TMDLs for Total Dissolved Solids, Selenium, and Boron in the Pariette Draw Watershed

EPA Approval Date: September 28, 2010

Prepared for:
US Environmental Protection Agency, Region 8

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Division of Water Quality
Water Quality Protection Section

Pariette Draw TMDL

EPA Approval Date:

Waterbody ID	HUC #14060005
Location	Uintah & Duchesne Counties, Utah
Pollutants of Concern	Total Dissolved Solids (TDS)
Impaired Beneficial Uses	Class 4: Protected for agricultural uses including irrigation of crops and stock watering.
Current Loading Loading Capacity (TMDL) Load Reduction	64.89 tons/day (mid-range flow percentiles) 16.18 tons/day 48.72 tons/day (75.1%)
Wasteload Allocation Load Allocation Margin of Safety	0 tons/day (mid-range flow percentiles) 14.56 tons/day 1.62 tons/day
Defined Targets/Endpoints	1) Total maximum load as an daily average of less than 16.18 tons/day 2) Load reduction of 48.72 tons/day 3) Water quality target of 1,200 mg/L
Implementation Strategy	1) Irrigation water and riparian best management practices
This document is identified as a TMDL for waters in the Pariette Draw drainage and is submitted under §303d of the Clean Water Act to U.S. EPA for review and approval.	

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Pariette Draw TMDL

EPA Approval Date:

Waterbody ID	HUC #14060005
Location	Uintah & Duchesne Counties, Utah
Pollutants of Concern	Selenium (Se)
Impaired Beneficial Uses	3B: Protected for warm water species of game fish and other warm water aquatic life including the necessary aquatic organisms in their food chain 3D: Protected for waterfowl, shore birds, and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain
Current Loading Loading Capacity (TMDL) Load Reduction	0.46 lbs/day (mid-range flow percentiles) 0.12 lbs/day 0.33 lbs/day (72.8%)
Wasteload Allocation Load Allocation Margin of Safety	0 tons/day (mid-range flow percentiles) 0.11 lbs/day 0.01 lbs/day
Defined Targets/Endpoints	4) Total maximum load as an daily average of less than 0.12 lbs/day 5) Load reduction of 0.33 lbs/day 6) Water quality target of 4.6 µg/L
Implementation Strategy	2) Irrigation water and riparian best management practices
This document is identified as a TMDL for waters in the Pariette Draw drainage and is submitted under §303d of the Clean Water Act to U.S. EPA for review and approval.	

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Pariette Draw TMDL

EPA Approval Date:

Waterbody ID	HUC #14060005
Location	Uintah & Duchesne Counties, Utah
Pollutants of Concern	Boron (B)
Impaired Beneficial Uses	Class 4: Protected for agricultural uses including irrigation of crops and stock watering.
Current Loading Loading Capacity (TMDL) Load Reduction	56.6 tons/day (mid-range flow percentiles) 20.21 tons/day 36.38 tons/day (64.3%)
Wasteload Allocation Load Allocation Margin of Safety	0.0 tons/day (mid-range flow percentiles) 18.19 tons/day 2.02 tons/day
Defined Targets/Endpoints	7) Total maximum load as an daily average of less than 20.21 tons/day 8) Load reduction of 36.38 tons/day 9) Water quality target of 750 µg/L
Implementation Strategy	3) Irrigation water and riparian best management practices
This document is identified as a TMDL for waters in the Pariette Draw drainage and is submitted under §303d of the Clean Water Act to U.S. EPA for review and approval.	

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1.0 Introduction

Section 303(d) of the Clean Water Act and US Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting applicable water quality standards/guidelines or designated uses under technology-based controls. TMDLs specify the maximum amount of a pollutant which a waterbody can assimilate and still meet water quality standards. Based upon calculation of the total load that can be assimilated, TMDLs allocate pollutant loads to sources and a margin of safety (MOS). This study determines allowable limits for pollutant loadings to meet water quality standards and designated uses for the Pariette Draw watershed. Pollutant load reductions are allocated among the significant sources and provide a scientific basis for restoring surface water quality. In this way, the TMDL process links the development and implementation of control actions to the attainment and maintenance of water quality standards and designated uses.

This document presents TMDLs for Pariette Draw, which is listed on Utah's 2002 303(d) list for impairments associated with excess concentrations of Boron (B) and Total Dissolved Solids (TDS) and on the 2004 303(d) list for Selenium (Se) (UDEQ 2004). Pariette Draw will be listed on the subsequent 303(d) lists for all 3 parameters until the TMDLs have been approved by EPA. It is important to note that data collection in support of this TMDL is an ongoing effort and that as new data are collected the TMDL may be revised accordingly.

Utah's Division of Water Quality (UDWQ) has assessed Pariette Draw (from the confluence of the Green River to the headwaters located in Pleasant Valley) and its tributaries and has determined that the river is not supporting its agricultural classification due to violations of water quality criterion for TDS and B and its warm water fisheries and waterfowl classifications due to violations of the criterion for Se. Table 1-1 presents the 2002 and 2004 303(d) list information for Pariette Draw.

Table 1-1. Pariette Draw Listed Waterbody Characteristics.

8-Digit HUC	**Designated Uses***	**Pollutants of Concern**	**Primary Source of Impairment**
14060005	3B & 3D	Selenium	Natural geologic formations, subsurface flows from irrigation, streambank erosion
14060005	4	Boron & Total Dissolved Solids	

*3B = Protected for warm water species of game fish and other warm water aquatic life including the necessary aquatic organisms in their food chain

3D= Protected for waterfowl, shore birds, and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain

4= Protected for agricultural uses including irrigation of crops and stock watering

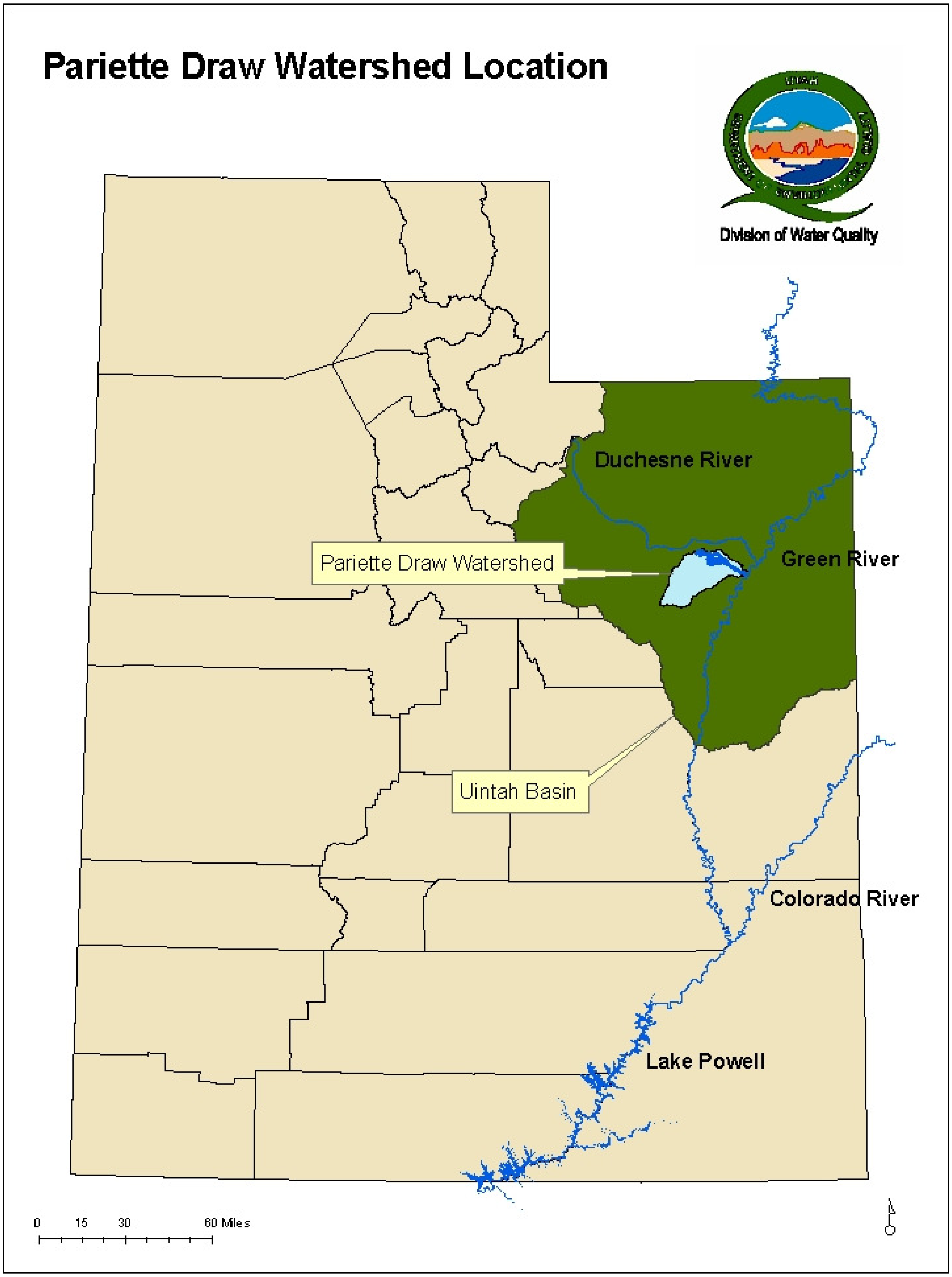
The Pariette Draw watershed, part of the Uintah Basin, is located in the northeast corner of Utah (Figure 1-1). The Uintah Basin is approximately 6,969,500 acres (10,890 mi^2) and includes all of Duchesne, Uintah, and Daggett Counties and part of Summit, Wasatch, Carbon, Emery, and Grand Counties. Most of the counties lie between 5,000 to 6,000 ft in elevation and have peaks rising to over 13,000 ft. The Pariette Draw watershed receives most of its water from the Duchesne River via Pleasant Valley Canal and is ultimately drained by the Pariette Draw into the Green River.

Major land uses in the watershed include agriculture, oil and gas mining, and managed wetlands. There are no permitted point source discharges within the watershed. Dry conditions make irrigation necessary for nearly all crops grown in the watershed. If irrigation water is applied in excess of plant requirements, that excess proportion will percolate below the rooting zone where it picks up TDS, Se, and B and returns it to the watershed streams either as surface runoff or groundwater baseflow with elevated concentrations. Because these pollutants are also washed off watershed surfaces and delivered to receiving streams, potential control options should address surface as well as subsurface transport of pollutants.

It is important to recognize that because the sources of pollutant loads originate from natural background and nonpoint sources, implementation of the best management practices (BMPs) is purely voluntary. The reasonable assurance that these implementation activities will occur is that implementation is currently ongoing under the cooperative efforts of local agricultural producers and the Colorado River Basin Salinity Control Program (CRBSCP). Conversion of flood irrigation to more efficient sprinkler irrigation is a common BMP for addressing TDS impairment. However, significant irrigation upgrades have been made in Pleasant Valley. In fact, approximately 17,000 acres of irrigated land within the watershed have already been treated. As of May 2009, salt loads have been estimated to be reduced by 82% (5,769 tons/acre/yr) since the late 1970s as presented in Table 8-1. The key to effectively reducing the anthropogenic loads in the Pariette Draw watershed while maintaining current water rights and irrigation use is to continue to improve and maintain water use and transport efficiency projects and to minimize surface runoff, seepage, and deep percolation.

The Pariette Draw Stakeholder group has agreed that since the BLM, USU Extension, and UDWQ will be working on an intensive study looking at the mobilization of Se in the both the watershed and local biota, these TMDLs will be re-evaluated in five years pending the results of this cooperative study.

Figure 1-1. Location of Pariette Draw Watershed.



2.0 Watershed Characteristics

2.1 Location

The Pariette Draw watershed is located in northeastern Utah in Duchesne and Uintah Counties and the Uintah and Ouray Indian Reservation. It is located in the eastern portion of the Lower Green-Desolation Canyon hydrologic unit (HUC 14060005-002). Pariette Draw drains into the Green River, and ultimately, into the Colorado River (Figure 1-1).

Pariette Draw flows into a series of manmade wetlands before flowing into the Green River. Pariette Wetlands (Figure 2-1) was created in the early 1970's and continues to be managed by the Bureau of Land Management (BLM). It is BLM's largest waterfowl management area in Utah. Prior to development, very few ducks and no geese occupied the wetlands. Currently the Pariette Wetlands support approximately 1,700 ducks and 55 geese (BLM 2008). These wetlands have been studied by the US Fish and Wildlife Service (USFWS) for possible Se contamination in biota (USGS 1991). There are no fish or waterfowl consumption advisories presently on it.

The Pariette Draw watershed encompasses 202,239 acres (316 mi^2) and is bordered by the Duchesne River drainage to the north, Tavaputs Plateau to the south and west, and the Green River valley to the east. The city of Myton, though not directly in the watershed, is located just north of the headwaters and has 539 residents (2000 U.S. Census).

Figure 2-1. Pariette Wetlands Managed by BLM.

Figure 2-2. Pariette Wetlands.

2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can very drastically by elevation. Figure 2-3 displays the general topography in the Pariette Draw watershed. Elevation ranges from 5,000 ft (1,524 m) at the confluence of Pariette Draw and the Green River to over 8,000 ft (2,438 m) at the south-western border of the Tavaputs Plateau.

2.3 Land Use and Land Use Cover

General land use and land cover data were gathered from the Gap Analysis Project (GAP) completed for the State of Utah. GAP classifications for the Pariette Draw are summarized in Table 2-1 and displayed in Figure 2-4.

2.3.1 Vegetative Land Cover

The Pariette Draw watershed is dominated by salt desert scrub (26%), sagebrush (18.4%), and pinyon-juniper (18.2%) vegetative land cover, accounting for 62.6% of the total watershed land cover. In addition, agriculture (4.2%), bedrock (5.8%), semi-desert scrub (5.8%), and greasewood (6.6%) collectively account for greater than 20% of vegetative cover.

Figure 2-4 displays the spatial distribution of the vegetative cover in the Pariette Draw watershed. It provides a general representation of dominant land cover and does not identify vegetation associations with each major category. Sagebrush and pinyon-juniper vegetation dominate the middle elevations of the watershed while salt desert scrub dominates at the lower elevations. Agricultural lands are concentrated along the headwaters area in Pleasant Valley and account for 7,670 acres or 4.2% of the total area in the watershed.

Figure 2-3. Topography in the Pariette Draw Watershed.

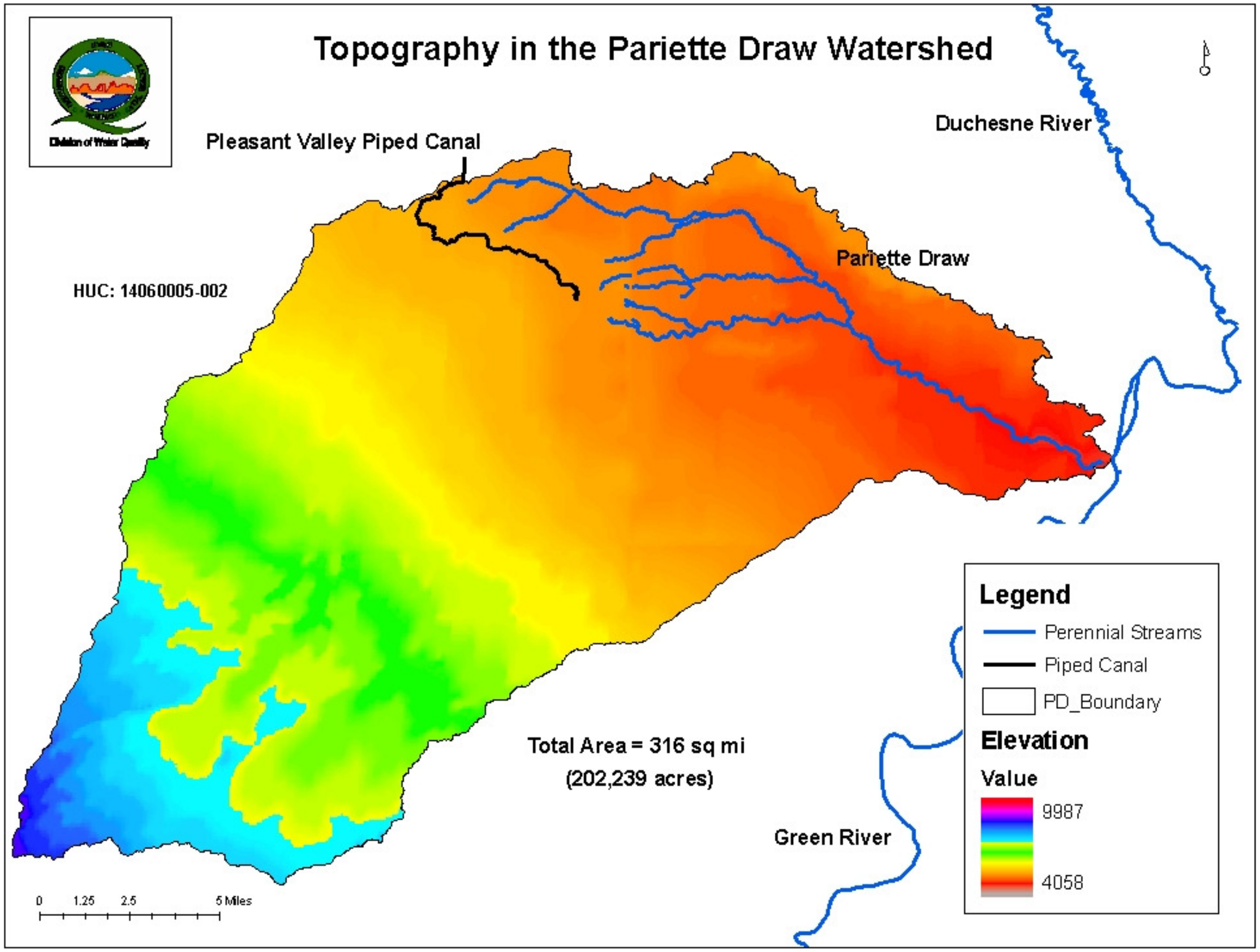


Figure 2-4. Land Use and Land Cover in the Pariette Draw Watershed.

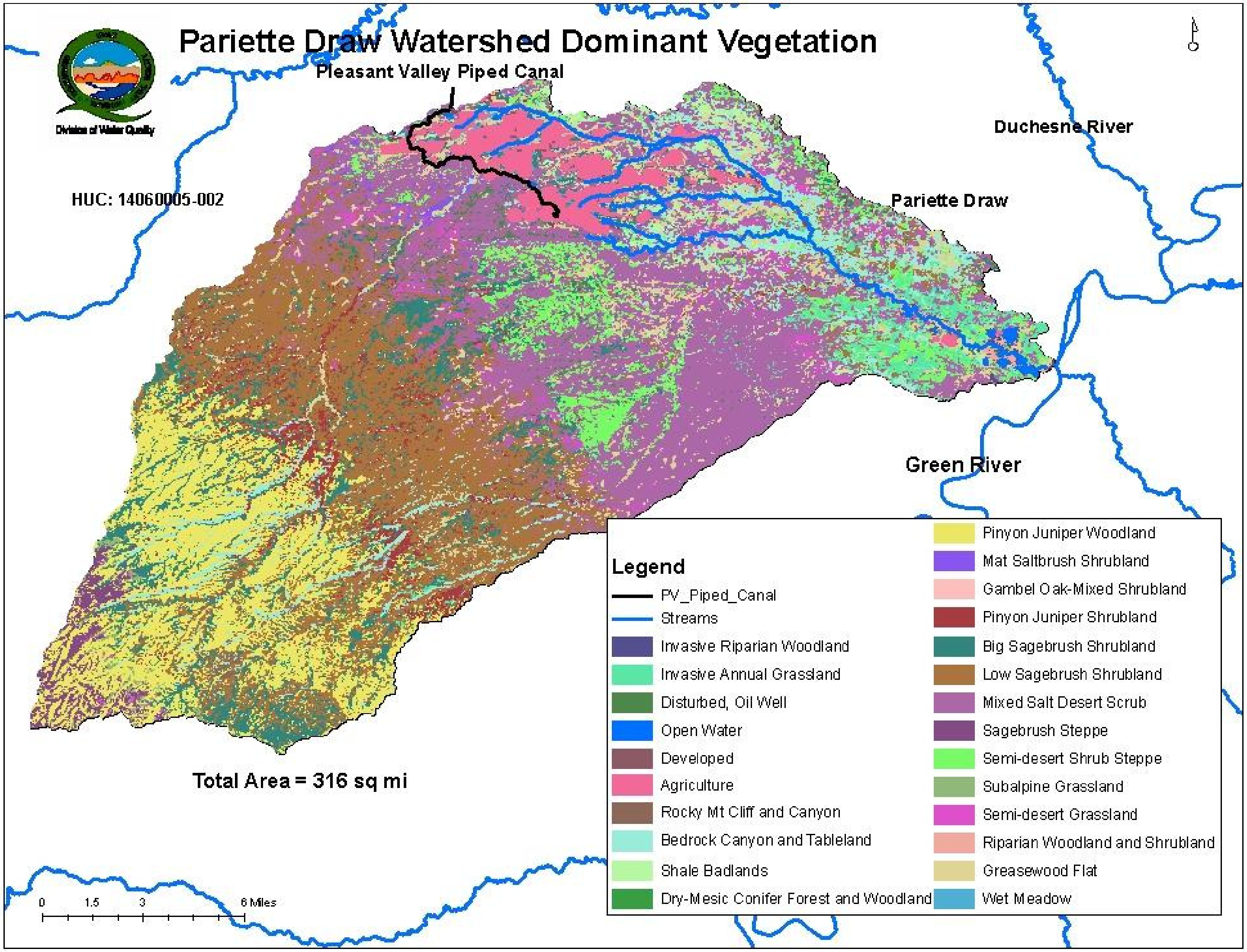


Table 2-1. Vegetative Land Cover in the Pariette Draw Watershed.

Vegetative Land Cover	Area (Acres)	Percent
Inter-Mountain Basins Shale Badland Mixed Salt Desert Scrub	52,582	26.0
Colorado Plateau Pinyon Juniper Woodland	36,807	18.2
Colorado Plateau Mixed Low Sagebrush Shrubland	18,808	9.3
Inter-Mountain Basins Shale Badland Big Sagebrush Shrubland	18,404	9.1
Inter-Mountain Basins Shale Badland Basins Greasewood Flat	13,348	6.6
Colorado Plateau Mixed Bedrock Canyon and Tableland	11,730	5.8
Inter-Mountain Basins Shale Badland Semi-desert Shrub Steppe	11,730	5.8
Agriculture	8,494	4.2
Colorado Plateau Pinyon Juniper Shrubland	7,078	3.5
Invasive Annual Grassland	4,449	2.2
Inter-Mountain Basins Shale Badland Semi-desert Grassland	4,449	2.2
Inter-Mountain Basins Shale Badland Montane Sagebrush Steppe	3,843	1.9
Inter-Mountain Basins Shale Badland	3,640	1.8
Rocky Mountain Cliff and Canyon	1,416	0.7
Inter-Mountain Basins Shale Badland Mat Saltbrush Shrubland	1,213	0.6
Southern Rocky Mountain Montane Subalpine Grassland	1,011	0.5
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	1,011	0.5
Disturbed, Oil Well	809	0.4
Open Water	809	0.4
Invasive Southwest Riparian Woodland and Scrubland	324	0.16
Rocky Mountain Alpine Montane Wet Meadow	202	0.06
Rocky Mountain Montane Dry-Mesic Mixed Confiner Forest and Woodland	101	0.05
Developed	61	0.03
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	13	0.0
Total	**202,239**	**100.0**

2.3.2 Water Related Land Cover

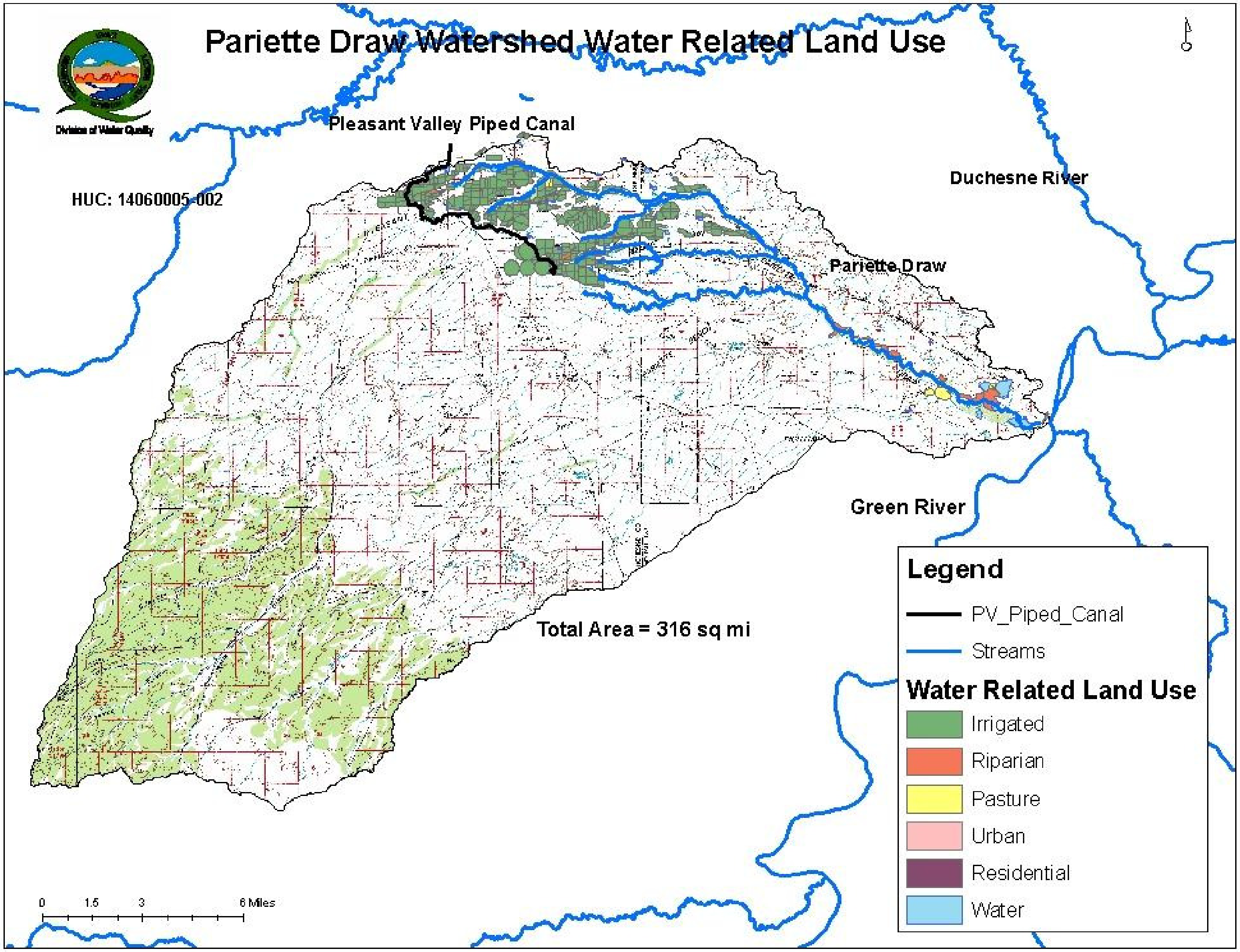
A detailed spatial database of water related land use is available from the Utah Department of Natural Resources, Division of Water Resources (1995). The database provides information on various land uses associated with water diversion and irrigation practices. The data shows that a total of 3,810 hectares (9,416 acres), or approximately 5% of the watershed, were devoted to water related land uses in the Pariette Draw watershed. Distinct water related land use types for the watershed and their associated area are given in Table 2-2.

Table 2-2 and Figure 2-5 show that water related land use is predominantly associated with irrigation and riparian zones and is typically along the stream corridors. Figure 2-5 shows that irrigated lands mainly occur up in the headwaters and the water/riparian land use is located downstream along BLM's Pariette Wetlands. Table 2-2 shows that irrigated lands account for 2,754 hectares (72%) of the total water related land uses in the watershed. Open water (ponds and streams) and riparian account for 587 (15%) and 346 hectares (9%), respectively. Pasture, residential, and urban make up less than 4% collectively.

Table 2-2. Types of Water Related Land Uses in Pariette Draw Watershed.

Land Use Type	Area (Hectare)	Area (Acres)	Percent
Irrigated	2,754	6,806	72%
Open Water	587	1,450	15%
Riparian	346	855	9%
Pasture	69	171	2%
Residential	29	72	<1%
Urban	25	62	<1%
Total:	3,810	9,416	100%

Figure 2-5. Water Related Land Use in the Pariette Draw Watershed.



2.4 Geology and Soils

The Uintah Basin is comprised of three physiographic provinces, Rocky Mountain Basin, Wyoming Basin, and Colorado Plateau (UDEQ 2005). The Uinta formation lowlands are within the Colorado Plateau, which are characterized by sloping, gravel covered pediments, rugged badlands, and narrow flat-bottomed alluvial valleys. Due to its chemical composition, exposure, and erodibility, Uinta formations presents significant natural sources of soluble salts. It contains coal-bearing beds, formed in coastal marine environments. Through mineral dissolution and cation/anion exchange, shale-, and coal beds are a known contributor of increased TDS in surface and groundwater. Soils are formed in alluvium from mixed sedimentary rocks on foothills, mountain slopes, and alluvial fans. Most soils are well-drained, although some are poorly drained and saline, particularly in the valley floors of the Uintah Basin.

Soils data and maps summarized in this report are primarily from two sources: 1) Soil Survey of Uintah area, Utah – Parts of Daggett, Grand, and Uintah Counties (UT047 NRCS published on Soil Datamart/Web Soil Survey, information downloaded October 2009) and 2) Draft Soil Survey, Duchesne County (portions of UT013 NRCS unpublished, draft data obtained January 2010, final publication is expected in 2013). Both of these are 1:24,000 scale maps. Data gaps in detailed soil maps and information were filled in using the 1:250,000 scale STATSGO data (State Soil Geographic Database, NRCS published Soil Datamart downloaded May 2008). These data gaps primarily were found in the westernmost part of the watershed and the upper Pleasant Valley area. Figure 2-6 shows the distribution of soil map units in the Pariette Draw watershed, and the following sections summarize relevant chemical and physical soil data.

Soil map unit data (Table 2-3) includes basic landform information and detailed chemical and physical properties, as well as interpretations regarding use and management based on those features and properties. Soil map units may contain multiple soils and interpretations and features may be summarized using various methods such as weighted averages of individual horizons or using the characteristics of the most predominant soil series to represent the map unit. The most appropriate method depends on the property or interpretation being described. The method used is included in the discussions of key soil properties and interpretations discussed in the following sections.

2.4.1 Soil Texture

Soil texture influences infiltration, runoff, erosion, available water holding capacity, and cation exchange. It determines the way water moves through and is retained in the soil, which in turn affects leaching potential of various nutrients and minerals and potential pollutants. Soil texture is determined by the relative proportion of sand, silt, and clay found in the fine earth fraction (soil particles less than 2 mm in size). It may also include a descriptive prefix that provides information about the size, shape, and amount of rocks greater than 2mm in size.

Surface textures are summarized in Table 2-4 and a map showing the spatial distribution of surface textures is shown in Figure 2-7. The information is based on the dominant (most representative) soil surface texture for the map unit. As would be expected the rockier soils (channers, flags, cobbles) tend to be associated with higher elevations and forested or hillier terrain and the fine earth fraction is mostly sandy loams and loams. Gravelly soils tend to be associated with the alluvial fans and larger drainages. The basins, valley floors, smaller drainages and floodplains tend to have finer textures and fewer gravels. 54% of the soils within the watershed have mostly loamy surface textures, while 3% are dominantly clays, and the remainder, approximately 43% is made up of sands to sandy loams. Surface texture is most important in influencing infiltration and runoff characteristics of a soil. While subsurface textures (including contrasting textures, hardpans, clay pans) influence permeability, drainage, leaching, water holding capacity and available water supply.

The available water capacity (AWC) refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in centimeters of water per centimeter of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the soil texture, organic matter content, bulk density, and soil structure, with corrections for salinity and rock fragments. Available water capacity is an important factor in the potential native vegetation or in agricultural lands, it is important in the choice of plants or crops to be grown and in the design and management of irrigation systems (NRCS, web soil survey). The Available water supply (AWS) is a better indicator of plant available water. It is computed as AWC times the thickness of the soil. For example, if AWC is 0.15 cm/cm, the available water supply for 25 centimeters of soil would be 0.15 x 25, or 3.75 centimeters of water. For soils that have varying texture and AWC at different depths these values are summed after calculating the AWS for each horizon in order to determine AWS for the entire soil profile. This value also can indicate how much water is held in the soil profile before the leaching process begins.

The potential to leach nutrients and minerals such as Boron or Selenium from a soil is a function of physical and chemical characteristics. Physical properties such as soil texture, structure, and depth, and its available water holding capacity all affect infiltration, water movement through the soil, and drainage. Also important to leaching are soil chemical and mineralogical properties such as the ability to hold and store cations and anions (cation exchange capacity), which is determined largely by organic matter and the type and amount of soil clays. The salinity of the water applied to the soil through rain or irrigation also affects leaching. Under irrigation, a certain amount of leaching is required to minimize the buildup of salts in the soil to a level that will affect or harm crops. This value is called the leaching requirement. In saline environments, the balance of leaching enough salt from the root zone to maintain a healthy plant growth medium while not excessively leaching contaminants into the groundwater or surface water can be a delicate balance.

Table 2-3. Soil Map Units and Descriptions in Pariette Draw Watershed.

Badland-Rock outcrop complex, 1 to 100 percent slopes	Muff-Cadrina complex, 2 to 4 percent slopes
Badland-Tipperary association, 1 to 8 percent slopes	Muff-Uffens complex, hummocky, 2 to 4 percent slopes
Bigpack loam, 1 to 8 percent slopes	Nakoy loamy fine sand, 1 to 5 percent slopes
Blackston loam, 0 to 2 percent slopes	Nolava-Nolava, wet complex, 0 to 2 percent slopes
Blazon very gravelly sandy loam, 2 to 8 percent slopes	Pariette gravelly sandy loam, 2 to 8 percent slopes
Blazon-Walknolls-Badland complex, 2 to 60 percent slopes, severely eroded	Pariette loam, 2 to 4 percent slopes
Boreham loam, 0 to 2 percent slopes	Pherson-Hickerson complex, 1 to 8 percent slopes
Cadrina-Casmos-Rock outcrop complex, 2 to 40 percent slopes	Riemod loam, 0 to 4 percent slopes
Cakehill sandy loam, 2 to 5 percent slopes	Rock outcrop
Cheetah-Rock outcrop complex, 30 to 80 percent slopes	Rock outcrop-Braf complex, 25 to 40 percent slopes, eroded
Crustown-Motto complex, 2 to 25 percent slopes	Shotnick loamy sand, 0 to 4 percent slopes
Greybull-Utaline-Badland complex, 8 to 50 percent slopes	Shotnick-Walkup complex, 0 to 2 percent slopes
Hiko Springs gravelly sandy loam, 2 to 4 percent slopes	Sugun sandy loam, 0 to 2 percent slopes
Ioka very gravelly sandy loam, 4 to 25 percent slopes	Tabyago-Cedarknoll-Whitesage association 2 to 25 percent slopes
Ioka-Cadrina complex, 2 to 25 percent slopes	Tipperary loamy fine sand, 1 to 8 percent slopes
Jenrid sandy loam, 0 to 2 percent slopes	Towave-Tosca-Sheepcan-Badland-Atchee (s7883)
Jenrid-Green River complex, 0 to 2 percent slopes	Turzo loam, 0 to 4 percent slopes
Kilroy loam, 1 to 4 percent slopes	Turzo-Umbo complex, 0 to 2 percent slopes
Leebench sandy loam, 0 to 2 percent slopes	Uffens loam, 3 to 8 percent slopes
Leebench-Cadrina complex, 2 to 4 percent slopes, eroded	Uffens sandy loam, 0 to 2 percent slopes
Leeko loam, 0 to 4 percent slopes	Uffens-Rock outcrop complex, 15 to 25 percent slopes, eroded
Leeko-Boreham complex, 0 to 4 percent slopes	Umbo silty clay loam, 0 to 2 percent slopes
Lind loam, 0 to 2 percent slopes	Utaline very gravelly sandy loam, 8 to 25 percent slopes
Luhon gravelly loam, nongravelly subsoils, 4 to 8 percent slopes, eroded	Utaline-Minchey-Leeko-Greybull-Avalon (s7916)
Mikim loam, 2 to 5 percent slopes	Walknolls extremely channery sandy loam, 4 to 25 percent slopes
Milok-Montwel-Badland association, 3 to 25 percent slopes	Walknolls-Atchee-Honlu Association, 4 to 35 percent slopes
Motto-Casmos complex, 2 to 25 percent slopes	Walknolls-Rock outcrop complex, 2 to 50 percent slopes
Motto-Muff-Rock outcrop complex, 2 to 25 percent slopes	Walknolls-Rock outcrop-Casmos-Atchee (s7880)
Motto-Rock outcrop complex, 2 to 25 percent slopes	Walknolls-Rock outcrop-Muff family-Motto-Crustown-Casmos
Motto-Uffens complex, 2 to 25 percent slopes	Walknolls-Uendal association, 2 to 25 percent slopes

Figure 2-6. General Soil Map Units in the Pariette Draw Watershed.

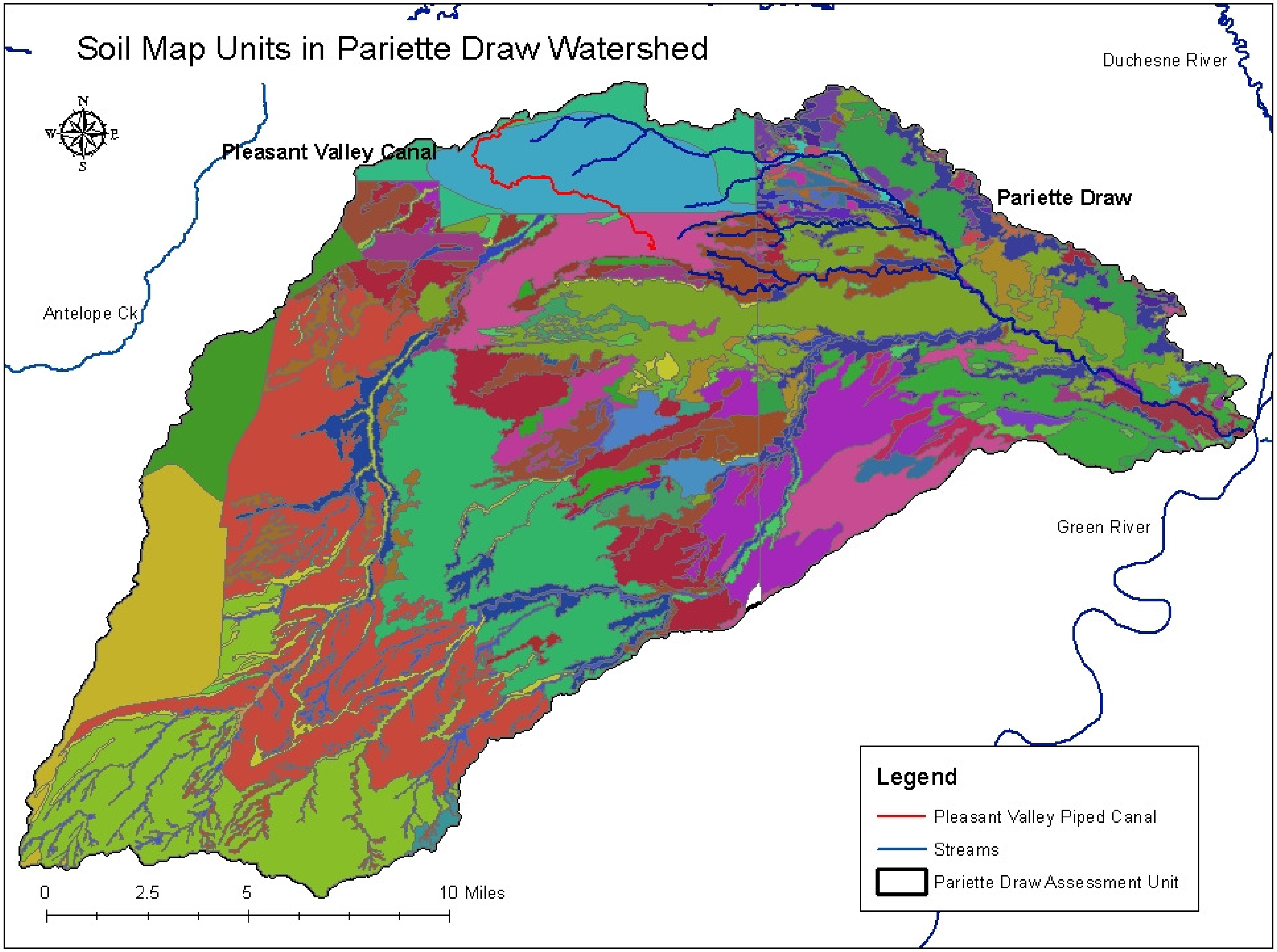
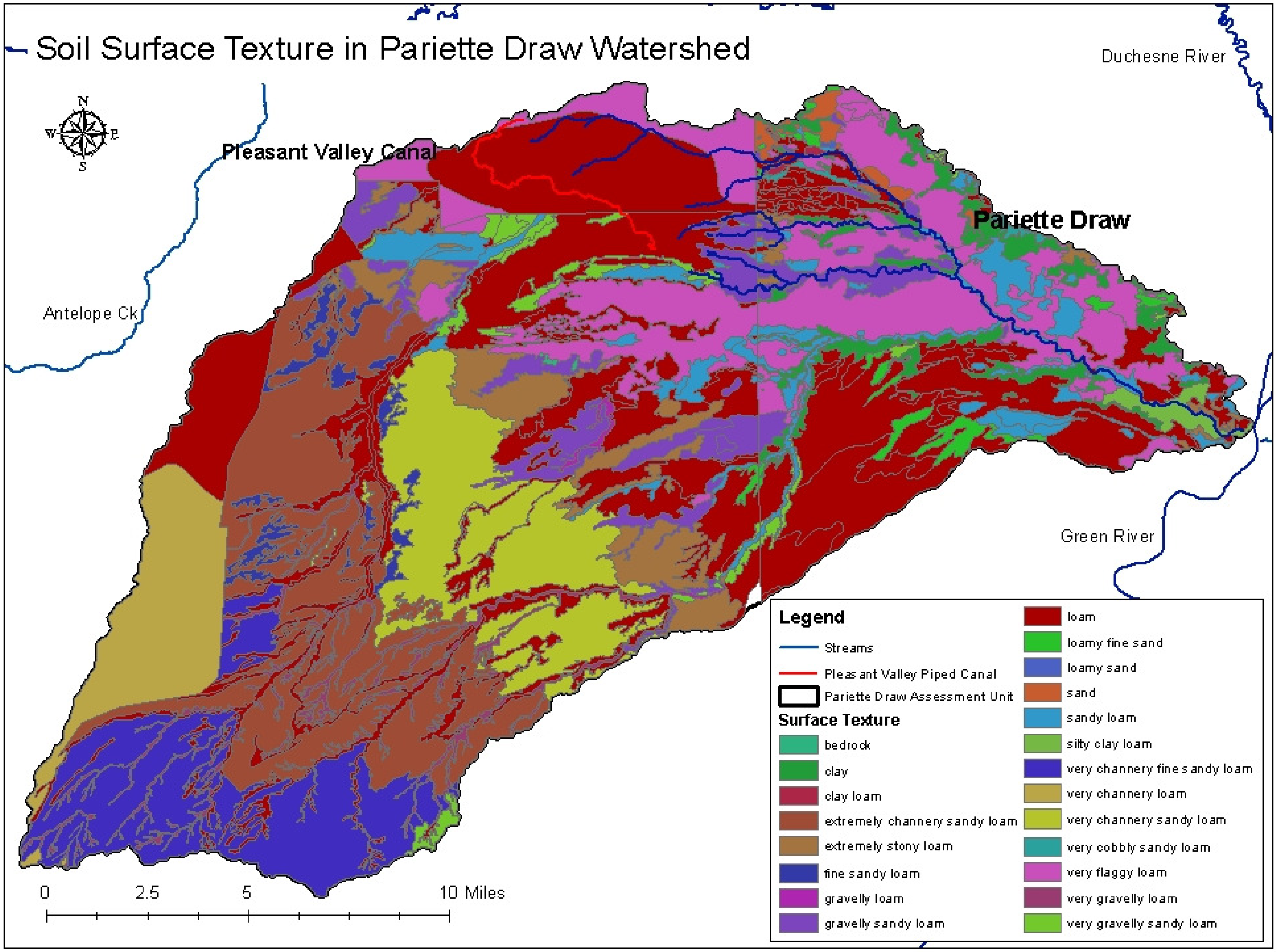


Table 2-4. Soil Surface Texture in Pariette Draw Watershed.

Surface Texture	Area (acres)	Area (%)
Bedrock	67.1	0.0%
Clay	5579.9	2.8%
Clay Loam	127.0	0.1%
Extremely Channery Sandy Loam	25517.1	12.6%
Extremely Stony Loam	9093.6	4.5%
Fine Sandy Loam	2572.6	1.3%
Gravelly Loam	351.4	0.2%
Gravelly Sandy Loam	10458.0	5.2%
Loam	58946.0	29.1%
Loamy Fine Sand	1871.1	0.9%
Sand	1047.5	0.5%
Sandy Loam	8906.5	4.4%
Silty Clay Loam	1097.3	0.5%
Very Channery Fine Sandy Loam	26323.4	13.0%
Very Channery Sandy Loam	17484.9	8.6%
Very Cobbly Sandy Loam	365.1	0.2%
Very Flaggy Loam	25454.4	12.6%
Very Gravelly Loam	3892.2	1.9%
Very Gravelly Sandy Loam	3083.5	1.5%
Total	202238.7	100.0%

Figure 2-7. Soil Surface Texture in Pariette Draw Watershed.



2.4.2 Erosion Hazard Rating

The erosion hazard rating is an indicator of the potential for soil loss after disturbance or with changes in vegetation. The ratings are based on slope and a value that is indicative of a soil's inherent erodibilty referred to as the K factor. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by wildfire, grazing, mining, or other kinds of disturbance associated with development or agriculture.

The ratings are both verbal and numerical. The hazard is described as "slight," "moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical (NRCS 1993).

Erosion hazard data was summarized based on the most common or representative soils within each map unit and is shown in Figure 2-8.

In general the western portion of the watershed, in the uplands, has a moderate erosion hazard. Most of the eastern portion of the watershed and the lowlands has a slight erosion hazard. There are localized areas of steep slopes along ridgelines and where the transition from uplands to the lower landforms occurs that have very severe erosion hazard. The drainages in the higher elevations and in the Wells draw area also have very severe erosion hazard potentials.

2.4.3 Salinity

Salts naturally occur in the Pariette Draw watershed due to saline bedrock materials that are easily weathered. These salts are found in varying concentrations in soils and waters throughout the watershed. In arid regions, salts also accumulate in soils due to evaporation, which concentrates salts in the upper soil layers. The term soil salinity collectively refers to several different anions and cations that may be present in the soil solution. The most common salts are calcium, magnesium, sodium, chloride, sulfate, and bicarbonate, and they are usually measured in terms of electrical conductivity or Total Dissolved Solids. NRCS defines 5 classes (Table 2-5) of soil salinity based on electrical conductivity measurements of saturated pastes. Slightly to strongly saline soils are known to inhibit plant growth of certain plants and crops. High salt concentrations in soil can limit the amount of water available to plants and cause plant mortality, but this depends on plant type, soil, depth of rooting, and type of salts. Figure 2-9 shows that the highest reported electrical conductivities are found near the confluence of Pariette Draw and the Green River and the lowest areas are located in the higher elevations close to the Tavaputs Plateau.

Table 2-5. Soil Salinity Classes in the Pariette Draw Watershed.

Salinity Class	EC (dS/m)	Acres	Percent
Non-saline	< 2	113,437	56
Very slightly saline	2 - 4	29,350	15
Slightly saline	4 - 8	47,188	23
Moderately saline	8 - 16	12,264	6
Strongly saline	> 16	0	0
Total		202,239	100

Figure 2-8. Erosion Hazard Ratings in the Pariette Draw Watershed.

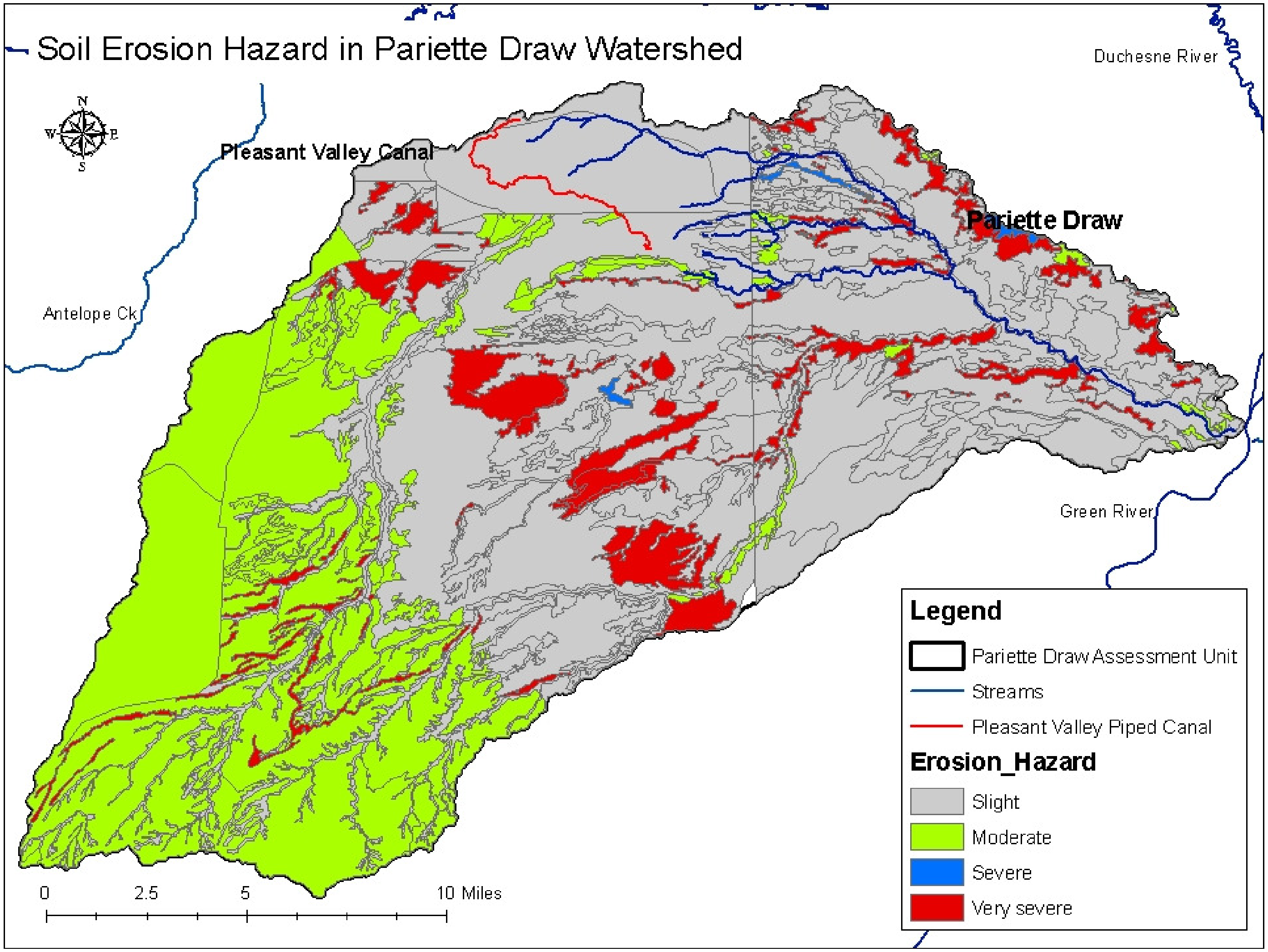
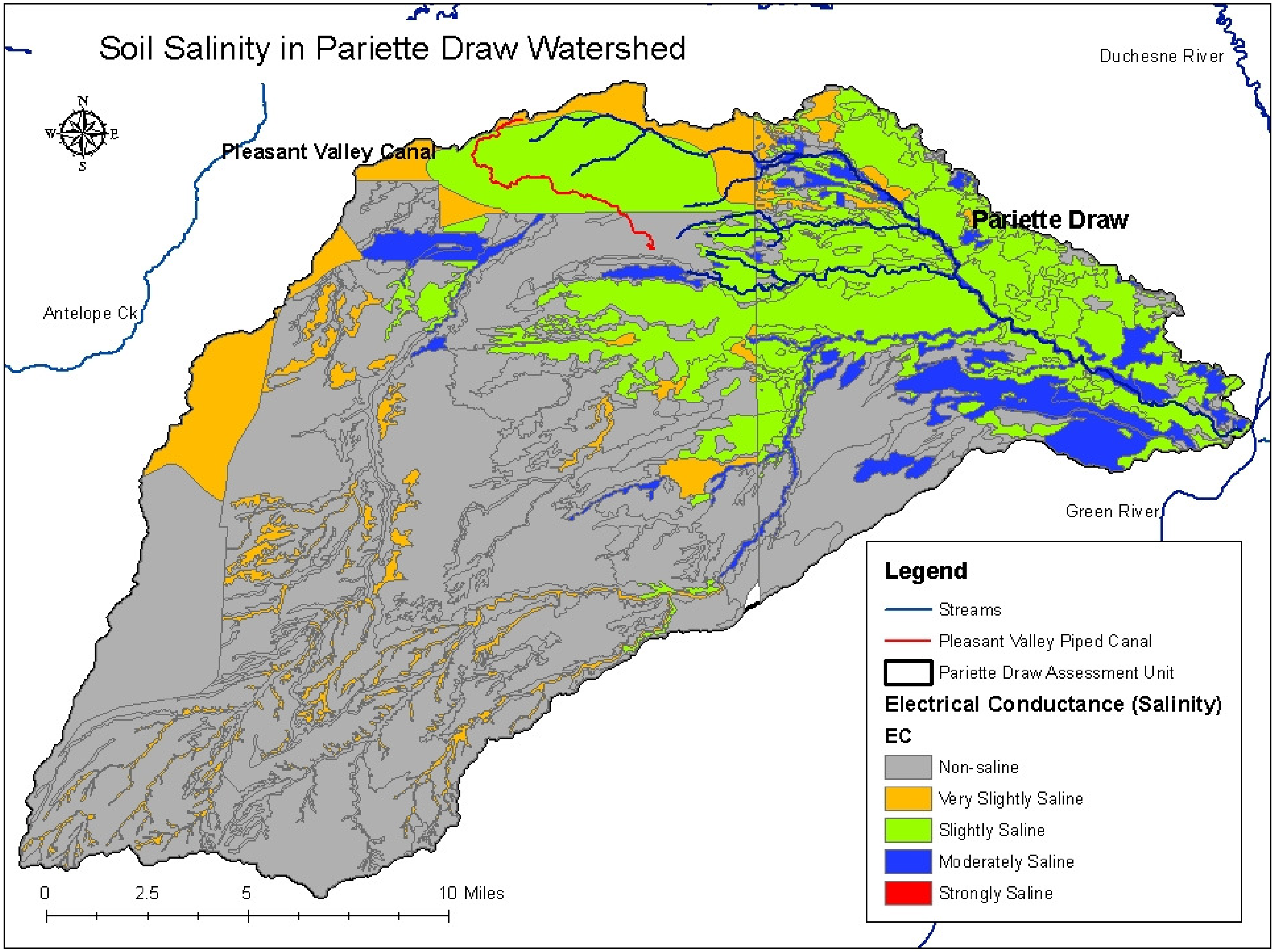


Figure 2-9. Soil Salinity in Pariette Draw Watershed.



2.4.4 Sodium Adsorption Ratio (SAR)

In addition to the total soil salinity the types of salts can strongly influence runoff, infiltration, plant available water, and leaching. Sodium salts react much differently in the soil than calcium or magnesium salts, in terms of swelling and sealing of clays and soil surfaces. This in turn affects infiltration, runoff, and erosion. Sodium salts naturally occur in the Pariette Draw watershed due to sodium-rich bedrock in certain areas. These salts make their way into soils through weathering processes and water transport. Sodium tends to accumulate in the soil surface layers due to evaporation and can have adverse effects on vegetation. High sodium concentrations disperse clays, changing the soil structure and rendering the soil hard and resistant to water infiltration and aeration. Sodium is also toxic to plants at elevated concentrations and raises soil pH, which can also affect nutrient availability and plant growth.

Calcium and magnesium in the soil solution help to mitigate the effects of high sodium concentrations on the soil structure. Because of this, a sodium adsorption ratio (SAR) is often used to determine the potential for sodium-caused impairment. The SAR is a ratio of sodium (Na) to calcium (Ca) and magnesium (Mg) in the soil solution, as follows

$$SAR = Na / \sqrt{(1/2(Ca + Mg))}$$

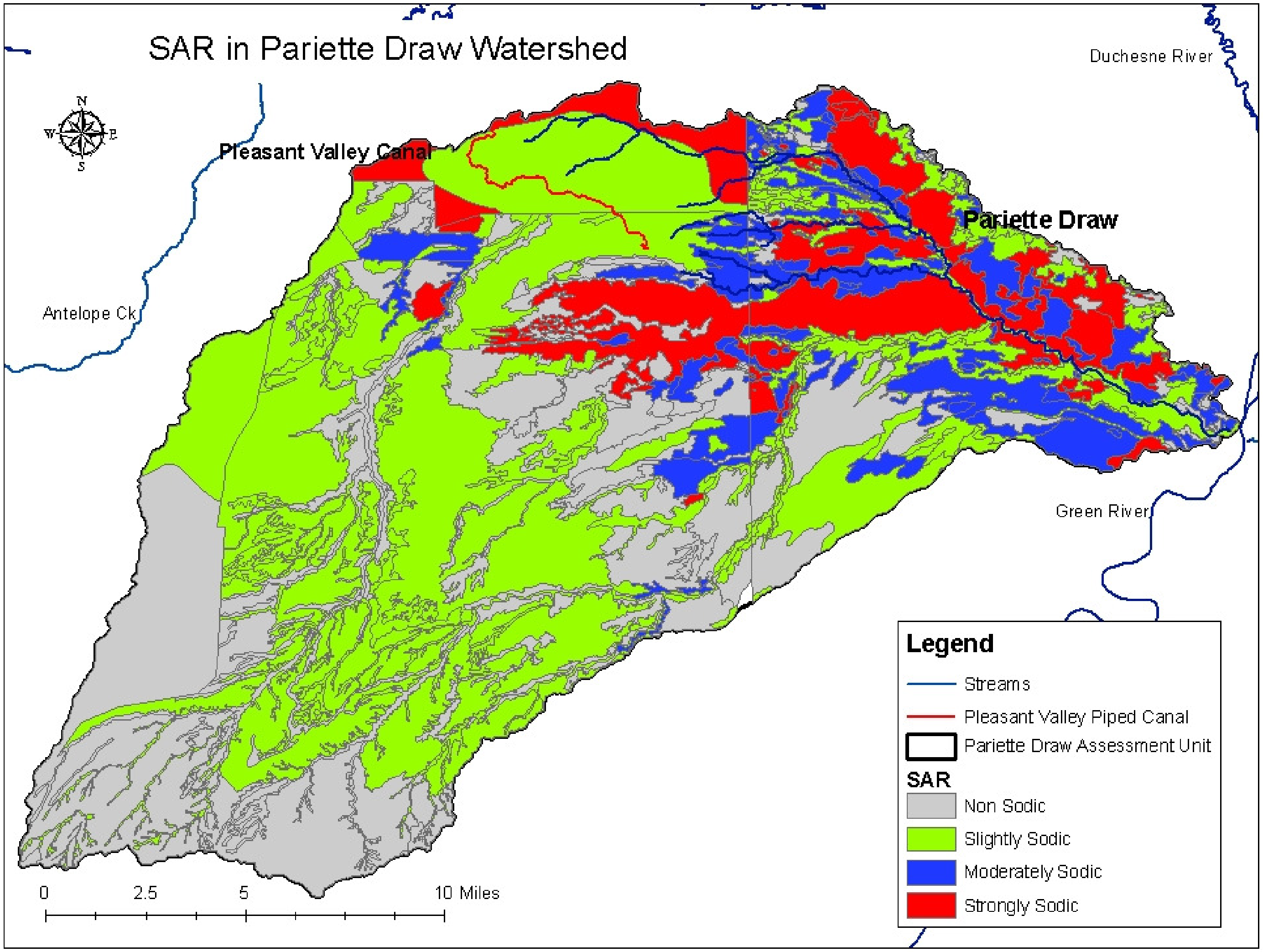
The degree at which sodium affects soil and crops varies with a number of factors, including precipitation, soil type, amount of clay, salinity, and crop type. It is generally recommended that irrigation water should have a SAR less than 10. The values used to summarize the soil data and display in the maps is based on weighted averages of the whole soil for all soils within the map unit. Based on groupings used in the Uintah Soil Survey, the following four classes (Table 2-6) were used to group soils with similar SAR values.

Figure 2-10 shows the distribution of soil SAR values in the Pariette Draw watershed. The mapping shows that the lowest SAR values occur in the highest elevation of the watershed and the highest ratios are along the eastern side of the watershed, the main stem of Pariette Draw, and the subwatershed of Wells Draw (intermittent). There seems to be higher concentrations of sodium salts downstream of Pleasant Valley meaning that this area is either high due to weathering of rocks or sodium has been deposited along the wetlands via water transport. Since sodium can render soils hard, this might help explain why this section of the watershed has moderate infiltration rates (hydrologic soil group B).

Table 2-6. SAR Classes in the Pariette Draw Watershed.

SAR Class	SAR	Acres	Percent
Non Sodic	0 - 5	62,431	31
Slightly Sodic	5 - 10	93,091	46
Moderately Sodic	10 - 25	21,297	11
Strongly Sodic	> 25	25,420	12
Total		202,239	100

Figure 2-10. Soil SAR Values in Pariette Draw Watershed.



2.4.5 Hydrologic Soil Group

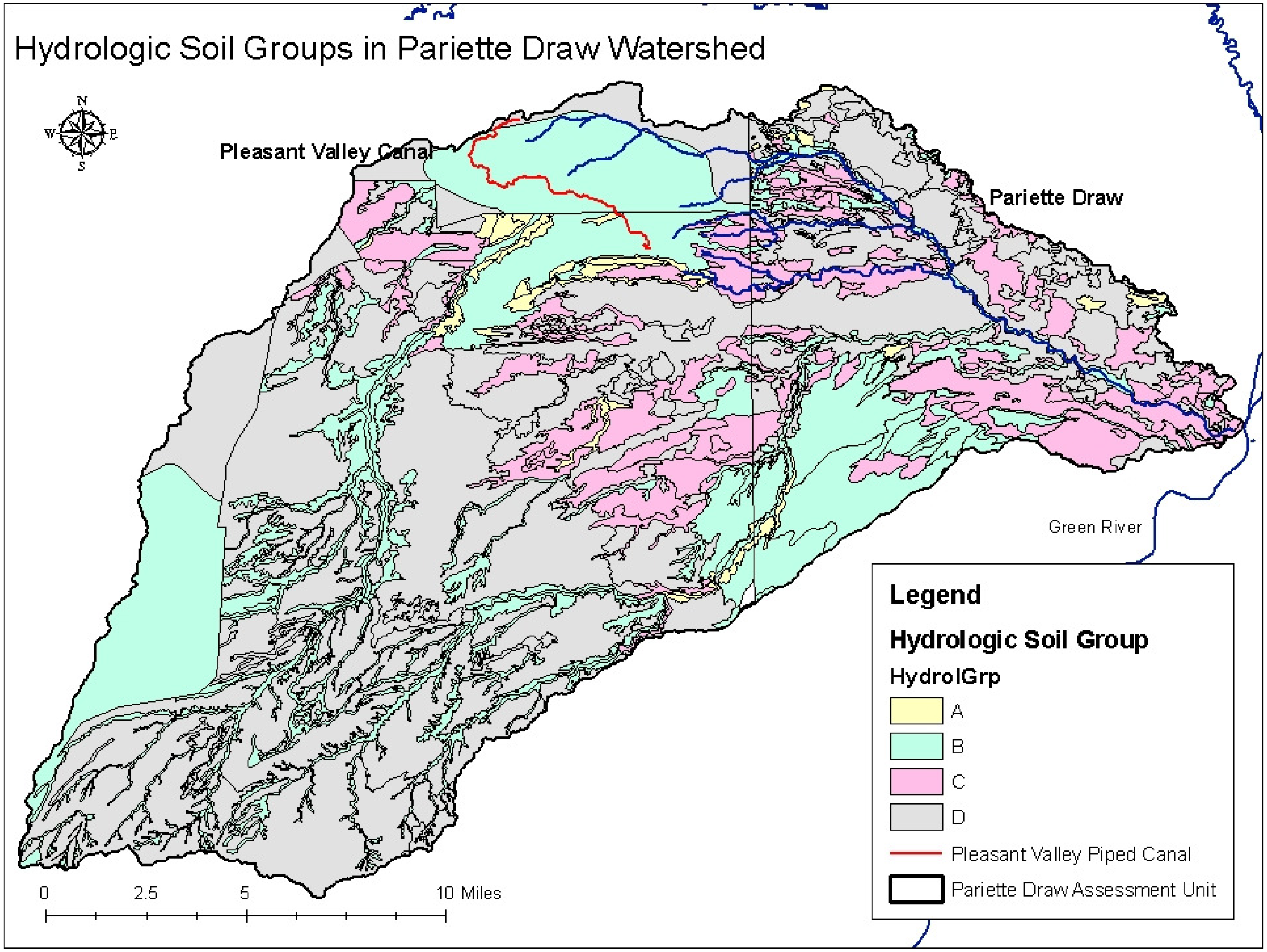
The hydrologic soil group classification is a means for grouping soils by similar infiltration and runoff characteristics, under conditions of prolonged wetting such as irrigation or continuous rainfall. Runoff and erosion also play a critical role in water quality and delivery of contaminants to streams via overland flow and irrigation return flows. Clay soils that are poorly drained have lower infiltration rates, while well-drained, sandy soils have higher infiltration rates. NRCS has defined four hydrologic groups for soils (Table 2-7) Data were summarized on the basis of the representative or most common hydrologic group within the map unit and are displayed in Figure 2-11.

The most common hydrologic groups are B (29%) and D (54%) within the watershed, with some C (15%) groups in the valley floors and drainages. Pleasant Valley area soils are characterized primarily as group B and some in group D. These soils have slow moderate to very slow infiltration and can have high runoff rates and high runoff rates characteristic of these groups. Combined with the fact that these soils have also have higher salinity and SAR values, they have a higher potential to be a source area for B, Se, and TDS loading to the Pariette wetlands through surface erosion. Erosion hazard under natural conditions is generally slight in this area, so water management has been critical in not creating excess runoff or erosion. The Pariette Draw riparian zone and wetlands are dominated by characteristics of group C. These soils have slow infiltration rates meaning that the pollutants are more prone to wash down stream and be retained in the wetland bottoms.

Table 2-7. Hydrologic Soil Groups.

Hydrologic Soil Group	Description
A	Soils with high infiltration rates. Usually deep, well drained sands or gravels. Little Runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well-drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high-clay content and poor drainage. High amounts of runoff.

Figure 2-11. Hydrologic Soil Groups in Pariette Draw Watershed.



2.5 Land Ownership

The drainage area of the Pariette Draw watershed is approximately 316 mi^2. It is owned or administered by several different entities including federal and state agencies and private landowners. Note that most of the private landowners lie in the headwaters area of Pleasant Valley. BLM administers most of the land in the watershed. Table 2-8 presents the different landowners and the amount of land they manage in this watershed and Figure 2-12 shows landowner boundaries.

Table 2-8. Landowners in Pariette Draw Watershed.

Landowners	Area in Watershed (mi^2)	% of Total Area
BLM	214	68
Private	37	12
SITLA	29	9
Tribal	24	7
USFS	12	4
Total:	316	100

2.6 Climate

Precipitation, temperature, and hence evaporation potential are strongly influenced by topography. While the average annual precipitation throughout the Uintah Basin totals approximately 8.8 inches, the local climate varies greatly with elevation and location relative to the mountain ranges that border to the west and north. Average annual precipitation ranges from less than 7 inches near Ouray at the Duchesne River-Green River confluence to about 40 inches in the adjacent Uinta Mountains. Snowfall characterizes winter precipitation, while thunderstorms dominate during the summer season when a northerly flow of warm, moist air from the Gulf of Mexico prevails. The Uintah Basin gets little precipitation from the frontal systems coming from the northwest or west because fronts weaken as they descend the slopes of the Wasatch Range and Uinta Mountains.

Daily temperature extremes can vary as much as 40 degrees and the variation is more pronounced at higher elevations. Annual extreme temperature ranges from 30^o to 105^o F. The basin averages between 80 to 160 frost-free days a year while much of the Uinta Mountains have fewer than 40 days free of frost. The average frost-free period is 115 days at Duchesne and 125 days at Roosevelt.

A distribution of annual average precipitation in the Pariette Draw watershed is available from the NRCS Water and Climate dataset (NRCS 1998). The NRCS climate dataset is a continuous distribution of average annual precipitation interpolated from precipitation measurements made at local climate stations. This interpolated method, Parameter-elevation Regressions on Independent Slope (PRISM), uses precipitation measurements and Digital Elevation Models (DEMs) to generate a gridded system of precipitation that incorporates spatial scale and the effects of precipitation.

Figure 2-12. Landownership and Administration in Pariette Draw Watershed.

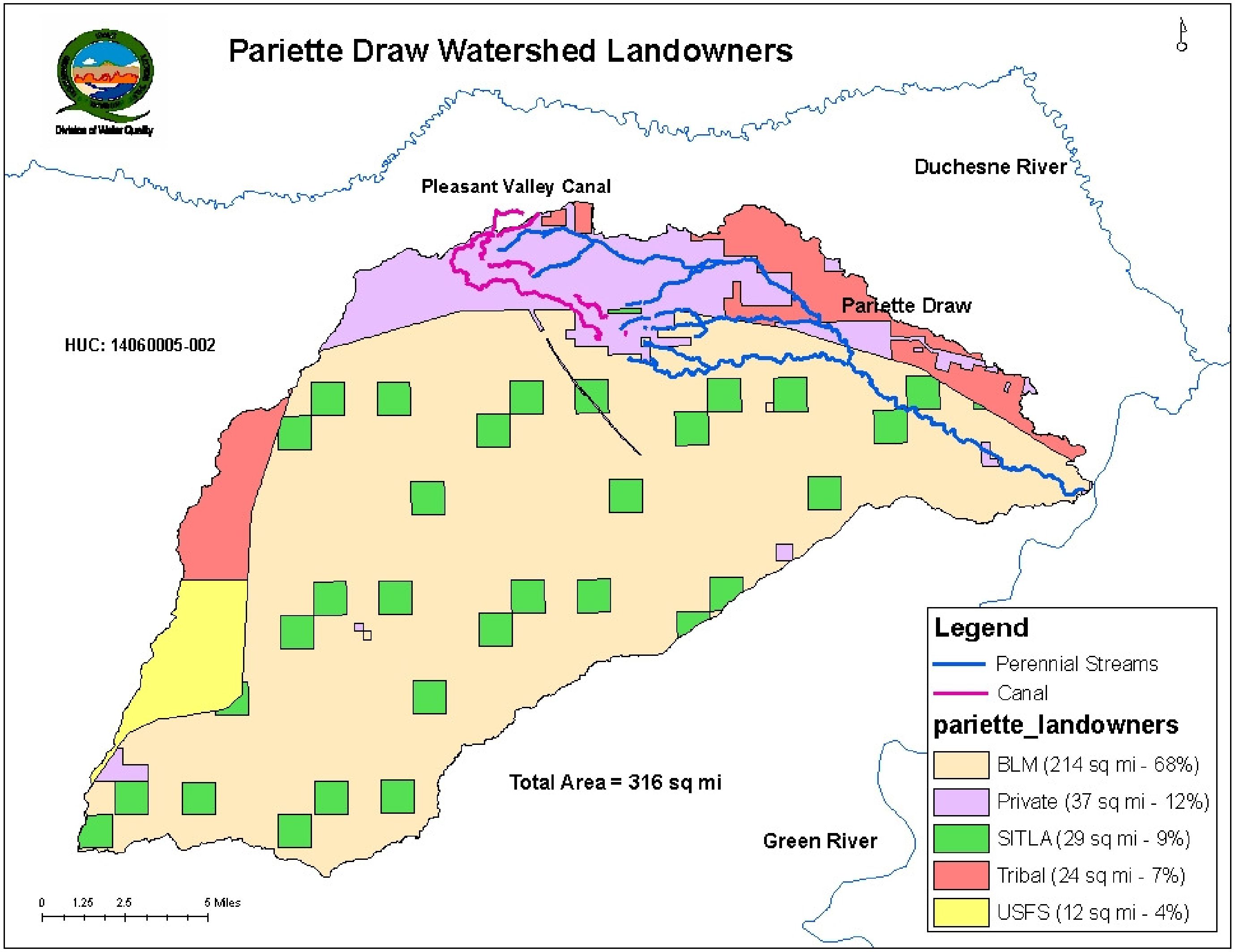
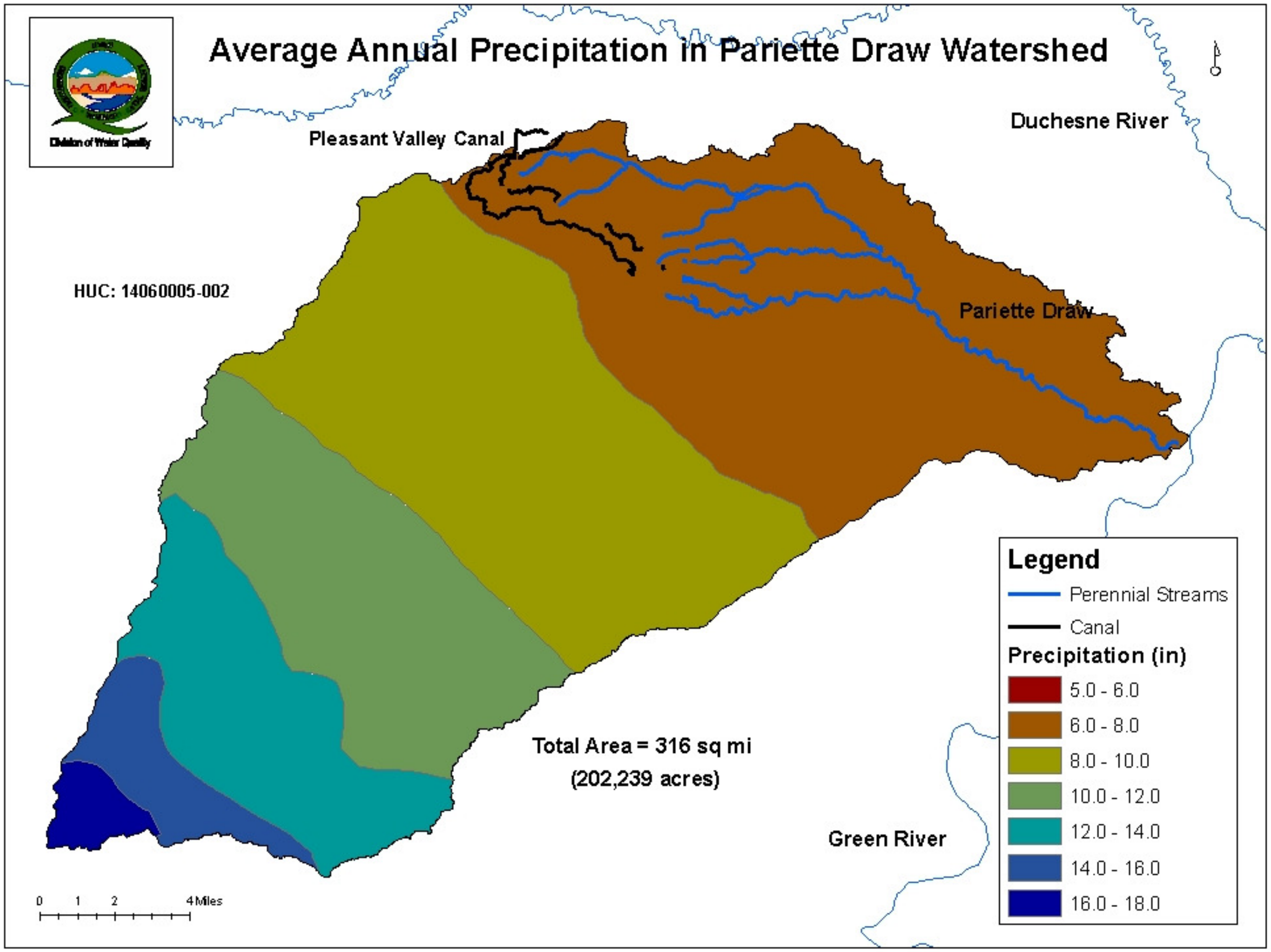


Figure 2-13. Annual Average Precipitation in the Pariette Draw Watershed.



Precipitation distribution estimates and elevation are presented in Figure 2-13. The average annual precipitation in Pariette Draw watershed ranges from 6 inches along the Pariette Draw to 18 inches at the higher elevations of the Tavaputs Plateau.

2.7 Watershed Hydrology

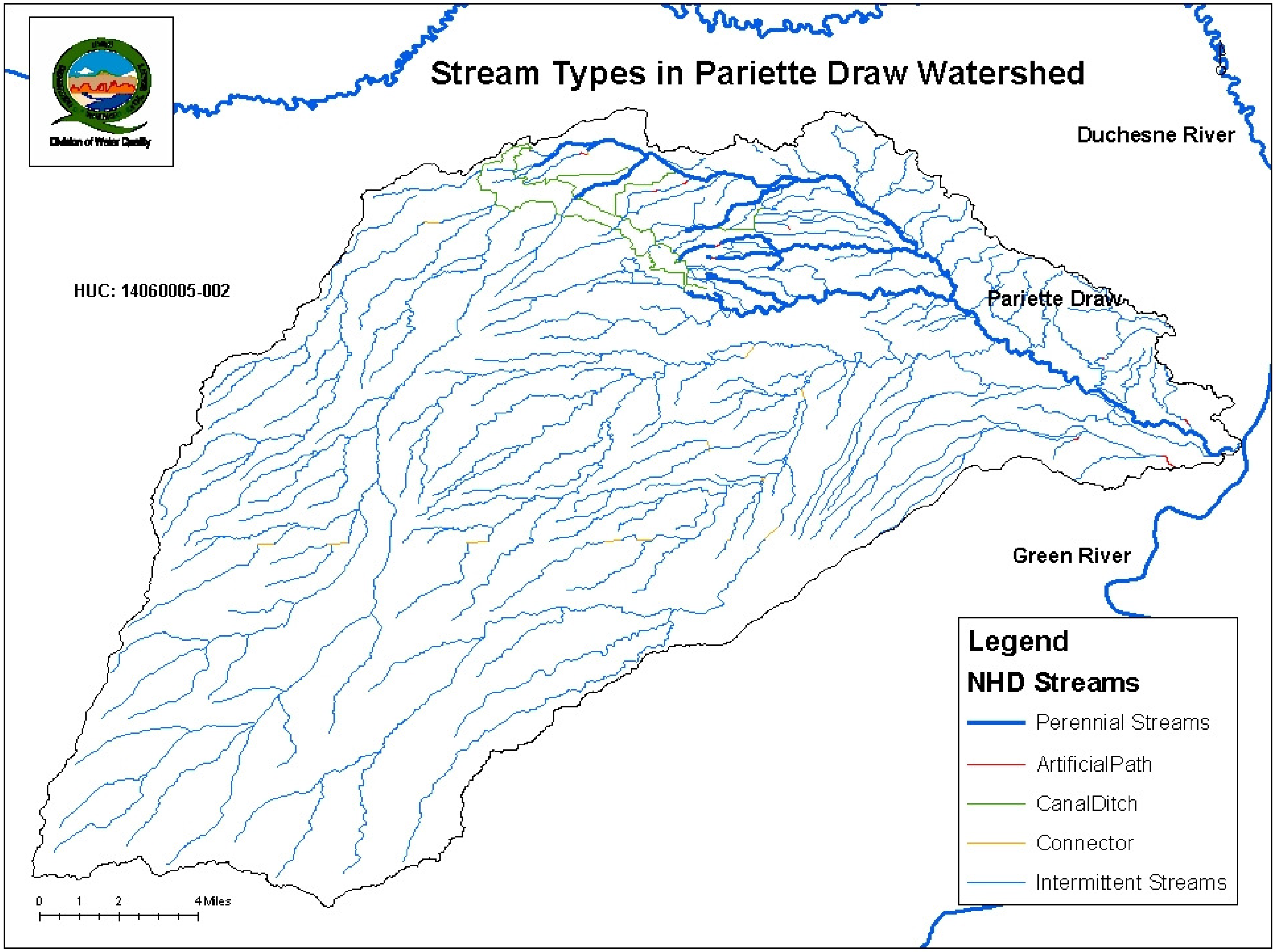
The hydrology of the Uinta Basin is dominated by spring runoff and from brief, intense storms that occur in late summer. Several large reservoirs in the basin have altered the natural hydrology of the major rivers by reducing spring peak flows and providing higher minimum flows during summer and winter months. Water diversion for agricultural, municipal, and industrial uses has also altered the natural hydrology of the basin by reducing instream flows below diversion points (BLM 2005). This section discusses the variety of stream types and water uses in the Pariette Draw Watershed.

The National Hydrography Dataset (NHD) created by EPA and USGS, indicate 5 different stream types in the Pariette Draw watershed (Figure 2-14). Most of the streams were classified as intermittent (Table 2-9). Intermittent streams flow only for short periods during the course of the year and flow events are usually initiated by rainfall. Perennial stream flow was identified predominantly in the main stem of the Pariette Draw.

Table 2-9. Summary of Stream Types in Pariette Draw Watershed.

Stream Type	Stream Length (km/mi)	Percent
Intermittent Stream/River	913.7 / 567.7	86.8%
Perennial Stream/River	87.0 / 54.1	8.3%
Canal	41.5 / 25.8	3.9%
Connector	7.8 / 4.8	0.7%
Artificial Path	3.1 / 1.9	0.3%
Total	1053.1 / 654.3	100.0%

Figure 2-14. Stream Types in the Pariette Draw Watershed.



2.8 Water Supply and Uses

Sprinkler irrigation has been an important part of Utah's agricultural production since the early 1950's. Approximately 40% of Utah's 1.3 million irrigated acres are watered with sprinklers. 2020 projects for the Uintah Basin include: 790,480 acre-feet to be diverted annually for agricultural, municipal and industrial uses divert 48,730 acre-feet which includes 3,460 ac-ft for secondary water uses (culinary, lawns, golf courses) (UDNR 1999). The Gray Mountain Canal transports water from a diversion on the Duchesne River and has a capacity of 320 cubic feet per second (cfs). Approximately 7.6 miles below the diversion, the Pleasant Valley Canal branches from the Gray Mountain Canal and serves the Pleasant Valley area, which is the headwater of the Pariette Draw. The Pleasant Valley Canal has a capacity of 200 cfs and the Lower Gray Mountain Canal has a capacity of 50 cfs. According to an USGS Study conducted in 1976, the net loss of canal water from the Gray Mountain Canal is about 8% (24.5cfs) of the canal capacity. The estimated return of canal loss to the river is 20% or 5.6 cfs. The study concluded that the water loss is small considering the materials through which the canals were cut and the lack of canal lining (USGS 1976). Since the 1976 report, most the canals have been piped reducing the amount of canal loss. Per conservation with the Uintah Basin Irrigation Company, during the last ten years the Pleasant Valley Canal's flow averages 137 cfs with a maximum of 182 cfs and a net loss of 10%.

3.0 Water Quality Standards and TMDL Target

The goal of a TMDL is to restore an impaired waterbody's designated beneficial uses by attaining and maintaining water quality standards. One of the primary components of a TMDL is the establishment of an instream numeric target to evaluate the attainment of water quality goals. Instream numeric targets, therefore, represent the water quality goals to be achieved by implementing the load reductions specified in the TMDL. The targets allow for a comparison between instream conditions and conditions required to support designated uses. The targets are established on the basis of numeric or narrative criteria from state water quality standards. If applicable numeric water quality standards are available, they can serve as a TMDL target. If only narrative criteria are available, a numeric target is developed to represent conditions resulting in the attainment of designated beneficial uses.

3.1 Overview of 303(d) List Status

Pariette Draw, from the confluence of the Green River to headwaters, and all its tributaries are listed on Utah's 2002 Section 303(d) list of impaired waters for total dissolved solids and boron. It was then listed again in 2004 for selenium impairments, as show in Table 3-1. The beneficial uses that are listed as impaired include warm-water aquatic life (3B), waterfowl (3D), and agriculture (4).

Table 3-1. Classification of Impaired Waters in the Pariette Draw Watershed.

Name	Year Listed	Impaired Beneficial Use	Cause of Impairment
Pariette Draw and tributaries from confluence of Green River to Headwaters	2002	4	TDS, B
Pariette Draw and tributaries from confluence of Green River to Headwaters	2004	3B, 3D	Se

3.2 Parameters of Concern

This section provides a summary of the parameters identified on the Utah 303(d) list as causing impairments in the Pariette Draw watershed. The purpose of the section is to provide an overview of the parameters, sampling methods, and potential sources for readers who might not be familiar with these issues. The relevance of the parameter to the various beneficial uses is also briefly discussed.

3.2.1 Selenium (Se)

Selenium is both an essential micro-nutrient and potentially detrimental element in high concentrations, predominately found in black shale derived soils and landscapes. In elevated concentrations, selenium has been proven to cause mortality, deformity, and reproductive failure in fish and aquatic birds (USEPA 1998). The toxicity of selenium depends on its chemical form. Selenium becomes bioavailable to aquatic biota through surface and groundwater interactions with surrounding geology. In alkaline soils and in oxidizing conditions selenium uptake is increased because it is in its biologically active form. Se is also hypothesized as contributing to the decline of endangered fish species within the upper Colorado River Basin because it may inhibit reproduction and recruitment (USGS 2004). Due to the bioaccumulative properties of Se, EPA is currently proposing Se criteria be expressed as a concentration in fish tissue rather than a concentration in water (USEPA 2004).

Black shale is comprised of organic-rich, fine-grained sedimentary rock deposited in very low oxygen conditions. Oil and gas are valued resources that originate in black shale, thus explaining the large amount of oil and gas exploration in the Pariette Draw watershed. This type of shale is also a probable source of metals found in some mineral deposits. Many black shale formations are sources for pollutants such as Se (USGS 2004). Selenium also occurs in sulfide ores of heavy metals including pyrite, clausthalite, naumannite, tienammite, and seleosulfur. In addition, soils in proximity to volcanic activity contain elevated selenium concentrations. Selenium is also found in coal.

Normal aqueous chemical processes, enhanced by seepage from irrigated agriculture in the watershed, are capable of transporting some of the naturally-occurring Se in the sediments in the watershed to the stream system. In the San Juan River watershed in California, water samples from seeps and tributaries draining irrigated land developed on Cretaceous soils contained approximately 10 times more Se than samples from sites draining irrigated lands on non-Cretaceous soils (CA EPA 2005).

Groundwater return flow from irrigated areas contributes substantially to surface water flow in the Pariette Draw watershed. Seepage of irrigation water from fields in the upland areas appears to be the cause of the perennial flow in this watershed. This seepage is also likely leaching out and mobilizing the Se, thus leading to elevated concentrations. In general, increased Se in the water column can commonly be linked to sediment transport and accumulation where the Se is a constituent part of the sediment.

Irrigation practices have been noted to concentrate selenium when irrigation waters evaporate and concentrate the dissolved components (GBSTF 2003). Other anthropogenic sources of selenium include the combustion of coal and petroleum fuels and the smelting or other metals.

3.2.2 Boron (B)

Boron is a naturally occurring substance found throughout the environment. Deposits of boron minerals are associated with volcanic activity or where marshes or lakes have evaporated under arid conditions. The highest concentrations of boron are found in sediments and sedimentary rock, particularly clay rich marine sediments. Boron is released into the environment very slowly and at low concentrations by natural weathering processes. Anthropogenic sources of boron in the environment include sewage sludge and effluents, coal combustion, glass, cleaning compounds, and agrochemicals.

Boron is less persistent in light textured acidic soils and in areas with high rainfall because of its tendency to leach out. As a result, boron toxicity tends to be more of a problem in arid climates. Boron retention in soil depends on the concentration in the soil solution, soil pH, texture, organic matter, cation exchange capacity, type of clay, and mineral coating on the clay. Research suggests that less than 5% of soil boron is available for plants.

Boron is an essential trace element for the growth of crop plants and some algae, fungi and bacteria, but can be toxic in excess. Toxicity to aquatic organisms, including vertebrates, invertebrates and plants can vary depending on the organism’s life stage and environment. Early stages are more sensitive to boron than later ones. In mammals, excessive consumption can adversely affect growth, reproduction or survival. There is no evidence of carcinogenicity or mutagenicity; however, egg injection studies have indicated potential embryo teratogenicity.

3.2.3 Salinity and Total Dissolved Solids (TDS)

As water flows over and through soil particles and rock, soluble materials accumulate in the water. The materials dissolve in the water to form cations (positively charged ions) and anions (negatively charged ions). The term salinity refers to the total amount of dissolved cations and anions in water. Major ions in water are generally sodium, calcium, magnesium, potassium, chloride, sulfate, and bicarbonate. Metals (e.g., copper, lead, and zinc) and other trace elements (e.g., fluoride, boron, and arsenic) are usually only minor components of the total salinity. Salinity is determined by measuring the conductance of water, which is the opposite of resistance. This is done by sending an electrical current through the water and measuring the electrical conductance. The conductance of the water is corrected to a water temperature of 25 °C, and is called specific conductivity (SC). The units for SC are typically microsiemens per centimeter (µS/cm). SC is an easy and cost efficient measurement that can be performed in the field or the laboratory.

In addition to cations and anions, there are other dissolved substances in water, such as dissolved organic materials that are not measured by SC. The sum of all of the dissolved substances in water is called total dissolved solids (TDS), and is measured in milligrams per liter (mg/L). TDS is a laboratory measurement and cannot be determined in the field. Pure distilled water has a TDS of zero. TDS concentrations in rainfall and snowfall vary, and generally range from zero to 10 mg/L. In comparison, the average TDS for the lower segment of Pariette Draw 1 mile above the Green River is approximately 2,600 mg/L. Because dissolved organic materials are usually such a small percentage of TDS, SC and TDS typically measure the same amount of dissolved materials in water. However, the SC and TDS values of water cannot be directly compared because of the different sampling techniques and units (µS/cm versus mg/L).

The salinity of a waterbody is important to many aquatic organisms because it regulates the flow of water into and out of an organism’s cells through osmosis. Increases or decreases in salinity can affect the composition of the aquatic organisms. High salinity can also cause adverse effects on native vegetation such as willows and cottonwoods, and allow for the establishment of the invasive Tamarix, which is more tolerant of high salinity. Highly saline waters can adversely affect crop production depending on the amount of water applied and the salt tolerance of the crop. Livestock can also be adversely affected by high salinity values. Natural sources, such as geologic formations, soils, and geothermal activity, contribute to the salinity of a stream.

The subsurface bedrock formations in the Pariette Draw Watershed are saline and soluble, dissolving easily and contributing TDS to water flowing through them. Natural background sources of TDS in the watershed include saline soils and areas of poor drainage where groundwater rises to the surface and evaporates leaving soluble salts on the surface. This salt efflorescence is then available for washoff and delivery to watershed streams. Precipitation that falls in excess of plant requirements and soil holding capacity also percolates down into the shallow alluvial aquifer where it comes in contact with saline bedrock formations. The primary source of human induced TDS loading in the watershed has been attributed to seepage from canals and deep percolation of irrigation water, which then discharges to surface streams as baseflow.

Anthropogenic and natural TDS issues impacting water quality in the Uintah Basin including the Pariette Draw watershed consist of an increase in salt loading from inefficient irrigation techniques, erosion of saline soils, and elevated levels of dissolved solids in the shallow alluvial aquifer. Sources of TDS in groundwater originate from natural geologic sources, such as the

Green River and Uinta formations. Most of the salt is derived from soils and subsurface parent material of marine origin, which underline most of the Uintah Basin. Seepage and deep percolation from unlined irrigation canals also dissolve salts from the soil and shales and convey the salts through the groundwater system to natural drainages and ultimately to the Colorado River. Salinity can also be affected by flow alterations associated with irrigation diversions and reservoir management.

3.3 Applicable Water Quality Standards

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nations' surface waters. These standards represent a level of water quality that will support the Clean Water Act's goals of "swimmable/fishable" waters. Water quality standards consist of three major components:

- Beneficial uses reflect how humans can potentially use the water and how well it supports those uses. Examples of beneficial uses include aquatic life support, agriculture, drinking water supply, and recreation. Every waterbody in Utah has a designated use or uses; however, not all uses apply to all waters.
- Criteria express the condition of the water that is necessary to support the beneficial uses. Numeric criteria represent the maximum concentration of a pollutant that can be in the water and still protect the beneficial use of the waterbody. Narrative criteria are the general water quality criteria that state that all waters must be free from sludge, floating debris, oil/scum, color and odor producing materials, substances that are harmful to human, animal, or aquatic life, and nutrients in concentrations that may cause algal blooms.
- The Antidegradation policy establishes situations under which the state may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need.

The Utah Water Quality Board (UWQB) is responsible for creating the water quality standards that are then enforced by the Utah Department of Environmental Quality, Division of Water Quality. Utah has numeric criteria for TDS, B, and Se. These standards are found in the Utah Administrative Code, Standards of Quality for Waters of the State R317-2 and vary based on the beneficial use assignment of the waterbody (UDWQ 2009). Table 3-2 summarizes the standards pertaining to the 303(d) listed segment in the Pariette Draw watershed.

Table 3-2. Water Quality Standards for Impaired Waters in the Pariette Draw Watershed.

Designated Use	Description	TDS	Se	B
3B	Warm water aquatic life	N/A	4-day avg: 4.6 ug/L 1-hour max: 18.4 ug/L	N/A
3D	Waterfowl	N/A	4-day avg: 4.6 ug/L 1-hour max:18.4 ug/L	N/A
4	Agriculture	1,200 mg/L	0.50 mg/L (max)	750 ug/L

3.4 Utah's Listing Methodology and 303(d) Status

The beneficial use support status for streams in Utah is determined using the water quality standards (Table 3-2). Utah has defined guidelines for assessing each beneficial use as listed in Table 3-3.

3.4.1 Selenium

To evaluate attainment of water quality standards Utah uses the acute selenium criterion of 18.4 micrograms per liter (ug/L) which is based on a 1 hour average of samples. In the case of the UDWQ's sampling methodology this typically entails a single grab sample. However, the goal for this TMDL is based upon the chronic selenium criterion of 4.6 ug/L, based on a 4 day average of samples, which is more applicable to loading calculations based upon annual average loads. The 303(d) listing criteria evaluates beneficial use support based on the number of violations of the water quality criterion for toxic parameters as listed in Table 3-2. A minimum of four samples collected at least once each season is required for assessment.

3.4.2 Total Dissolved Solids

Utah uses the total dissolved solids criterion of 1,200 milligrams per liter (mg/L) to evaluate attainment of water quality standards. The 303(d) listing criteria evaluates beneficial use support based on the number of violations of the water quality criterion for conventional parameters as listed in Table 3-2. A minimum of ten samples collected throughout the year (as in an intensive monitoring cycle) is required for assessment.

3.4.3 Boron

Utah uses the boron criterion of 750 micrograms per liter (ug/L) to evaluate attainment of water quality standards. The 303(d) listing criteria evaluates beneficial use support based on the number of violations of the water quality criterion for conventional parameters as listed in Table 3-2. A minimum of four samples collected at least once each season is required for assessment.

Table 3-3. 303(d) Criteria for Assessing Beneficial Use Support.

Degree of Use Support	Selenium (Toxic)*	Total Dissolved Solids (Conventional)**	Boron (Toxic)***
Full	For any one pollutant, no more than one violation of criterion.	Criterion exceeded <2 samples and <10% of samples if there were >2 exceedances.	For any one pollutant, no more than one violation of criterion.
Non-support	For any one pollutant, >2 violations of the criterion in a 3-year period	Criterion was exceeded 2 times and criterion was exceeded in >10% of the samples.	For any one pollutant, >2 violations of the criterion in a 3-year period

*Utah Code Ann. R317-2-14 Numeric Criteria. Table 2.14.2 Numeric Criteria for Wildlife
**Utah Code Ann. R317-2-7. Water Quality Standards. 7.1 Application of Standards.
***2006 Utah Integrated Report Volume 1. Table 5. Toxic Parameters (Priority Pollutants, Chlorine, Ammonia).

3.5 TMDL Endpoints

TMDL endpoints represent water quality targets used in quantifying TMDLs and their individual components. Because there are no established water quality standards for waters within the boundaries of the Uintah and Ouray Indian Reservation, the Utah State water quality standards are used as the basis for establishing a TMDL target for the Pariette Draw. Different TMDL endpoints are necessary for each pollutant of concern, Se, B, and TDS. Utah's chronic numeric water quality criteria for Se and TDS were used to identify endpoints for TMDL development. The TMDL endpoints applied were the chronic Warm Water Aquatic Life and Waterfowl criteria for Se of 4.6 ug/L, and the Agriculture criteria for TDS of 1,200 mg/L and B of 750 ug/L, established in Utah's water quality standards (UDWQ 2009). For Se, the reductions specified in the TMDL to meet the chronic 4 day average water quality standard will suffice to ensure no sample will exceed the acute Se water quality standard based upon the current data set.

4.0 Data Inventory and Review

Water quality data for the Pariette Draw watershed were obtained from UDEQ and downloaded from the USGS NWIS database. This section provides a description of available Se, B, and TDS data and analyses conducted to understand the current water quality conditions in the watershed. Water quality data has been collected by UDEQ at 11 stations in the Pariette Draw watershed, however only one station has long-term water quality data (Pariette Draw 1 mile above Confluence of Green River) from 1993 to the present. Water quality and flow data from the USGS NWIS database includes three USGS stations with sampling dates range from 1975 to 1991. This data will only be used to make comparisons to what UDEQ has collected within the past 15 years. See Figure 4-1 and Figure 4-3 for the locations of both the USGS and UDEQ monitoring stations in the Pariette Draw watershed.

4.1 Groundwater Data

Groundwater data for the Pariette Draw watershed are quite limited and highly variable. According to the 1975 Department of Natural Resources Hydrologic Reconnaissance of the Southern Uinta Basin, data from the few oil and gas wells and tests that penetrate the older rocks indicate that these rocks generally have low permeability and commonly yield very saline to briny water.

The State Ground Water Program, administered by the Utah Department of Agriculture and Food (UDAF), was implemented in 1996 to assist private well owners in determining the quality of their drinking, irrigation, and livestock water. The program receives assistance from local conservation districts in the selection of wells to sample. Many wells in the Uinta Basin have been sampled as part of this program. Unfortunately, none are within the Pariette Draw watershed. Due to high variability between well sites, it would be ill-advised to draw conclusions using wells from nearby but outside of the watershed boundary. The Division of Water Quality sampled Snyder spring on the southern side of the watershed hoping it would be useful in demonstrating reference conditions of groundwater in the area. The TDS concentration was 1,358 mg/L, which is higher than the state standard.

4.1 Flow Data

The USGS National Water Information System (NWIS) online database lists 5 continuous and 1 instantaneous flow gauges with historic flow data in the Pariette Draw Watershed (Figure 4-1 and Table 4-1). Flow at all gauges in the Pariette Draw watershed are affected by precipitation, evaporation, groundwater, irrigation, and water withdrawals. Figure 4-1 illustrates the different flow patterns and magnitude throughout the watershed with average monthly flows for 1975-1984 on the 5 stations on the Pariette Draw. USGS flow station 9308200 is located in Pleasant Valley however the only data available is maximum annual flow and 9307250 does not have daily flow data thus they are not comparable to the other 4 Pariette Draw flow stations. See Figures 4-3 and 4-4 for historical flow data. There are no current active flow stations in the Pariette Draw watershed. Flow data is included in this TMDL for a historical characterization of the watershed.

Figure 4-1. USGS Flow Station Locations in the Pariette Draw Watershed.

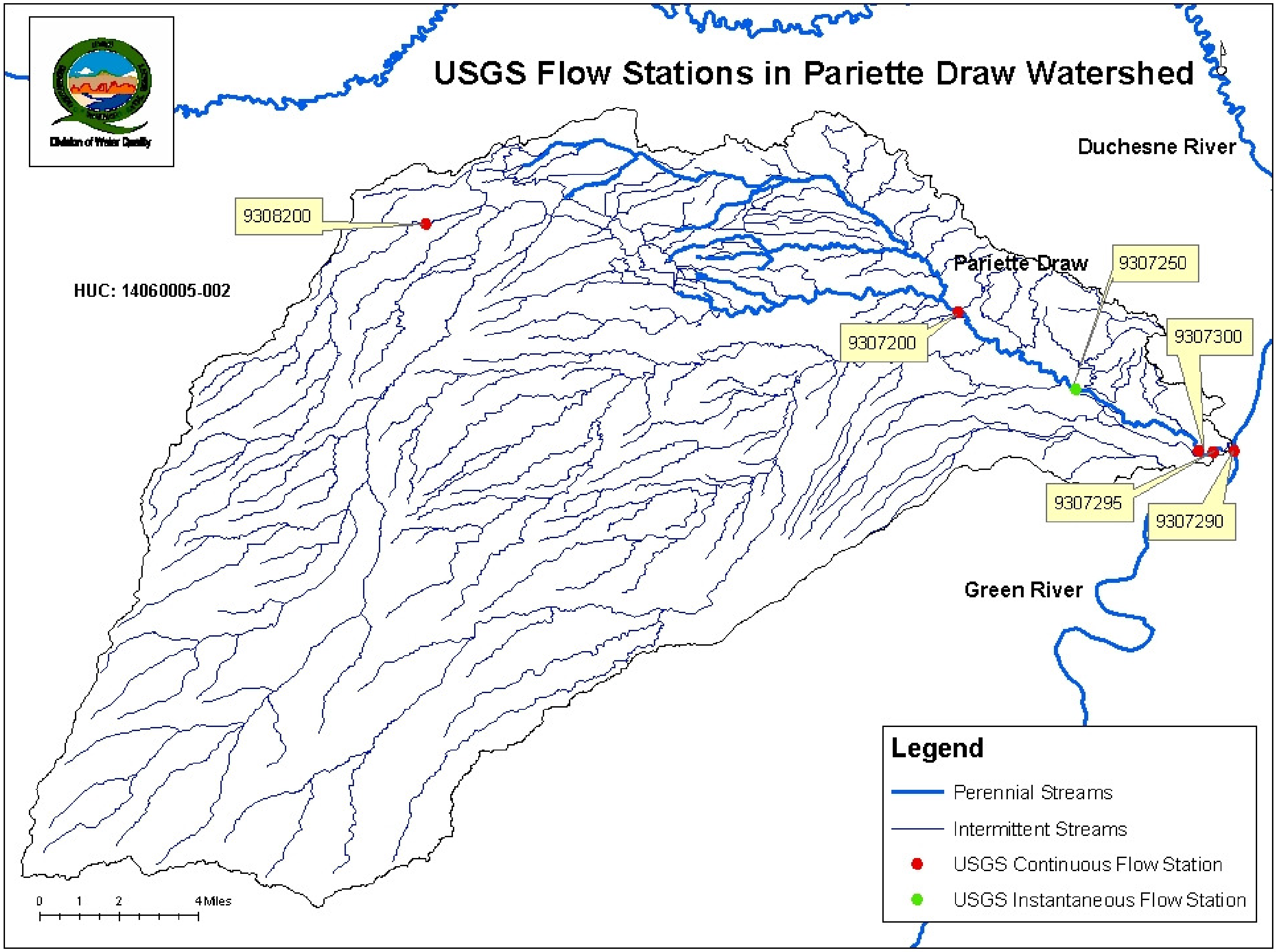


Table 4-1. USGS Stream Gauges in the Pariette Draw Watershed.

Station ID	Station Name	Start Date	End Date	Drainage Area (Hectares)	Drainage Area (Acres)
9307200	Pariette Draw nr Ouray	10/01/1975	09/30/1984	39,626	97,919
9307250*	Pariette Draw nr Eight Mile Flat nr Myton	10/21/1975	09/27/1982	NA	NA
9307295	Lamb Diversion from Pariette Draw nr Ouray	04/01/1978	09/30/1982	NA	NA
9307290	Com F Pariette Draw at Mouth and Lambs Div	04/01/1978	09/30/1980	NA	NA
9307300	Pariette Draw at Mouth nr Ouray	10/01/1975	09/30/1984	103,082	254,719
9308200	Pleasant Valley Wash Trib nr Myton	09/17/1960	09/06/1970	3,885	9,599

*Instantaneous USGS Flow Station.

Figure 4-2. Average Monthly Flow at 4 USGS Flow Stations in the Pariette Draw Watershed.

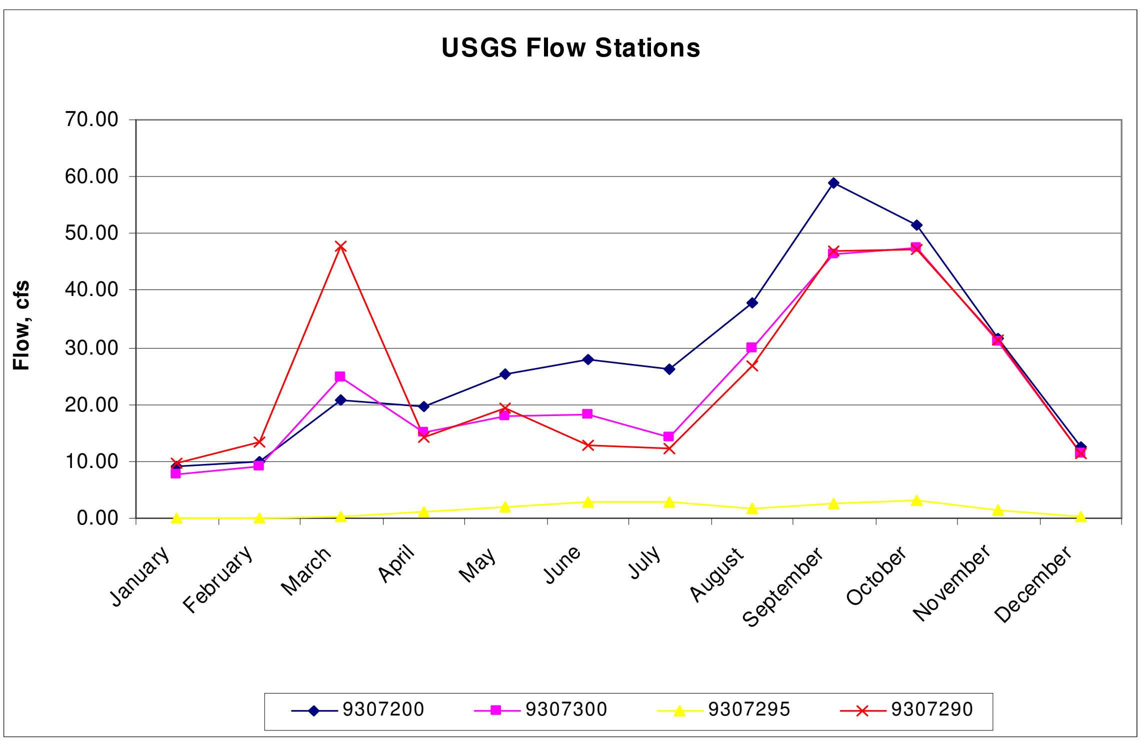
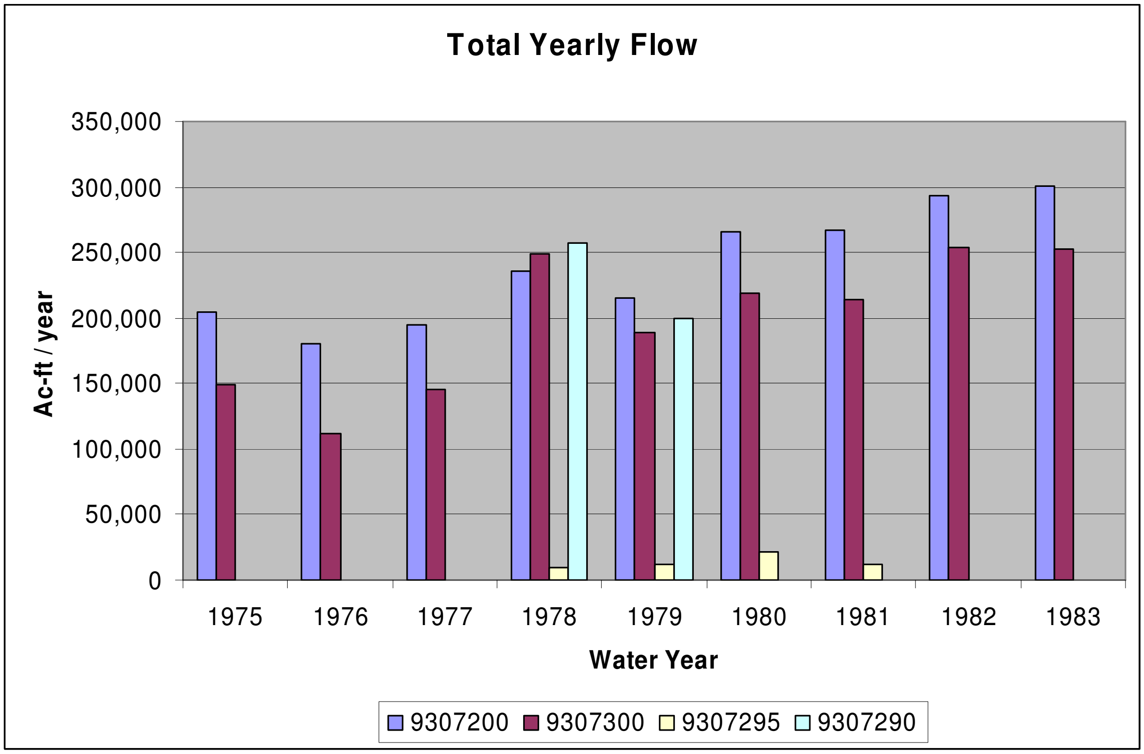


Figure 4-3. Yearly Total Flow at the USGS Flow Stations in the Pariette Draw Watershed.



4.3 Water Quality Data

Of the 12 water quality stations in the Pariette Draw watershed, 2 of them were used in the 2002 and 2004 303(d) listings, Pariette Draw Above Flood Control Structure (4933480) and Pariette Draw 1 mi Above Confluence of Green River (4933440). Figure 4-4 shows all the locations of the UDEQ monitoring stations. Summary statistics for Se, B, and TDS are presented in Table 4-2, 4-3, and 4-4.

Figure 4-4. Locations of the UDEQ Monitoring Stations in the Pariette Draw Watershed.

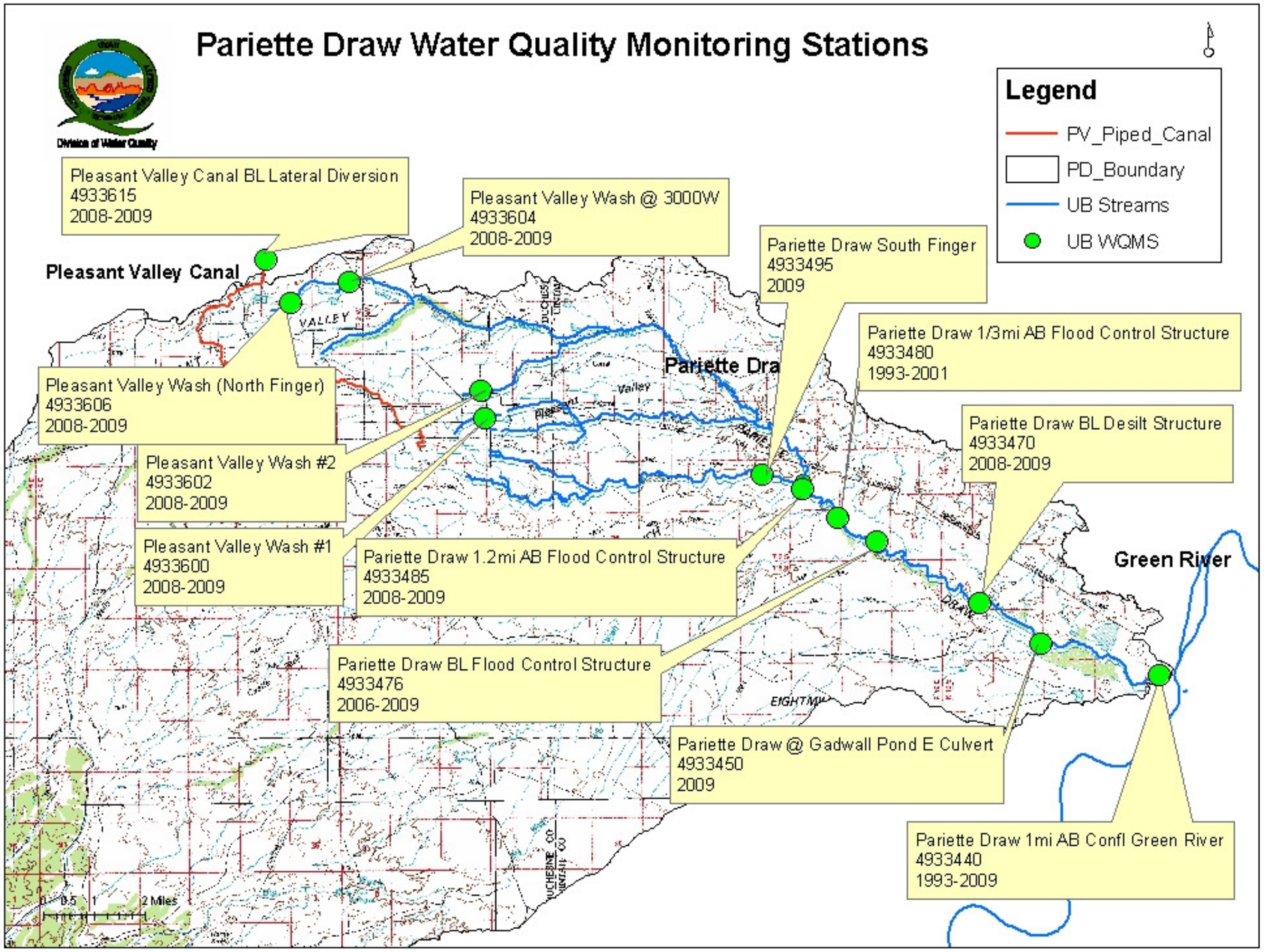


Table 4-2. Summary of TDS Data for UDEQ Water Quality Stations in Pariette Draw.

Station ID	Station Description	No. of Samples	Ave (mg/L)	Min (mg/L)	Max (mg/L)	First Sample	Last Sample
4933615	Pleasant Valley Canal BL Lateral Diversion	6	302	208	494	10/6/08	11/3/09
4933606	Pleasant Valley Wash (North Finger)	9	4,763	3,186	8,512	10/6/08	11/3/09
4933604	Pleasant Valley Wash @ 3000W	9	1,986	442	4,248	12/9/08	11/3/09
4933602	Pleasant Valley Wash #2	9	4,608	602	7,868	12/9/08	11/3/09
4933600	Pleasant Valley Wash #1	7	2,533	2,244	3,262	10/6/08	11/3/09
4933495	Pariette Draw South Finger	3	3,711	1,950	5,838	4/22/09	11/3/09
4933485	Pariette Draw 1.3mi AB Flood Control Structure	10	2,460	778	5,514	2/24/09	11/3/09
4933480	Pariette Draw 1/3mi AB Flood Control Structure	51	2,257	684	4,262	3/1/95	11/16/01
4933476	Pariette Draw BL Flood Control Structure	32	2,589	748	5,414	7/11/06	11/3/09
499340	Pariette Draw BL Desilt Structure	9	2,503	958	4,084	12/8/08	11/3/09
4933450	Pariette Draw @ Gadwall Pond Culvert	5	2,760	1,444	4,512	4/21/09	11/3/09
4933440	Pariette Draw 1mi AB Confl Green River	97	2,818	662	6,146	7/23/93	11/3/09

Table 4-3. Summary of Boron Data for UDEQ Water Quality Stations in Pariette Draw.

Station ID	Station Description	No. of Samples	Ave (ug/L)	Min (ug/L)	Max (ug/L)	First Sample	Last Sample
4933615	Pleasant Valley Canal BL Lateral Diversion	6	271	150	579	10/6/08	11/3/09
4933606	Pleasant Valley Wash (North Finger)	9	2,190	1,410	3,480	10/6/08	11/3/09
4933604	Pleasant Valley Wash @ 3000W	9	1,010	295	2,010	12/9/08	11/3/09
4933602	Pleasant Valley Wash #2	9	1,384	350	2,060	12/9/08	11/3/09
4933600	Pleasant Valley Wash #1	7	1,115	974	1,240	10/6/08	11/3/09
4933495	Pariette Draw South Finger	3	2,260	1,580	3,190	4/22/09	11/3/09
4933485	Pariette Draw 1.3mi AB Flood Control Structure	10	1,104	462	2,260	2/24/09	11/3/09
4933480	Pariette Draw 1/3mi AB Flood Control Structure	23	1,279	421	1,830	3/1/95	11/16/01
4933476	Pariette Draw BL Flood Control Structure	18	1,159	443	2,360	7/11/06	11/3/09
4993370	Pariette Draw BL Desilt Structure	9	1,31	628	2,050	12/8/08	11/3/09
4933450	Pariette Draw @ Gadwall Pond Culvert	5	1,533	885	2,340	4/21/09	11/3/09
4933440	Pariette Draw 1mi AB Confl Green River	54	1,68	92	3,000	7/23/93	11/3/09

Table 4-4. Summary of Selenium Data for UDEQ Water Quality Stations in Pariette Draw.

Station ID	Station Description	No. of Samples	Ave (ug/L)	Min (ug/L)	Max (ug/L)	First Sample	Last Sample
4933615	Pleasant Valley Canal BL Lateral Diversion	6	0.5	0.5	0.5	10/6/08	11/3/09
4933606	Pleasant Valley Wash (North Finger)	9	17.4	13.9	30.8	10/6/08	11/3/09
4933604	Pleasant Valley Wash @ 3000W	9	5.7	1.1	12.1	12/9/08	11/3/09
4933602	Pleasant Valley Wash #2	9	39.2	3.4	88.1	12/9/08	11/3/09
4933600	Pleasant Valley Wash #1	7	8.3	3.6	19.9	10/6/08	11/3/09
4933495	Pariette Draw South Finger	3	6.42	5.23	7.08	4/22/09	11/3/09
4933485	Pariette Draw 1.3mi AB Flood Control Structure	10	6.9	2.4	13.5	2/24/09	11/3/09
4933480	Pariette Draw 1/3mi AB Flood Control Structure	43	7.4	1.0	21.9	3/1/95	11/16/01
4933476	Pariette Draw BL Flood Control Structure	18	7.2	2.3	15.7	7/11/06	11/3/09
4993370	Pariette Draw BL Desilt Structure	9	3.6	1.34	7.7	12/8/08	11/3/09
4933450	Pariette Draw @ Gadwall Pond Culvert	5	2.4	1.5	4.1	4/21/09	11/3/09
4933440	Pariette Draw 1mi AB Confl Green River	74	3.9	0.5	18.0	7/23/93	11/3/09

4.4 Water Quality Analysis

Assessments of water quality monitoring stations 4933480 and 4933440 were used in the assessment of beneficial use support, which lead to the listing of Pariette Draw as impaired due to TDS and B in 2002 and Se in 2004. These 2 sites were also used in the analysis in the TMDL. The remaining 9 monitoring sites are used to characterize the impairments in the Pariette Draw watershed. See Tables 4-4, 4-5, and 4-6 for water quality data associated with each of these sites. These sites also showed exceedances of the numeric standard for all 3 parameters. Site 4933480 was moved approximately 1 mile upstream and reassigned as 4933485 due to the recent enlargement of the flood control structure in 2008-2009.

UDEQ station 4933480 has data from 1995 to 2001 and is located 0.3 miles upstream from the flood control structure and station 4933476 is located directly downstream of the flood control structure and has data from 2006 to 2009. These two sites were compared to see if their data could be combined due to their close proximity. A 2-tailed *t*-test shows that there is no significant difference in TDS (p-value = 0.31376), B (p-value = 0.53788), or Se (p-value = 0.92332) between these two sites, thus their data were combined to compare concentrations above and below the desilt structure and wetlands.

4.4.1 Summary of Se, B, and TDS Concentrations

UDEQ Water Quality Station 4933480 has data from 1995 to 2001 and is located upstream of the Flood Control Structure. At this station, the TDS water quality standard of 1,200 mg/L was exceeded 75% of the time, the 750 ug/L Boron standard was exceeded 83%, and the Selenium standard of 4.6 ug/L was exceeded 52% of the time. Station 4933746 is located directly downstream from the Flood Control Structure, approximately 0.3 miles downstream from 4933480, and has data from 2006 to 2009. This site was used to determine if any changes in water quality have occurred since the assessment for the 303d listings in 2004 and 2006. Table 4-5 shows that the TDS standard was exceeded 73% of the time, the Boron standard exceeded 69%, and the Selenium standard exceeded 56% of the time. Station 4933440 is the furthest downstream water quality monitoring station and is located downstream of all the ponds in the Pariette Wetlands where there were violations of water quality standards, TDS of 92%, B of 98%, and Se of 25%. Since 2006, the percent violations for all 3 parameters are similar. There is no significant difference prior to and after 2006 for all 3 parameters.

Table 4-5. Summary of TDS, B, and TDS Violations at 4933480, 4933746, and 4933440.

Station ID / Parameter	N	# Violations	% Violating	N (since 2006)	# Violations (since 2006)	% Violating (Since 2006)
4933480:				4933746:		
TDS	51	38	75%	30	22	73%
B	23	19	83%	16	11	69%
Se	43	23	52%	16	9	56%
4933440:						
TDS	95	87	92%	30	30	100%
B	52	51	98%	20	20	100%
Se	72	18	25%	19	5	26%

TDS, Se, and B data for water quality stations 4933480, 4933746, and 4933440 are shown graphically in Figures 4-5 through Figure 4-10.

Figure 4-5. TDS Observations for Stations 4933480 (Pariette Draw AB Flood Control Structure) and 4933746 (Pariette Draw BL Flood Control Structure).

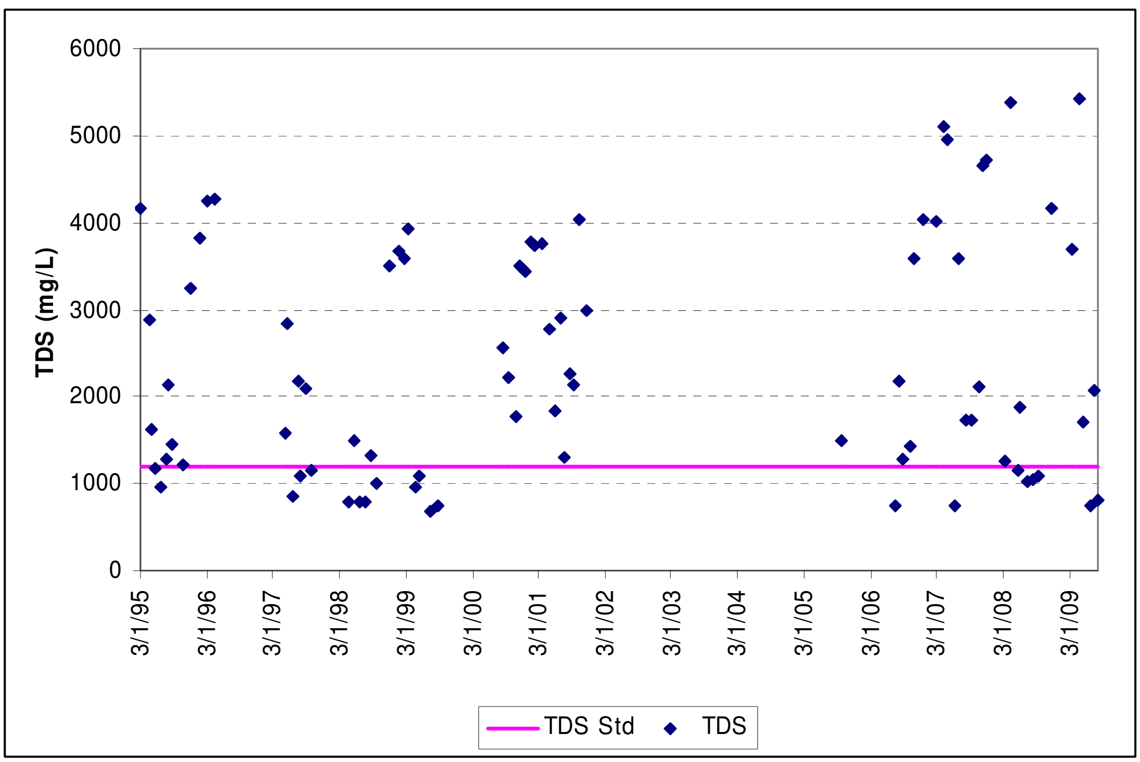


Figure 4-6. Boron Observations for Stations 4933480 (Pariette Draw AB Flood Control Structure) and 4933746 (Pariette Draw BL Flood Control Structure).

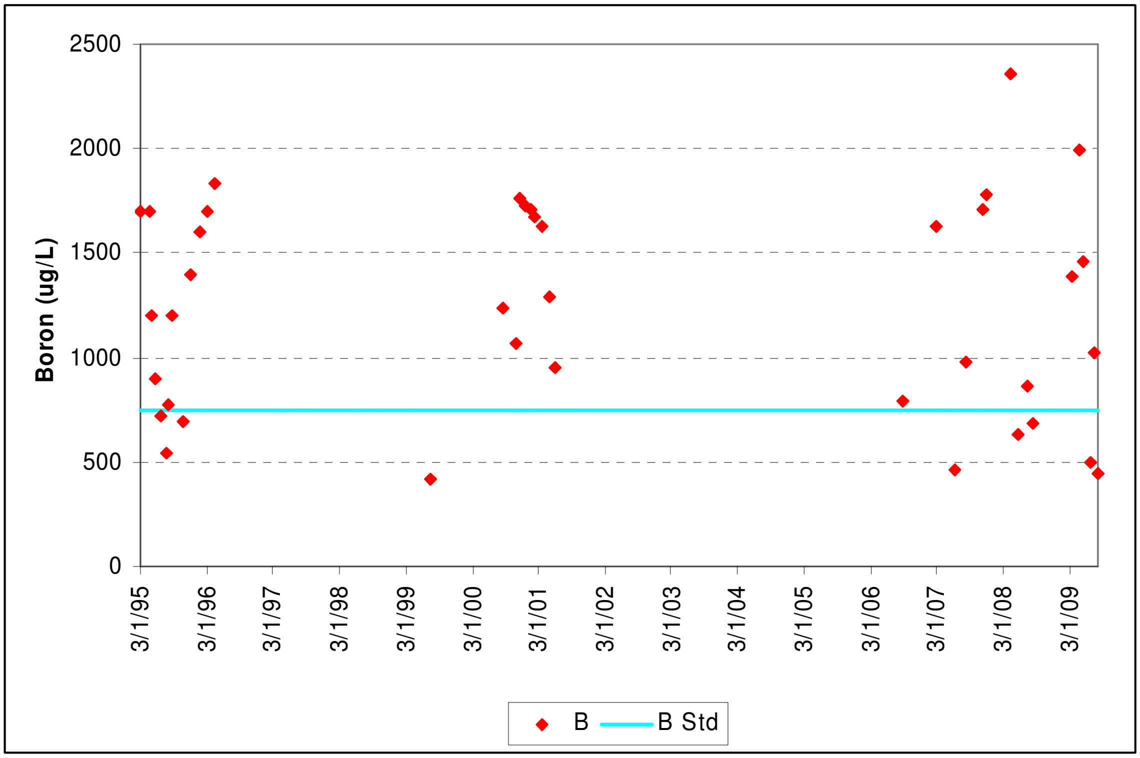


Figure 4-7. Selenium Observations for Stations 4933480 (Pariette Draw AB Flood Control Structure) and 4933746 (Pariette Draw BL Flood Control Structure).

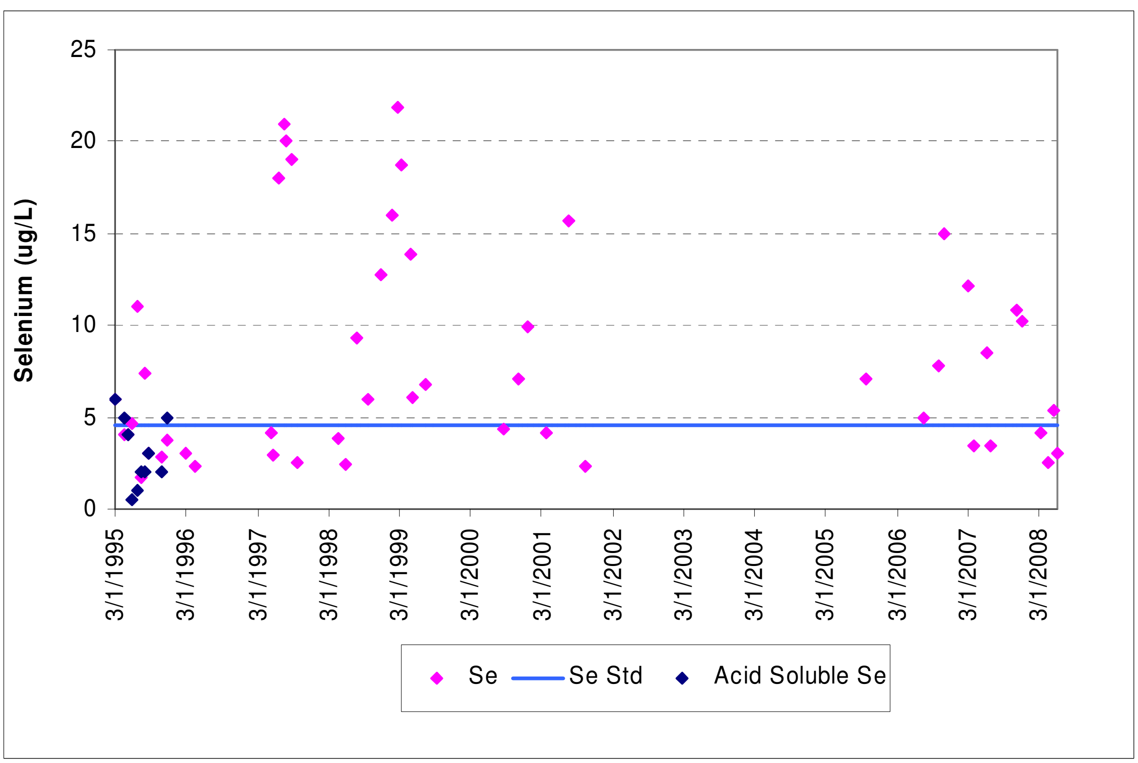


Figure 4-8. TDS Observations for 4933440 (Pariette Draw 1mi AB Confluence of Green River).

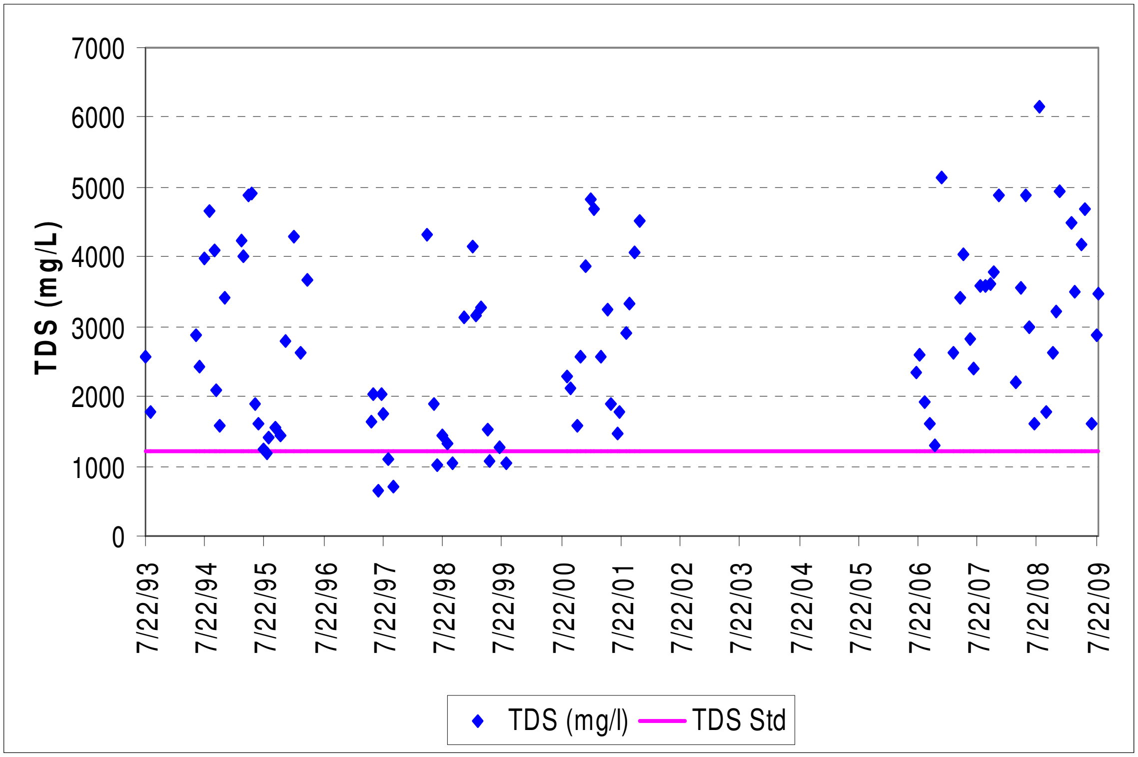


Figure 4-9. Boron Observations for 4933440 (Pariette Draw 1mi AB Confluence of Green River).

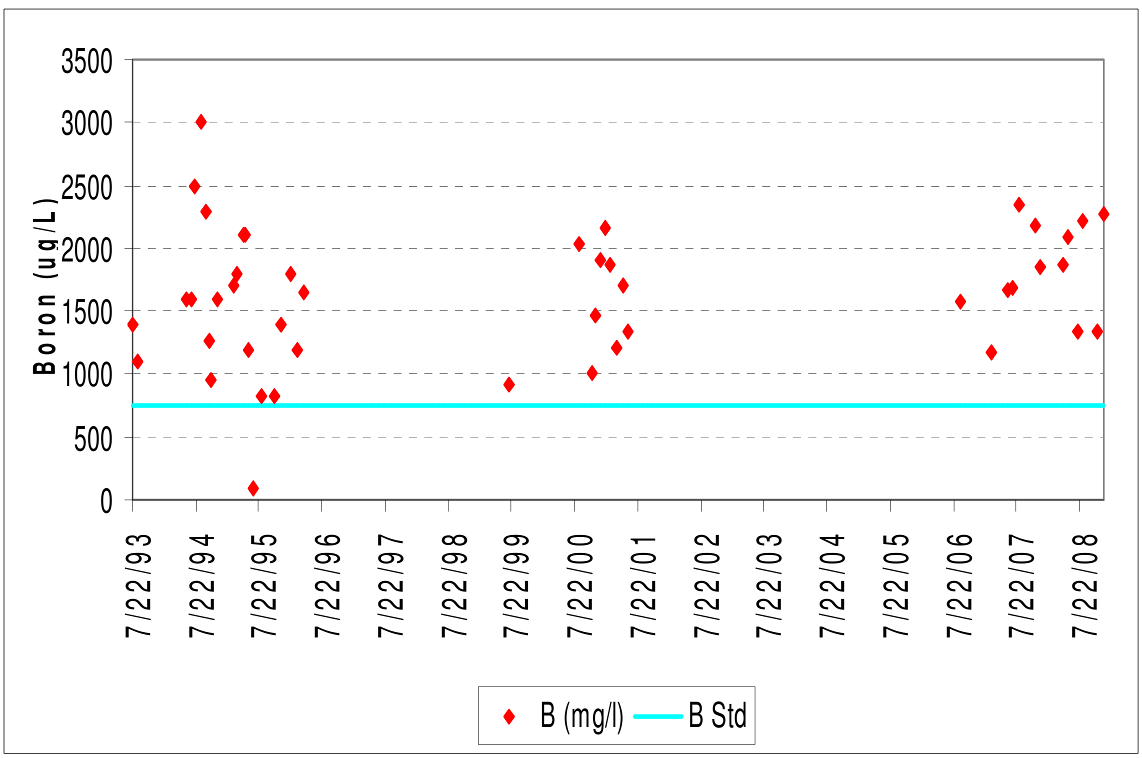
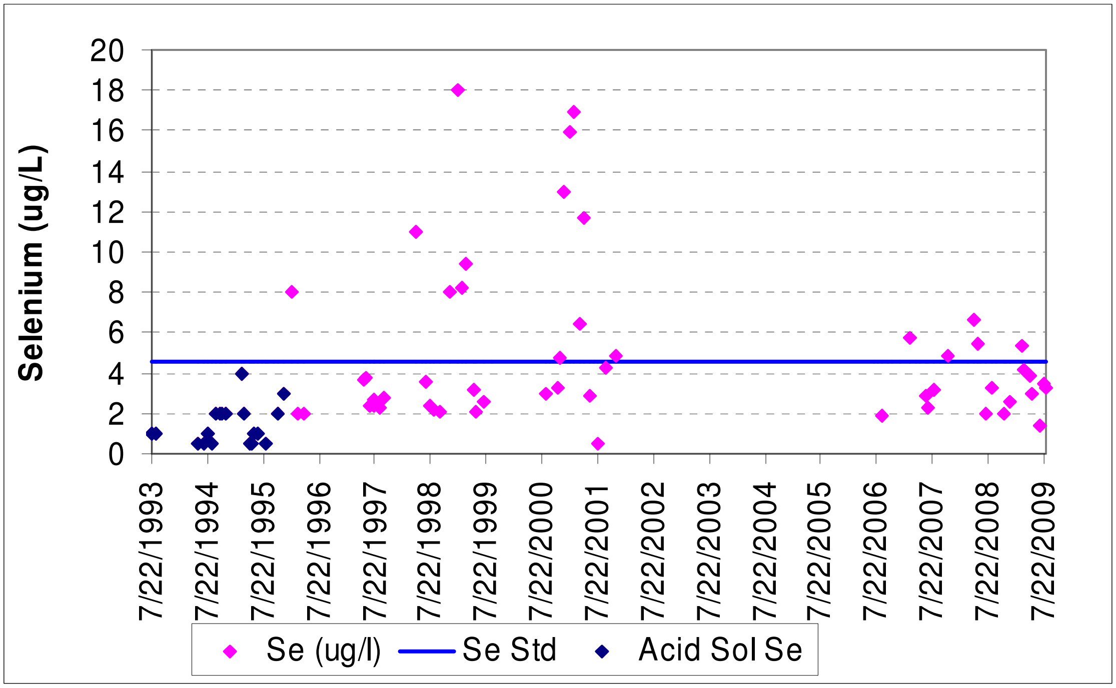


Figure 4-10. Selenium Observations for 4933440 (Pariette Draw 1mi AB Confluence of Green River).



4.4.2 Seasonal Variations in Se, B, and TDS

This section presents the monthly variation in TDS, Se, and B data from UDEQ water quality monitoring stations, in particular 4933440**,** 4933480, and 4933746. Figure 4-11 through 4-15 presents the monthly average parameter concentration. Note that the flow data presented here is instantaneous and not continuous flow data. Continuous flow data was recorded at the USGS flow gauges but does not coincide with the water quality data collection time period so the mean instantaneous flow data from the UDEQ monitoring sites were used in this analysis.

At the Station 4933480/4933476, the average monthly flow is highest in June and July with smaller peaks in March and September. At 4933440, the flow is highest in June with smaller increases during March and October. At both stations, the TDS concentration is lowest during May through October and highest from November through April. There are higher Se concentrations from November through March at the upper STORET site and at the lower STORET monitoring site; the concentrations of Se are below the Se standard from May to October with peaks in December and January. Boron concentrations follow a similar pattern as TDS and Se, with higher concentrations during the winter months than summer at the Flood Control Structure sites, however at the lower site below the Pariette Wetlands, B does not seem to follow any seasonal patterns other than the concentrations are lower during months with higher flow (Figure 4-15). The higher flows are attributed to both intense summer storms and water being diverted from the Duchesne River for irrigation purposes during April through September. Generally speaking, lower pollutant concentrations are associated with higher flows due to dilution. This trend is observed at both sites with all parameters.

Table 4-6. Average Monthly Flow (cfs), TDS (mg/L), B (ug/L), and Se (ug/L) Concentrations at UDEQ Monitoring Stations 4933480/4933476 and 4933440.

	4933480 / 4933476				4933440			
Month	Flow	TDS	B	Se	Flow	TDS	B	Se
January	4.3	3,752	1,655	16.3	3.7	4,411	1,980	14.0
February	5.3	3,790	1,667	14.6	5.7	3,514	1,443	7.6
March	30.3	3,358	1,573	12.4	31.9	3,300	1,535	5.2
April	12.0	3,611	1,834	6.2	7.0	3,643	1,920	6.1
May	19.1	1,672	1,029	4.8	6.5	2,774	1,835	2.6
June	70.8	1,557	561	2.1	24.7	1,893	1,226	2.0
July	10.8	1,240	711	4.4	6.0	1,998	1,780	2.1
August	9.4	1,639	873	4.6	5.9	2,588	2,073	2.2
September	37.9	1,547		4.3	8.8	2,284	2,290	2.8
October	17.2	2,356	880	4.0	25.0	2,423	1,078	2.3
November	6.5	3,680	1,623	10.7	6.9	3,350	1,663	4.6
December	7.0	4,070	1,755	15.5	2.6	4,704	2,010	7.8

Figure 4-11. Average Monthly TDS and Flow Data for Stations 4933480 (Pariette Draw AB Flood Control Structure) and 4933746 (Pariette Draw BL Flood Control Structure).

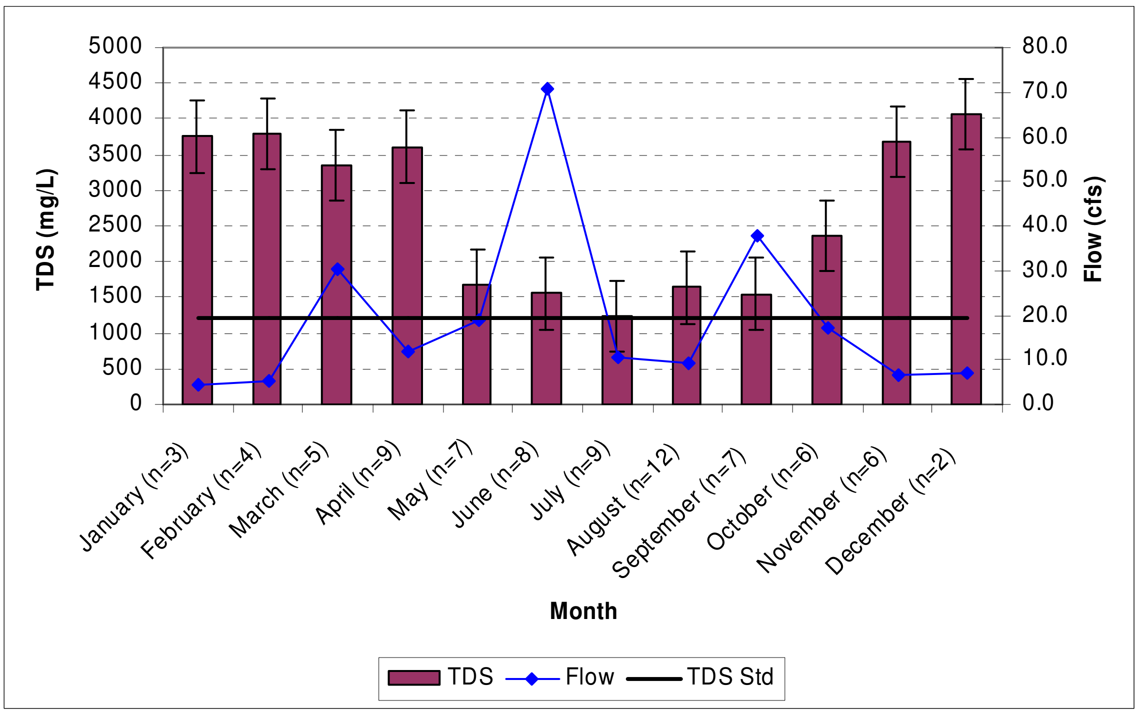


Figure 4-12. Average Monthly Boron and Flow Data for Stations 4933480 (Pariette Draw AB Flood Control Structure) and 4933746 (Pariette Draw BL Flood Control Structure).

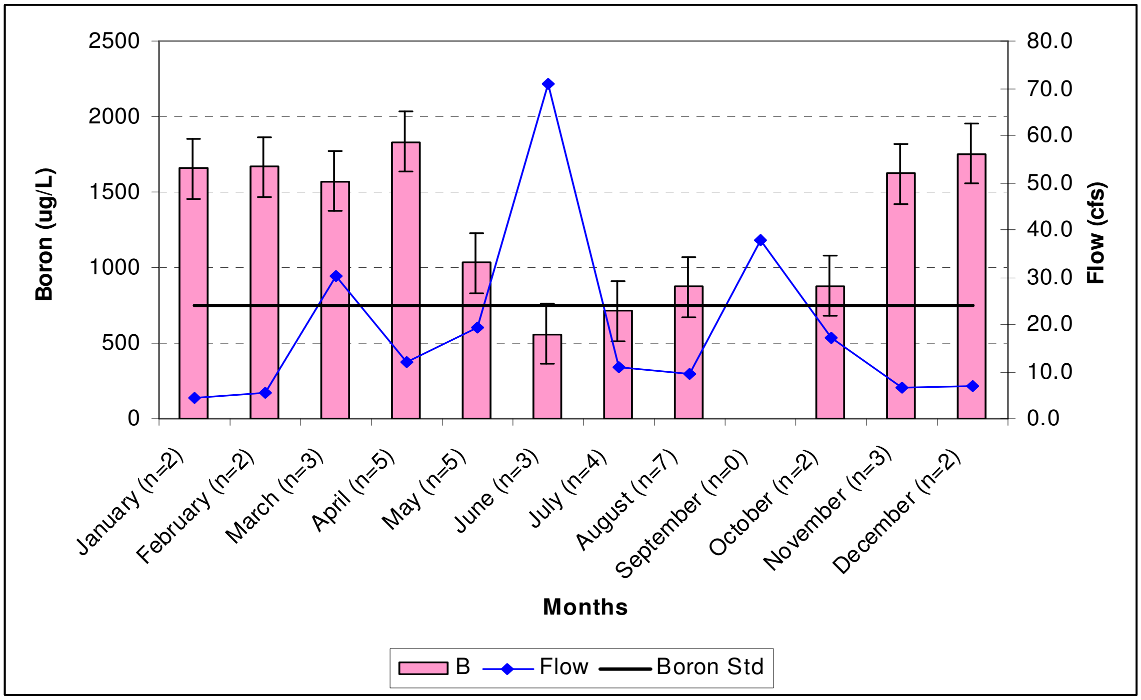


Figure 4-13. Average Monthly Selenium and Flow Data for Stations 4933480 (Pariette Draw AB Flood Control Structure) and 4933746 (Pariette Draw BL Flood Control Structure).

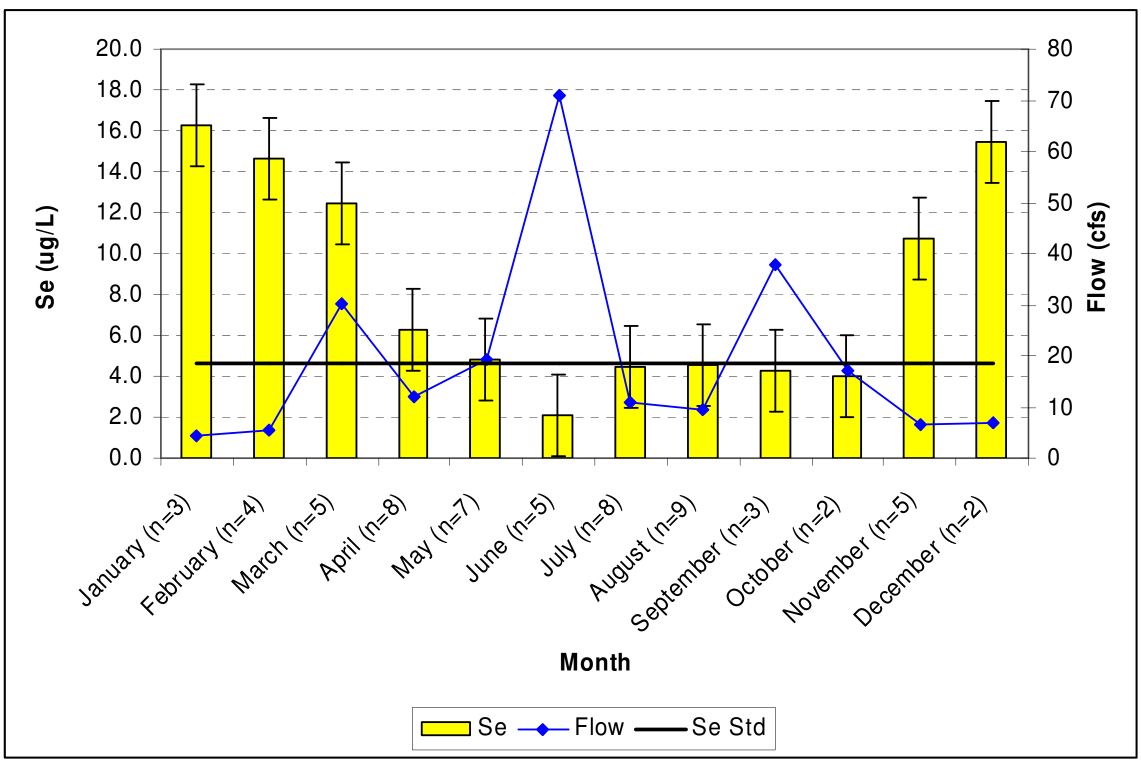


Figure 4-14. Average Monthly TDS and Flow Data for 4933440 (Pariette Draw 1mi AB Confluence of Green River).

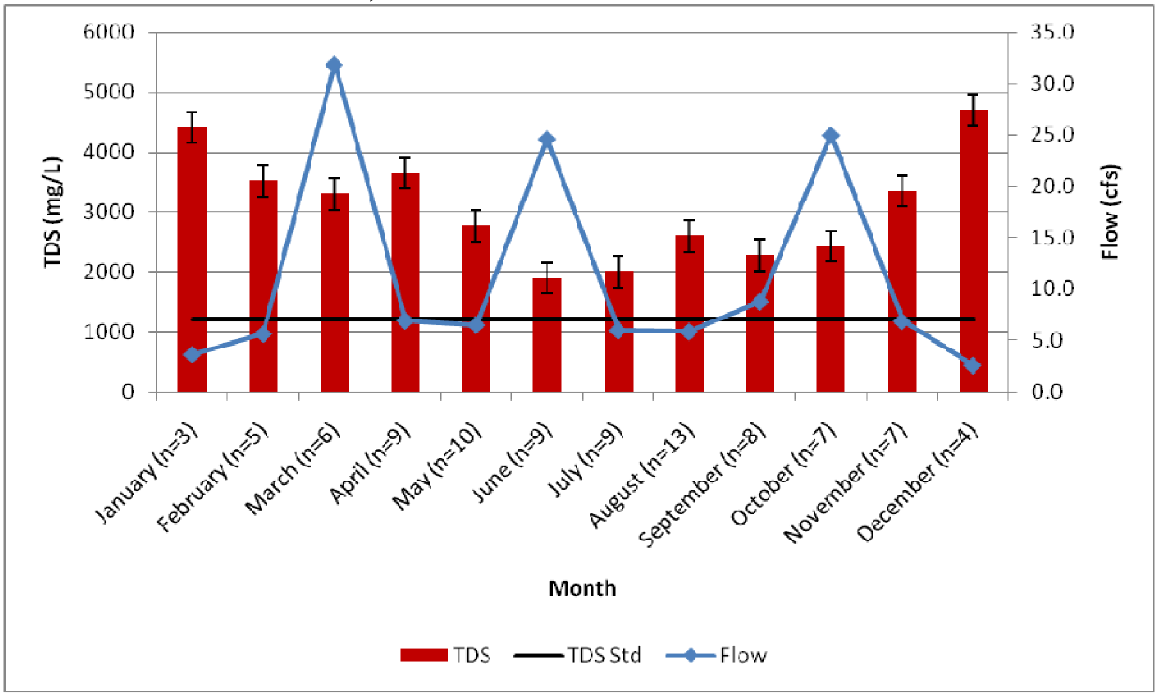


Figure 4-15. Average Monthly Boron and Flow Data for 4933440 (Pariette Draw 1mi AB Confluence of Green River).

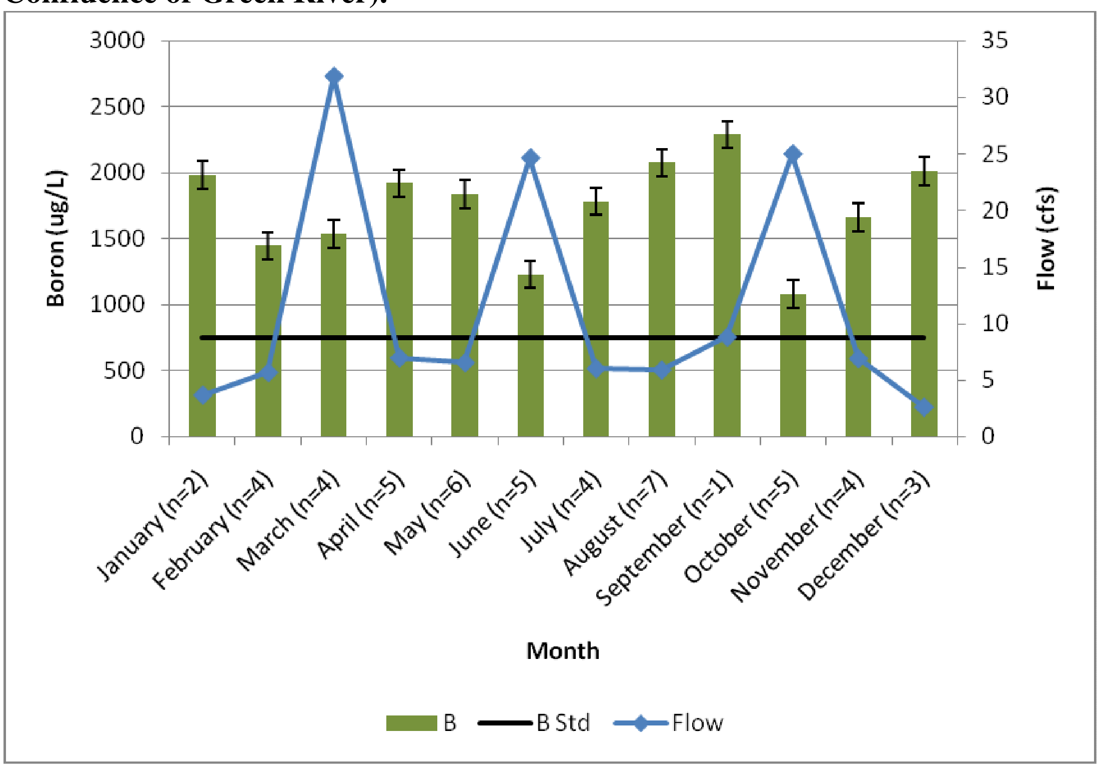
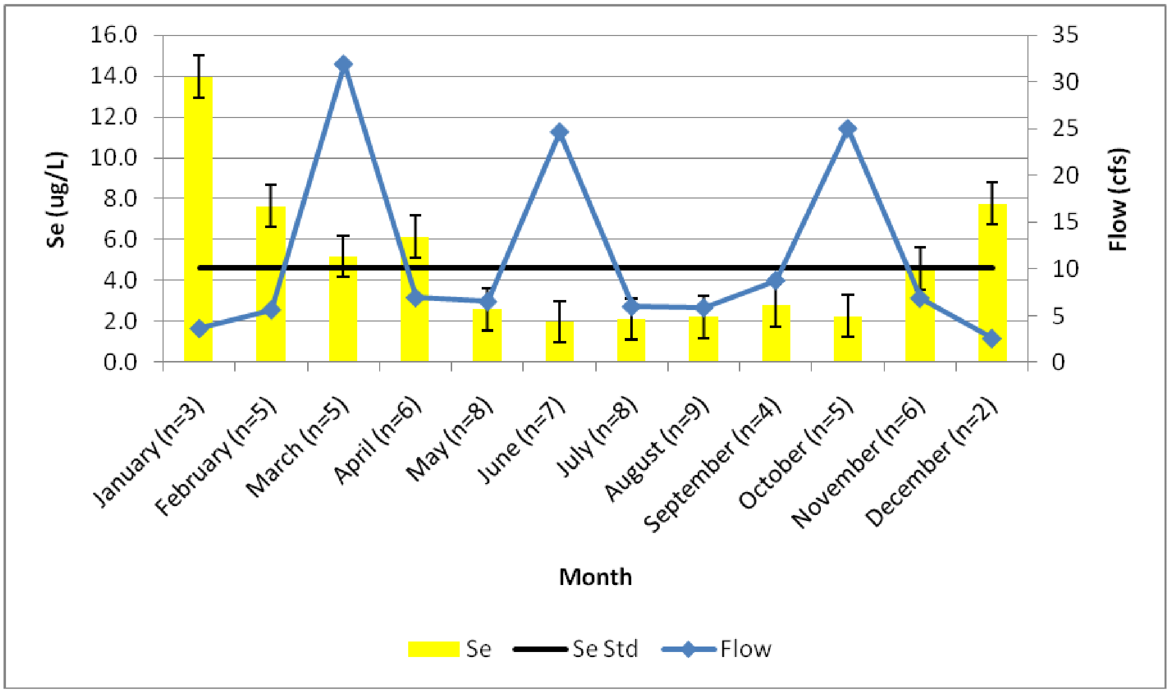


Figure 4-16. Average Monthly Selenium and Flow Data for 4933440 (Pariette Draw 1mi AB Confluence of Green River).



4.4.3 Comparison of UDEQ Water Quality Stations 4933480/4933476 and 4933440

The BLM has built structures along the main stem of the Pariette Draw between UDEQ water quality monitoring sites 4933480/4933476 and 4933440 to both retain the high amount of sediment upstream of the wetlands and also create artificial wetlands for waterfowl species. There are 23 ponds between these 2 sites, including a desiltation structure consisting of gabions to trap and hold sediment. The concentrations of TDS, Se, and B were compared between these 2 sites to see if the ponds and desilt structure make a significant difference in TDS, Se, and B concentrations. Statistical analyses using a 2-tailed *t*-test showed that there were significant differences in all 3 parameters between these 2 sampling sites. Both TDS (p-value = 0.03483) and Boron (p-value = 0.00016) had significantly higher concentrations below the wetlands (4933440), however Selenium (p-value = 0.00028) had a significantly lower concentration below the wetlands than above (4933480/4933476).

These two monitoring sites were also compared with the data collected since December of 2008 (n=8). These analyses used the same statistical test and show different results. There is no significant difference between TDS (p-value = 0.63532) and Se concentrations (p-value = 0.13572) between these 2 sites in the 2008-2009 dataset. Boron concentrations, however, are significantly higher below the wetlands than above with a p-value of 0.01815 with this dataset.

4.4.4 Flow versus Se, B, and TDS Concentrations

To investigate the relationship between flow and pollutants, matching data is normally paired from the UDEQ stations and USGS gauges located throughout the watershed. In the Pariette Draw watershed, water quality data and flow gauge data is not concurrent. The flow data from the USGS flow gauges ended in 1984 and the water quality data from the UDEQ stations did not start until 1993. At USGS flow gauges, Boron data was also collected. See Figure 4-17 through 4-19 for the relationship between flow and Boron at these stations. The correlation coefficient indicates that the relationship between flow and boron is only moderately strong at one of the three stations, 9307200, with an R^2=0.731.

The flow and pollutant concentration relationships at the UDEQ monitoring sites are also not apparent or strong, with correlation coefficients ranging from 0.007 for the relationship between Se and flow at the Flood Control Structure station to 0.280 for the relationship between B and flow at the lower monitoring site (4933440). Note that this relationship is based on grab samples and instantaneous flow data.

Figure 4-17. Flow Data versus Boron for USGS Station 9307300 (Pariette Draw @ Mouth Nr Ouray).

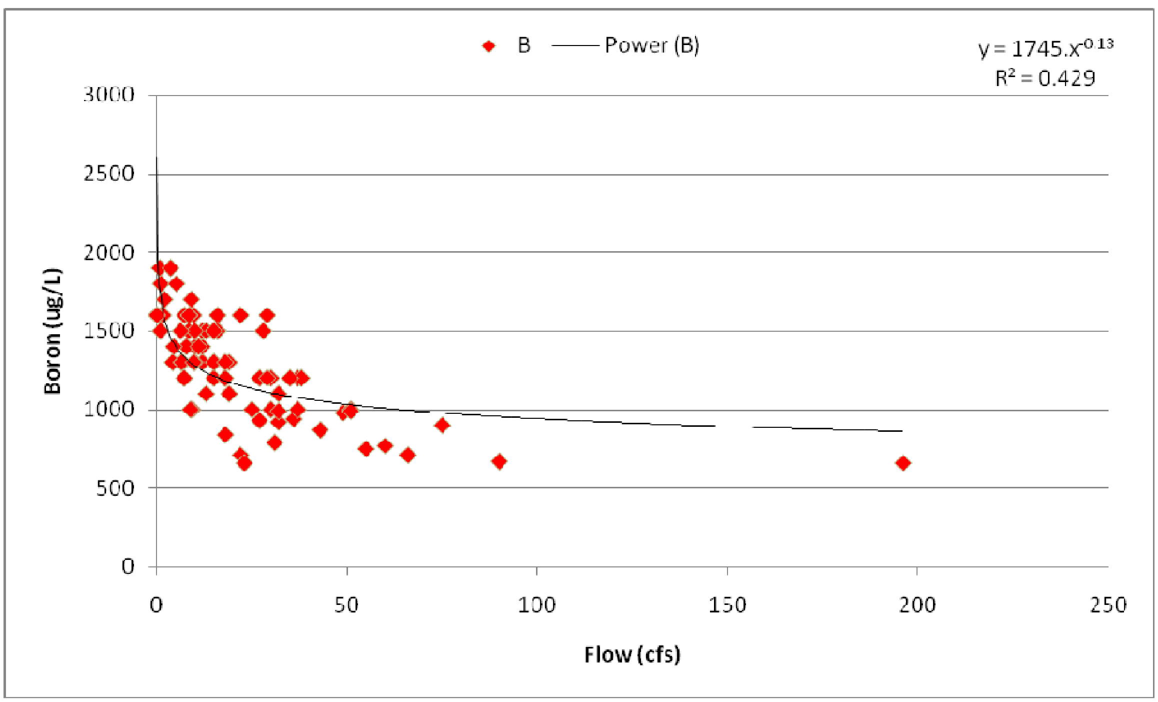


Figure 4-18. Flow Data versus Boron for USGS Station 9307200 (Pariette Draw Nr Ouray).

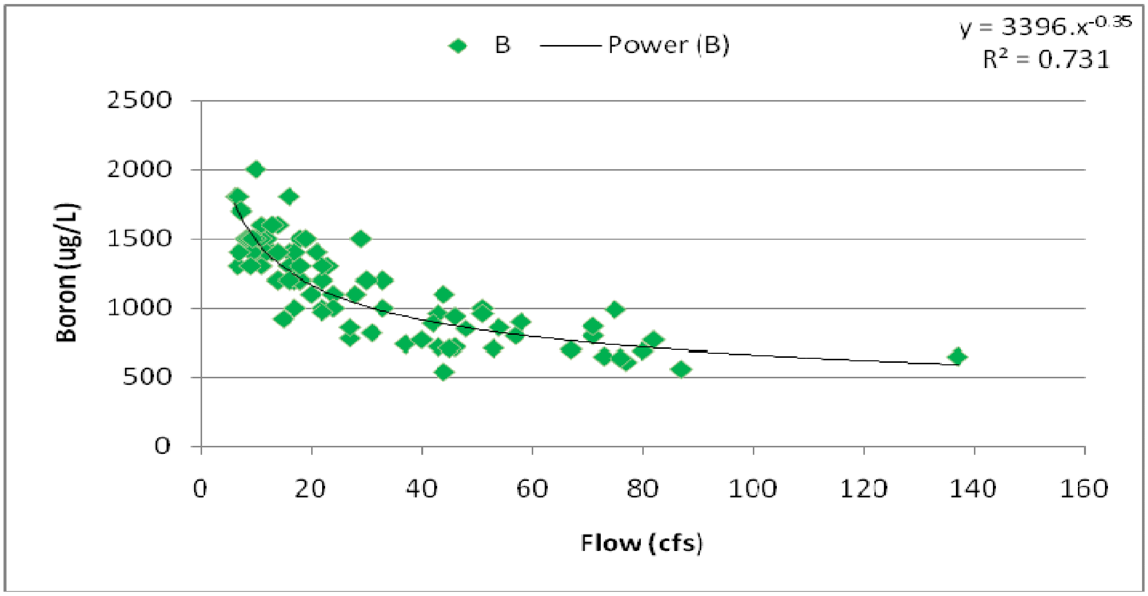
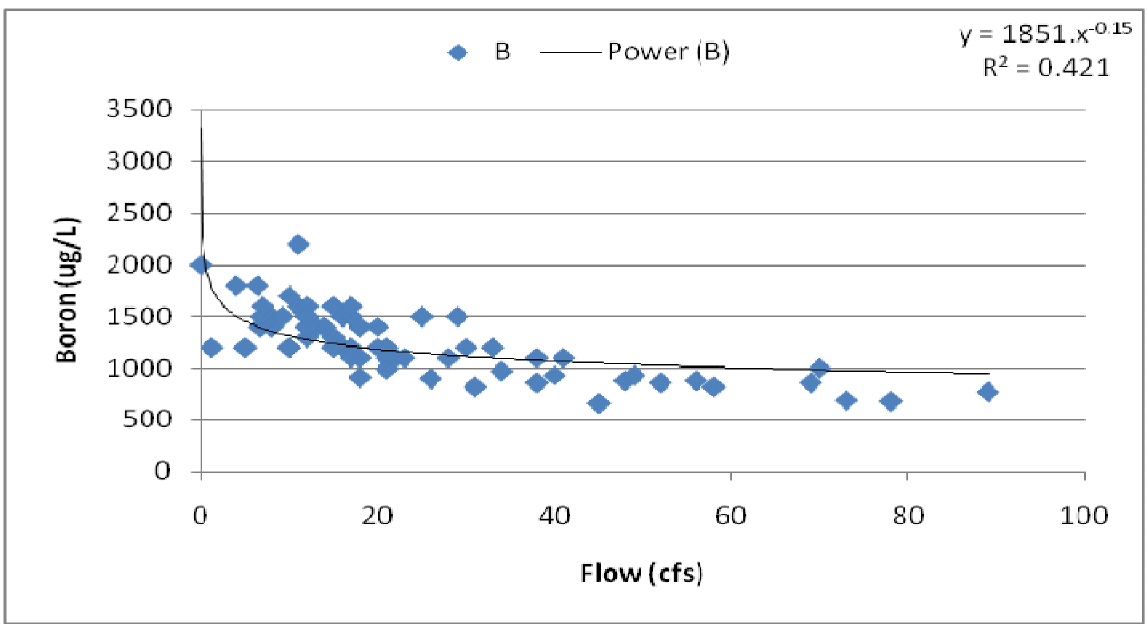


Figure 4-19. Flow Data versus Boron for USGS Station 9307250 (Pariette Draw Nr Eight Mile Flat Nr Myton).



4.5 Conclusions

Of the 12 water quality monitoring stations located within the Pariette Draw watershed, 11 reported exceedances of the TDS and Boron water quality standard and 9 reported exceedances of the Selenium water quality standard. Samples collected at these sites exceeded the TDS water quality standard of 1,200 mg/L between 43-100% of the time, Boron's water quality standard of 750 ug/L was exceeded between 43-100%, and the Selenium water quality standard of 4.6 ug/L was exceeded between 0-100% of the time. The Pleasant Valley Canal was also sampled as part of this monitoring effort. UDWQ

The flow tends to be higher during the irrigation season of April through October, due to the import of water from the Pleasant Valley Canal. During this, the pollutant concentrations are lower due to dilution. The concentrations are higher during the non-irrigation season, October through April. UDWQ and BLM-Vernal will continue to monitor the Pariette Draw watershed as part of an on-going, long-term monitoring strategy.

TDS and Boron concentrations are higher below the wetlands while Selenium is lower. A possible explanation for the decrease in Se below the wetlands is bio-accumulation and/or chemical transformations of Se. Fish and waterfowl species exposed to Se in the wetlands remove it from the system through uptake and retention in their bodily tissue. TDS and B do not bioaccumulate and are transported through the system. USGS conducted a study looking at the bio-accumulation of Se in the Pariette Draw watershed. The study concluded that Se is found in all types of biota from aquatic plants to waterfowl (USGS 1991).

5.0 Source Assessment

Field assessments of the Pariette Draw watershed have been conducted since October 2008 through October 2009 to obtain a better understanding of water quality issues and the potential sources of pollution in the watershed. The assessments were performed through an on-the-ground survey complemented with photo points. During the survey potential sources of pollution were identified. Potential sources include geology, subsurface agricultural return flows, animal feeding operations (AFOs), oil and gas mining activity, and streambank erosion and channelization. The primary sources of pollutant loading are the saline geologic formations prevalent throughout the watershed. Irrigation efficiency improvements have been completed throughout the upper watershed - see section 5.2.2 for more detail and a summary on these efforts.

Available datasets and references used in assessing the pollutant sources in the watershed include the USGS Spatially Referenced Statistical Assessment of Dissolved Solids Load Sources, USDA Salinity Control Program Reports, stream networks and characteristics, watershed boundaries, and soil types and characteristics.

5.1 Assessment of Point Sources

There are no permitted point source dischargers in the Pariette Draw watershed. All pollutant loading is attributed to nonpoint and natural sources. Oil and gas developments must adhere to the BLM's best management practices (BMPs) standards and specifications to prevent runoff from the pads into surface waters and must obtain a permit from Utah Division of Oil Gas and Mining (UDOGM). The industry is required to collect and transport produced wastewater to approved disposal facilities. There is some evidence of illicit discharges of produced water occurring in the past throughout the Uintah Basin because regulatory fines have been levied. Though oil and gas well pads are prevalent in the watershed, they are not considered a major source based on observations of BMPSs employed during site visits in the field. Figure 5-1 shows the oil and gas wells located in the Pariette Draw Basin. There are approximately 2,945 oil and gas wells located in this watershed or 11.4% of the total number of oil/gas wells in Utah. Though the demand for this industry has slowed, there are several hundred more leases that have not been developed yet.

5.2 Assessment of Non-Point Sources

All pollutant loading in the Pariette Draw watershed is a result of nonpoint sources. The following sections describe each potential source. Improvements in water quality will result from addressing one or more of the following sources. It should be noted however that there is the potential for increasing in-stream TDS concentrations by reducing salt loads. This potential initially appears to be counter-intuitive but since imported irrigation water is the predominant source of water in Pariette Draw, increases in irrigation efficiency and crop use will reduce the amount of diluting return flow and hence increase salt concentrations. Therefore this TMDL report recommends proceeding with implementation of BMPs to address anthropogenic sources but recognizes that development of site-specific criteria or use attainability analysis may be required in the future if meeting the existing criterion proves infeasible.

5.2.1 Geology

Significant natural and anthropogenic sources of TDS, Se, and B exist in the Pariette Draw watershed. The area is naturally saline, and there are background contributions of all 3 parameters resulting in elevated concentrations in the streams. Geologic features of the watershed are dominated by the Green River and Uinta formations. Salts are naturally occurring in the Pariette Draw watershed due to bedrock materials that are easily weathered. These salts are found in varying concentrations in soils and waters throughout the basin. In arid regions, salts accumulate in soils due to evaporation, which concentrates salts in the upper soil layers. However, due to the highly modified hydrology of the watershed from canals and diversions, it is almost impossible to identify the true "natural" condition of the watershed. See 2.4 for more information on the geology of the watershed.

Figure 5-1. Locations of Oil and Gas Wells in the Pariette Draw Watershed.

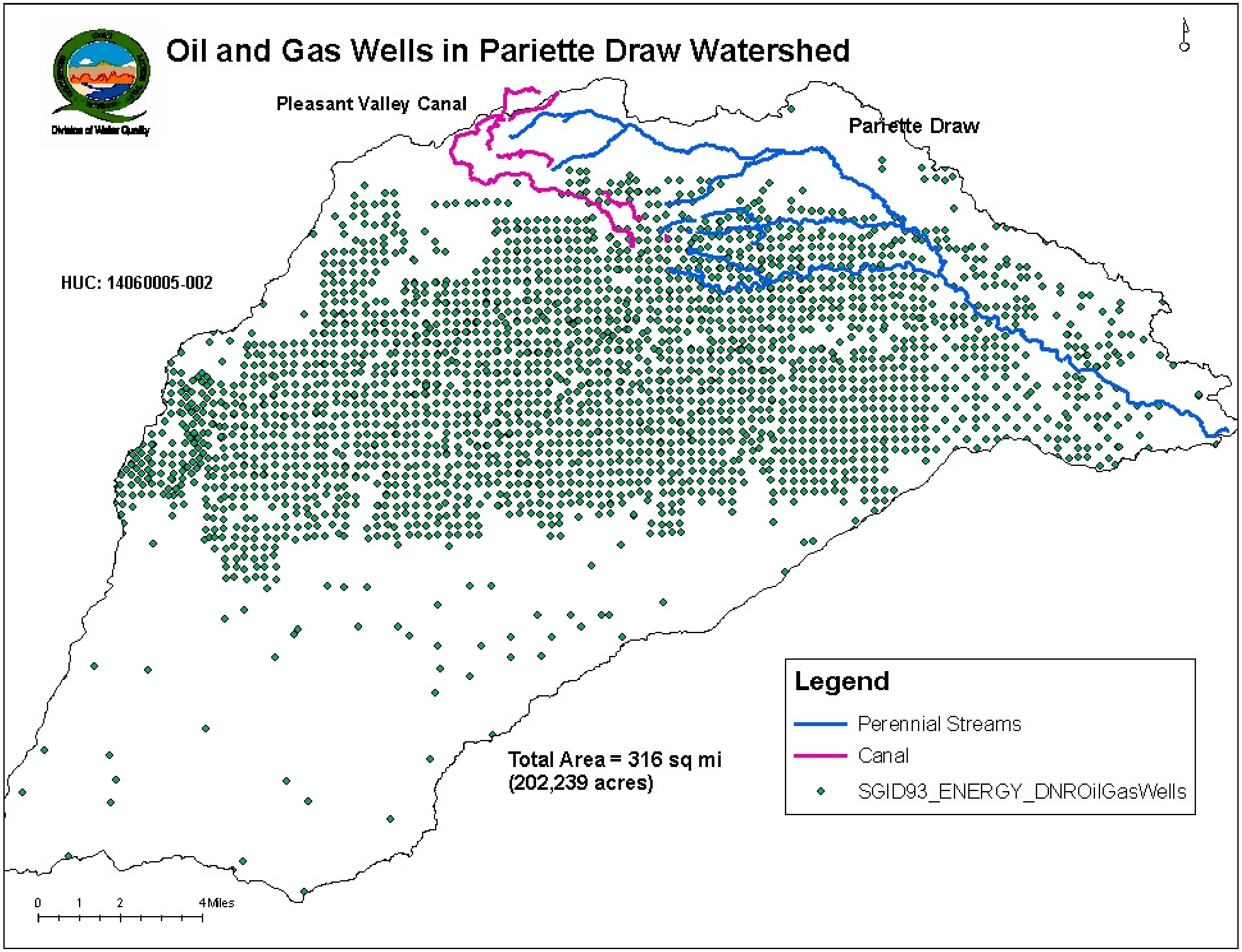


Figure 5-2. Saline Geologic Formation in Pariette Draw Watershed.

5.2.2 Irrigation Return Flows

The majority of the water in Pleasant Valley used for irrigation and stock watering comes from the Duchesne River, which is diverted approximately 15 miles upstream. That water is high quality with TDS concentrations below500 mg/L. Return flows from irrigated field however are a source of TDS, Boron, and Selenium loads. Irrigation water and natural precipitation in excess of soil holding capacity and plant requirements percolates through the soils and transports these pollutants into the shallow alluvial aquifer (groundwater) eventually returning to the watershed streams as base flow. Deposition of salts on the ground surface also seals the soil pores preventing percolation and increasing the volume and velocity of runoff leading to sheet flows and increased pollutant loading.

Irrigation return flows in the watershed are a potential source of salinity because they dissolve and transport soil particles and salts from fields and return them to surface waters through surface and subsurface flows. Flood irrigation in particular is a potential source of salinity because of the large amounts of excess water used to leach salts from the soil surface. During the field assessment, it was noted that almost all of the agricultural fields in the watershed were irrigated by some method and most fields were irrigated with efficient sprinkler systems. Table 8-1 shows that approximately 17,000 acres of irrigated land within the watershed have already been upgraded to either central pivots (48%) or wheel lines (46%) and only 6% remain as flood irrigated lands. Return flows were mostly through subsurface flows. See Section 8.1 for more information regarding irrigation upgrades to the Pariette Draw Watershed.

5.2.3 Streambank Erosion

Selenium and TDS loading attributable to streambank erosion is highly variable from year to year, depending primarily on the magnitude and duration of peak flows and the streambank's soil type. Soils in the Pariette Draw watershed are derived from alluvial material and the Uinta formation. In general, the main stem of Pariette Draw is fairly stable in most locations. However, there are areas where erosion occurs, especially in the upper watershed throughout Pleasant Valley. Table 2-3 shows that the major soil type is Uffens loam (36%), which contains moderate to high amounts of salts, particularly sodium (Na). These alkaline soils have a low permeability, low runoff, and are highly erodable.

Livestock grazing can result in surface disturbance and soil compaction, which can decrease infiltration, vegetative cover, and streambank stability, thereby potentially increasing pollutant loading. Dahkuh and Gifford (1980) found that untrampled soils exhibit more than two times the infiltration rate as trampled soils. They also reported that by increasing the cover of grasses from 30 to 50%, erosion was decreased by more than 50%. Streambank erosion caused by watering animals in readily accessible streamside areas can also result in increased sediment production and loading (UDEQ 2007).

Figure 5-3. Example of Streambank Erosion in the Pariette Draw Watershed.

5.2.4 Animal Feeding Operations

Several animal feeding operations (AFOs) are present in the Pariette Draw watershed, primarily located in the Pleasant Valley area. These areas have the potential to affect water quality, particularly those in direct proximity to watershed streams and canals, allowing for direct discharge of animal waste to the surface water and through increased erosion rates from lack of vegetation and hoof action.

Figure 5-4. Example of Cattle Access to Water in Pariette Draw Watershed.

5.2.5 Exotic Vegetation

Tamarix, also known as salt cedar, (Tamarix ramosissima, Tamarix chinensis, and Tamarix ramosissima x chinensis) is a non-native species that has established itself throughout many parts of the Southwest, including in the Pariette Draw watershed. Tamarix dominates much of the lower watershed riparian corridors. Tamarix has deeper roots than most native vegetation and is therefore able to survive in riparian corridors with lower groundwater tables and is able to withstand extended drought conditions better than most native vegetation. In addition, Tamarix is able to germinate and seed when many native plants cannot.

The presence of Tamarix is exacerbated by the fact that peak flood flows in many streams, including Pariette Draw, are greatly diminished due to diversions for agricultural, wildlife and domestic water uses. The containment of spring flood flows suppresses the recruitment of native vegetation, such as cottonwoods and willows. Tamarix is also able to survive in heavily grazed areas due to its low palatability to cattle.

Tamarix is both a direct and indirect source of increased TDS to surface waters. First, Tamarix excretes salt as it grows which is then deposited within the riparian corridor (Stromber *et al*. 2002). Secondly, Tamarix trees are an indirect source of impairment because of the relatively large quantities of water they consume compared to native vegetation. This water is lost to evapotranspirational rather than being available to the stream. Estimated evapotranspirational water used by Tamarix varies from 1.2 to 10.2 acre-feet per year. A mature tree can transpire 78 gallons/day (IBWC 2005).This can lead to reduced flows and higher salinity concentrations in areas where the riparian corridor is densely populated with Tamarix.

Figure 5-5. Tamarix Dominates the Riparian Corridor Along the Lower Pariette Draw.

5.3 Summary of Sources

Observed TDS, B, and Se concentrations support the conclusion that weathering and erosion of the geology and soils is transported to Pariette Draw through irrigation return flows and shallow groundwater (subsurface) flows. Through the Colorado River Basin Salinity Control Program, a majority of the irrigated lands have been converted from surface flood to pressurized irrigation systems, reducing return flows and deep percolation (Section 8.1). However some proportion of this irrigation water still returns to the Pariette Draw. It must be recognized that without these return flows the wetlands downstream would dry out during the summer. Oil and gas developments, roads, and livestock grazing are also identified as sources of human-induced loading to Pariette Draw.

"Natural condition" implies the absence of human manipulation. The hydrology of the Pariette Draw watershed been extensively altered to allow for human settlement and use. Without a reference condition, it is impossible to determine what effect that alteration and use has had on water quality and to what degree natural and anthropogenic sources influence these pollutants. Given the interconnectedness of the surface and groundwater hydrology and the watershed's natural salinity, there is ample uncertainty in identifying the sources of pollutant loads in this watershed.

The watershed characteristics that make it difficult to identify natural conditions also make it difficult to isolate specific areas or sources of loading. The watershed is characterized by an extensive network of diversion canals and irrigation ditches that divert and transport water within the watershed as well as into and out of the watershed. It would be impossible to appropriately establish representative conditions and evaluate loadings and responses at specific points in this complex stream network. Therefore, the TMDL analyses will focus on the watershed as a whole, not isolating loading from specific areas or sources.

6.0 Technical Approach

Establishing a relationship between the in-stream water quality targets and source loading is a critical component of TMDL development. Identifying the cause-and-effect relationship between pollutant loads and the response in water quality concentrations is necessary to evaluate the loading capacity of the receiving waterbodies. The loading capacity is the amount of pollutant that can be assimilated by the waterbody while still attaining water quality standards. In other words, the load capacity, or maximum allowable load, is calculated by multiplying existing flows by the water quality standard. This section discusses the calculation of the loading capacity and existing Se, B, and TDS loadings in the Pariette Draw watershed.

6.1 Technical Analysis

Methods available for estimating existing and allowable loading include watershed models and statistical analysis of existing water quality data. A watershed model consists of a series of algorithms applied to watershed characteristics and meteorological data to simulate naturally occurring land-based processes over an extended period of time, including hydrology and pollutant transport. Many watershed models are also capable of simulating instream processes using the land-based calculations as input. Once the model has been adequately set up and calibrated for a watershed, it can be used to quantify the existing loading of pollutants from subwatersheds or land use categories. Models can also be used to assess the potential benefits of various implementation efforts.

Watershed models used to simulate hydrology and pollutant transport over large spatial scales often are not able to accurately incorporate the complexities associated with significant anthropogenic alterations to watershed-scale hydrological processes when water quality data is limited. These alterations can include diversions, canals, and other withdrawals or discharges to surface or ground water. The large number of diversions, canals, and other irrigation pathways has significantly altered the hydrology of the Pariette Draw watershed. Because of the difficulties associated with setting up and calibrating a watershed model for the Pariette Draw watershed, a statistically based load duration curve method was used instead to calculate the loading capacities and existing loadings within the watershed.

The load duration approach relies on instream data, allowing direct comparisons between existing conditions and conditions required to meet water quality standards. It also accurately identifies the allowable and existing loads, uses data for all flow and loading conditions, and provides insight into critical conditions. The approach also provides consistency with other TMDLs calculated in Utah, including those in the Virgin River watershed, Duchesne River watershed, and Uinta River watershed. However, disadvantages to using a statistical approach are that is provides limited information regarding the source of the loads and does not allow simulations of BMPs effectiveness. Therefore, the TMDL was supported by field surveys to identify and characterize the watershed and focus implementation efforts.

The load duration approach for the Pariette Draw watershed TMDL included the following steps:

1. A flow duration curve for the river segment was developed using the available flow data and generating a flow frequency table that consisted of ranking all the observed flows from the smallest observed flow to the greatest observed flow and plotting all the values.
2. The flow duration curve was translated into a load duration curve by multiplying each flow by the water quality standard and plotting the results. This represents the loading capacity for each observation.
3. Each observed parameter value was then converted to a daily load by multiplying the sample concentration by the corresponding observed flow.
4. Per Utah's Assessment Strategy, a 10% exceedance of the water quality standard is allowed for TDS and B and one sample may exceed the Se water quality standard in three years. This methodology was taken into account in calculating the TMDLs by reducing the data set to allow for allowable exceedances.
5. The largest difference between the observed load and allowable load for each flow regime was compared to identify the necessary load reductions during critical conditions. Both loads for each flow regime were then plotted on the TMDL graph.
6. Loads plotted above the curve represent exceedances of the load capacity. Loads plotted below the curve represent compliance with standards and represent allowable daily loads.

Through careful interpretation, the load duration approach can help identity the major issues contributing to the impairment and differentiate between various types of sources. Loads that plot above the allowable load curve in the 1-10% flow ranges (high flow conditions) represent hydrologic conditions of extreme flooding. Loads plotting above the curve between the 10-60% flow ranges likely reflect precipitation driven contributions (nonpoint sources). Those plotting above the curve in 70- 90% flow ranges are likely indicative of constant discharge sources. Loads that plot above the curve in greater than 90% reflect hydrologic conditions of extreme drought.

6.2 Stations and Data Used in the Analysis

Ideally, the load duration approach includes sufficient matching flow and pollutant observations across all flow ranges. While there are sufficient datasets of TDS, B, and Se concentrations at monitoring stations in the Pariette Draw watershed, there are limited flow data. Water quality stations used to calculate TMDLs were selected on the basis of their locations and also the quantity of water quality data. To characterize the water quality representative of the entire impaired watershed, the farthest downstream station was selected.

A percent ranking model based on flow was used to establish associated Se, TDS, and B loads. Ideally, this load duration approach is applied at the monitoring stations for each listed segment with corresponding parameter and flow data. It is important to have data for all flow conditions and to have sufficient matching flow and parameter data across all flow regimes. While there are sufficient datasets of the 3 parameters in this watershed, there are limited continuous flow data. To characterize the water quality representative of the entire impaired watershed, the farthest downstream station was selected. The data and flow record at the UDEQ 4933440 (Pariette Draw 1 mi AB confluence Green River) was used to develop the flow duration curves and the loading analyses for the TMDLs. The observed flows (7/93 to 11/09) were ranked in order of magnitude and each flow was assigned a percentile that reflects the chance of a flow greater than or equal to it. To evaluate the allowable Se, TDS, and B loadings for the watershed, each flow was then multiplied by the 4.6 ug/L, 1,200 mg/L, and 750 ug/L criterion, respectively, to calculate a corresponding maximum loading limit for each flow. The individual lines were plotted to present a loading capacity line by flow percentile, as shown in Figures 7-1, 7-5, and 7-9.

7.0 TMDL Allocations

7.1 Description of TMDL Allocation

A TMDL is composed of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for non-point sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. The TMDLs for Se, B, and TDS for Pariette Draw are expressed on a mass loading basis.

The TMDL process is designed to establish the total loading a stream can assimilate without causing violation of the water quality standards. Because of the complex hydrology, the interconnectedness of the sources, and the location and temporal record of the monitoring data, these TMDLs do not distinguish between the contribution of Se, B, and TDS from the various tributaries. Therefore, the TMDL analyses will focus on and establish the TMDLs for the entire watershed of Pariette Draw based on flow. The TMDLs are calculated on a daily basis to account for complex and varying hydrology and critical conditions in the watersheds and consistent violations of Se, B, and TDS water quality standards.

7.2 Selecting a Margin of Safety

The MOS is a required part of the TMDL development process. There are two basic methods for incorporating the MOS (USEPA, 1991). Implicit methods incorporate the MOS using conservative model assumptions to develop allocations. Explicit methods specify a portion of the total TMDL as the MOS, allocating the remainder to sources.

For the Pariette Draw TMDLs, the MOS was included explicitly by allocating 10 percent of the loading capacity to the MOS due to the uncertainties regarding the proportion of natural versus anthropogenic sources and with the data gaps primarily associated with flow.

7.3 Allocation Summary

Existing loadings of Se, TDS, and B for the Pariette Draw watershed were calculated using monitoring data and flow measurements from station UDEQ 4933440 (Pariette Draw 1 mi AB confluence Green River). UDWQ will continue to monitor Pariette Draw indefinitely, allowing more accurate tracking of changes in water quality over the long term. This section presents the methods and results of the analysis of existing Se, TDS, and B loadings in the watershed.

Table 7-1 summarizes the Se, TDS, and B load reductions identified to meet the TMDL allocations for each flow range. Details on the allowable and existing loads are included in the following sections.

Figure 7-1. Summary of Load Reductions Needed in the Pariette Draw Watershed.

Flow Percentile Ranges	Selenium (% reduction)	Total Dissolved Solids (% reduction)	Boron (% reduction)
0-10%	0.0	64.8	40.9
10-40%	28.1	65.8	53.1
40-60%	72.8	75.1	64.3
60-90%	60.7	71.0	59.7
90-100%	58.2	73.4	70.1
Average	43.9	70.0	59.6

Because of extensive hydrologic modifications and the use and reuse of water for irrigation and other uses in the Pariette Draw watershed, it is difficult to separate anthropogenic influences on instream concentrations from those of natural conditions caused by saline soils and resulting loads in runoff and groundwater sources. If the load reductions identified in these TMDLs are attained from current or future salinity projects and water quality standards are still being violated, these TMDLs will be reviewed and site-specific standards or use attainability analysis performed based on the additional data collected. Regardless of the short-term effect on instream flows and concentrations, the available and recommended BMPs will help continued improvements in irrigation efficiency and downstream water quality will ultimately benefit.

7.4 Selenium TMDL

This section presents the wasteload and load allocations for Se in the Pariette Draw watershed.

7.4.1 Wasteload Allocation

Because there are no point sources discharging into Pariette Draw, the wasteload allocation is 0 lbs/day.

7.4.2 Load Allocation

Water quality and flow data at station 4933440 were used to calculate the existing and allowable Se loads for Pariette Draw. The results of the load duration curve analysis are presented in Figures 7-1 and Table 7-2. Se loads above loading capacity occur during all flow periods except high flow period (0-10%). The greatest load reduction needed (72.8%) is needed for the mid-range flows (40-60%). Since there are no point sources in this watershed, all allowable loading are allocated to nonpoint and background sources.

Figure 7-1. Se Load Duration Curve at Station 4933440.

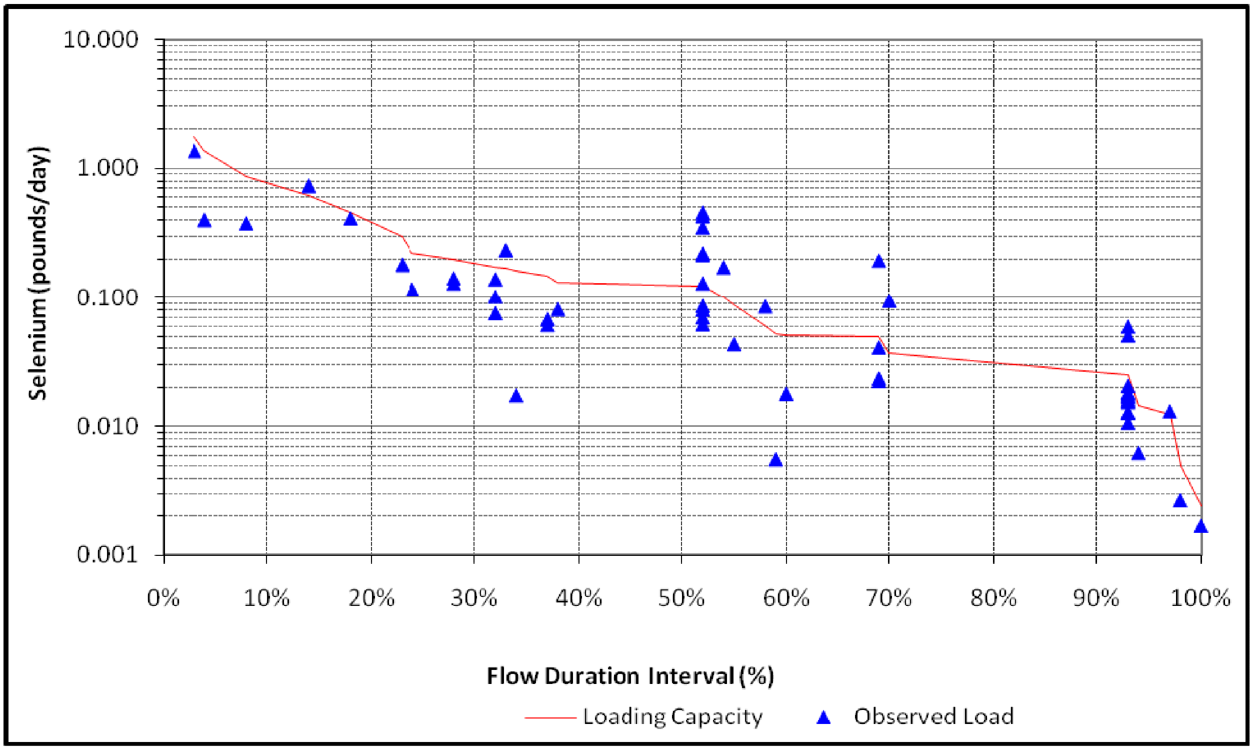


Table 7-2. Observed and Allowable Se Loading at Station 4933440.

Flow Percentile Ranges	52-Sample Distribution	Average Observed Flow (cfs)	Allowable Load (lbs/day)	Observed Load (lbs/day)	Reduction (%)
0-10	3	66.8	1.374	0.4	0.0
10-40	13	13.8	0.169	0.235	28.1
40-60	13	4.8	0.124	0.455	72.8
60-90	8	1.9	0.037	0.095	60.7
90-100	15	0.8	0.025	0.059	58.2

7.4.3 TMDL

Figure 7-2 shows the Se TMDL graphically for Pariette Draw watershed including the observed loading, loading capacity, and the load allocation (loading capacity minus the 10% MOS). The Selenium TMDL is summarized in Table 7-3 and includes suggestions for implementation opportunities for each flow regime. There is no load reduction needed in the high flow stages (0-10%). The TMDL corresponds only to the 10-100% flow regimes. The implementation strategies should be focused on erosion control, riparian buffers, and efficient irrigation water management.

Figure 7-2. Se TMDL Summary for Pariette Draw Watershed.

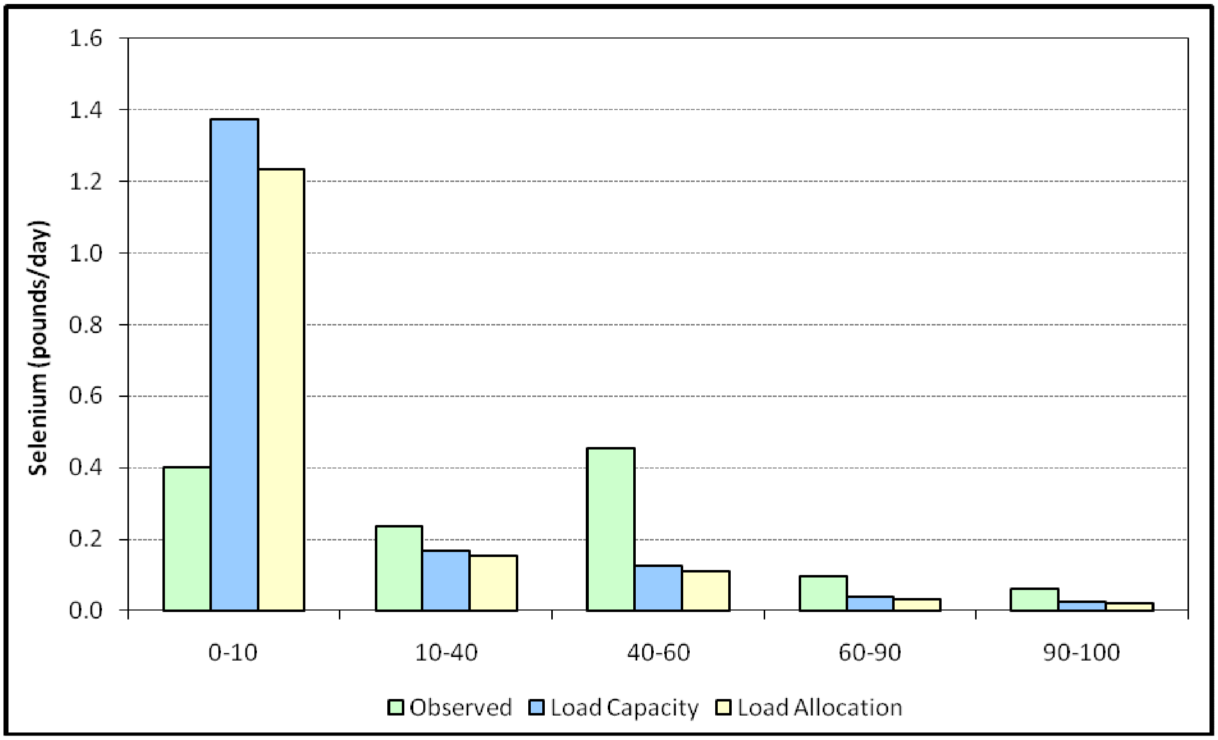


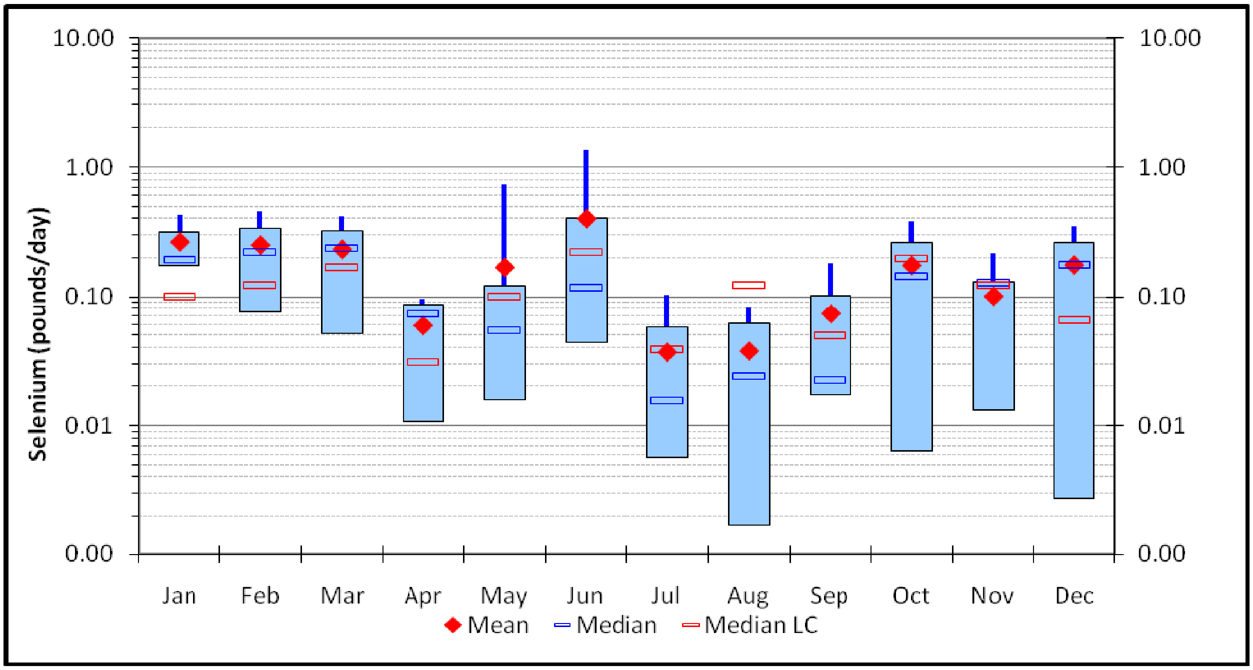
Table 7-3. Selenium TMDL (lbs/day) Summary for Pariette Draw Watershed.

TMDL Summary (lbs/day)	High (0-10%)	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)	Low (90-100%)
Observed Load	0.40	0.23	0.46	0.09	0.06
Load Capacity (TMDL)	1.37	0.17	0.12	0.04	0.02
Load Reduction	0.00	0.07	0.33	0.06	0.03
% Load Reduction	0.0%	28.1%	72.8%	60.7%	58.2%
Margin of Safety	0.14	0.02	0.01	0.00	0.00
Load Allocations	1.24	0.15	0.11	0.03	0.02
Wasteload Allocations	0.0	0.0	0.0	0.0	0.0

7.4.4 Seasonality

Se loads calculated from the irrigation (April – September) and non-irrigation seasons were compared to evaluate the effects for irrigation water management on Pariette Draw. Figure 7-3 shows the monthly average observed and allowable loading. The observed loading is generally higher during the fall and winter months (non-irrigation season). The loading capacity for the irrigation season is approximately double the loading capacity for the non-irrigation season. Figure 4-17 shows that Se loads in the irrigation season are lower than the non-irrigation season due to increased flow that in turn allows for a greater loading capacity. This observation could suggest that the source of Se is not coming from the irrigation return flow but from natural sources such as groundwater and the geologic formations; however, the high loading in the late spring and early summer are due to the flushing of salts from the irrigation fields and high loading post irrigation season could be attributed to the latent draining of irrigated lands along with erosion.

Figure 7-3. Monthly Average Se Loading Compared to the Average Loading Capacity (LC) at Station 4933440.



7.5 Total Dissolved Solids (TDS) TMDL

This section presents the wasteload and load allocations for TDS in the Pariette Draw watershed.

7.5.1 Wasteload Allocation

Because there are no point sources discharging into Pariette Draw, the wasteload allocation is 0 tons/day.

7.5.2 Load Allocation

Water quality and flow data at station 4933440 were used to estimate the existing and allowable TDS loads for Pariette Draw. The results of the load duration curve analysis are presented in Figures 7-4 and Table 7-4. They indicate that TDS loads above loading capacity occur during all flow periods. Since there are no point sources in this watershed, all allowable loading is allocated to nonpoint and background sources. The implementation strategies should be focused on erosion control, riparian buffers, and efficient irrigation water management.

Figure 7-4. TDS Load Duration Curve at Station 4933440.

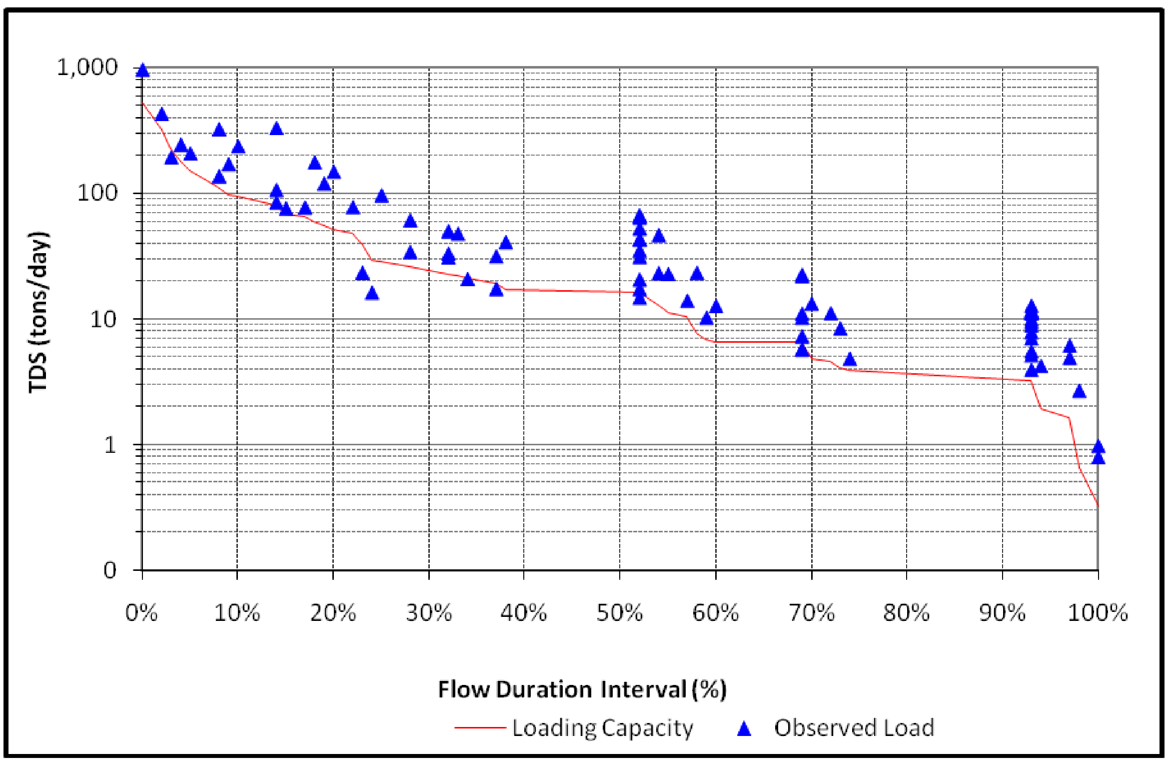


Table 7-4. Observed and Allowable TDS Loading (tons/day) at Station 493440.

Flow Percentile Ranges	81-Sample Distribution	Average Observed Flow (cfs)	Allowable Load (tons/day)	Observed Load (tons/day)	Reduction (%)
0-10	9	66.8	113.2	321.6	64.8
10-40	22	13.8	59.9	174.8	65.8
40-60	18	4.8	16.2	64.9	75.1
60-90	11	1.9	6.5	22.3	71.0
90-100	21	0.8	1.6	6.1	73.4

7.5.3 TMDL

Figure 7-5 shows the TDS TMDL graphically for Pariette Draw watershed including the observed loading, loading capacity, and the load allocation (loading capacity minus the 10% MOS). The TDS TMDL is summarized in Table 7-5. Since they are higher TDS load reductions needed in the mid-range and low flow conditions and no point sources in Pariette Draw watershed, the loading could be linked back to shallow groundwater from deep percolation of irrigation water or precipitation as a source of TDS loading.

Figure 7-5. TDS TMDL Summary for Pariette Draw Watershed.

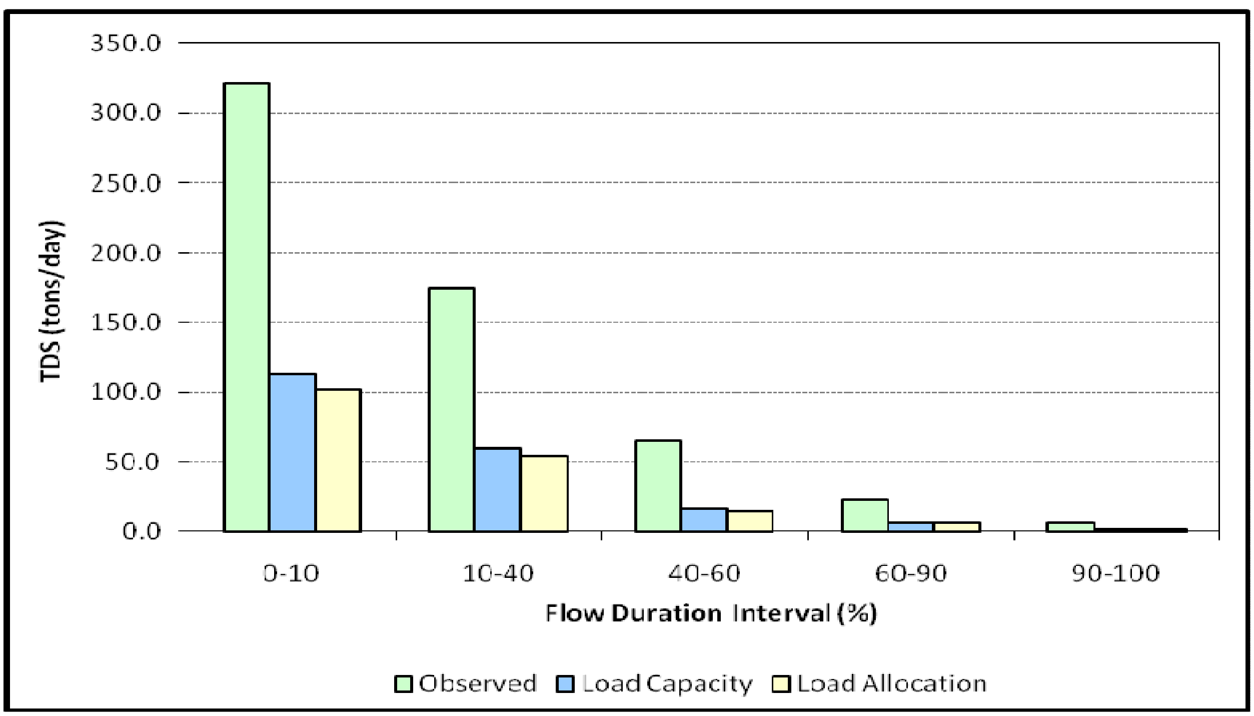


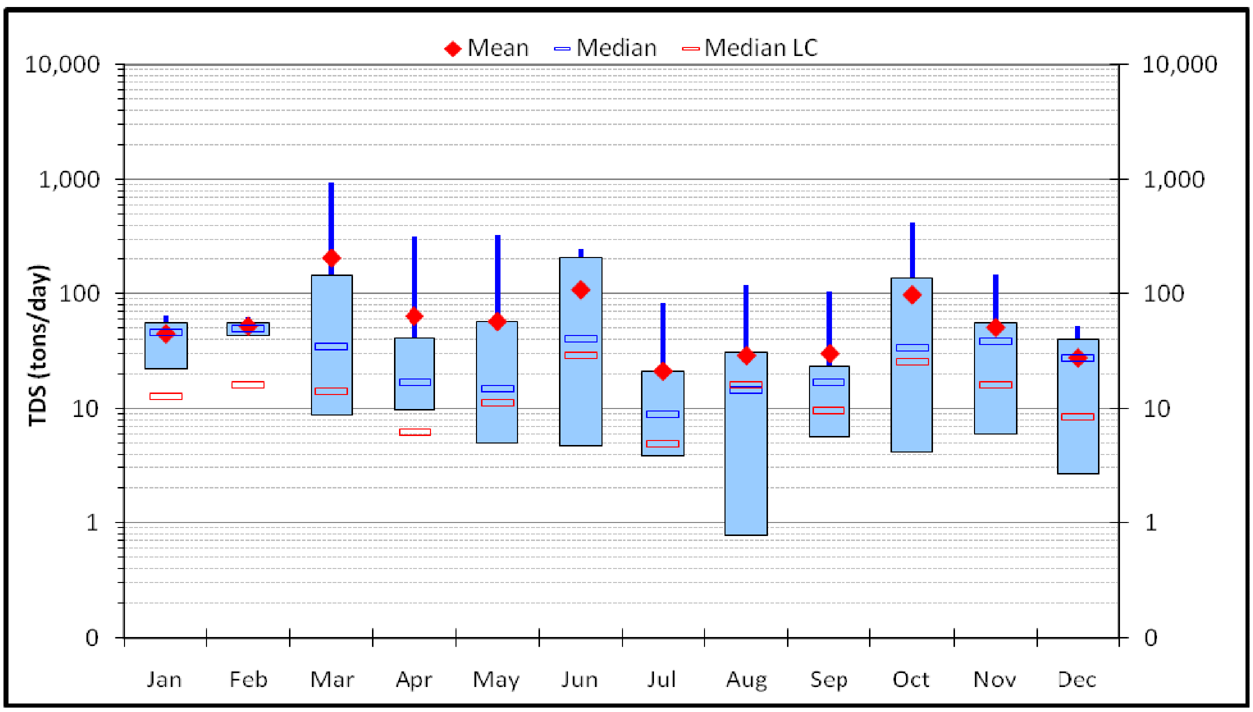
Table 7-5. TDS TMDL (tons/day) Summary for Pariette Draw Watershed.

TMDL Summary	High (0-10%)	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)	Low (90-100%)
Observed Load	321.58	174.77	64.89	22.32	6.08
Load Capacity (TMDL)	113.23	59.85	16.18	6.47	1.62
Load Reduction	208.35	114.91	48.72	15.85	4.46
% Load Reduction	64.8%	65.8%	75.1%	71.0%	73.4%
Margin of Safety	11.32	5.99	1.62	0.65	0.16
Load Allocations	101.91	53.87	14.56	5.82	1.46
Wasteload Allocations	0.0	0.0	0.0	0.0	0.0

7.5.4 Seasonality

Average monthly TDS loads and loading capacities are presented in Figure 7-6 to evaluate the seasonality of loading and their potential source. Observed loads are generally higher during the fall and winter months. During the irrigation season, there is more flow but lower TDS concentration and yet during the non-irrigation season, there is lower flow but higher concentration (Figure 4-15). The source for the loading during the irrigation season could from increased irrigation return flow and the source during the non-irrigation season could be background (geologic, groundwater) in nature.

Figure 7-6. Monthly Average TDS Loading Compared to the Average Loading Capacity (LC) at Station 493440.



7.6 Boron (B) TMDL

This section presents the wasteload and load allocations for TDS in the Pariette Draw watershed.

7.6.1 Wasteload Allocation

Because there are no point sources discharging into Pariette Draw, the wasteload allocation is 0 tons/day.

7.6.2 Load Allocation

Water quality and flow data at station 4933440 were used to calculate the existing and allowable B loads for Pariette Draw. The results of the load duration curve analysis are presented in Figures 7-7 and Table 7-6. They indicate that boron loads above loading capacity occur during all flow periods. Since there are no point sources in this watershed, all allowable loads are allocated to non-point and background sources. The implementation strategies should be focused on erosion control, riparian buffers, and efficient irrigation water management.

Figure 7-7. Boron Load Duration Curve at Station 4933440.

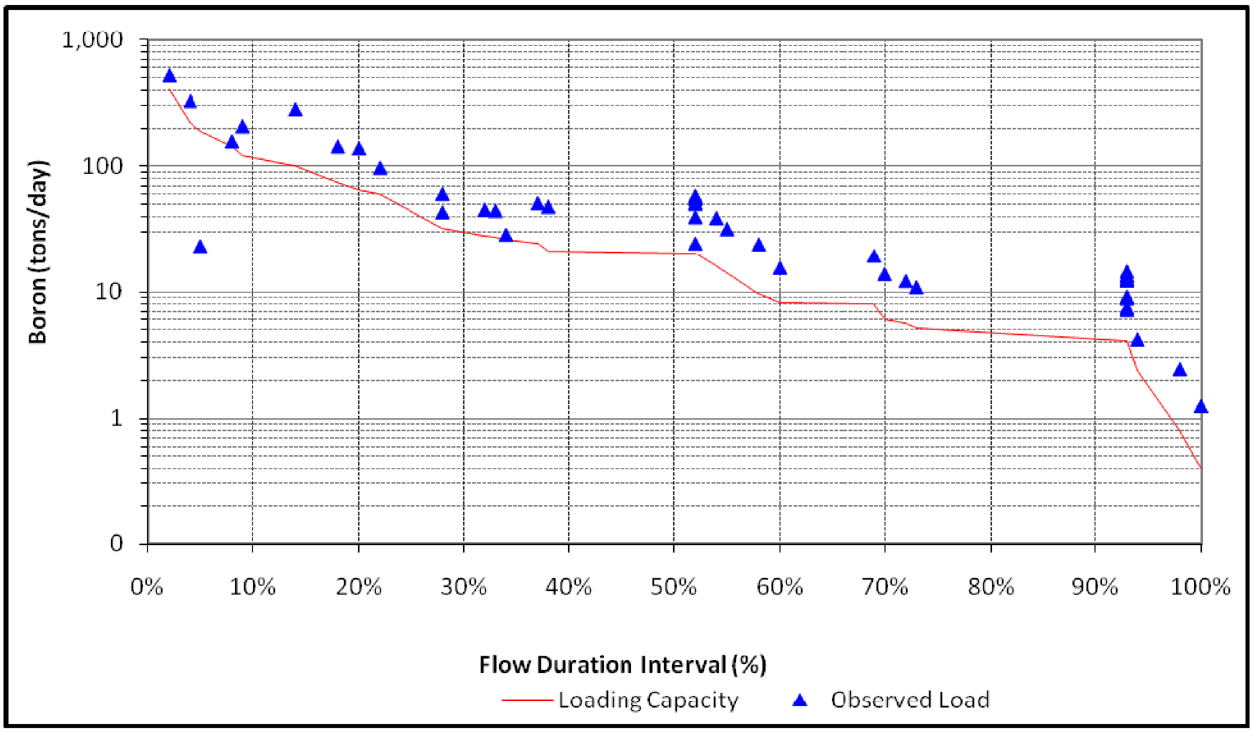


Table 7-6. Observed and Allowable Boron Loading (tons/day) at Station 4933440.

Flow Percentile Ranges	44-Sample Distribution	Average Observed Flow (cfs)	Allowable Load (tons/day)	Observed Load (tons/day)	Reduction (%)
0-10	5	66.8	121.3	205.4	40.9
10-40	10	13.8	64.7	138.0	53.1
40-60	10	4.8	20.2	56.6	64.3
60-90	6	1.9	14.4	24.1	59.7
90-100	13	0.8	9.5	13.5	70.1

7.6.3 TMDL

Figure 7-8 shows the B TMDL graphically for Pariette Draw watershed including the observed loading, loading capacity, and the load allocation (loading capacity minus the 10% MOS). The Boron TMDL is summarized in Table 7-7.

Figure 7-8. Boron TMDL Summary for Pariette Draw Watershed.

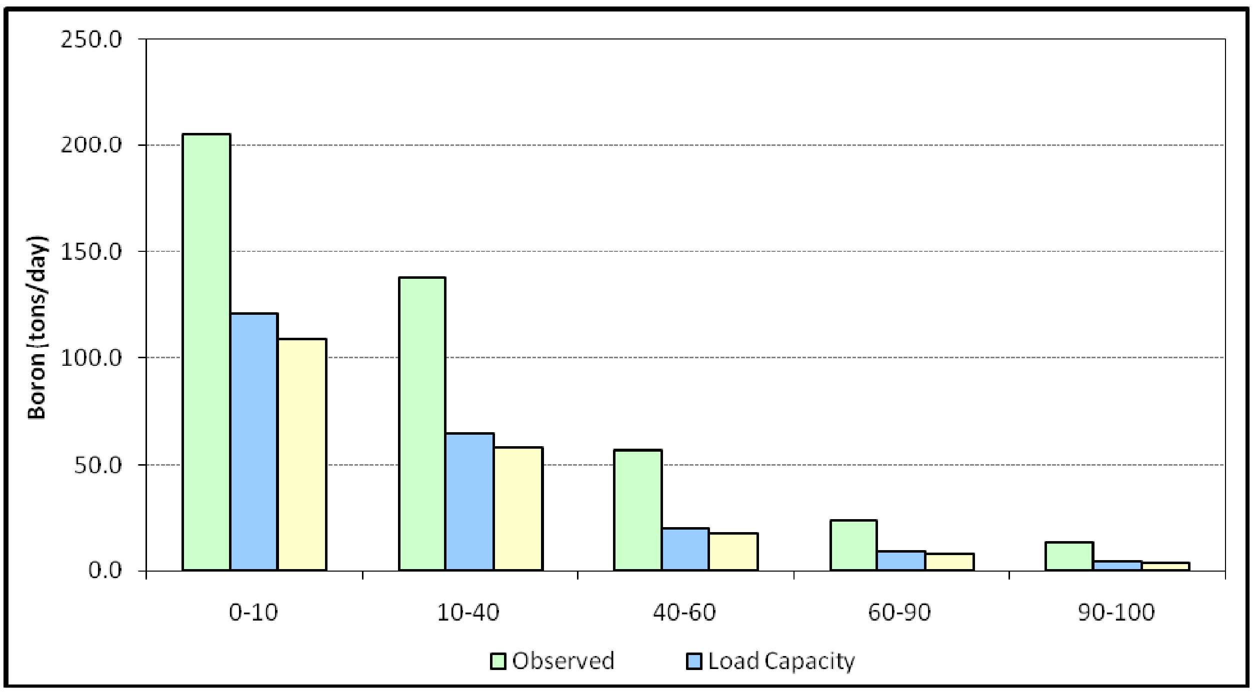


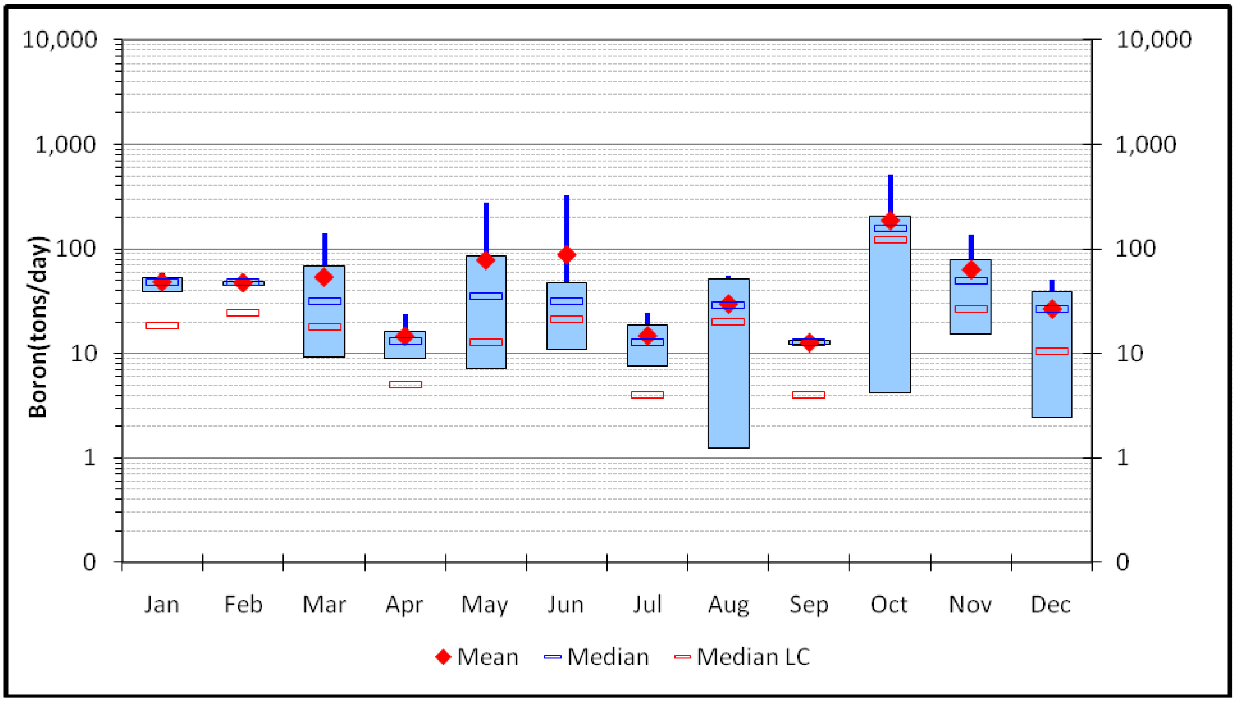
Table 7-7. Boron TMDL (tons/day) Summary for Pariette Draw Watershed.

TMDL Summary	High (0-10%)	Moist (10-40%)	Mid-Range (40-60%)	Dry (60-90%)	Low (90-100%)
Observed Load	205.36	137.98	56.60	24.06	13.53
Load Capacity (TMDL)	121.28	64.68	20.21	9.70	4.04
Load Reduction	84.08	73.30	36.38	14.36	9.49
% Load Reduction	40.9%	53.1%	64.3%	59.7%	70.1%
Margin of Safety	12.13	6.47	2.02	0.97	0.40
Load Allocations	109.15	58.21	18.19	8.73	3.64
Wasteload Allocations	0.0	0.0	0.0	0.0	0.0

7.6.4 Seasonality

Since this system is highly altered by Duchesne River diversion canal for irrigation in Pleasant Valley, B loading from the irrigated and non-irrigated seasons was compared. Figure 7-9 shows the monthly average observed and allowable loading. The observed loading is generally higher during the fall and winter months (non-irrigation season). Figure 4-16 shows no distinct trend in [B]. This graph vaguely suggests that [B] accumulates under lower flow conditions and then decreases during a storm event. Since there is a higher loading and lower flows in the non-irrigation season and inconsistent concentrations throughout the year, the additional loading could be attributed to consistent loading from shallow groundwater while during the irrigation season, irrigation return flows could contribute to the loading.

Figure 7-9. Monthly Average Boron Loading Compared to the Average Loading Capacity (LC) at Station 493440.



8.0 Potential Control Options (BMPs)

This section describes best management practices that can be implemented to achieve the load reductions described in the previous section. Many of the impairments in the Pariette Draw watershed occur during low-flow conditions when pollutants tend to be concentrated. The implementation strategies discussed here are designed to reduce the loadings introduced during storm events and to minimize their impacts during the low-flow season. It is important to recognize that because all load reductions are associated with nonpoint sources, implementation of BMPs to control these sources is voluntary.

Since the Pariette Draw watershed is heavily influenced by the oil and gas industry, current BMPs pertaining to the exploration and drilling activities should be implemented to reduce sediment erosion and loading. Such activities are outlined in the BLM's Gold Book (2007) and are summarized below:

- Determine appropriate BMPs needed to mitigate for activity earlier on during the onsite inspection
- Construct proper drainage and drainage structures, i.e. culvert design to allow passage of aquatic species and to install energy dissipation devices if needed
- Obtain Storm Water Permit to properly handle storm water runoff from construction activities via diversion berms, silt fencing, mats/mulches, vegetative stabilization

- Disposal of produced waste water (subsurface re-injection, lined evaporation ponds, trucking out)
- Proper site selection – avoid steep slopes, riparian areas, wetlands, and areas subject to severe soil movement
- Avoid constructing reserve pits in areas of shallow groundwater and natural watercourses
- Reclaim pits and well sites back to natural condition by revegetating with biologically active top-soil

Options for reducing non-point source loads in the Pariette Draw watershed include:

- Continue to improve irrigation efficiency by providing sprinkler irrigation, properly scheduling irrigation turns, reducing flood length and leveling land.
- Construct weirs or install flow metering devices at turnouts to ensure that proper amounts of water are applied.
- Maintain grassed waterways and uncultivated buffer strips along streams and channels.
- Re-establish and protect existing flood plains along Pariette Draw.

In addition to reducing deep percolation of irrigation water controlling soil erosion from streambanks and uplands will also reduce pollutant loading since soils in the lower watershed are saline. Potential control options for reducing soil and streambank erosion include:

- Promoting proper grazing management on uplands and riparian areas to maintain sufficient plant cover to protect the soil.
- Improve condition of riparian areas through plantings, temporary grazing exclusion and development of alternate watering sites.
- Stabilize streambanks through planting deep rooted species of woody plants, placement of rock barbs and revetment to deflect flow away from erosive banks and sloping vertical streambanks to reconnect the stream channel to its floodplain and allow native vegetation to re-establish.

These TMDLs are based on a representative flow regime that is determined using historical flow records. Therefore the allocated loadings and associated load reductions are calculated to meet water quality standards assuming the flow conditions remain similar to those established in the TMDL. However, it is possible with salinity control efforts focusing on decreasing TDS loads that instream TDS concentrations may increase. This could be the result of less dilution water available from flood irrigation return flows or higher TDS concentrations of groundwater baseflow. To offset this, the control options for the Pariette Draw watershed should focus on minimizing deep percolation of irrigation water through continuing to improve the efficiency of irrigation practices and conveyances on saline soils.

To address the possibility that implementation may lead to increased instream TDS concentrations and non-attainment of water quality standards this TMDL will utilize an approach that provides for the implementation of load reduction strategies while continuing to collect additional data. If or when the load reductions identified in this TMDL are attained or a reasonable effort towards implementation has occurred, and water quality standards are still violated, the TMDL will be revised accordingly based upon the additional data collected.

Regardless of the short-term effect on instream flows and concentrations, the available and recommended control efforts should improve irrigation efficiencies and water quality will ultimately benefit.

The reasonable assurance that these implementation activities will occur and attempt to meet the load reduction goals is that implementation is currently ongoing under the cooperative efforts of local agricultural producers and the USDI/USDA Salinity Control Program. In fact, approximately 17,000 acres of irrigated land within the watershed have already been treated. There is a great deal of local interest among watershed stakeholders to participate in the salinity control program. The availability of cost-share funding is the primary limitation on implementation. It is anticipated that with the establishment of this TMDL for the Pariette Draw watershed some of the funding shortfalls will be alleviated with 319 funding along with the priority status of other sources of funding associated with approved TMDL watersheds.

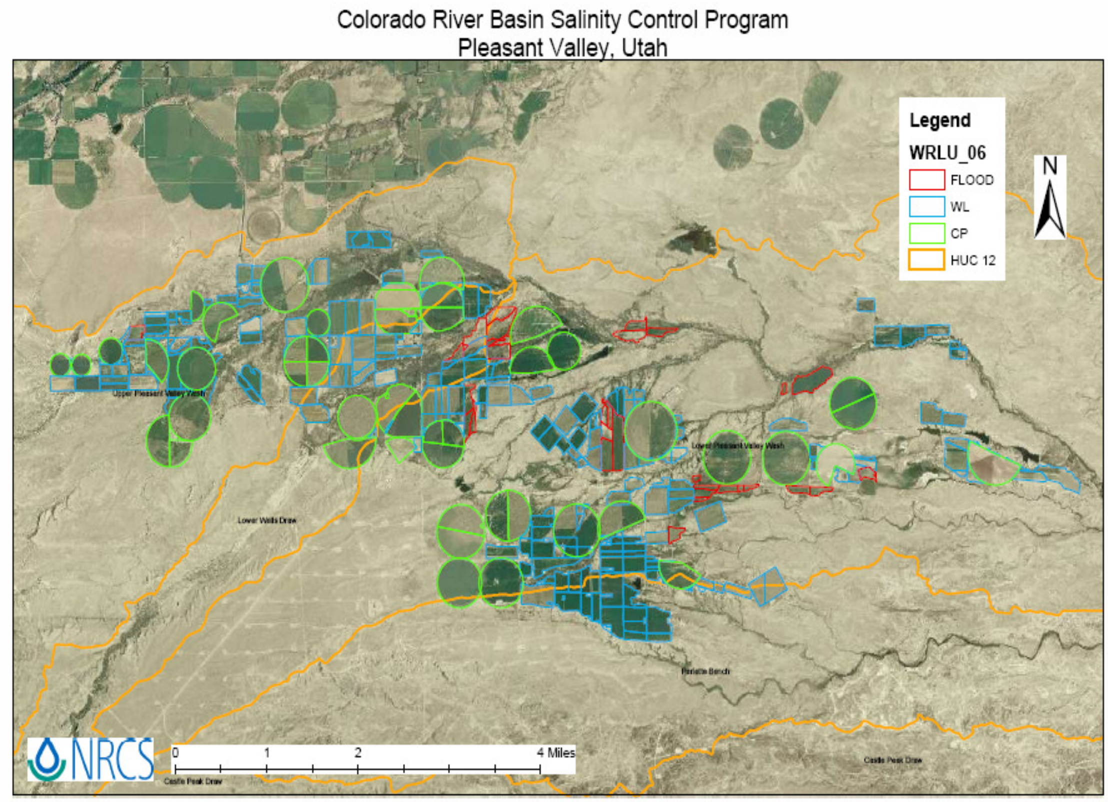
Conversion of flood irrigation to more efficient sprinkler irrigation is a common BMP for addressing TDS impairment. Significant irrigation upgrades have been made in Pleasant Valley. The Colorado River Basin Salinity Control Program (CRBSCP) and the Department of Agriculture and Food (UDAF) have worked with landowners to convert irrigation systems and line canals throughout the valley. The Environmental Protection Agency (EPA) required development of water quality standards for salinity in the Colorado River in 1972. The basin states formed the Colorado River Basin Salinity Control Forum (Forum) in 1973 to develop these standards including numeric salinity and a basin-wide plan of implementation for salinity control that EPA subsequently approved. The goal of the CRBSCP is reduction of salt loading to the Colorado River and its associated impacts throughout the Colorado River Basin. Millions of dollars have been spent on irrigation conversion in Pleasant Valley to help achieve CRBSCP goals. As of May 2009, salt loads have been estimated to be reduced by 82% (5,769 tons/acre/yr) since the late 1970s as presented in Table 8-1.

Table 8-1: Estimated Salt Load Reductions (tons/acre/year) from Pleasant Valley (NRCS).

Irrigation Type	Acres	Salt Load (Before)	Salt Load (May 2009)	Change in Loading
Center Pivot	3,224	3,353	302	-3,052
Wheel Line	3,111	3,235	518	-2,717
Flood	429	446	446	0
Total	6764	7,035	1,266	-5,769

There is 6% of the total 6,764 acres throughout Pleasant Valley that remains flood irrigated. The plots are so small that that it is currently prohibitive to convert them to more efficient sprinkler systems. The following map in Figure 8-1 depicts where each of the irrigation types is located throughout Pleasant Valley.

Figure 8-1. Areas of Flood, wheel line (WL) and center pivot (CP) irrigation in Pleasant Valley, Utah.



9.0 Future Monitoring

9.1 Continued Water Quality Monitoring

Long-term monitoring of water quality including selenium, boron and TDS should conducted at representative locations to evaluate the effects of BMPs, as well as progress toward meeting water quality goals and supporting beneficial uses. Continued monitoring will allow for the periodic reevaluation of the implementation strategies and goals defined in this TMDL document.

9.2 Storm Event Sampling

Water quality monitoring stations used in the TMDL data set are located on perennial or intermittent streams in the watershed. Data from these stations may include storm flows and runoff events captured during routine monitoring visits; however storm flows are not specifically targeted. Additionally, a large portion of the watershed is drained by dry washes that only flow after storm events. Pollutant loads generated from storm events in these drainages are not captured by the current water quality monitoring strategy. In order to fully characterize these loads, a targeted stormwater monitoring program would need to be implemented on both the standard monitoring locations and the previously un-sampled ephemeral washes.

9.3 Wetland and Pond Sediment Characterization

Large amounts of sediments have been deposited behind the desilting and flood control structures in the lower end of the watershed. Sediment removal will be required to maintain the effectiveness of these structures. Land managers have expressed interest in using removed sediments as topsoil material in land remediation efforts. Captured sediment should be sampled and analyzed for its physical and chemical suitability as a topsoil substitute.

9.4 Selenium-specific monitoring

Utah's chronic aquatic life standard for selenium is 4.6 ug/l, measured as Dissolved Selenium in the water column. This value is based on EPA's aquatic life criteria for Selenium as published in 1987. Since then, new data has become available that a tissue-based standard (as opposed to a water quality concentration) would more appropriately reflect the risk of chronic Selenium exposure to fish and waterfowl. A tissue-based criterion accounts for Selenium's biological effects because it integrates the duration and magnitude of exposure, complex chemical transformations and site-specific factors. It is likely that EPA and the states will adopt a tissue-based Se standard for fish and possibly an egg-based standard for aquatic birds in the future.

We recommend that a sampling plan be developed and implemented to characterize Selenium in Pariette Draw biota. Sampling should focus on fish and waterfowl tissue, but should also include algae, zooplankton, macroinvertebtrates, and emergent vegetation.

Additional studies to determine the biogeochemical processes controlling Selenium toxicity in the watershed include could include: 1) determination of inorganic and organic Selenium speciation in the water column and fractionation of solid-phase Selenium in sediments from stream, pond and wetland sites; 2) bio-availability estimates of different species of Selenium in different biogeochemical settings; and, 3) investigation of Selenium in stream, pond and wetland sites to determine if these environments are acting as sources or sinks of bio-available Selenium.

9.5 Shallow groundwater sampling

Very little shallow groundwater data was available for this study. Dissolution and leaching of soil salts by irrigation water is a likely source of Selenium, Boron and TDS to shallow groundwater in the Pariette Draw Watershed. Sampling and analysis of shallow groundwater from irrigated and non-irrigated sites throughout the watershed would help quantify the nature and extent of these sources.

9.6 Additional Topics

1. Efforts should be made to sample the volume and characteristics of irrigation return flows to better estimate their impact on in-stream water quality.
2. Photo monitoring sites can be used for future comparisons of changes in geomorphology, streambanks, riparian conditions, flow levels, and salt crusts.
3. Aerial photo analysis can be used to monitor the riparian corridor health, the composition of the vegetation in the riparian corridor, and amount of invasive Tamarix, and to track geomorphic changes over time.
4. Any detailed water quality information, stream flow, irrigation diversions, and land use information from the Ute Tribe for the Pariette Draw watershed would be helpful in refining the TMDLs.
5. Any current monitoring or assessment information from Upper Colorado River Endangered Fish Recovery Program on the impacts of water development projects on endemic fish species of the Upper Colorado River system.
6. Current updates from the Utah Salinity Workgroup Task Force Meetings that may affect activities in the Pariette Draw watershed should be considered.
7. Information on any local watershed planning efforts currently taking place in the watershed should be considered during implementation.
8. Oil and gas development is expected to continue within the Uintah Basin over the 15-year planning period of the proposed BLM Resource Management Plan (RMP). Because oil and gas drilling could be a water quality issue in the basin, more detailed information on the location and the potential for new wells will be important.

10.0 Public Participation

Local stakeholder participation for these draft TMDLs was accomplished through stakeholder meetings in 2009. The first Pariette Draw watershed TMDL meeting was held at the BLM office in Vernal on August 5, 2009. This meeting was designed to present the issues and bring all the stakeholders to the table. The second stakeholder meeting was held in the NRCS offices in Myton on October 15, 2009. This meeting was held to review the data summary and technical analysis. The draft TMDL sans data was given to the stakeholders for comments. Stakeholder comments were due to UDWQ on November 12, 2009. The first round of comments was addressed and another final draft of the TMDL was delivered to the group on July 7, 2010. This round of comments had a deadline of July 21, 2010. The public meeting is scheduled for July 27, 2010 and will include a 30 day comment period.

Participants included:

- Duchesne County Water Conservancy District
- Uintah County Water Conservancy District
- NRCS
- UDEQ, Division of Water Quality
- USU
- BLM
- SITLA
- USFWS
- UACD
- Uintah Basin Irrigation Company

It is important to have local input to affect water quality improvements and practices. Local irrigation companies and shareholders involved in agricultural production are already actively participating in the CRBSCP to reduce salt loading in the watershed through improved irrigation practices. This proven program has and will continue to help reduce salt loading into the Pariette Draw watershed and Colorado River System.

The draft TMDL report was available for public review and comment from July 27, 2010 through August 25, 2010. Public notice was published in the *Uintah Basin Standard* in the Basin Briefs on July 20 and July 27, 2010 and also in the *Salt Lake Tribune* and *Deseret News* the week of July 20 -27, 2010. The public meeting to present the draft TMDLs was held on July 27, 2010 at the Utah State University Extension Center in Roosevelt, Utah at 7:30 pm.

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Appendix A

Sediment and Soil Survey in Pleasant Valley

In the summer of 2009, UDWQ and Duchesne County Conservation District partnered up to survey Pleasant Valley's soils and Pariette Draw's sediment. The Utah State Revolving Fund (SRF) funded the project while Duchesne County CD took the lead on the ground. Approximately 100 sites were sampled in the Pleasant Valley area. Sites were chosen based on the irrigation type and land use type. Sediment from a selected number of UDEQ Water Monitoring Sites was also collected. Each 100 g composite sample was analyzed for Selenium, Boron, and Electrical Conductivity, which is a surrogate for salinity, by USU Lab in Logan. Each sampling site was then classified by land use, irrigation, crop, and soil texture. The goal of this analysis was to see if any soil/sediment characteristics have a higher Se, B, or Salinity (TDS) concentrations. If so, these certain locations should be investigated more thoroughly to determine potential "hot spots" of contamination in the headwaters of Pariette Draw. The average concentrations of the soil surrounding the certain characteristic are summarized in the tables below. Figures 1 shows the sampling locations in the Pariette Draw watershed. Samples were taken along the main stem of the Pariette Draw but mostly the study concentrated in the Pleasant Valley headwater area. Figure 2-4 shows the spatial range of Se, B, and EC concentrations in the Pleasant Valley soils. Figures 5-8 shows the soil sampling locations categorized by vegetation, land use, irrigation, and soil texture.

Table 1. Mean Concentrations in Soil Surrounding Specified Vegetation Type.

	Alfalfa	**Barley**	**Cattails**	**Corn**	**Grass**	**Oats**	**Shrub**	**Sorghum**
Sample Size	40	6	1	9	6	2	29	3
Se (mg/kg)	1.49	1.32	9.18	1.44	1.73	1.50	1.68	1.17
B (mg/kg)	0.74	0.57	5.05	0.89	1.29	0.53	2.05	1.17
EC (dS/m)	1.87	0.90	16.20	1.80	2.41	1.00	12.24	2.04

The [Se] in the soils surrounding most of the various vegetation types found in Pleasant Valley is relatively similar except for cattails which was higher; however, only one sample was taken here. Research shows that cattails are phytostablizers of Se meaning they accumulate Se in their roots. The soils surrounding the cattails have higher B and EC as well. Soils with an electrical conductance > 4 dS/m are considered saline. Soils with high EC levels generally have higher amounts of dissolved materials. High conductivity in soils correlates with high amounts of nutrients which can restrict plant growth, while low conductivity in soils yields to nutrient deficiency. In the Pleasant Valley area, only shrub and cattail soils have higher levels of EC. The shrubs are found outside of the irrigated lands and the higher levels of EC could be attributed to the geology of the surrounding areas. Since cattail soils/sediment seem to have higher B, Se, and

EC, more research should be conducted in these wetlands to see if cattails are actually pulling Se out of the soils.

Table 2. Mean Concentrations in Soil of Varying Land Uses.

	Crop	Desert	Pasture	Range	Wet
Sample Size	60	23	3	8	2
Se (mg/kg)	1.45	1.52	1.80	2.13	5.46
B (mg/kg)	0.76	1.96	1.36	2.25	3.48
EC (dS/m)	1.74	10.24	2.50	15.43	9.56

The type of land use was also investigated to see if one type has a different concentration of Se, B, or EC than another found in Pleasant Valley. With only 2 samples taken in the wet land use, the values of Se and B were higher than crop, desert, pasture, and range. These wetlands are spring-fed areas. The higher concentrations support the conclusion drawn from the TMDLs that the main source of B loading is groundwater. [EC] are higher in the range and desert land use types which can be attributed to the vegetative type and geology of the surrounding areas.

Table 3. Mean Concentrations in Soil of Varying Irrigation Types.

	Gated Pipe	Handline	Nothing	Pivot	Wheeline
Sample Size	4	1	34	32	25
Se (mg/kg)	1.64	2.05	1.90	1.45	1.42
B (mg/kg)	0.92	0.95	2.08	0.82	0.65
EC (dS/m)	4.29	1.35	11.25	1.71	1.37

There is no major difference in [Se] when comparing the 5 different irrigation types found in Pleasant Valley. [B] doubles and [EC] is about 6 times greater in soils that have no irrigation. This large amount of B and EC on soils with no irrigation is due to the fact that since no irrigated water is washing these parameters into the river system, they are concentrating in the soils.

Table 3 shows the average concentration of Se, B, and EC in the various soil textures in Pleasant Valley. The [Se] is very similar in all 3 types of soil texture. B is noticeably higher in clay textured soils while EC is highest in loamy soils.

Table 3. Mean Concentrations in Soil of Varying Soil Textures.

Texture	Sample Size	Se (mg/kg)	B (mg/kg)	EC (dS/m)
Loam	89	1.62	1.14	5.22
Sand	5	1.72	1.61	3.19
Clay	2	1.38	4.27	4.83

Table 4 shows the sediment data at each UDEQ Monitoring Station. The stations are listed from upstream to downstream. Refer to Figure 4-4 for the sampling locations. Stations 4933606 – 4933600 are located in Pleasant Valley and Stations 4933495 – 4933440 are on the main stem of Pariette Draw. EC and B in the sediment of Pleasant Valley are slightly lower than those of Pariette Draw. [Se] is a little higher in Pleasant Valley sediment than Pariette Draw.

Table 4. Mean Concentrations in Pariette Draw Sediment.

Station ID	Texture	EC (dS/m)	B (mg/kg)	Se (mg/kg)
4933606	Sandy Clay Loam	5.53	2.28	1.29
4933604	Clay Loam	2.42	0.66	0.47
4933602	Loamy Sand	0.93	0.41	0.68
4933600	Sandy Loam	1.85	0.69	0.65
4933495	Silty Clay	3.85	2.66	0.64
4933485	Loamy Sand	2.00	0.56	0.52
4933476	Sandy Clay Loam	2.47	0.64	0.42
4933470	Sandy Clay Loam	6.11	2.99	0.36
4933440	Sandy Loam	3.29	0.85	0.67

Figure 1. Overview of Soil and Sediment Sampling Locations in Pariette Draw Watershed.

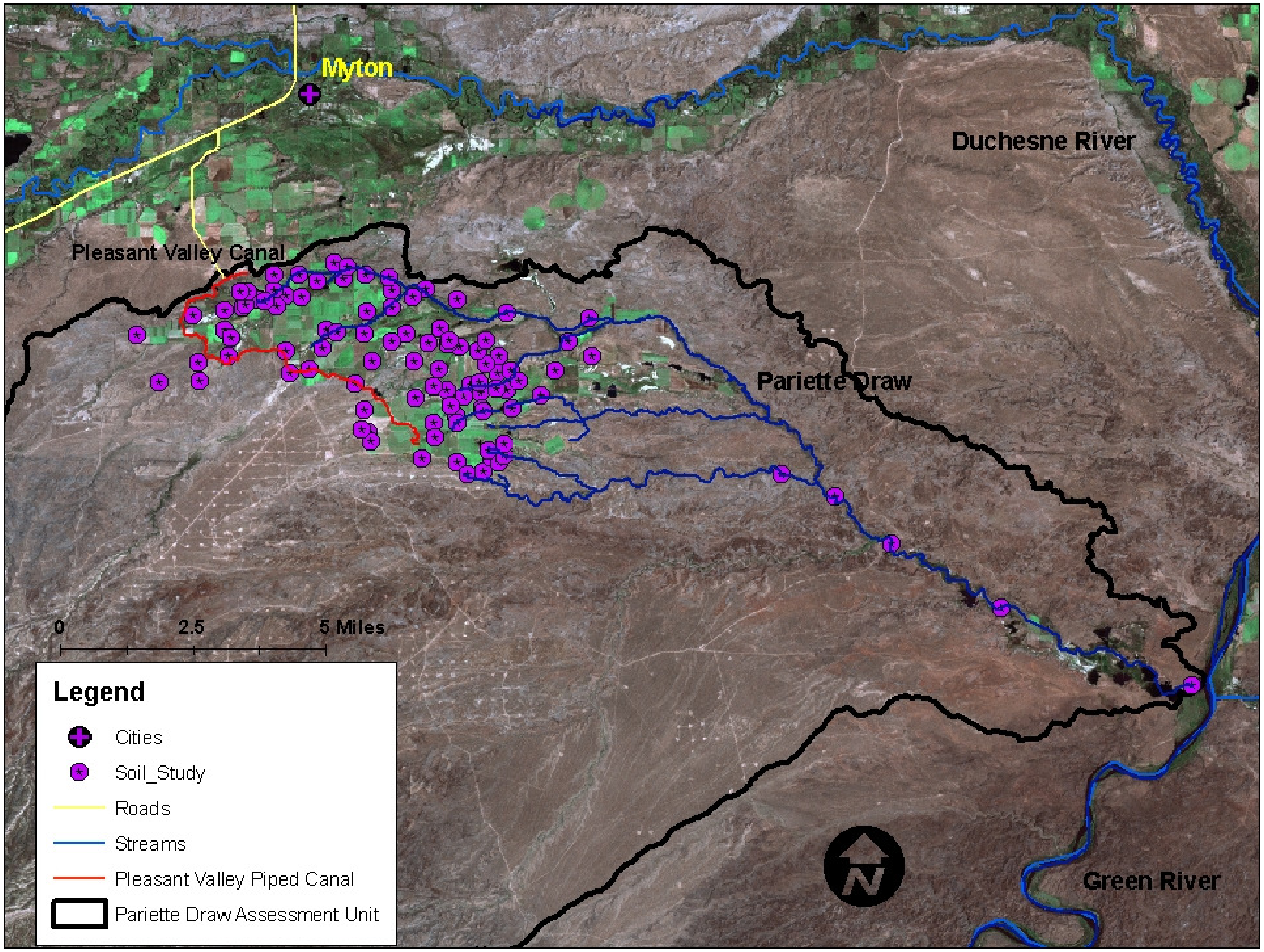


Figure 2. Spatial Range of Selenium (mg/kg) in Pleasant Valley Soils.

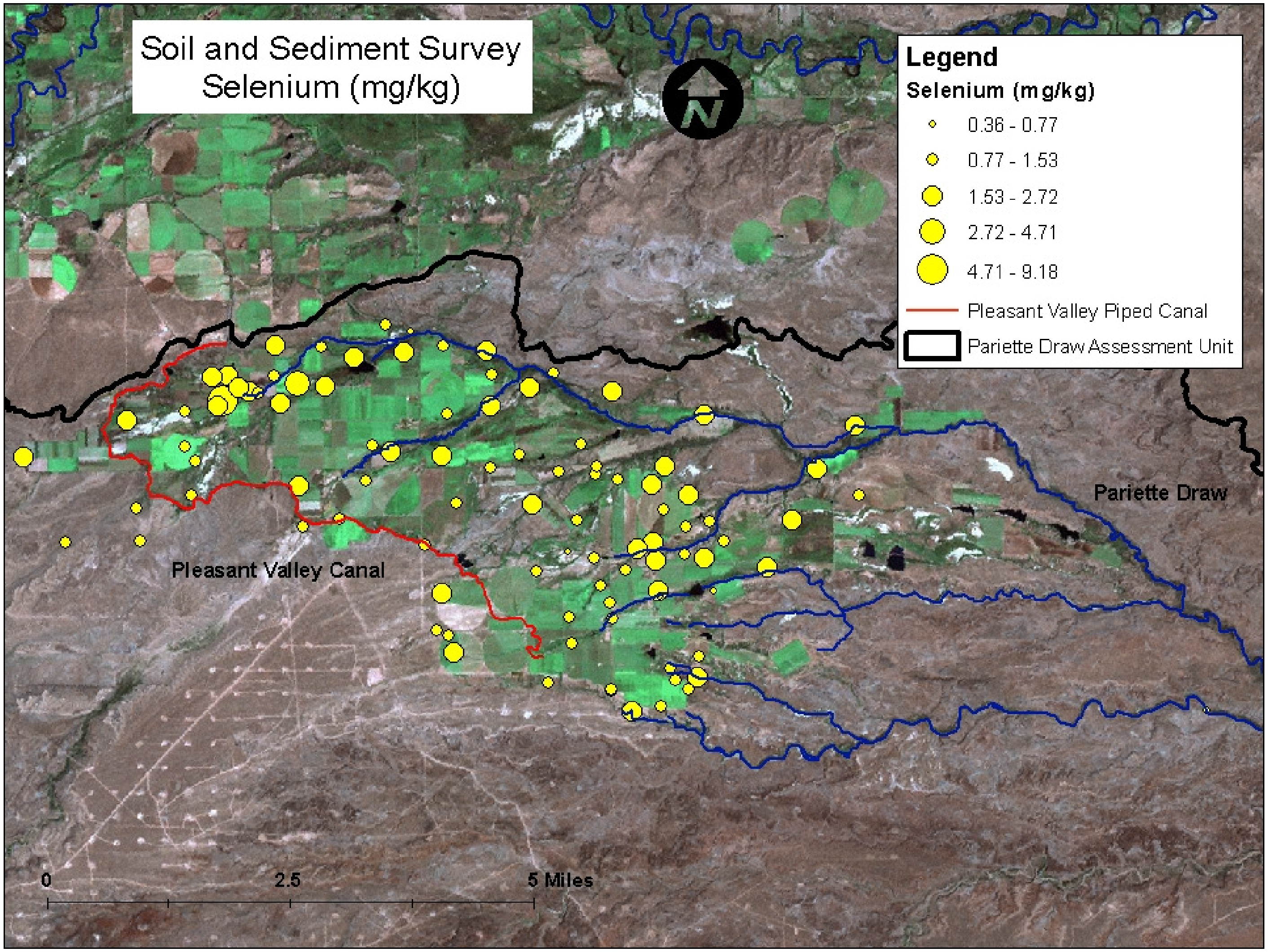


Figure 3. Spatial Range of Boron (mg/kg) in Pleasant Valley Soils.

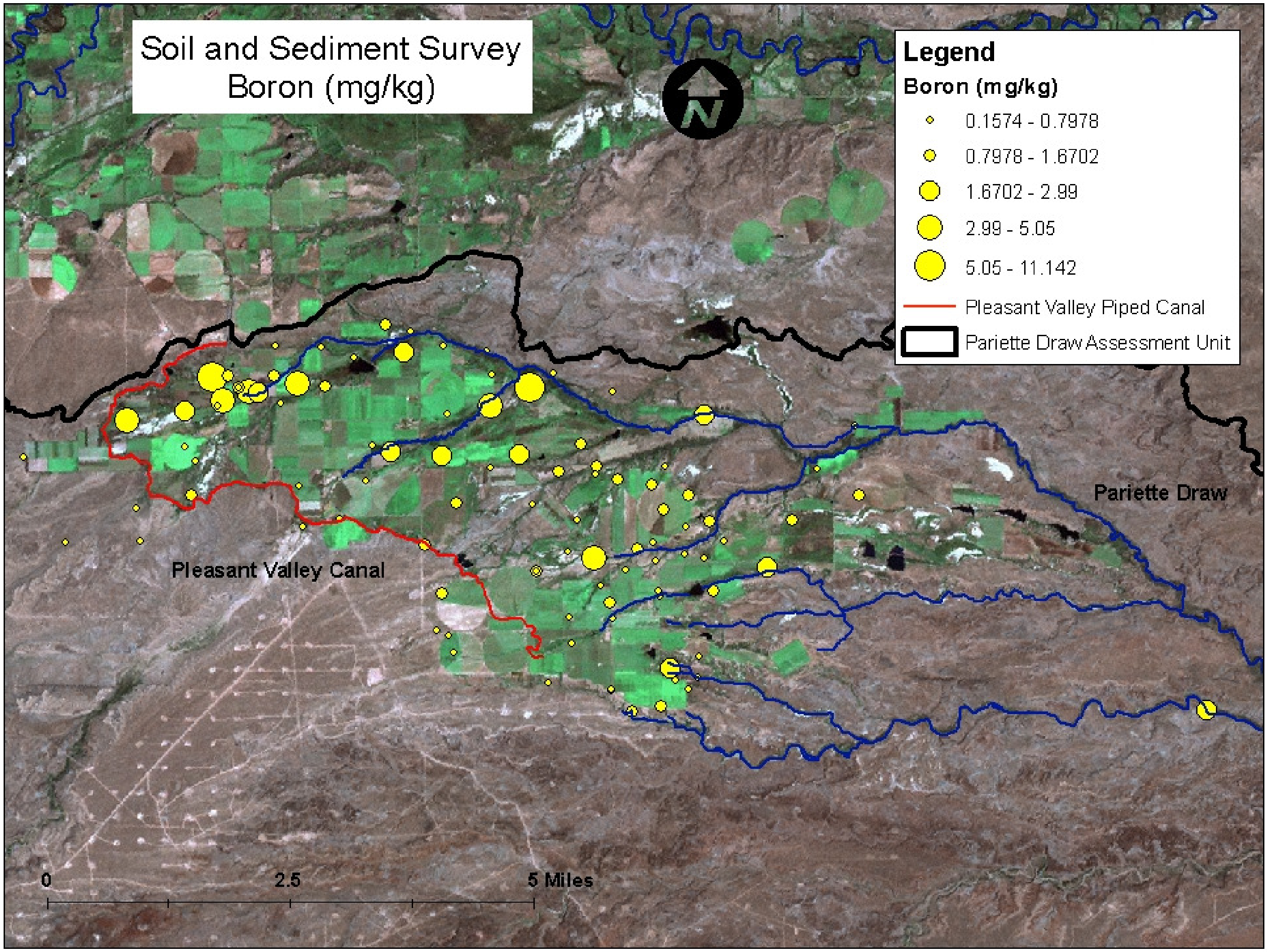


Figure 4. Spatial Range of Electrical Conductance (dS/m) in Pleasant Valley Soils.

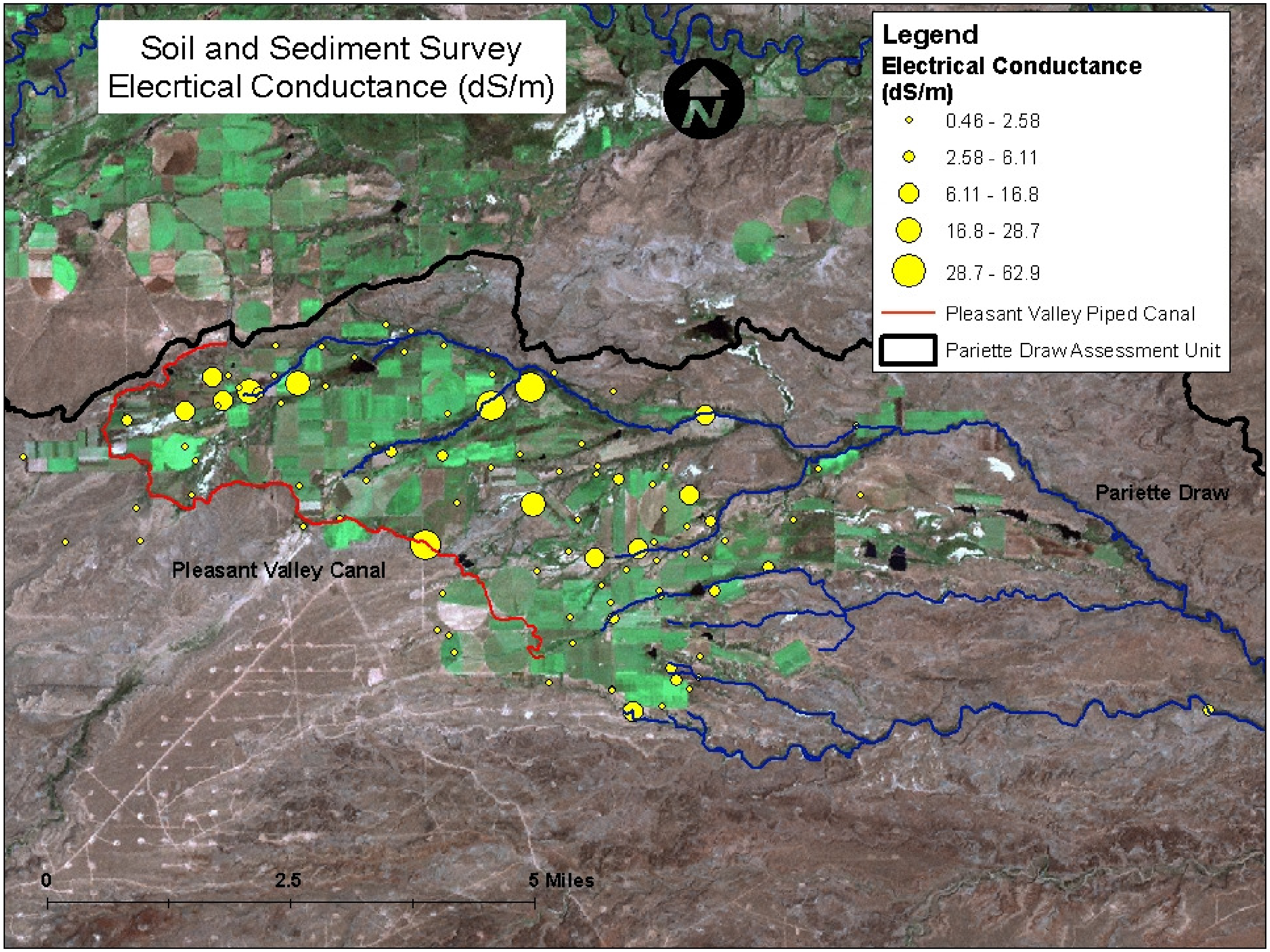


Figure 5. Soil Sampling Locations in Pleasant Valley Categorized by Vegetation Types.

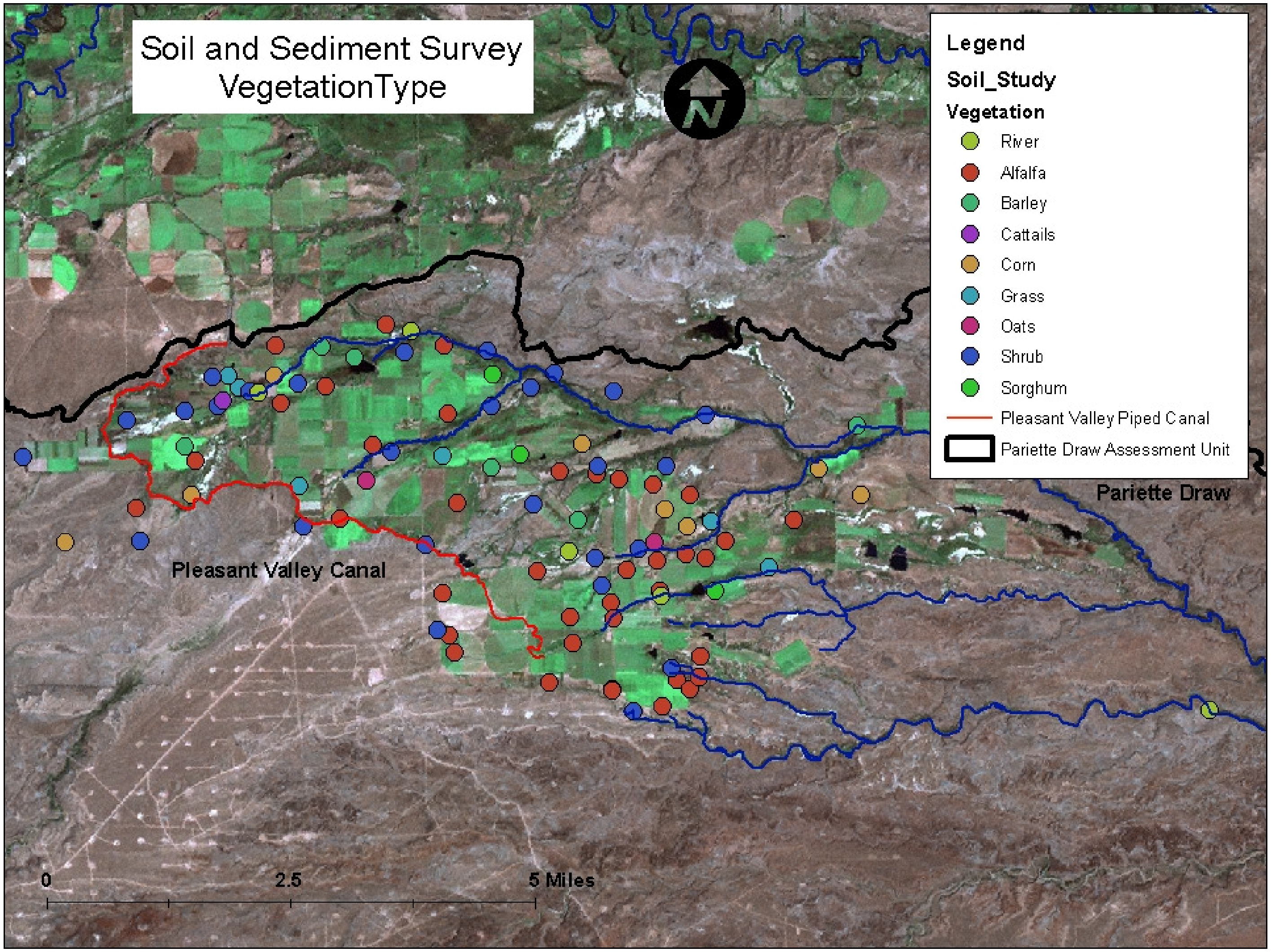


Figure 6. Soil Sampling Locations in Pleasant Valley Categorized by Land Use.

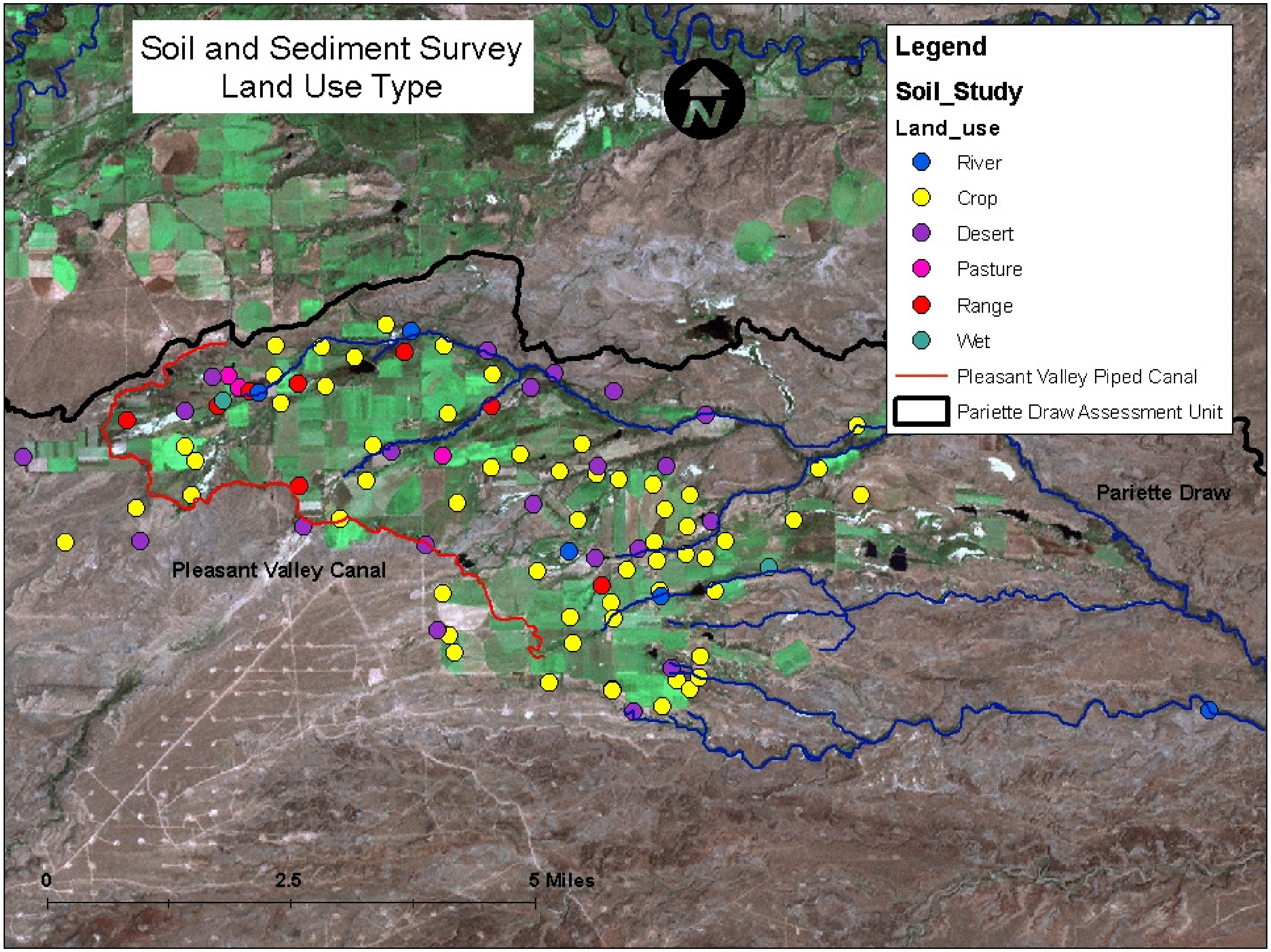


Figure 7. Soil Sampling Locations in Pleasant Valley Categorized by Irrigation Type.

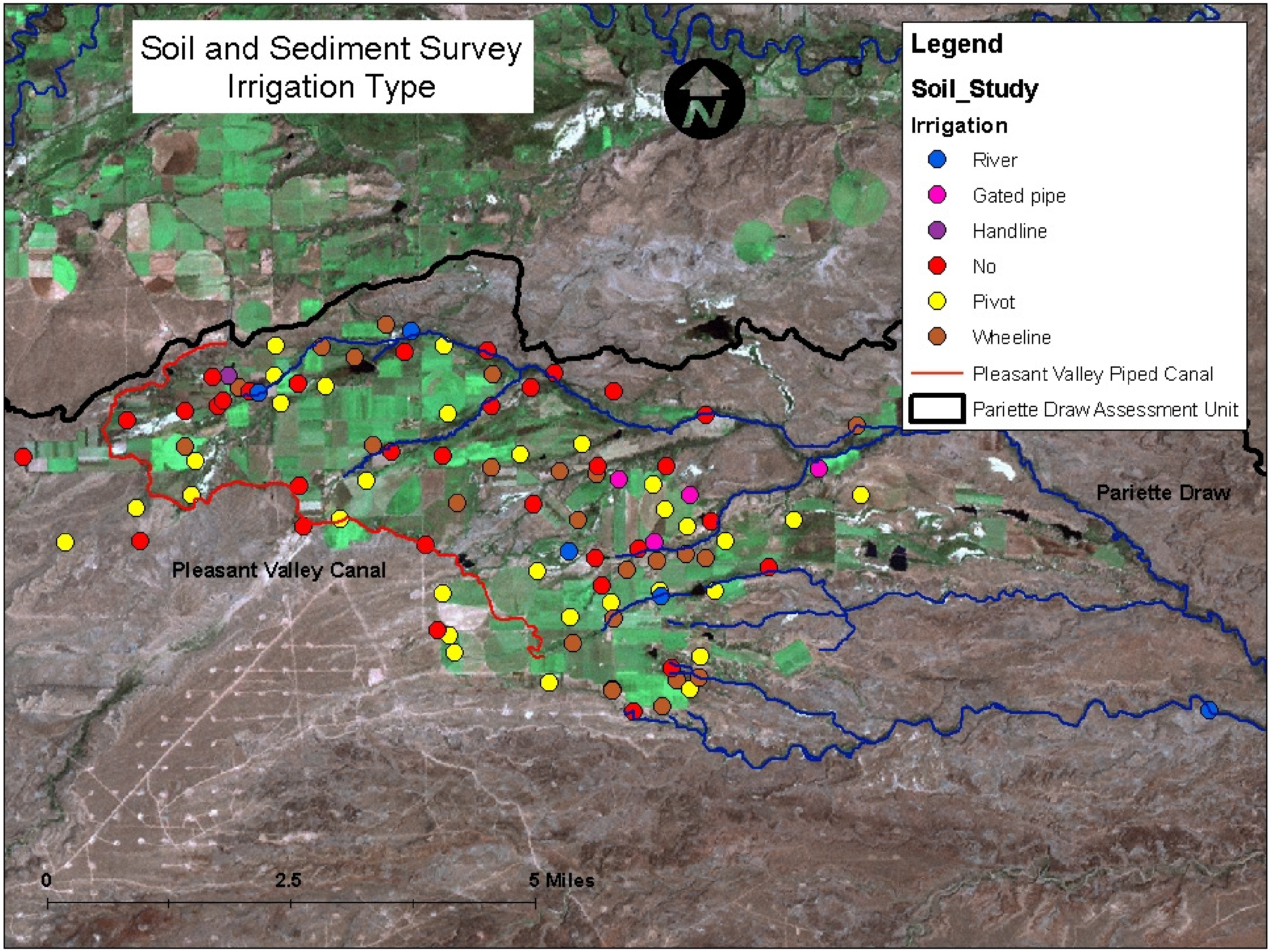
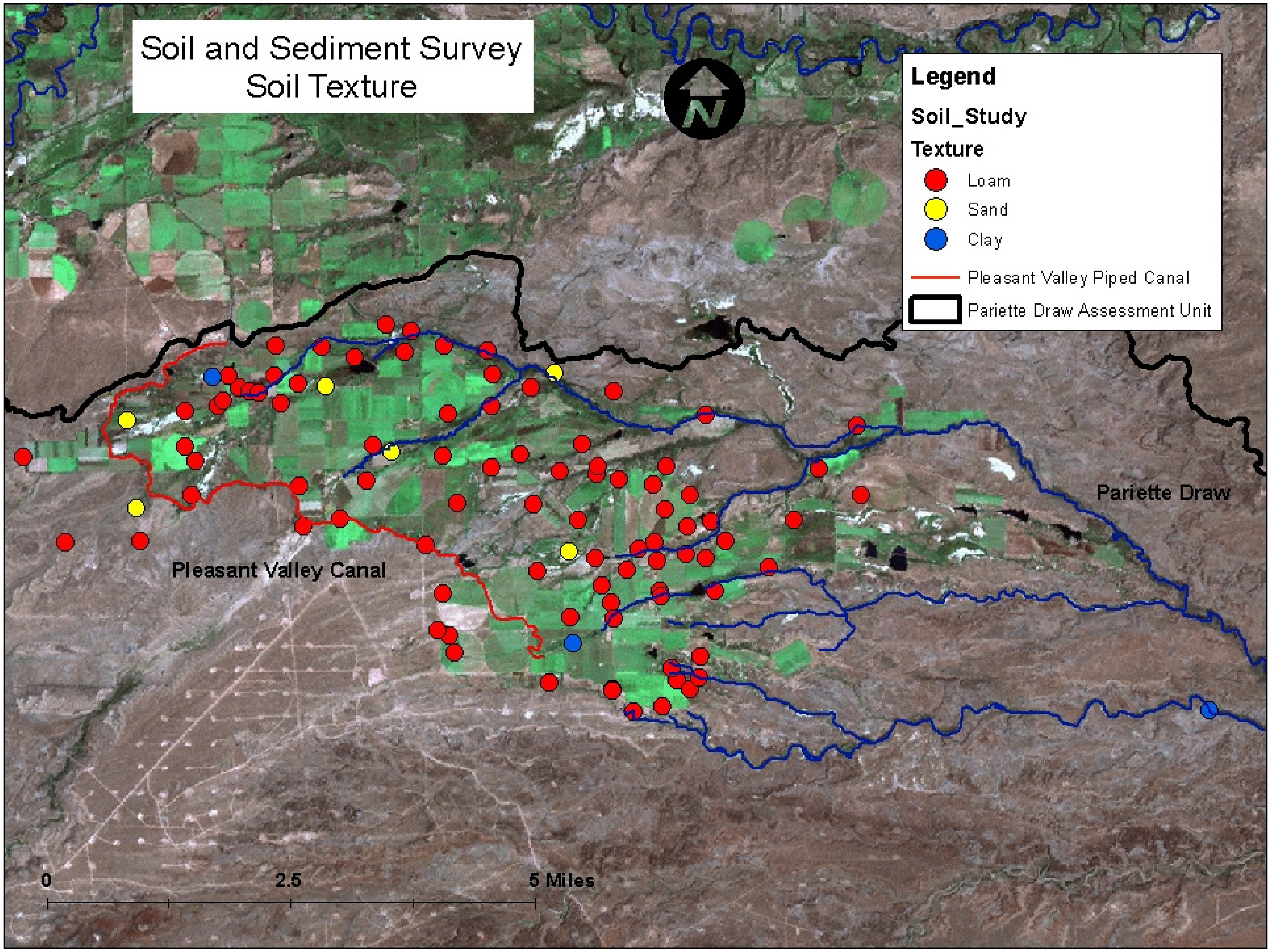


Figure 8. Soil Sampling Locations in Pleasant Valley Categorized by Soil Texture.



Appendix B

Water Quality Data for UDEQ Monitoring Sites Located in the Pariette Draw Watershed

Figures 4-4 and 4-5 show the locations of the UDEQ STORET monitoring stations in the Pariette Draw watershed. Tables 4-2 through 4-4 show the summary data for TDS, B, and Se for these 12 stations. This appendix includes the raw data collected at each site for each sampling event. The data is arranged from the furthest upstream site at the Pleasant Valley Canal (4933615) to the farthest downstream site, Pariette Draw 1 mile above the confluence of the Green River (4933440). Water temperature is measured in degrees Celsuis, pH in standard units, dissolved oxygen (DO) in mg/L, specific conductance (SpC) in uS/cm, flow in cubic feet per second (cfs), and Total Dissolved Solids (TDS) in mg/L, and boron (B) and selenium (Se) in ug/L.

4933615 Pleasant Valley Canal

Date	Time	W Temp	pH	DO	SpC	Flow (cfs)	TDS (mg/L)	B (ug/L)	Se (ug/L)*
10/6/08	1605	16.2	8.9	12.2	832		494	579	0.5
12/9/08	1105								
3/9/09	1635								
4/21/09	1700								
5/11/09	1720	12.3	8.6	9.8	527	85	320	234	0.5
6/22/09	1100	14.1	8.1	10.0	353	150	208	150	0.5
7/20/09	1145	20.6	8.4	8.7	381	130	228	179	0.5
8/4/09	1315	17.3	7.5	10.1	350	132	218	169	0.5
9/10/09	820	15.8	8.7	8.0	591	99			
11/3/09	1100								

*The selenium measured at the site is below the detection limit of 1.0 ug/L thus a substituted value of half (0.5 ug/L) was used for any calculations.

4933606 Pleasant Valley Wash North Finger

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
10/6/08		12.9	8.1	10.0	10,110	0.33	8,512	3,480	30.8
12/9/08	1200	2.2	7.9	10.7	3,275		4,364	2,180	17.7
3/9/09	1645	10.3	8.1	19.4	5,728	0.214			
4/21/09	1645	23.2	8.1	12.8	5,654	0.02	4,508	1,990	17.6
5/11/09	1130	15.5	8.0	11.7	4,253	0.2	3,186	1,410	14.9
6/22/09	1115	15.6	8.0	10.2	5,222	0.8	4,386	2,050	16.3
7/20/09	1200	20.0	7.8	9.0	5,635	0.8	4,450	2,120	15.8
8/4/09	1332	20.2	7.6	8.9	5,534	0.05	4,298	2,040	15.3
9/10/09	830	12.9	7.8	4.4	5,390	0.05	5,126	2,520	13.9
11/3/09	1115	6.59	6.9	10.6	5,271	0.05	4,032	1,920	14.4

4933604 Pleasant Valley Wash at 3000 W 10735 S

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
10/6/08		11.7	8.2	10.2	4,705				
12/9/08	1330	0.8	7.9	9.3	2,982		4,248	2,010	12.1
3/9/09	1740	4.6	7.6	11.5	4,748	0.06	3,704	1,590	11
4/21/09	1705	15	7.75	9.6	4,570	0.57	3,466	1,610	8.03
5/11/09	1700	16.85	8.51	7.12	1,166	3.25	814	627	3.2
6/22/09	1215	16.65	8	8.82	720	21	442	295	1.11
7/20/09	1245	22.3	8.29	8.56	974	2.96	634	403	2.19
8/4/09	1415	20.05	7.89	8.55	683	4.73	444	345	1.9
9/10/09	1120	15.96	8.17	8.41	1,403	5.65	1,204	732	2.97
11/3/09	1200	6.85	7.0	10.88	3,797	0.44	2,916	1,480	8.38

This site is influenced by canal water thus the concentrations are lower when little water is being used for irrigation or the canal overflow is open releasing straight canal water into the wash above this sampling point.

4933602 Pleasant Valley Wash at Road Crossing #2

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
12/9/08	1245	0.1	8.1	10.4	4,695		7,868	2,060	24.3
3/10/09	1240	1.1	7.4	11.3	7,404	0.003	6,478	1,710	88.1
4/21/09	1720	16.2	7.7	8.9	7,769	0.007	6,550	2,030	40.9
5/11/09	1645	17.3	8.1	8.1	6,219	0.06	5,066	1,960	32
6/22/09	1145	15.4	8.2	10.7	1,033	6.12	716	353	3.57
7/20/09	1230	22.1	7.8	6.2	1,806	0.05	1,334	526	38.9
8/4/09	1405	18.7	8.0	7.2	7,763	0.05	6,858	1,860	56.3
9/10/09	920	13.8	8.2	7.9	942	8.4	620	350	3.41
11/3/09	1145	5.1	6.1	7.2	7,221	0.5	5,980	1,610	65.3

4933600 Pleasant Valley Wash at Road Crossing #1

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
10/6/08		55.5	8.0	8.0	4,089	1	3,262	1,200	19.9
12/9/08	1310	33.8	8.0	10.8	1,701	0.05	2,474	1,240	10.6
3/9/09	1720								
4/21/09	1730								
5/11/09	1640	23.1	8.4	6.9	2,904	0.05	2,374	974	6
6/22/09	1130	14.4	8.1	7.9	2,745	0.05	2,312	1,060	4.24
7/20/09	1220								
8/4/09	1400	20.2	7.8	4.4	2,765	0.01	2,244	1,120	3.61
9/10/09	900	13.4	8.1	8.1	2,618	0.05	2,252	1,050	5.54
11/3/09	1130	7.1	6.4	11.1	3,444	0.05	2,812	1,160	8.16

4933495 Pariette Draw South Finger ¾ Mile Above Pariette Draw Main Stem

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
4/22/09	1300	22.8	8.2	6.5	7,256	0.5	5,838	3,190	5.23
5/11/09	1600								
6/22/09	1300	20.7	8.3	6.7	2,618	0.5	1,950	1,580	6.95
7/20/09	1330								
8/4/09	1500								
9/10/09	1140	9.92	8.4	9.8	3,035	0.1	3,346	2,010	6.42

This site was only sampled twice. The rest of the time, the creek was dry.

4933485 Pariette Draw 1.2 miles Above the Flood Control Structure

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
12/8/08	1600								
2/24/09							4,254	1,720	13.5
3/10/09	1130	0.0	7.8	12.8	4,588	5.9	3,870	1,490	11.2
4/21/09	1545	22.6	8.3	8.2	6,682	2.36	5,514	2,260	11.5
5/11/09	1445	21.2	8.7	8.0	2,444	5	1,790	785	4.3
5/19/09		15.2	9.1		2,520	3.5	778	494	2.4
6/22/09	1430	17.3	8.2	9.1	1,149	203.8	778	494	2.4
7/20/09	1440	27.2	8.5	8.1	2,791	9.8	2,168	1,060	5.3
8/4/09	1600	24.6	8.6	7.8	1,204	7.5	830	462	2.9
9/10/09	1215	17.1	8.4	9.1	1,236	36.6	894	502	3.5
11/3/09	1300	4.1	7.9	11.9	4,771	4.36	3,730	1,770	11.9

4933476 Pariette Draw Below Flood Control Structure

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
7/11/06			8.5		1,144		748		
8/1/06		18.0	8.5		2,980		2,178		
8/28/06		17.0	8.5		1,795	5.3	1,272	792	4.2
10/2/06		19.0	8.5		2,020	3.0	1,432		
10/30/06		7.0	8.3		4,520	7.0	3,582		
12/18/06		1.0	8.5		5,100		4,032		
2/26/07		1.0	8.3		5,040		4,022	1,630	15.7
4/3/07		13.0	8.4		6,130	17.1	5,096		
4/30/07		24.0	8.5		6,130	11.5	4,958		
6/4/07		16.1	8.5		1,175	60.0	754	465	2.3
6/25/07		15.5	8.6		4,560	13.6	3,580		
8/6/07		30.0	8.7		2,450	7.8	1,732	983	4.9
9/10/07		17.0	8.7		2,440	100.0	1,734		
10/15/07		7.5	8.7		1,355	60.0	2,110		
11/5/07			8.5		5,930		4,662	1,710	7.8
12/3/07			8.6		5,630		4,710	1,780	15.0
3/10/08		0.1	8.7		1,796	122.0	1,264		
4/14/08		11.4	8.3		6,240	48.0	5,376	2,360	12.1
5/19/08		16.3	8.3		1,580	60.0	1,162	634	3.4
6/2/08		16.4	8.3		2,670	150.0	1,874		
7/7/08							1,030	864	8.5
8/11/08							1,046	684	3.4
9/15/08							1,098		
11/18/08							4,168		
12/8/08	1550								
3/10/09	1030	37.3	7.8	13.1	3,520	11.0	3,692	1,390	10.8
4/21/09	1520	22.9	8.3	7.5	6,575	1.9	5,414	1,990	10.2
5/11/09	1400	20.5	8.7	7.9	2,397	4.9	1,708	1,460	4.1
6/22/09	1400	17.0	8.2	8.2	1,093	200.0	754	498	2.5
7/20/09	1500	27.7	8.4	7.6	2,738	16.4	2,062	1,020	5.4
8/4/09	1630	25.0	8.5	6.6	1,192	16.7	816	443	3.0
9/10/09	1245	17.7	8.4	8.3	1,271	75.4	908	545	3.69
11/3/09	1345	4.8	7.4	11.6	4,744	14.1	3,880	1,610	12.5

4933470 Pariette Draw Below Desilt Structure

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
12/8/08	1515	3.0	8.3	9.2	2,961	1.3	4,084	2,050	7.7
3/10/09	1000	2.9	7.8	13.1	3,520	11.0	2,660	1,040	5.1
4/21/09	1330	16.0	8.2	8.5	5,058	2.4	3,986	1,760	5.4
5/11/09	1215	17.0	8.3	8.5	3,520	12.8	2,526	1,560	2.9
6/22/09	1450	20.9	8.1	10.1	1,380	48.2	958	628	1.3
7/20/09	1540	26.6	9.1	8.3	2,650	1.9	1,910	1,170	2.3
8/4/09	1700	26.3	9.1	8.6	2,938	10.9	2,118	1,330	2.2
9/10/09	1310	20.4	8.8	8.1	1,773	2.8	1,318	883	1.6
11/3/09	1410	8.6	7.0	10.4	3,937	6.1	2,974	1,400	3.6

4933450 Pariette Draw at East Gadwall Pond Culvert

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
4/21/09	1445	18.8	7.81	6.23	5112	1	3872	1750	4.05
5/11/09	1325	20.08	8.24	7.93	5632	1	4512	2340	2.72
6/22/09	1530	22.37	8.27	7.49	2035	4.9	1444	885	1.45
7/20/09	1615	27.5	8.92	5	2771	0.01	1822	1450	2.26
8/4/09	1740								
9/10/09	1345								
11/3/09	1500	8.39	8.14	12.9	2,927	0.01	2,152	1,240	1.68

4933440 Pariette Draw 1 mi Above Confluence Green River

Date	Time	W Temp	pH	DO	SpC	Flow	TDS	B	Se
7/22/93	1030				3,440	1.0	2,574	1,400	0.5*
8/17/93	1000				2,350		1,780	1,100	1.0
5/24/94	915	20.3			3,745	1.4	2,890	1,600	0.5
6/22/94	1115				3,335	1.3	2,430	1,590	0.5
7/18/94	800				4,880		3,966	2,500	1.0
8/17/94	1330				6,036		4,664	3,000	0.5*
9/20/94	1400				4,978	1.0	4,092	2,290	2.0
10/5/94	1200				2,768	30.0	2,094	1,270	2.0
10/18/94	1045				2,279	100.0	1,578	960	2.0
11/21/94	1430				4,154	16.0	3,416	1,600	2.0
3/2/95	1230				4,925	1.0	4,224	1,700	4.0
3/20/95	900				4,948	2.0	4,018	1,800	2.0
4/20/95	1000				5,922		4,886	2,100	0.5
5/2/95	800				5,930	5.0	4,914	2,100	0.5
5/23/95	1430				2,580	15.0	1,904	1,200	1.0
6/20/95	1015				2,096	47.0	1,622	92	1.0
7/17/95	1130	23.9				25.0	1,246		
8/4/95	800	22.2			1,738	6.5	1,172	820	0.5*

8/21/95	1130	24.4			1,969	20.0	1,416		
9/26/95	1230				2,137	25.0	1,566		
10/24/95	1530	8.8			1,962	35.0	1,436	830	2.0
11/27/95	1200	6.6			3,588	8.0	2,808	1,400	3.0
1/24/96	1400	1.0			5,152	4.0	4,278	1,800	8.0
2/27/96	1530	1.1			3,458	7.0	2,624	1,200	2.0
4/10/96	1345	6.1			4,577	1.0	3,656	1,650	2.0
5/7/97	800	15.6			2,268	7.0	1,624		3.7
5/20/97	1200	14.4			2,732	2.0	2,020		3.8
6/18/97	730	20.0			1,011	9.0	662		2.4
7/17/97	1230	24.4			2,844	1.0	2,032		2.4
7/19/97	1030	22.2			2,390	7.0	1,742		2.7
8/25/97	730	21.0			1,550	5.0	1,088		2.3
9/23/97	1500	16.7			1,050	12.0	716		2.8
4/20/98	900				5,350	1.0	4,312		11.0
5/25/98	830	16.7			2,410	2.0	1,880		
6/22/98	1000	20.0			1,400	70.0	1,018		3.6
7/20/98	1500	16.7			2,048	1.0	1,448		2.4
8/17/98	845	17.8			1,850	2.0	1,338		2.2
9/21/98	1230	16.7			1,479	2.0	1,054		2.1
11/30/98	1120	11.1			4,080	5.0	3,136		8.0
1/20/99	1435	7.2			5,540	2.0	4,140		18.0
2/16/99	1540	0.0			4,100	5.0	3,170		8.2
3/15/99	1525	10.0			4,180	1.0	3,280		9.4
4/27/99	1420				2,190	5.0	1,514		3.2
5/11/99	1511	13.3			1,500	6.0	1,064		2.1
7/12/99	1546	26.1				5.0	1,272	909	2.6
8/23/99	1230	25.0			1,490	2.0	1,046		
8/21/00	1050	16.7				5.0	2,294	2,040	3.0
9/16/00	915	19.6				4.0	2,128		
10/29/00	1400	5.2				8.0	1,568	1,000	3.3
11/18/00	900	2.5				5.0	2,574	1,470	4.8
12/16/00	1230	0.2				5.0	3,869	1,900	13.0
1/19/01	1600	0.0				5.0	4,814	2,160	15.9
2/10/01	1000	0.0				5.0	4,688	1,860	16.9
3/23/01	1500	12.7				6.8	2,582	1,210	6.4
4/27/01	1430	20.0				1.5	3,244	1,710	11.7
5/25/01	1220	22.5				1.0	1,886	1,340	2.9
6/28/01	1405	26.6			2,030	1.2	1,472		
7/17/01	1400	27.1			2,520	2.1	1,792		0.5*
8/23/01	1200	24.6			3,820	0.1	2,912		
9/14/01	1130				3,910		3,342		4.3
10/11/01	1130	10.3			5,020	1.0	4,054		
11/15/01	920	2.0	9.0	7.7	4,830	0.5	4,510		4.9
7/11/06	1015				3,340		2,334		
8/1/06	1300	23.0			3,690	17.0	2,586		
8/28/06	1350	22.0			2,720	6.0	1,928	1,580	1.9
10/2/06	1200	20.0			2,360	3.2	1,606		

10/30/06	1230	10.0			1,986	21.4	1,304		
12/18/06	1230	1.0			6,510		5,134		
2/26/07	1230	1.0			3,550		2,614	1,180	5.8
4/3/07	1345	12.0			4,560	35.0	3,408		
4/30/07	1342	22.0			5,240	8.8	4,028		
6/4/07	945	16.9			3,990	5.3	2,836	1,670	2.8
6/25/07	940				3,380	3.5	2,394	1,690	2.3
8/6/07	1450	21.5			4,810	0.1	3,588	2,340	3.2
9/10/07	1048	18.0			4,920		3,598		
10/15/07	1108	8.5			2,370	0.5	3,600		
11/5/07	1132				4,940		3,788	2,180	4.8
12/3/07	1430				5,980		4,886	1,850	
3/10/08	1211	1.6	8.0		3,050	162.0	2,190		
4/14/08	1145	13.5	7.8		4,720	2.4	3,562	1,860	6.6
5/19/08	1130	20.2	8.2		6,020	25.0	4,872	2,080	5.5
6/2/08	1025	20.3	8.2		4,030	29.2	2,984		
7/7/08	912				2,350		1,606	1,340	2.0
8/11/08					4,210		6,146	2,220	3.2
9/15/08					2,550		1,772		
10/28/08	1647	10.6	8.6	11.4	3,179	0.6	2,632	1,330	2.0
11/18/08					4,220		3,220		
12/8/08	1300	0.4	7.9	8.1	3,328	0.2	4,926	2,280	2.5
2/24/09							4,476	1,530	5.3
3/10/09	900	-0.2	7.9	11.0	4,476	18.5	3,504	1,430	4.1
4/21/09	1410	21.7	8.0	8.3	5,717	1.0	4,178	2,280	3.9
5/11/09	1310	19.5	8.2	12.9	5,947	1.0	4,686	2,690	3.0
6/22/09	1600	21.4	8.3	8.9	2,216	55.4	1,616	1,090	1.3
7/20/09	1630	24.3	7.9	8.6	4,216	1.0	2,876	2,370	3.4
8/4/09	1800	21.8	8.1	7.0	4,733	1.0	3,472	2,510	3.3
9/10/09	1400	23.8	8.0	7.7	4,774	1.0	4,172	2,490	3.2
11/3/09	1510	9.3	8.4	14.5	3,215	2.1	2,282	1,410	1.7

Appendix C.

Response to Comments

The following comments were received by UDWQ during the public comment period for the Draft Pariette Draw TMDLs.

Moreen Henderson (email 8/18/10)
Comment 1

I have just a few comments this time.

1. I like that you have recognized that the Pleasant Valley area has done a lot of work with sprinkler systems and piping the canal.

2. I support continuing to do water sampling and the studies USU is going to do. I hope that there can be more studies done South of Pleasant Valley in the Wells Draw and Castle Peak area.

3. I think that the language that Randy Crozier wants included is a very good idea. As the water tests and soil samples support the theory that the water quality can't be met, because of the geology of area.

Response 1

UDWQ added a sentence in the introduction section stating that these TMDLs will be re-evaluated in 5 years after the completion of a comprehensive study by USU in coordination with BLM and UDWQ looking at the mobility of Se in the watershed and biota. This language was suggested by Randy Crozier and was agreed upon by the Pariette Draw Stakeholder group.

Dex Winterton (emailed letter 7/20/10)
Comment 2

On behalf of the Duchesne County Water Conservancy District I am sending you comments in regard to the "Draft TMDLs for Total Dissolved Solids, Selenium, and Boron in the Pariette Draw Watershed". This is our first round of comments and we intend to follow up with more after the public hearing scheduled for July 27th. There are several issues that have been observed with the process in which the document was formed and with the document itself. From the very beginning it was promised that the public and involved parties would be involved with the formation of the Draft TMDL. This did not happen as there has been very little communication from the Utah Division of Water Quality between the first meetings and the release of the draft document. This is very concerning due to the seeming lack of understanding of the importance of the farm ground and the significant investments that have been made to improve the management of the water in those areas.

While much of the document tends to point to agriculture as the main source of pollution or one of the only places where reductions can be made, it seems that agriculture is one of the only places that benefit water quality within the watershed. Within the document it is noted in section 4.5 that concentrations of the pollutants are lower during the irrigation season due to dilution. So the only time of year when concentrations are lower are also the only times that there is a source of water coming directly from the agricultural lands. Section 5.3 also points out that there would be no wetlands and almost no flow downstream at that time of the year if it were not for the irrigation that takes place on the agricultural lands. It appears that more than a majority of the pollution is naturally occurring and that making changes to current agricultural practices may only serve to increase the concentrations of the pollutants in the water. Due to natural conditions there may be no way to meet the requirements listed in the TMDL. Thank you for your time concerning this matter.

Response 2

Three Pariette Draw Stakeholder meetings were held during the past year and a time for the stakeholders to comment on the draft (sans completed data) back in October 2009. The meetings here held in Vernal (BLM Office) on August 5, 2009 and then two in Roosevelt (NRCS Office) on October 15, 2009 and July 6, 2010. In early 2009, we met with Darrell Gillman to pick out water quality monitoring sites in the Pleasant Valley area and also met with Moreen Henderson for a field tour of the sampling sites in the summer of 2009. Local involvement was solicited for each of the meetings but of course not mandated. We did our best to incorporate local knowledge and concerns during these meetings and field tours. In regards to the implementation section of this report, once the TMDL has been finalized, the Uintah Basin Watershed Coordinator in conjunction with the Pariette Draw Stakeholders will work together on project implementation plans. The implementation suggestions documented in the TMDLs are standard recommended BMPs, particularly when dealing with significant TDS loading. In multiple places within the TMDL document, UDWQ states that the most significant source for the pollutant loading comes from the geology but the return flows and groundwater deliver these pollutants to Pariette Draw.

Sandie Spence (email 8/24/10)
Comment 3

Here are my comments on the public draft for you. Thanks, it looked great - we have no new comments. No worries on our part regarding the Assessment Methodology question you had unless this is a change from the 2006 IR Assessment Methodology (that was the last one used for an approved IR). Could you just check that out and reference this in the document instead of the 2008 IR? (I don't believe the 2008 IR has been released for EPA approval yet.) Just a technicality but we might as well reference the last approved IR for which the assessment method was used.

Response 3

The 2008 IR was referenced in the Water Quality Standards section; however since the 2008 Report is still in draft form, the 2006 Final IR was referenced instead.