through basalt outcroppings the substrate is often composed of an intermixed complex of basalt slabs or fractured basalt.

Below the New York Canal the stream substrate ranges from sand and silt (<2.5 mm) to large cobble (128 – 256 mm). Quantitative substrate count performed in September 2000 by DEQ showed that above Nampa fine materials (< 6.0 mm) make up 62% of the substrate material. The remaining 38% of the material ranged from pebble to small cobble. Above Caldwell, the percent of fine materials was nearly the same, at 64%. The remaining material ranged from pebble to small cobble. The substrate counts were performed in riffles below moderately deep pools following the Wolman pebble count procedure (Wolman, 1954)

Macroinvertebrates

There is little information that directly relates quantitative levels of surface sediment to deleterious affects on aquatic life beneficial uses. While several authors have shown how different ranges of sedimentation effect macroinvertebrate community composition and distribution (Waters 1995, Richards and Bacon 1994), few have correlated specific values to aquatic life beneficial use support status. However, habitat and water quality conditions can be inferred from the numbers and types of pollution tolerant and pollution intolerant organisms present at a site. In Indian Creek, current benthic macroinvertebrate data are available from DEQ for two sites sampled in 1997. One site is located above the reservoir near Mayfield and the other site is located just upstream of the city of Nampa.

Interpretation of benthic macroinvertebrate data is based on two mechanisms, a guide published by Aquatic Biology Associates (Wisseman, 1996) and the DEQ macroinvertebrate biotic index (MBI). Following Wisseman, an abundance of *Ephemeroptera*, *Plecoptera*, and *Tricoptera* (EPT taxa) is an indicator of high predator richness and is in turn an indicator of good water quality. EPT taxa are generally most rich in cold, clean waters with good quality gravel substrates. When collector-gatherer organisms represent a disproportionately large percentage of the total population at a site, conditions are generally degraded by nutrient and organic loading. Specific organisms can also be useful indicators of habitat and water quality conditions. Intolerant stoneflies (*Plecoptera*) are generally present in large numbers only where water temperatures are cold and fine sediments are minimal. *Naididae* are worms that tolerate fine sediment substrates. *Hirudinea* (leeches) are typically present in aquatic systems that have slow water velocities and nutrient-rich and sediment-dominated bottoms. *Tricorythodes minutus* is a tolerant organism that increases in abundance and percent of the total population as habitat and water quality conditions decline. In general, diversity and abundance increase with substrate stability (Allan 1995).

The DEQ MBI is a multi-metric index of macroinvertebrate communities that is used as a surrogate for stream health as it relates to aquatic life. The MBI is currently used by the DEQ as a surrogate for cold water biota support status in the state of Idaho (IDEQ 1996). Seven metrics (measures of certain aspects of macroinvertebrate community structure) are combined. These metrics are normalized by taking the ratio to their ecoregional benchmark and then summed into a final MBI score. The score is then compared to the ecoregional reference condition to yield an aquatic life beneficial use support status. The macroinvertebrate community, and the water body in which it resides, are considered impaired if the MBI score is less than or equal to 2.5. MBI scores greater than or equal to 3.5 are considered non-impaired. Those scores in-between are considered inconclusive, and require further investigation before aquatic life support status can be determined. The MBI is an excellent indicator of water quality impairment, but does not specifically identify the impairing pollutant(s). Further evaluations must be done to determine the impairing pollutant(s).

The data indicate that the macroinvertebrate population in Indian Creek above the reservoir (Mayfield) is limited in composition. Very few EPT taxa were present in the sample. Of the three taxa, only *Ephemeroptera* was present. This initially suggests a lack of good gravel substrates throughout the stream. The total number of organisms collected in the sample was also small, totaling 33 individuals. Of that total, 15 individuals were *chironomids* (midges), which made up 45% of the population. This high percent dominance indicates a community diversity imbalance. The DEQ MBI score for the upper

Indian Creek monitoring site is 2.38, which when compared to the Snake River Basin / High Desert ecoregional reference condition indicates an impaired aquatic life community. As mentioned above, this score in-itself only indicates impairment, it does not identify the impairing pollutant(s).

An initial review of the macroinvertebrate population in Indian Creek above the reservoir suggests that the naturally high levels of fine material in the stream are limiting the diversity of the community. While the lack of substrate complexity certainly adds to the poor community composition, the population is not dominated by silt and sediment tolerant organisms or collector-gatherers, which would likely be the case if surface sediment were the ultimate limiting factor. This implies that another factor or combination of factors limits the diversity of the macroinvertebrate community more so than surface sediment.

The flow regime of Indian Creek above the reservoir is most likely the major factor that limits the establishment of a robust macroinvertebrate community. The intermittent nature of the stream does not favor a robust macroinvertebrate community because the community does not have time to develop before water ceases. Boulton (1992) showed that intermittent streams are dominated by rapidly developing, opportunistic species, thereby resulting in low MBI scores. The sandy composition of the substrate is also limiting, but is largely uncontrollable because of the geologic nature of the adjacent lands. For these reasons, the DEQ does not recommend additional controls above the reservoir for surface sediment.

The data indicate that the macroinvertebrate population in Indian Creek below the Callopy Gates is moderately limited in composition. Relative to the remaining species, fifteen percent (15%) of the population was composed of EPT taxa. No *Plecoptera* species were present. This initially suggests that the substrate composition is slightly better than upstream, although the lack of *Plecoptera* indicates gravels and large cobble are not prevalent. Twenty-one (21) taxa were present in the sample with a total of 452 individuals. Of that total, 138 individuals were *chironomids* (midges), which made up 31% of the population. Midge larvae are typically more prevalent in sediment laden substrates. Additionally, 58% of the population is composed of collector-gatherer organisms, indicating nutrient rich sediment may be in excess. *Hirudinea* (leeches) were also present in the sample, further indicating an excess of nutrient rich sediment.

The DEQ MBI score for the Indian Creek below the Callopy gates is 3.36, which when compared to the Snake River Basin / High Desert ecoregional reference condition is "needs verification". This essentially means the composition of the macroinvertebrate community does not conclusively show that impairment has or has not occurred. Further investigations using additional surrogates or other measures should be performed to determine support status. For this analysis, surface sediment conditions will be further evaluated as they relate to the conditions needed for salmonid spawning. The geographic scope of the salmonid spawning designation is limited to the Callopy Gates to Sugar Avenue segment, but the resultant analysis will be applied to the mouth of the stream as it relates to cold water biota. This accommodates the need for a secondary analysis to determine support status.

Salmonid Spawning / Fisheries

The current designation for salmonid spawning spans from the headwaters to Sugar Avenue in Nampa. CH2M Hill has recommended changing the boundaries of the designated segment to span from the New York Canal at the Callopy Gates to Sugar Avenue. This segment represents the section of the stream that could feasibly support salmonid spawning. As described above, the upper portion of the stream is largely dry during the spawning and rearing season and cannot physically support salmonid spawning. Based on this rationale, substrate conditions in Indian Creek from the Callopy Gates to Sugar Avenue in Nampa should be suitable for salmonid spawning.

Deposited surface sediments generally have a greater impact on fish than do suspended sediments because spawning and incubation habitats are most directly affected by deposited sediment. The effect of fine sediments on salmonid spawning depends on the percentages of other size fractions (Peterson et al. 1992). Consequently, there are differences in the recommended percent of fine material that should be present in a stream suitable for supporting salmonid spawning. In a literature review performed by Bjornn and Reiser (1991), they found that the percent emergence of salmonid fry begins to decrease when the percent fine sediment smaller than 6.4 mm exceeded 15%. Bjornn and Reiser (1991) also reviewed species specific data for five salmonids and found that embryo survival begins to decrease when percentage fines exceed 10%-25%. In a more regional study, Rhodes et al. (1994) concluded that survival to emergence for chinook salmon in the Snake River Basin (of which the lower Boise River is located) is substantially reduced when fine sediment concentrations (< 6.4 mm in size) in spawning gravel exceed 20%. Reiser and Bjornn (1979) in part verify this conclusion by indicating that the emergence of fry can be reduced when fine sediments make up >20 percent of the substrate composition. Witzel and MacCrimmon (1983) also found a high survival to emergence ratio of brown trout in substrates containing less than 20% fine material. The Garcia River TMDL, developed by EPA Region 9, used 30% fines <6.5 mm as the target necessary to support the emergence of juvenile trout.

The aforementioned literature suggests that there is a range of appropriate surface sediment targets for salmonid spawning. However, the establishment of a surrogate target must take into the account the achievability of the target based on site-specific conditions. Surrogate targets are appropriate in instances where there is a direct link between pollutant loading and impairment, whereby the target represents the threshold between impairment and non-impairment. The desired effect is a measurable move toward the target when pollutant loads are decreased. The analysis outlined below shows that the surface sediment levels in Indian Creek are not as closely linked to anthropogenic (man-made) loading as they are to natural conditions. Hence, establishing a surface sediment target that can not be achieved by controlling anthropogenic loads is not appropriate.

Rosgen Stream Channel Classification

From the Callopy Gates to the mouth Indian Creek exhibits Rosgen F4 type channel characteristics. According to Rosgen 1996, the F4 type channel is typified by deeply entrenched, structurally controlled, gentle gradient streams, similar to Indian Creek. More importantly, the adjacent soils in F4 channels are normally highly weathered bedrock or depositional soils. The soils in the Indian Creek subbasin are consistent with the F4 channel in that they are primarily depositional sand and silts with weakly developed profiles (Priest et. al 1972). The natural level of surface fines (particles <6 mm) in a Rosgen F4 type stream channel is 66% (Rosgen 1996). Figure 14, taken from Rosgen 1996, is a graphical representation of the natural particle size class distribution for type F4 streams.

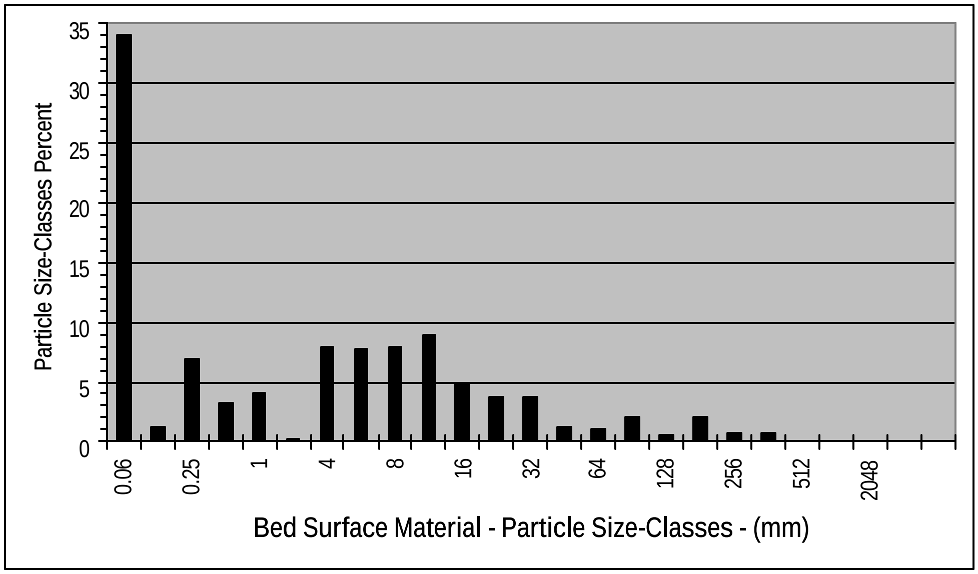


Figure 14. Substrate particle size distribution for Rosgen Type F4 streams (Rosgen 1996)

Consistent with Indian Creek, Rosgen F4 channels typically contain high levels of sand. In most F4 channels the sand is supplied by the stream banks and by bed recycling as the sand moves downstream. In Indian Creek, sand does appear to be generated in the bed and moved downstream as bedload, but banks do not appear to be a source because they are kept stable to maintain the irrigation water conveyance aspect of the stream and to protect adjacent urban lands. Eroding banks and the associated mass wasting are uncommon in Indian Creek.

The quantitative substrate data show that Indian Creek currently contains 62% surface fines in riffles below the Callopy Gates, which is within 3% of the expected level of fine sediments in type F4 streams (66%). These data suggest that the level of fine substrate material in Indian Creek is consistent with the natural functioning conditions of an F4 type stream and not necessarily correlated with external sediment inputs. This is substantiated by a recent United States Geologic Survey (USGS) report indicating that based on the geological framework of the valley, the bulk of the material transported by the lower Boise river tributaries is sand and silt (Bliss and Moyle, 2001). The lower Boise River basin served as a slackwater area during the Bonneville flood. A temporary lake formed over the basin and the sediment-charged water deposited large amounts of silt and clay throughout the valley (Othberg and Stanford, 1992). A further investigation into the sources that do contribute sediment and their effect on surface fines is located below.

Sediment Inputs

Sediment sources were identified using USGS 1:24,000 scale maps and on-site field surveys. The maps were used to identify tributary-type sources such as streams drains and ditches. Field surveys were used to validate the map work, determine bank conditions and to identify riparian land uses that could yield controllable sediment loads. The intricate system of roads that run perpendicular and parallel to Indian Creek on a one-mile grid allowed for a visual survey of nearly the entire stream. Arial photographs were also reviewed to detect any additional large-scale sediment sources. The objective of the source identification was to identify controllable sources.

In comparison to many of the other tributaries that drain the southern portion of the lower Boise River watershed, the input and withdrawal regime of Indian Creek is not particularly complex. Indian Creek does not return as much agricultural use water to the lower Boise River as adjacent systems such as Mason Creek and Fifteenmile Creek. Figure 15 shows the input and withdrawal features in the Indian Creek subwatershed.

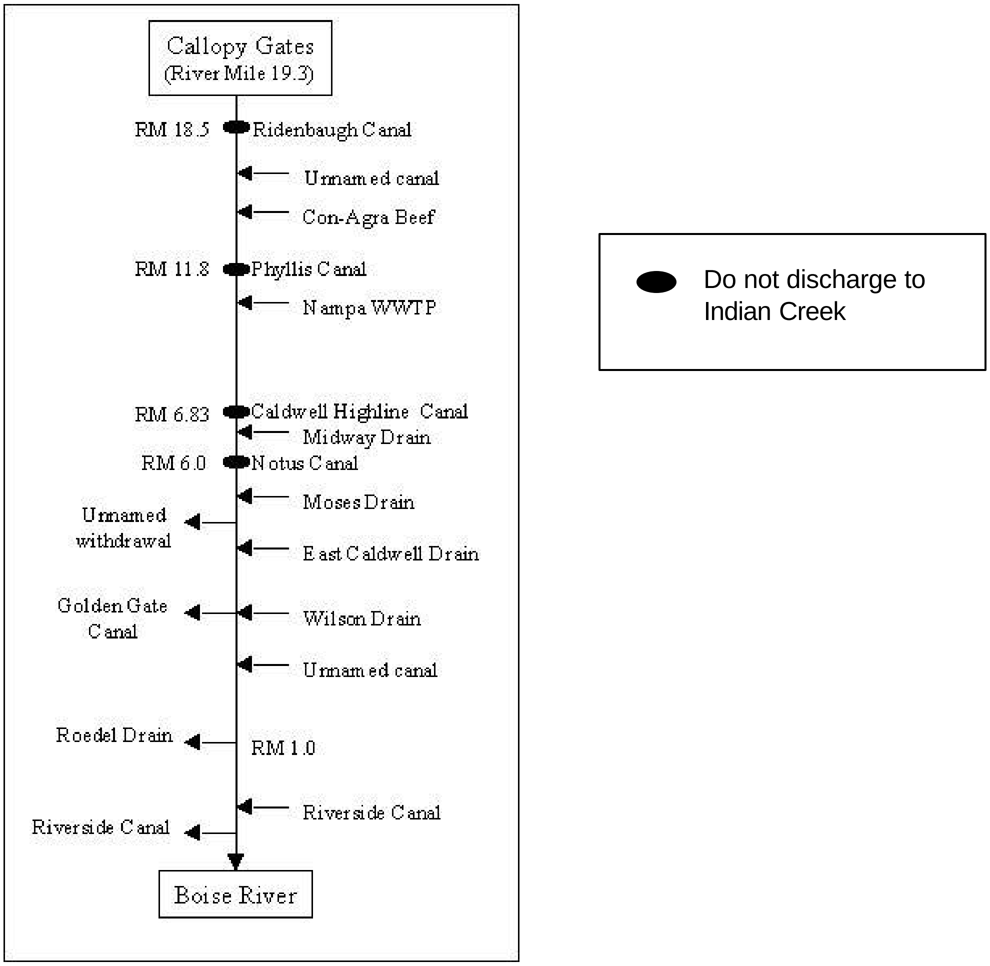


Figure 15. Inputs and withdrawals in Indian Creek

The point sources that discharge to Indian Creek are the Nampa Wastewater Treatment Plant (WWTP) and Con-Agra Beef. Both facilities are subject to relatively strict effluent limits in their NPDES permit. The reasonable assurance analysis that is associated with the NPDES permitting process typically ensures that the effluent discharge will not contribute to the degradation of water quality. Both facilities consistently discharge below their permit limits for total suspended solids.

Using a scale of 1:24,000, DEQ determined that there is one unnamed canal directly discharging into Indian Creek between the Callopy Gates and Sugar Avenue. While other smaller sources may be present, they most likely discharge relatively little sediment and are not accounted for in this analysis. The Ridenbaugh Canal does not discharge to Indian Creek. The DEQ also performed a landuse and bank survey and did not locate any large land use related sources of sediment to the stream above the City of Nampa. The banks above Nampa are nearly 100% covered and stable and the lands adjacent to the stream are used primarily as grass pasture or other type of high residue crop. There was no evidence of soil mounding at the base of vegetation, root exposure, or sediment fans entering the stream channel, all of which are indicators of sheet erosion from adjacent lands. Additionally, there was very limited evidence of rills, gullies or other types of surface erosion. As the stream moves through the outer margins of Nampa much of the adjacent lands are used for grass pasture or border industrial parks or light residential areas. As the stream moves through Nampa, the adjacent land is a mix of light residential housing, parking lots, parks, and vacant lots. These urban areas most likely discharge an unknown amount of sediment during storm events, but the amounts are highly variable and have not been quantified. The City of Nampa does not have a comprehensive stormwater policy in place, but is expected to be included in Phase II of the national stormwater management program. The Phase II requirements will require the city to develop a stormwater management policy and begin to inventory and monitor stormwater discharge points.

Based on the sediment source survey, there do not appear to be any significant controllable sources of external sediment above Sugar Avenue. The high level of surface fines appears to be natural, as described in the aforementioned Rosgen stream channel characterization. The only unknown is the City of Nampa's storm water contribution. However, because the stream exhibits greater than 60% fine material above the City of Nampa, and above any external sources for that matter, the storm water contribution from the City of Nampa appears to be a minor issue.

Below Sugar Avenue there are six direct inputs, not including the Nampa WWTP. The WWTP discharges relatively little in terms of the overall sediment load. The remaining inputs are nonpoint source return drains of varying size. While other smaller sources may be present, they most likely discharge relatively little sediment and are not accounted for in this analysis. Of the six direct inputs that discharge sediment to Indian Creek, only Wilson Drain is significant in terms of the potential to significantly effect the surface fines level on a chronic basis. The DEQ monitored two of the six drains (Moses Drain and Wilson Drain) during the 2000 irrigation season and found that in the Moses Drain the average suspended sediment concentration was 22 mg/L. The range was 11-41 mg/L. Relative to the 50 mg/L and 80 mg/L durational targets used in the lower Boise River, these concentrations are small. Based on the drain size and the area of land served, the remaining inputs (other than Wilson Drain) likely discharge at concentrations similar to or less than the Moses Drain. No bedload data were collected on either drain, so it is assumed that the suspended sediment concentrations are, in part, an indicator of the relative bedload contribution of each input. Several authors have explained how this assumption can be derived, although a quantitative link is not and should not be made with the available data. Agriculture return drains are typically kept clear of bed obstructions by local irrigation districts to facilitate the effective conveyance of water. The result is a reduced amount of near-bed turbulence such that the streambed's ability to move particles is similar to the water column's ability to move particles (Sterk et al. 1998, Clifford et al. 1991, Williams et al. 1989).

In the Wilson Drain, the average suspended sediment concentration during the 2000 irrigation season was 118 mg/L with a range of 114-122 mg/L. These concentrations are approximately double the typical irrigation season TSS concentration at the mouth of Indian Creek. Figure 13 illustrated the increase in TSS concentration between the I1 and I2 monitoring locations. The increase in in-stream concentration is likely due to inputs from the Wilson Drain. The lower Boise River sediment TMDL allocated a sediment load of 5.74 tons/day to Indian Creek to meet the watershed-wide 37% reduction necessary to meet the water quality targets in the river. The implementation plan that describes how this goal will be met is currently being prepared and should be finalized by December

2001. The DEQ recommends placing a priority on reducing sediment loads to Wilson Drain as part of the basin-wide implementation plan in lieu of allocating a load specifically to the drain. This is consistent with the implementation strategy being taken by the Soil Conservation Commission in identifying areas that yield critical loads.

Using the same procedure as the segment above Sugar Avenue, a landuse and bank survey was conducted below Sugar Avenue. No land use related sources of sediment were noted, although a small percentage of the stream was not accessible because of a lack of public roads. Between Nampa and Caldwell the land uses are primarily grass pasture, industrial and light residential. As the stream moves through Caldwell, the land use is primarily light residential, light commercial and industrial. The banks between Sugar Avenue and the mouth are again nearly 100% covered and stable. The City of Caldwell does not have a comprehensive stormwater policy in place, but is expected to be included in Phase II of the national stormwater management program. The Phase II requirements will require the city to develop a stormwater management policy and begin to inventory and monitor stormwater discharge points.

The data outlined above indicate that while the substrate conditions in Indian Creek below the Callopy Gates exceed the literature values recommended for salmonid spawning, the conditions are representative of natural functioning conditions. Placing additional control requirements on sediment sources to the stream will be necessary to meet the 37% TSS reduction for the lower Boise River sediment TMDL, but are more appropriately addressed in the lower Boise River sediment implementation plan.

Contact Recreational Response to Surface Sediment

Excess sediment can impair recreational beneficial uses. In extreme excess, fine substrate sediment can create unsafe swimming and wading conditions by physically interfering with body movement. 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 Indian Creek, the sediment levels do not appear to be impairing secondary contact recreation. During the 2000 monitoring season, DEQ employees waded Indian 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 Indian Creek at several locations.

Turbidity

None of the agencies that currently monitor Indian Creek or have monitored Indian Creek in the past has collected turbidity data. No current turbidity data exists for Indian Creek.

Nutrients and Aquatic Algae Biomass

Phosphorus

High concentrations of phosphorus have been recorded in Indian Creek from 1994 to 2000. Figure 16 shows the concentrations during the years 1998 -2000. The concentrations prior to 1998 are very similar. Based on numerous studies (Bothwell 1988, 1889) and Horner and others (1983), the water column total phosphorus (TP) levels in Indian Creek are more than sufficient to support algae growth. EPA's gold book criterion for water column total phosphate phosphorus is .10 mg/L. EPA has recognized that the potential for eutrophication exists at this level. Under many scenarios, eutrophication does in fact occur at this level. However, data presented in the lower Boise River nutrient Subbasin assessment (IDEQ, unpublished DRAFT) suggests that eutrophication (nuisance algae growth in this case) does not always exist at even high concentrations. This is due to a host of other growth limiting factors in the Boise River.

As with TSS concentrations, the TP concentrations in Indian Creek do not necessarily fluctuate with the irrigation season. Table 8 shows the irrigation and non-irrigation seasonal average concentrations at the four monitoring locations for the years 1998 to 2000. The TP concentrations range from as low as .09 mg/L above Nampa to as high as 2.3 mg/L in the City of Nampa. These data show that the EPA gold book criterion is exceeded in nearly every sampling event. However, the data do not directly indicate beneficial use impairment. As they relate to nutrients, aquatic life beneficial use impairment is generally based on surrogate measures such as dissolved oxygen concentrations and pH levels. Contact recreation and aesthetic beneficial use support status is generally based on suspended and benthic algal biomass levels and the explicit recreational value of the system, as determined by evidence of contact recreation and the water quality complaint data.

No nutrient data has been located for Indian Creek above the Callopy Gates. However, the lack of algae growth suggests that nutrients are not in excess or algae growth is being limited by other factors such as high flow velocities in the New York Canal or the lack of flow and unstable substrate above the reservoir, all of which are likely the case.

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

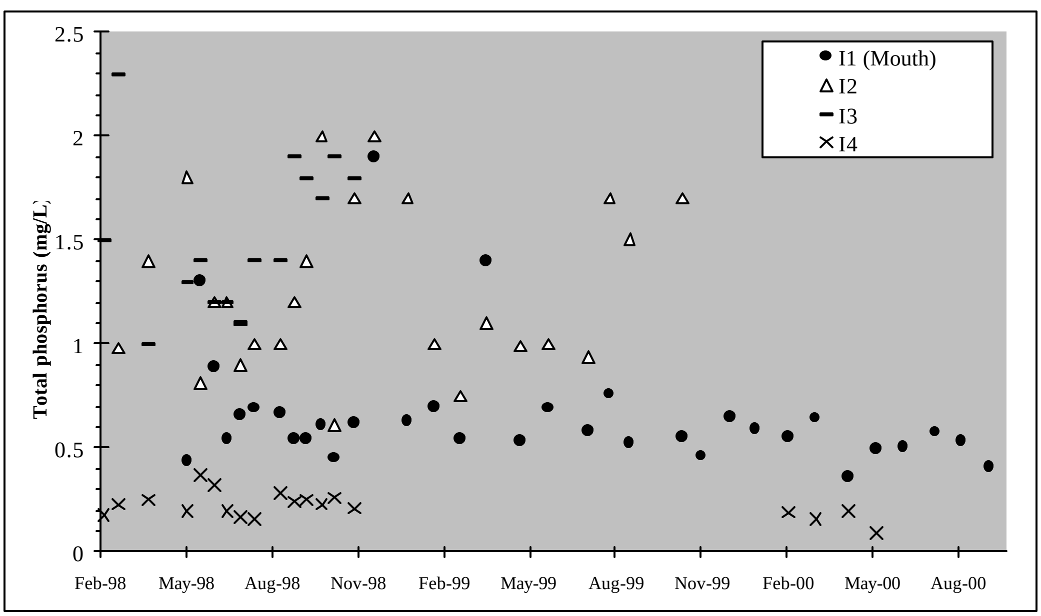


Figure 16. Total phosphorus levels in Indian Creek: 1998-2000.

Table 8. Irrigation and non-irrigation season TP concentration averages in Indian Creek in mg/L

Location	**Irrigation Season Ave**	**Non-Irrigation Season Ave.**
IC1 (mouth)	.57	.64
IC2	1.09	1.46
IC3	1.31	1.62
IC4 (at Happy Valley Road)	.20	.23

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 on pebbles, cobbles and boulders along the streambed. In streams that do not experience an over abundance of nutrients, periphytic algae grow as single celled organisms called diatoms that are kept in check by the grazing of aquatic insects. When nutrient availability exceeds the basic needs of diatoms, other periphytic species, including bulky, filamentous algae such as Cladophora may grow on the streambed. When the filamentous algae become excessive they can impede intergravel flow and decrease intergravel dissolved oxygen levels, both of which are detrimental to aquatic life. In excess, periphytic algae can also cause significant aesthetic and water quality impairments. These include reduced water column DO concentrations, increased pH, clogging of irrigation pipes and ditches when large volumes die and sluff into the water column and unsafe wading and swimming conditions. Decomposing algae can also create objectionable odors and under the right conditions, some species may produce toxins that could impair agricultural water supply and contact recreation. All of these effects can be linked to impaired beneficial uses.

The state of Idaho does not have a numeric criterion for periphytic chlorophyll-a. 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, and others, 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.

No benthic chlorophyll-a data exist for Indian Creek above the reservoir or in the New York Canal segment of Indian Creek. However, the intermittent flow regime and the sandy substrate in upper Indian Creek likely prevent the establishment of an excessive benthic algae community. Likewise can be said for the New York Canal segment of the stream, except extremely high flow velocities likely limit the growth.

The benthic chlorophyll-a data for Indian Creek below the Callopy Gates are sparse. However, the available data 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 (in terms of algal requirements) and riparian shading throughout the segment, all of which directly affect periphytic algae growth. A sample collected by the DEQ above Nampa in September 2000 revealed benthic chlorophyll-a levels of 13.3 mg/m2, well below the minimum nuisance threshold of 100 mg/m2. The low benthic chlorophyll-a level in Indian Creek is not surprising given the growth limiting factors in the stream. The substrate surveys that have been conducted in Indian Creek indicate that below the New York Canal the stream bottom is dominated by (62%) sand and small pebble material with sporadically distributed areas of gravel and cobble. Sand is unstable and does not provide a desirable attachment point for benthic algae. Another factor that likely limits benthic algae growth in Indian Creek, particularly below the City of Nampa, is the flow velocity. This will be further discussed in the "Macrophytes and Other Bulky Species" section of this analysis.

In addition to being well below the literature nuisance threshold values, the periphytic biomass levels in Indian 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. In addition, the DEQ has received no 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

The state of Idaho does not have a numeric criterion for water column chlorophyll-a. However, 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) also proposed a level of 25 ug/l for surface waters used for viewing pleasure, boating, safe swimming and fishing.

As with benthic chlorophyll-a, the water column chlorophyll-a data for Indian 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 same factor as for benthic chlorophyll-a. A sample collected by the DEQ above the city of Nampa in July 2000 revealed water column chlorophyll-a levels of 5.1 µg/L, well below the most stringent nuisance threshold value of 15 µg/L.

No water column chlorophyll-a data are available above the Callopy Gates. However, it is again assumed that the intermittencey of the stream prevents nuisance phytoplankon from establishing.

Macrophytes and Other Bulky Species

During the growing season Indian Creek exhibits significant macrophyte growth above the City of Nampa. The mass decreases significantly below Nampa. Above Indian Creek Reservoir and in the New York Canal segment no macrophytes have been observed. Indian Creek above Nampa is less shaded and typically, exhibits lower point velocities due to the low gradient and a few nonpoint source return drains. Flow measurements conducted by DEQ during the 2000 growing season show that point velocities in Indian Creek above Nampa 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 .48 fps. Below Nampa and at the mouth the average point velocities were 1.57 fps and 5.97 fps, respectively. This indicates that flow velocity does not limit the establishment of macrophytes above Nampa, but does limit it below Nampa where velocities are higher. These factors in combination with relatively clear water, which allows for more light penetration, contribute to the macrophyte growth in Indian Creek above Nampa. Field surveys conducted from June through October 2000 at locations above and below Nampa identified macrophytes covering between 40% and 50% of the cross-sectioned stream channel above Nampa and less than 20% below Nampa. At both locations, the aquatic macrophyte that dominates the population is *Potamogeton pectinatus* L (Sago Pondweed).

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).

During the growing season, Sago Pondweed and a variety of other less prevalent submergent and emergent macrophytes grow heavily in Indian Creek above Nampa. The relationship between macrophyte growth and aquatic life and contact recreation beneficial use support status is based on whether or not the macrophytes inhibit the beneficial uses. The lack of suitable spawning gravels due to excess surface sediment appears to be the factor most limiting spawning and rearing in Indian Creek. However, as mentioned above, substrate attached macrophyte frequently cover 40 to 50% of the stream channel, thereby reducing the amount of available surface area for fish to spawn.

The dissolved oxygen data for Indian Creek initially suggest that the DO demand created by the macrophytes may also be contributing to the impairment of cold water biota and salmonid spawning. However, the lack of diurnal DO sags suggests that while macrophyte densities are greater than expected, they do not cause a significant oxygen deficit at night, which is when the DO is expected to be at its lowest.

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. As indicated above, the analysis show that macrophyte densities may be encroaching on salmonid spawning and rearing space in Indian Creek. A reduction in surface sediment in Indian Creek would reduce the mass of macrophytes. To meet the lower Boise River sediment TMDL requirements (DEQ 2000), Indian 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 management practices (BMPs) that can be used to control TSS are ultimately designed to prevent all surface erosion and sediment delivery to water bodies. Thus, attempts to control TSS loading to Indian Creek (which will primarily occur below Nampa) will inherently result in a reduced level of surface sediment loading. The problem with this concept is that the bulk of the think macrophyte growth occurs above the city of Nampa, where there are relatively few sediment sources. Further investigation needs to occur in terms of methods to reduce the macrophyte density above the city of Nampa.

The continued presence of contact recreation at several locations in Indian Creek and the lack of macrophyte related complaints to DEQ in part indicate that the macrophyte community is not impairing contact recreation. Due to the flow regime and the channel shape of the stream, the contact recreation that occurs is primarily limited to wading. The macrophyte community in Indian Creek is not such that it prevents wading.

While the available data do not indicate the impairment of beneficial uses due to nutrients and associated nuisance aquatic growths in Indian Creek, high nutrient concentrations and macrophyte biomass together 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 indicates that beneficial uses are not impaired by nutrients. The DEQ does not recommend developing a nutrient TMDL for Indian Creek with the intention of restoring beneficial uses in Indian Creek proper. However, nutrient reductions will likely be needed from Indian Creek in order to meet the Snake River-Hells Canyon TMDL nutrient load allocation to the Boise River.

Bacteria

The lower Boise River bacteria TMDL allocated a 94% reduction in fecal coliform concentrations in Indian Creek to meet bacteria standards in the river (50 CFU/100 ml). The fecal coliform geometric mean at the mouth was 770 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 the four (I1-14) Indian Creek monitoring locations indicate that during the recreation season (May-August), Indian Creek exceeds the E.Coli standard at all locations (Table 9). The data are not represented as a monthly geometric mean, but clearly show that the recreation season concentrations are above the standard. No data exists for the New York Canal segment, but since the New York Canal is essentially Boise River water from the Diversion Dam, where concentrations are well below the state standard, it is unlikely that bacteria exceeds the standards in the New York Canal.

Table 9. Bacteria concentrations in Indian Creek

Location	Year (May-Aug)	Geo-mean (#/100ml)
IC1 (mouth)	1998	765
	1999	841
IC2	1998	426
	1999	610
IC3	1998	496
	1999	No Data
IC4 (at Happy Valley Road)	1998	1128
	1999	No Data

DEQ recommends listing Indian Creek for bacteria on the 2002 303(d) list from the New York Canal to the mouth. Upon listing the stream, DEQ will establish a TMDL schedule. It makes more sense to evaluate the need for a bacteria TMDL 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 standards in Indian Creek.

Status of Beneficial Uses

Table 10 summarizes the beneficial use support status for Indian Creek.

Table 10. Beneficial Use Support Status in Indian Creek.

<table>
<tr><th colspan="2">Segment</th><th>Designated Use</th><th>Recommended Use*</th><th>Impaired Use</th><th>Pollutant(s) Causing Impairment</th></tr>
<tr><td colspan="2">Headwaters to Indian Creek Res.</td><td>SS, CWB, PCR</td><td>SCWB, SCR</td><td>None</td><td>None</td></tr>
<tr><td colspan="2">Indian Creek Res.</td><td>SS, CWB, PCR</td><td>WWB, PCR</td><td>Not Assessed</td><td>Not Assessed</td></tr>
<tr><td rowspan="2">Indian Creek Res. to Callopy Gates</td><td>Aquatic Live</td><td>SS, CWB</td><td>MOD</td><td>None</td><td>None</td></tr>
<tr><td>Contact Recreation</td><td>PCR</td><td>SCR</td><td>None</td><td>None</td></tr>
<tr><td rowspan="2">Callopy Gates to Con-Agra Beef</td><td>Aquatic Live</td><td>SS, CWB</td><td>SS, CWB</td><td>SS, CWB</td><td>Sediment**, Dissolved Oxygen</td></tr>
<tr><td>Contact Recreation</td><td>PCR</td><td>SCR</td><td>SCR</td><td>Bacteria</td></tr>
<tr><td colspan="2">Con-Agra Beef to Sugar Ave.</td><td>SS, CWB, SCR</td><td>SS, CWB, SCR</td><td>CWB, SCR</td><td>Bacteria, Sediment**</td></tr>
<tr><td colspan="2">Sugar Ave. to mouth</td><td>CWB, PCR</td><td>CWB, SCR</td><td>CWB, SCR</td><td>Bacteria, Sediment**</td></tr>
</table>

* Support Status based on uses recommended by (Dupuis and Doran, 2001)
** Natural sediment conditions, load allocations not recommended

The data indicate that nutrients and oil & grease are not impairing aquatic life or contact recreation beneficial uses in Indian Creek. Consequently, DEQ does not recommend preparing TMDLs for the pollutants and recommends removing them as pollutants of concern on the 2002 303(d) list. The available data also indicate that excess surface sediment and dissolved oxygen are limiting the diversity of the cold water biota and salmonid spawning between the Callopy Gates and Con-Agra Beef and that excess surface sediment is limiting cold water biota below Con-Agra Beef. However, the surface sediment levels appear to represent natural conditions and the dissolved oxygen conditions should be partially addressed by implementing the lower Boise River sediment TMDL. While TMDLs are not recommended at this time, DEQ does not recommend removing sediment or DO from the 303(d) list until the 37% TSS reduction for the lower Boise River TMDL is implemented. If substrate and DO conditions do not improve upon full implementation of the TMDL, DEQ will proposed de-listing them based on natural conditions or consider any new information that may suggest TMDLs are appropriate.

Data Gaps

This assessment has identified several data gaps that limit full assessment of the affects 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 11.

Table 11. Data gaps identified during development of the Indian Creek SBA

Pollutant or other Factor	Data Gap
Sediment	Only instantaneous suspended sediment data available; cannot evaluate duration of concentrations
	Substrate sediment oxygen demand
	A more robust substrate particle size distribution and water column particle size distribution at multiple locations
	Turbidity data at multiple locations
	Stream bank erosion rates
	Sediment data for all flow regimes (low, average, high)
Nutrients	Only instantaneous data available; cannot evaluate duration of concentrations
	Nutrient data for all flow regimes (low, average, high)
Biological	Benthic and suspended algae data for hot summer drought conditions as well throughout the growing season, at multiple locations
	A quantified determination of macrophyte density throughout the stream
	Macroinvertebrate data throughout the system for multiple years
Other	Additional flow data from the headwaters to the Callopy Gates
	Additional physical, chemical and biological data for Indian Creek Reservoir

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 Indian 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 TMDL, 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, TMDL or implementation plan must be addressed on a case-by-case basis, as additional funding becomes available.

Pollution Source Inventory

Pollutants enter Indian Creek from point and nonpoint sources. The Nampa wastewater treatment plant and Con-Agra Beef are subject to relatively strict effluent limits in their NPDES permit. The reasonable assurance analysis that is associated with the NPDES permitting process typically ensures that the effluent discharge will not contribute to the degradation of water quality.

Nonpoint sources of sediment include agricultural activities, stormwater runoff, runoff from construction activities 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 activities on sites that exceed five acres are subject to a general NPDES permit that requires best management practices to limit sediment releases. 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 that can generate sediment include surface irrigated row crops and surface irrigated pastures. Sediment that erodes from agricultural lands has the potential to be delivered to multiple drains, canals and laterals and is often 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 CAFOs 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 nutrients is unknown.

Nonpoint sources of nutrients include runoff from agricultural activities, 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, Canyon and Elmore Counties, there are existing water quality programs for nonpoint source pollutant reductions. Most of the agricultural programs are either state or federally funded the Idaho Soil Conservation Commission (ISCC) or the Natural Resource Conservation Service (NRCS). These programs are targeted at the agricultural community to assist with conservation practices. For example, the Ada Soil and Water Conservation District and the Canyon County Soil Conservation Districts (SCD) have Water Quality Program 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 conservation districts and other funding sources has demonstrated a willingness to protect water quality in the lower Boise River valley. Ada SWCD 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 Resource Conservation and Rangeland Development Program, and the Federal Environmental Quality Incentive Program (EQIP). 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.

In the future, the cities of Nampa and Caldwell will likely be subject to Phase II NPDES storm water requirements. Based on the rapidly growing population in Nampa and Caldwell and their proximity to the city of Boise, they likely meet the criteria for a Phase II stormwater permit. The Phase II requirements take effect in 2002.

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. The OnePlan web site offers many additional on-line tools such as crop nutrient demands and crop water consumption charts.

Point Sources

The two discrete point sources on Indian Creek are the Nampa WWTP and Con-Agra Beef. As part of the discharge monitoring portion of their NPDES permits, the WWTP's are 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 Indian Creek subwatershed has a combination of point and nonpoint sources. However, the pollution distribution is such that reduction goals can only be achieved by including a degree of nonpoint source reductions. A TMDL must incorporate reasonable assurance that nonpoint source reductions will be implemented and effective in achieving the load allocation (EPA, 1991). The Indian Creek sediment reductions will rely substantially on nonpoint source sediment reductions to meet the desired water quality and to restore designated beneficial uses. If the appropriate load reductions are not achieved from nonpoint sources through existing regulatory and voluntary programs, then additional reductions must come from point sources.

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 (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 decrease pollutant loading from point and nonpoint sources that affect water quality limited water bodies. The Lower Boise River Water Quality Plan is the designated WAG for the lower Boise River watershed, which includes Indian Creek.

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 12.

Table 12. 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 Health and Welfare
Rules Governing Subsurface and Individual Sewage Disposal Systems	58.01.02.350.03(c)	Idaho Department of Health and Welfare
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(e)	Idaho Department of Lands
Rules Governing Placer and Dredge Mining in Idaho	58.01.02.350.03(f)	Idaho Department of Lands
Rules Governing Dairy Waste	58.01.02.350.03.(g)	Idaho Department of Agriculture

The State of Idaho uses a voluntary approach to address 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 Health and Welfare'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. The Nampa WWTP and on-Agra Beef are candidates for nutrient trading.

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.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in Streams. American Fisheries Society Special Publication. 19: 81-138.

Bliss, J.D. and P.R. Moyle. 2001. Assessment of sand and gravel resources of the Lower Boise River Valley Area, Idaho. Part one: Geologic framework of the sand and gravel deposits. United States Geological Survey. Open-File Report 01-130.

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.

Clark, W.H and D.M. Martin. 1979. Water Quality Status Report # 42, Indian Creek (Canyon County), Idaho Department of Health and Welfare.

Clifford, N.J., J. McClatchey, and J.R. French. 1991Measurements of turbulence in the benthic boundary layer over gravel bed and comparison between acoustic measurements and predictions of the bedload transport of marine gravels. Sedimentology. 38:161-171.

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. 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.

Horner, R. R., J. J. Skupien, E. H. Livingston, and H. Shaver. 1994. Fundamentals of urban runoff management: technical and institutional issues. Terrene Institute, Washington, D.C.

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 Environmental Quality. 2000. Lower Boise River TMDL Subbasin assessment and Total Maximum Daily Loads. September 1999.

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.

Maguire, T. 1997. Environmental planning tools and techniques. 1997. Idaho Department of Health and Welfare, Division of Environmental Quality, Boise.

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.

Othberg, K.L and R.L Stanford. 1992. Geologic map of the Boise Valley and adjoining area, Western Snake River Plain, Idaho: Idaho Geological Survey Geologic Map Series GM-18, scale: 1:100,000.

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.

Peterson, N.P., A. Henry, and T.P. Quinn. 1992. *Assessment of cumulative effects on salmonid habitat: Some suggested parameters and target conditions*. Prepared for the Washington Department of Natural Resources and The Coordinated Monitoring, Evaluation and Research Committee, Timber Fish and Wildlife Agreement. March 2.

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

Rhodes, J.R., D.A. McCullough, and A. F. Espinoza, Jr. 1994. A course screening process for evaluation of the effects of land management activities on salmon spawning and rearing habitat in ESA consultations. Columbia River Inter-Tribal Fish Commission, Technical Report 94-4, 256 p.

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. 1996. A Classification of Natural Rivers. Catena, Vol. 22, pp. 169-199.

Rowe, M., 1998. Portneuf River Subbasin Assessment and TMDL, Idaho Department of Health and Welfare, Division of Environmental Quality, Pocatello Regional Office.

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.

Sterk, G, A. Jacobs, and J. Van Boxel. 1998. The effects of turbulent flow structures on saltation sand transport in the atmospheric boundary layer. Earth Surface Process and Landforms. 23:877-887.

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

Thruston, R.V., R.C. Russo, C.M. Fetterrolf, T.A. Edsall, and T.M. Barber Jr., editor. 1979. Review of EPA Red Book: Quality Criteria for Water. Water Quality Section, American Fisheries Society, Bethesda, MD. 313 pg.

Trimbell, J.A., 1989. "An Introduction to Toxicology", University of London: Taylor and Francis Press.

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.

Williams, J., P. Thorne, and A. Heathershaw. 1989. Comparisons between acoustic measurements and predictions of the bedload transport of marine gravels. Sedimentology. 36:973-979.

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

Witzel, L.R., and H.R. MacCrimmon. 1983. Embryo survival and alevin emergence of brook trout and brown trout relative to redd gravel composition. Canadian Journal of Zoology. 61:1783-1792.

Wolman, M.G. 1954. A method of sampling course river-bed material. Transaction of American Geophysical Union. 35:951-956.

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