Middle San Juan River Watershed-Based Plan

San Juan County, NM

Acknowledgements

List of Acronyms

Acronym	Full Term
BMP	Best Management Practice
BLM	Bureau of Land Management
CEAP	Conservation Effects Assessment Project
CFR	Code of Federal Regulations
CRP	Conservation Reserve Program
CWPP	Community Wildfire Protection Plan
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FSA	Farm Service Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
MRGCD	Middle Rio Grande Conservancy District
MSJR	Middle San Juan River
MSJWBP	Middle San Juan Watershed-Based Plan
NHD	National Hydrology Dataset
NMED	New Mexico Environment Department
NMSU	New Mexico State University
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Initiative
OHV	Off-Highway Vehicle
PLET	Pollutant Load Estimation Tool
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
WBP	Watershed-Based Plan
WQCC	Water Quality Control Commission

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Executive Summary

The Middle San Juan Watershed-Based Plan (MSJWBP) focuses on the segment of the San Juan River in New Mexico that starts at Navajo Dam, heads south towards Blanco, NM then west to the Hogback of the Navajo Nation before the confluence with the Chaco River. The San Juan River is listed on the State of New Mexico's Clean Water Act Section 303(d) list of impaired waters for both *Escherichia coli* (*E. coli)* and sedimentation.

The MSJWBP will focus on the Upper and Middle San Juan Watersheds (Hydrologic Unit Codes (HUC) 14080101 and 14080105) to specifically address the eighteen 12-digit HUCs that encompass the northwest corner of New Mexico and Navajo Nation. Reaches of the river's mainstream and outlets of major ephemeral tributaries are found between Navajo Dam and the Chaco River's confluence. The aforementioned HUC12s were selected to be incorporated into this plan for a variety of factors, including impairment statuses within New Mexico Environment Department (NMED) jurisdiction, Navajo Nation Environmental Protection Agency, local/community input, land use, population density and distribution, stakeholder priorities, and HUC12s are a common planning unit for watershed-based plan (WBP) development.

The objective of the MSJWBP is to combine water quality trends with land use data and the practical experience of local stakeholders to make informed decisions on how best to improve water quality on the San Juan River.

- Measured concentrations of *E. coli* often exceeded New Mexico state water quality criteria, as well as total maximum daily load (TMDL) targets established for the San Juan (which confirms impairment). The San Juan River was listed as impaired for sedimentation/siltation in 2012 using the National Sedimentation Laboratory's 2002 methodology; a new protocol for evaluating sedimentation of New Mexico's boatable rivers in currently under development (2024-2026 NMED Assessment Rationale).

- *E. coli* loads in the San Juan River vary seasonally; during summer and fall, precipitation events cause an increase in river flow and turbidity, and concentrations of *E. coli* become elevated (2024-2026 NMED Assessment Rationale).

- The primary source of *E. coli* loads in the San Juan River at low flow cannot be solely explained by inflows at tributary drainages. It is possible that inflows do contribute a higher portion of the nutrient and *E. coli* load during storm events. 2021-2022 water testing showed substantially higher rates of *E. coli* during/after storm events (SJWG, 2022).

- There is a very consistent source of ruminant bacteria in the San Juan River (90% of samples positive), and a less pervasive but consistent source of human bacteria (60% samples positive) (SJWG, 2022).

From these datasets, the San Juan Soil and Water Conservation District (San Juan SWCD) concludes that management practices should not solely focus on reducing pollutant loads from single, discrete inflows. Instead, a more holistic watershed approach should be taken by addressing contributions from different land uses during low flow, and especially during storm event conditions. Thus, a plethora of projects/outreach efforts will be outlined throughout this plan to effectively address the pollutant sources, impairments, and threats to watershed health. Project types will be specific to a given land use or pollutant source category, which includes:

- Septic, sewer, and wastewater management
- Agricultural best management practices (BMPs)
- Upland restoration and BMPs
- Urban stormwater projects
- Riparian restoration
- Streambank, wetland, and floodplain restoration
- Irrigation infrastructure improvements

For each of these land uses or pollutant source categories, management measures will be described, as well as: implementation strategies, implementation schedule, and possible funding sources. Project locations, costs, and expected pollutant load reductions are summarized throughout this plan. In order to estimate the sediment load reduction that can be expected from implementing BMPs for specific projects, the MSJWBP utilizes a model developed by the U.S. Environmental Protection Agency (EPA) called PLET (Pollutant Load Estimation Tool). As this plan is updated through adaptive management over time, the management measures and implementation strategies should stay relatively the same, while specific project areas and costs will be updated as original projects are completed. The long-term goal of this plan is to restore the Middle San Juan River to an unimpaired condition so that it may meet the necessary standards to uphold all of its designated uses. This means that bacteria concentrations are reduced to a point where they do not impact the designated use for primary contact, which includes recreation. Additionally, functioning capacity and sediments are improved to a degree that will support healthy aquatic life and other ecosystems. The effectiveness of this plan will be assessed through data tracking (interim achievement criteria, progress milestones, and continued water quality monitoring).

Mission and Goals

The mission of this WBP is to be a living work plan to empower and support all stakeholders to work towards a functional, sustainable, and resilient watershed for current and future generations. It is the intent of the San Juan SWCD to ensure that community values are thoroughly represented and incorporated into all explored watershed strategies over time to collaboratively address water quality, water quantity, human connections and impact, and floodplain conditions.

This plan seeks to assimilate all previous and current watershed background information and strategies to support future watershed planning activities addressing specific parameters of concern. To work towards this mission, several goals have been identified by the San Juan SWCD and incorporated into this watershed planning initiative:

- Characterize existing information on the background and state of the watershed, including water quality, quantity, aquatic habitat, floodplain condition, recreation access, irrigation infrastructure, and land use data
- Conduct a gap analysis of this data to identify further research, collaboration, and assessments needed for scientifically informed strategies
- Describe existing and ongoing programs, projects, and data collection initiatives being implemented by agencies and work groups throughout the project area
- Outline project and research opportunities for further analysis and planning to address the resource concerns, community needs, and support the further collaboration of partner programs

Table 1: HUC12 Watersheds and Acreage of the Middle San Juan River Watershed Plan

HUC12 Name	Total Urban Acres	Total Cropland Acres	Total Pastureland Acres	Total Forest Acres	Total Watershed Acres
Eagle Nest Arroyo-SJ River	1,122	553	6,573	13,433	21,681
Eagle Nest Arroyo	60	14	2,653	26,764	29,491
Outlet Shumway Arroyo	255	155	5,116	24,441	29,967
Shumway Arroyo-SJ River	2,493	3,891	10,581	14,851	31,817
Outlet Ojo Amarillo	478	3,455	6,632	3,853	14,418
Ojo Amarillo Canyon-SJ River	2,707	404	10,026	11,794	24,934
Farmington Glade	1,917	15	6,076	15,616	23,625
Head Canyon-San Juan River	1,466	324	9,501	746	18,753
Gallego Spring-Gallegos Canyon	359	3,241	9,621	4,712	17,934
Gallegos Canyon	2,018	3,134	13,999	8,984	28,135
Kutz Canyon	407	33	11,898	24,125	36,462
Kutz Canyon -San Juan River	2,400	336	15,133	15,895	33,764
Armenta Canyon-San Juan River	911	140	13,505	23,137	37,693
Armenta Canyon	11	0	7,292	9,852	17,155
Pump Canyon - San Juan River	461	9	379	20,063	20,913
Lower Gobernador Canyon	484	4	368	29,010	29,867
Lower Pump Canyon	12	4	979	13,064	14,059
Canon Largo-San Juan River	829	110	6,608	22,499	30,045
Grand Total [% of Total Watershed Acres]	18,389 [4.0%]	15,823 [3.4%]	136,941 [29.7%]	282,840 [61.4%]	460,714

Chapter 1. Introduction

Sections 303(d) and 305(b) of the federal Clean Water Act (CWA) require each state to identify waters not meeting water quality standards and waters where water pollution controls are not stringent enough to meet those standards. Water quality standards protect designated uses of water such as primary contact (i.e. swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock, and wildlife. The 303(d)/305(b) list of impaired waters, available at https://www.env.nm.gov/surface-water-quality/303d-305b/, identifies impaired waters that need attention and help in addressing water quality problems. The San Juan River in San Juan County is currently on the state's 303(d) list of impaired waters for excess levels of *E. coli* bacteria and sedimentation. Potential sediment sources include crop production, drought-related impacts, flow alterations from water diversions, loss of riparian habitat, petroleum/natural gas related activities, rangeland grazing, and streambank modification/destabilization. Potential *E. coli* sources include municipal point source discharges, drought-related impacts, septic systems, rangeland grazing, flow alterations from water diversions, and loss of riparian habitat (NMED, 2005 Final Approved Total Maximum Daily Load for the San Juan River Watershed).

Nonpoint source (NPS) pollution refers to contaminants that do not come from specific conveyances, such as pipes or other permitted sources. It includes contaminants carried in runoff from fields, roads, parking lots, etc., as well as more specific sources such as improperly functioning on-site wastewater treatment systems. In New Mexico, agriculture is a common source of NPS pollution, although urban areas and abandoned mine lands can also be significant sources.

Point sources are regulated under Section 402 of the Clean Water Act and are usually subject to permit requirements under the National Pollutant Discharge Elimination System (NPDES) that focus on pollutant limits and water quality protection. However, most nonpoint sources of pollution are typically unregulated and are addressed by citizens, farmers, and educators on a voluntary basis. The responsible parties may include citizens, industries, agribusinesses, commercial businesses or homeowners, and public land management agencies.

The overall goal of the MSJWBP is to provide guidance to the San Juan SWCD, local stakeholders, community members, and government agencies as they work together to improve water quality.

Stakeholder engagement started under San Juan Watershed Group's (SJWG's) US Bureau of Reclamation (BOR) WaterSMART grant. Agency stakeholders were identified and include: San Juan SWCD, NMED Environmental Health Bureau, NMED Surface Water Quality Bureau (SWQB), New Mexico State Land Office, San Juan Basin Recovery and Implementation Program (SJRIP), Diné College: Diné Environmental Institute, Navajo Nation chapter houses, US Bureau of Reclamation, US Geological Survey, NMED Wetlands Program, City of Farmington, City of Bloomfield, City of Kirtland, NM Interstate

Stream Commission, Navajo Nation Environmental Protection Agency, Bureau of Land Management (BLM), Bureau of Indian Affairs Natural Resources Department, River Reach Foundation, NM State Forestry, and NMED Surface Water Quality Bureau. Initial engagement with these stakeholders stemmed from existing partnerships with the San Juan SWCD and SJWG, presenting the SJWG's legacy and current work regularly at agency meetings, and requests from stakeholders for resource management expertise and/or partner for complementary projects and outreach. These engagement methods were used to continue to build relationships with additional stakeholders that were key to participate in the watershed planning process, including Navajo Nation chapter houses, river recreation businesses, and irrigation districts. Key private landowners in the river corridor were identified using county assessor GIS data and engaged via mailings or existing relationships via the San Juan SWCD when possible.

All stakeholders specifically listed above have participated in watershed planning meetings since May of 2021. Each planning meeting was focused on specific watershed-based planning topics and facilitated through interactive management measure identification (using ArcGIS web maps), restoration priority/meeting feedback surveys, guest presentations from stakeholders who already have expertise in the meeting topic, and submitting interim documents to be incorporated into the watershed plan to the group for review and comments. Action items for further information sharing, co-authoring of the watershed-based plan, and establishment of subcommittees have been conducted in coordination with these monthly meetings.

Watershed Characterization

The entirety of the Middle San Juan River and its contributing drainages in this watershed-based plan (WBP) are located within the San Juan Basin, which is a large, circular geological depression. The center of this basin is primarily located in San Juan and Rio Arriba Counties of New Mexico and La Plata and Archuleta Counties in Colorado.

The San Juan River is a politically, ecologically, and culturally complex river. The headwaters originate in southwestern Colorado in the San Juan Mountains at altitudes greater than 13,000 feet starting in the Alpine Life Zone and within the highly mineralized San Juan Caldera. Its headwater tributaries, including the Upper San Juan, Los Piños, Piedra, and Navajo Rivers, flow into the Navajo Dam Reservoir, which regulates release flows on average between 500 and 1,000 cubic feet per second (CFS) downriver to maintain critical habitat flows designated by the United States Fish and Wildlife Service (USFWS) SJRIP. Seasonal releases from Navajo Dam Reservoir immediately flow through the Quality Waters, a world class trout fishing reach spanning approximately four river miles. Below this recreational hub the river meanders through the cottonwood-willow bosques, semi desert sagebrush shrublands, and highly erodible sedimentary strata of New Mexico, Navajo Nation, and Utah into an elevation as low as 3,000 feet at its confluence with Lake Powell. On this journey, the river passes through several

jurisdictions, including but not limited to EPA Region 6 and 8, the state of Colorado, the city of Pagosa Springs in Colorado, the state of New Mexico, the cities of Bloomfield, Farmington, Kirtland, and Shiprock in New Mexico, the Navajo Nation, and the state of Utah. The river is fed by several tributaries, including but not limited to the perennial La Plata, Animas, Mancos Rivers, the ephemeral Cañon Largo, Chaco River, McElmo Creek, Montezuma Creek, and Chinle Wash.

The entirety of the San Juan Watershed encompasses 24,930 square miles and 15,955,360 acres. This WBP focuses on the New Mexico and Navajo Nation reach of the San Juan River below Navajo Dam to the Hogback boundary of the Navajo Nation just upstream of the confluence with the Chaco River. A characterization of other reaches of the San Juan Watershed are available below:

- 2011 Animas River Watershed Based Plan: https://drive.google.com/file/d/1VohIM0eGe_eSXtXABMWJ41EmMmJLObrY/view?usp=drivesdk
- 2021 Lower Animas River Watershed Based Plan: https://drive.google.com/file/d/1N_6NDJkYVqCN6MSN6aH_kIw1bKvjOlIw/view?usp=drivesdk
- Arizona NEMO Watershed Based Plan: https://repository.arizona.edu/handle/10150/188191
- Mancos Watershed Stream Management Plan: https://static1.squarespace.com/static/5d9f93634b2d110c1d44ddc2/t/5dbc88d9f3590333e3c7eb77/1572636961606/Mancos-Watershed-Mancos-Watershed-Plan.pdf
- Upper San Juan Watershed Stream Management Plan: https://www.mountainstudies.org/sanjuan/smp
- Montezuma Creek and Lower San Juan-Four Corners Watershed Coordinated Resource Management Plan: https://drive.google.com/file/d/1VT6j1rXeDdapWFVaNktcW8mtqqV0_1CA/view?usp=drivesdk

The eighteen HUC12 watersheds that are the focus of the MSJWBP encompass several ephemeral and intermittent tributaries to the San Juan River, but does not include the La Plata River, the Animas River, or Cañon Largo. The Animas River is a key perennial tributary that is well characterized and analyzed in the Lower Animas River Watershed Based Plan (LAWBP) and the Animas WBP. Due to these previous and ongoing initiatives, the Animas River is omitted from this WBP focus area but is referenced throughout this document. Cañon Largo is a key ephemeral tributary to the San Juan River. However, due

to its nearly equal complexity to the Animas River and large size (approximately 44 HUC12s), it is omitted from this version of the MSJWBP and is considered a key data gap along with the La Plata River. Future watershed planning efforts for Cañon Largo and the La Plata River are highly recommended.

An extensive network of irrigation ditches and laterals adds considerable hydrologic complexity to the MSJWBP area, with many ditches crossing sub watershed boundaries as they flow parallel to the San Juan River through the valley. These irrigation ditches include the Turley-Manzanares, Echo, Farmers Mutual, Fruitland, Hammond, Bloomfield Irrigation, and Hogback Ditch systems. This renders watershed boundaries less relevant for planning units than political boundaries or irrigation ditch networks depending on the project. Irrigation ditches throughout the MSJWBP area are displayed in the sub-watershed land uses/maps section.

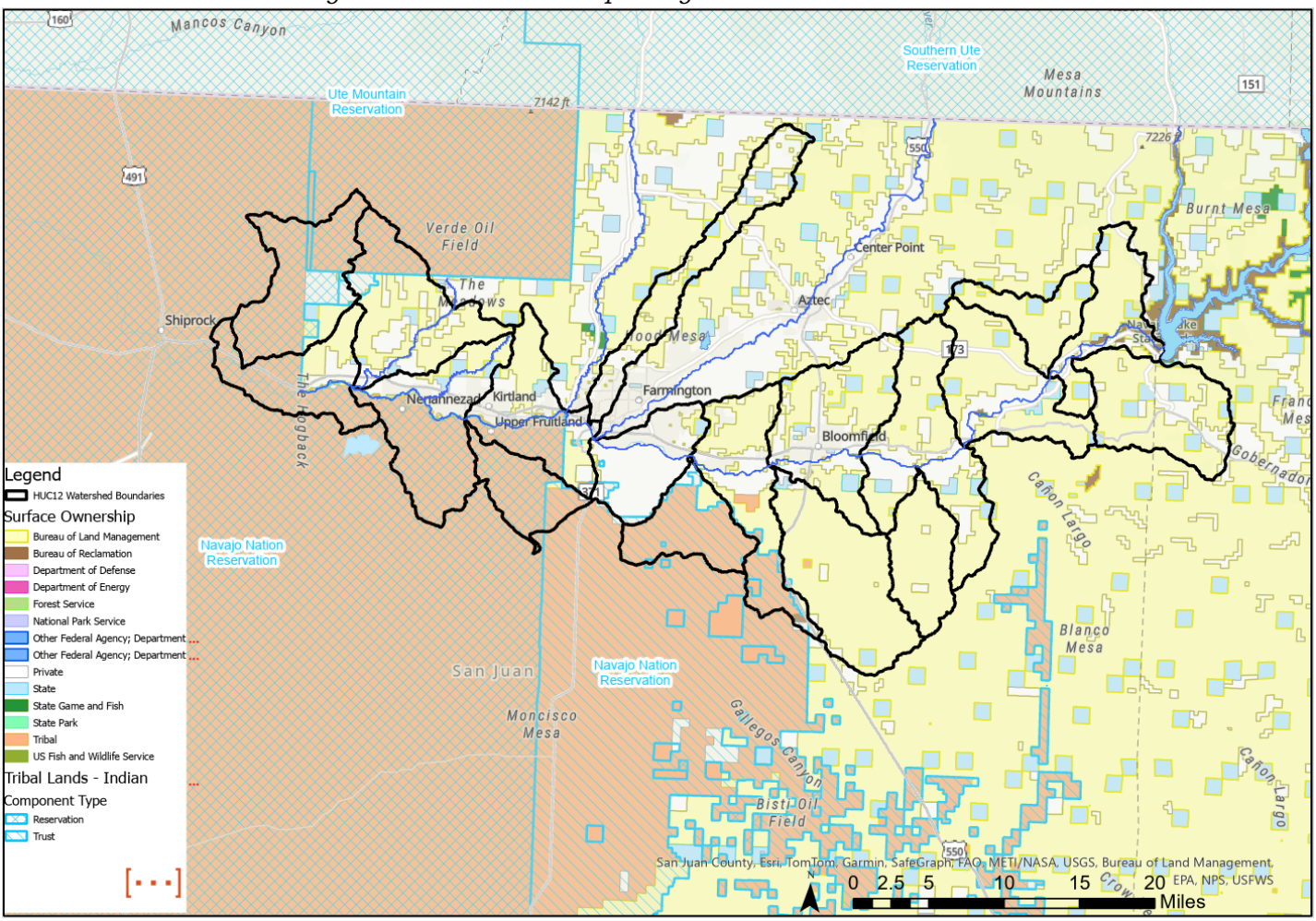
Surface ownership within the watershed-based plan focus area is described in the table below. While private land is dispersed throughout both the floodplain and uplands, private land (including both New Mexico and Navajo Nation communities) encompasses the majority of the land within a one-mile buffer of the San Juan River. New Mexico and the Navajo Nation share jurisdiction on the mainstem of the San Juan River from the Navajo Nation at the Hogback upstream to its confluence with the La Plata River. As is common in the Southwest, surface ownership throughout the scrub/shrub uplands is distributed in a “checkerboard” fashion primarily by BLM, NM State Land Office, and Navajo Nation jurisdictions.

Table 2: Land Ownership within the MSJWBP Focus Area

Land Ownership	Percentage of Focus Area
Bureau of Land Management	48.88%
Bureau of Reclamation	0.5%
Navajo Nation	23.24%

State Land Office	5.05%
State Game and Fish	0.03%
Private	22.30%

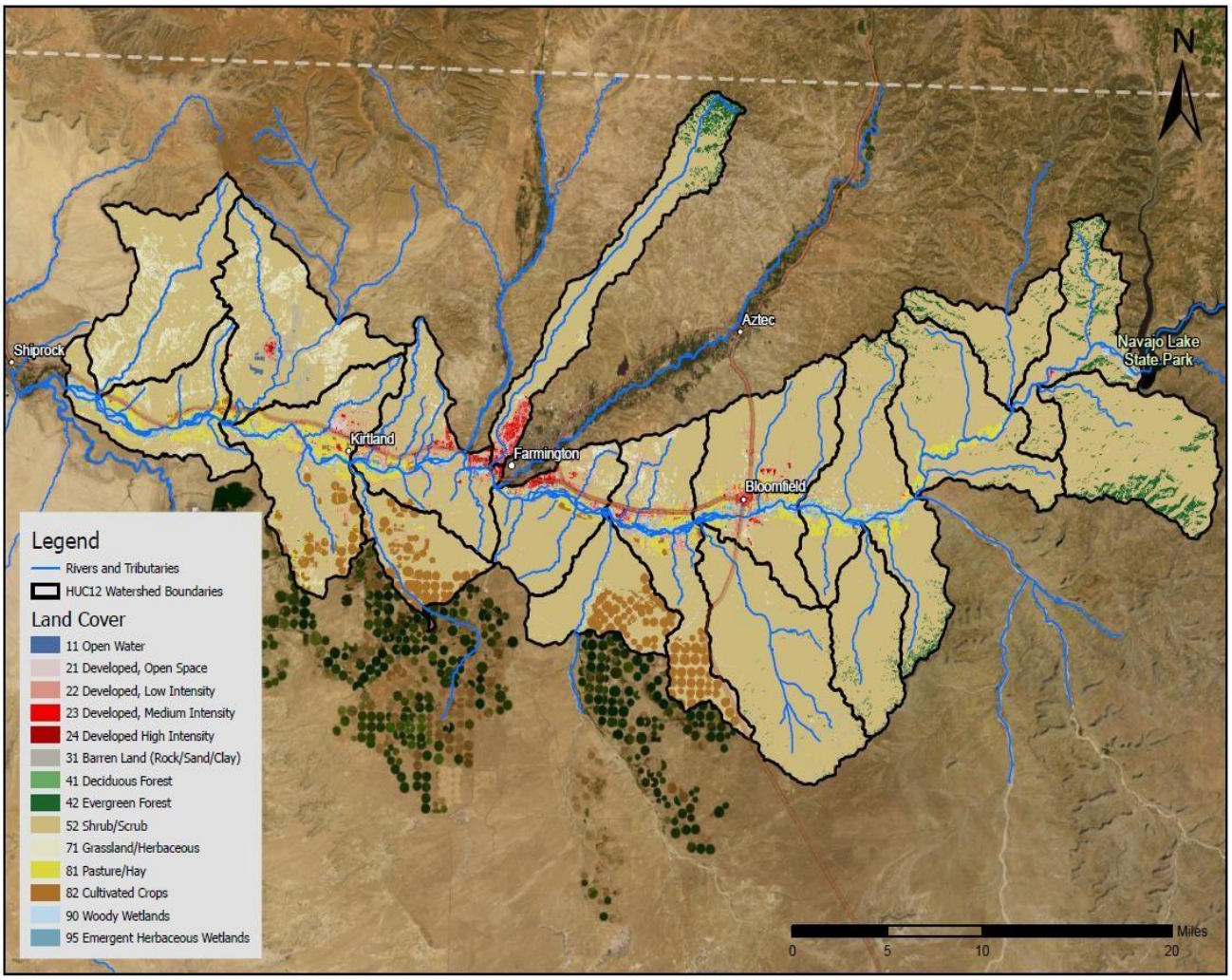
Figure 1: Land Ownership along the Middle San Juan River



Land Uses

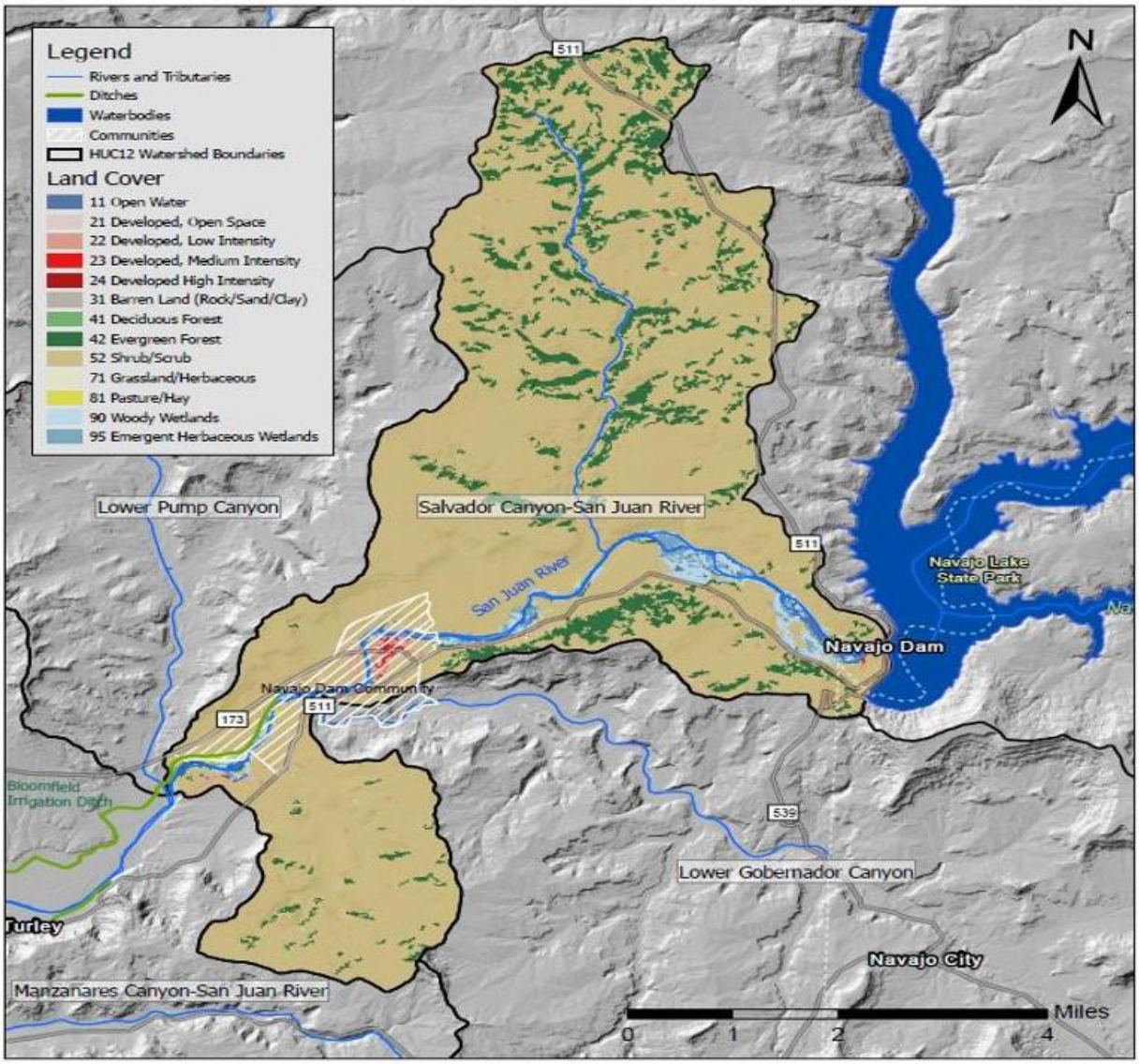
Land use and cover includes 2.29% forest, 79.32% shrub/scrubland, 3.57% grassland, 3.39% pasture/hay production, 3.5% cultivated crop production, 4.75% developed, 0.49% open water, 2.31% wetlands, and 0.45% barren lands (rock/sand/clay). While shrub and scrubland represent the most widespread land cover in the focus area and will be a central consideration in the restoration strategies, the role of agricultural and developed lands—due to their proximity to the San Juan River and potential influence on erosion, runoff, and water quality—will be strongly emphasized throughout the watershed management strategies outlined in this plan.

Figure 2: Land Use and Cover within the MSJWBP Focus Area



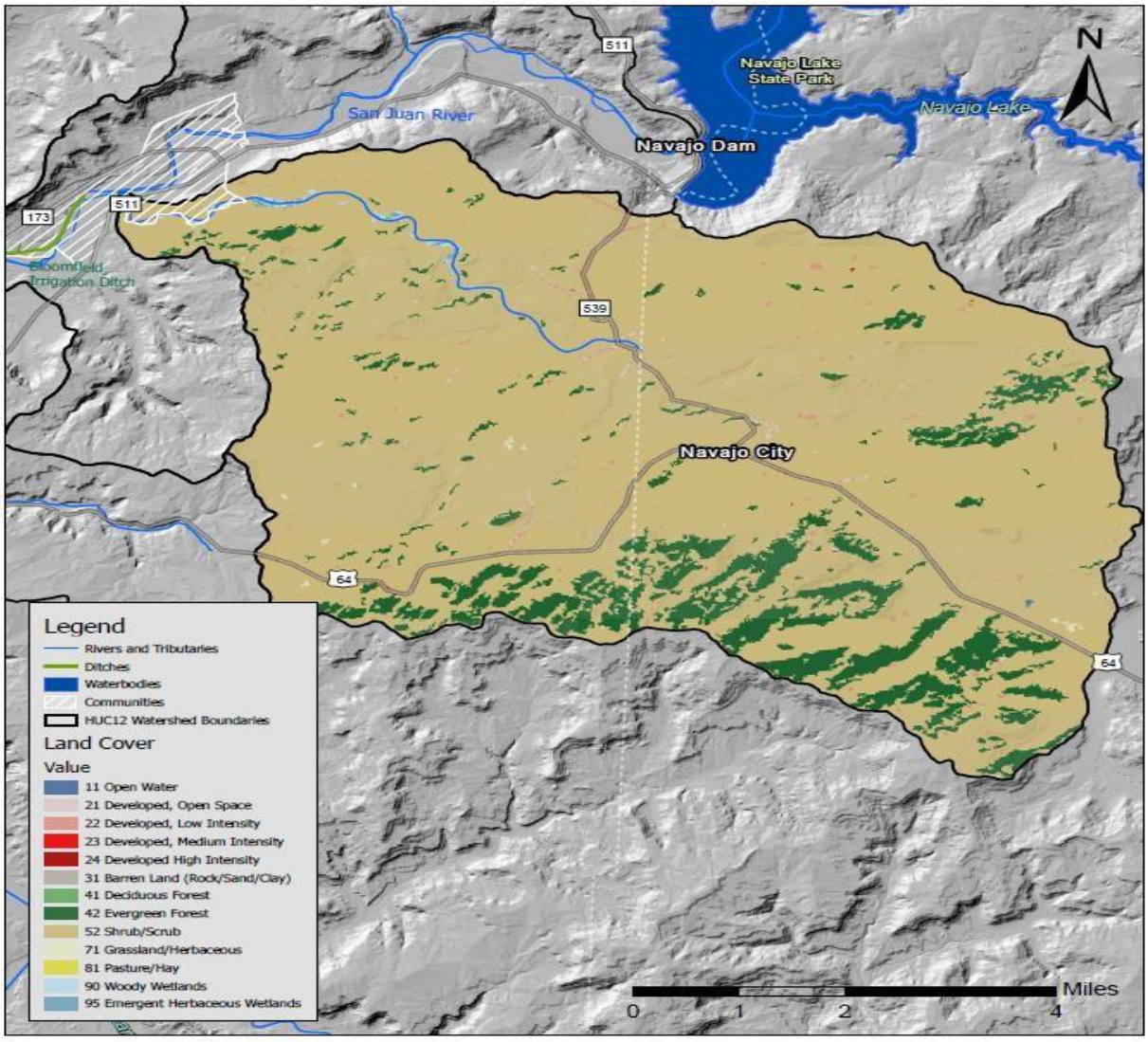
1. Pump Canyon — San Juan River (HUC 140801011901)

Description: Pump Canyon lies west of Navajo Lake State Park, the San Juan River comes out of Navajo Dam. There are a series of tributaries, wetlands, and small waterbodies that follow the river downstream. The Bloomfield Irrigation Ditch comes off the SJ River below the Navajo Dam Community. Navajo Lake State Park provides a great mass of open water in the area, several miles long north to south. Development in the area is in the Navajo Dam Community, widespread in a small area. Evergreen forest stands in small patches on the north stretch of the watershed but there is also a portion on the southcentral portion of the boundary, otherwise scrub dominates the watershed. Grassland, pasture, and agriculture are not present in this watershed.
Area: 33 mi^2
Land Use: Recreation, oil & gas, development, and paved transit
Communities: Navajo Dam Community
Irrigation Ditches: Bloomfield Irrigation Ditch
Impairment Status: This segment of the San Juan River currently meets surface water quality standards and is not impaired.
Restoration and Protection Needs: Erosion mitigation from oil & gas roads, recreation and cattle grazing. Invasive weed removal. Potential increased erosion with fire hazard of dead/dying and overcrowded Pinon Juniper Forest. Human impact, litter, noise, traffic.



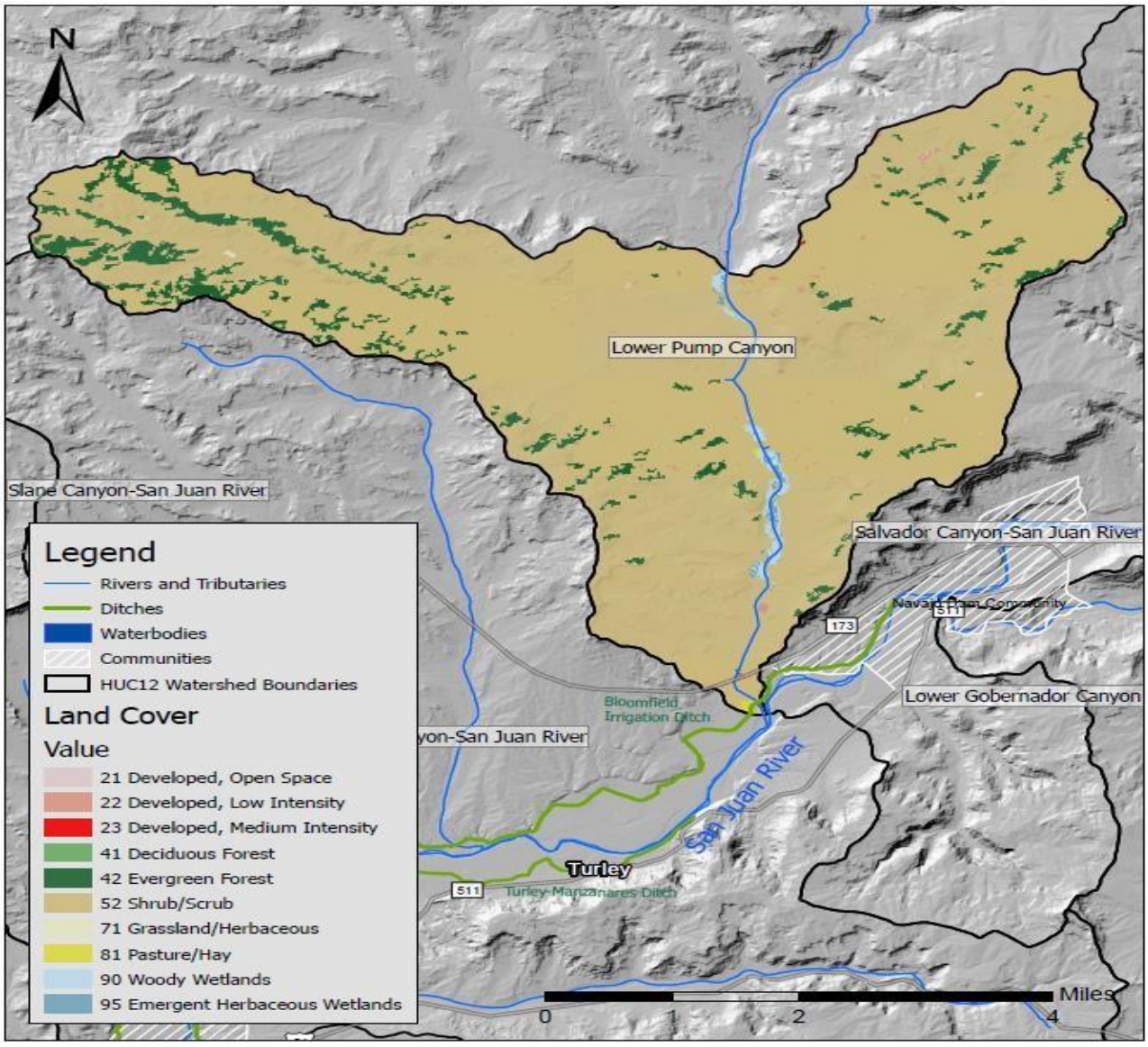
2. Lower Gobernador Canyon (HUC 140801011703)

Description: Lower Gobernador Canyon lies south of Navajo Lake State Park and Navajo Dam and is identified as an intermittent stream in the National Hydrography Dataset (NHD). The San Juan River runs north of the boundary. There are no ditches in this watershed, and Navajo City is located in the center of the watershed. There is no prominent development within the boundary other than the abandoned gas station at Navajo City. Evergreen forest stands in dense patches along the southern portion of the watershed, otherwise scrub dominates the area. Grassland, pasture, and agriculture are not present but there are three branches of highways that cross the watershed.
Area: 47 mi^2
Land Use: Oil & gas, recreation, cattle grazing, and paved transit
Communities: Archuleta
Irrigation Ditches: None
Impairment Status: Water quality in Lower Gobernador Canyon has not been assessed by NMED SWQB. This may be considered a data gap; However, the portion of the San Juan River that Gobernador Canyon flows into is not currently impaired.
Restoration and Protection Needs: Erosion mitigation from oil & gas roads, recreation and cattle grazing. Invasive weed removal. Fire hazard with dead/dying and overcrowded Piñon Juniper Forest. Human impact, litter, noise, traffic.



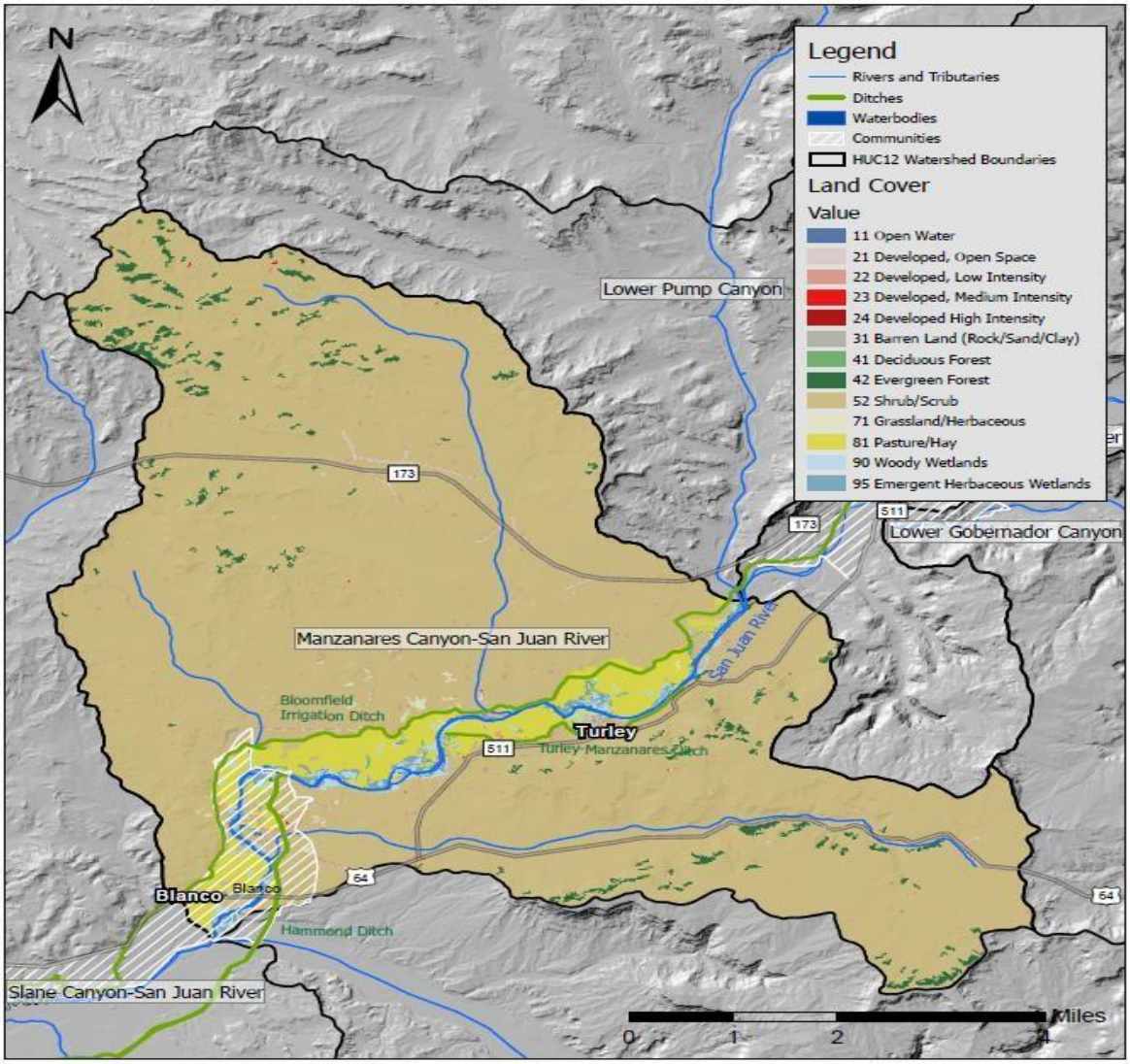
3. Lower Pump Canyon (HUC 140801011805)

Description: Lower Pump Canyon is directly west of Salvador Canyon and Navajo Lake State Park. The San Juan River runs south of the watershed, and Pump Canyon itself runs center down the middle lined by a series of wetlands that follow the river. Lower Pump Canyon is identified as intermittent in the NHD. Low-intensity development is located on the southern tip of the watershed, the Bloomfield Irrigation Ditch crosses the southern tip of the watershed boundary. Evergreen forest is concentrated in the west and east wings of the boundary, but more so in the west wing, scrub dominates the watershed. There are a few specks of grassland.
Area: 22 mi^2
Land Use: Oil & gas, cattle grazing, and recreation
Communities: None
Irrigation Ditches: Bloomfield Irrigation Ditch
Impairment Status: Lower Pump Canyon has not been assessed by NMED SWQB. This may be considered a data gap; However, the portion of the San Juan River that Lower Pump Canyon flows into is not currently impaired.
Restoration and Protection Needs: Erosion mitigation from oil & gas roads, recreation, and cattle grazing. Invasive weed removal.



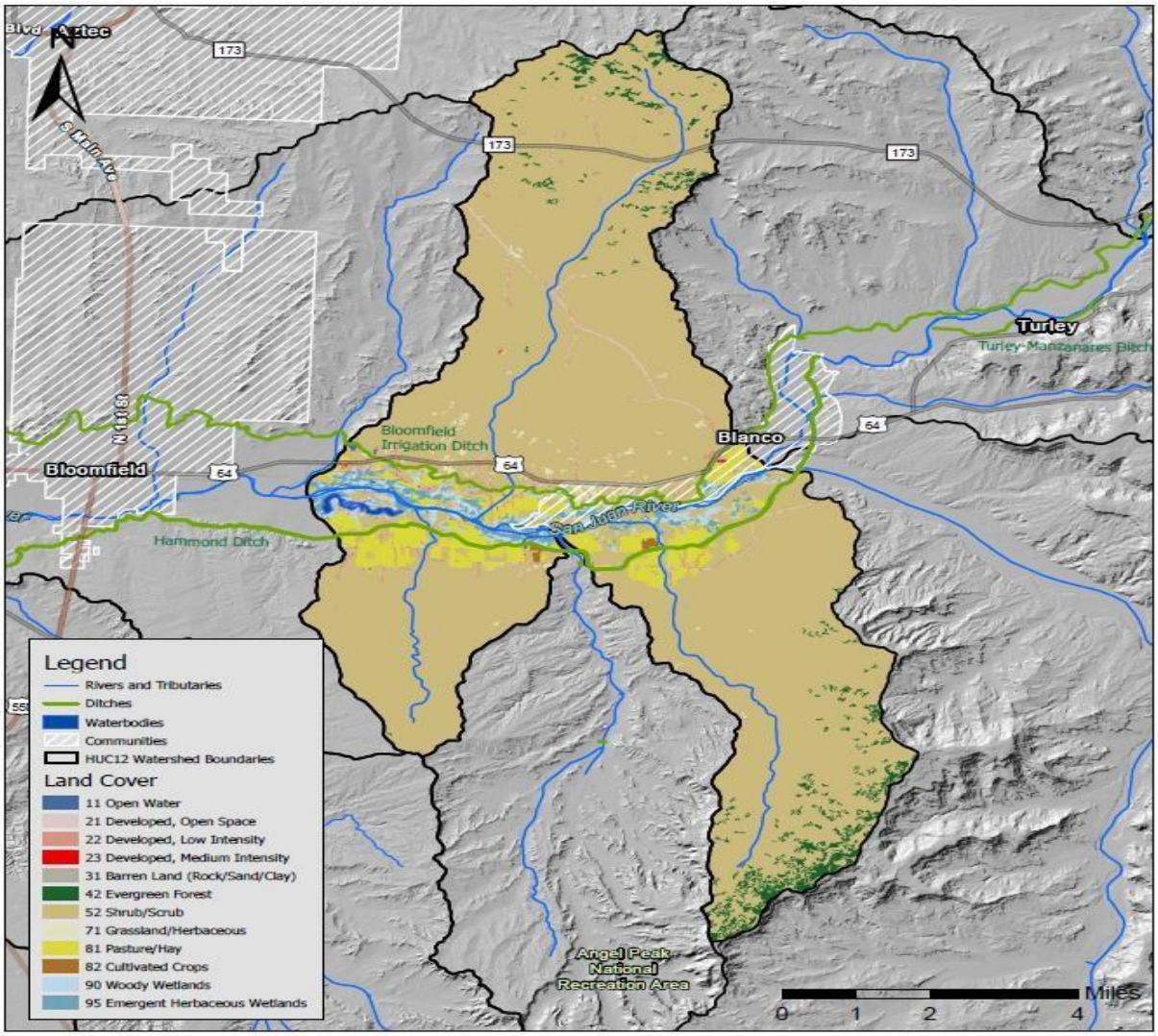
4. Cañon Largo — San Juan River (HUC 140801011902)

Description: Cañon Largo — San Juan River Watershed is directly west of Lower Pump Canyon. The towns of Blanco and Turley as well as the Bloomfield Irrigation Ditch run through the middle of the watershed along the San Juan River. There are some tributaries that run down toward the SJ River which are identified as intermittent in the National Hydrology Dataset (NHD). Wetlands and pasture run along the length of the river in this watershed. The Turley-Manzanares Ditch is only about 2.5 miles long and is found in the center of the watershed. Several paved highways run across the watershed, otherwise very low-intensity development. The Hammond Ditch diverts from the SJ River on the southwest end of the watershed. Evergreen forest stands in small patches on the northwest corner of the boundary and in more scattered patches in the southeast area. Small concentrations of grasslands are found in the central portion, and the rest of the watershed is dominated by scrub.
Area: 47 mi^2
Land Use: Oil & gas, cattle grazing, development, recreation, and paved transit
Communities: Blanco and Turley
Irrigation Ditches: Hammond Ditch, Bloomfield Irrigation Ditch, and Turley-Manzanares Ditch
Impairment Status: This portion of the San Juan River (Cañon Largo to Navajo Reservoir) is not currently impaired.
Restoration and Protection Needs: Erosion mitigation from oil & gas roads, recreation, and cattle grazing. Invasive weed removal.



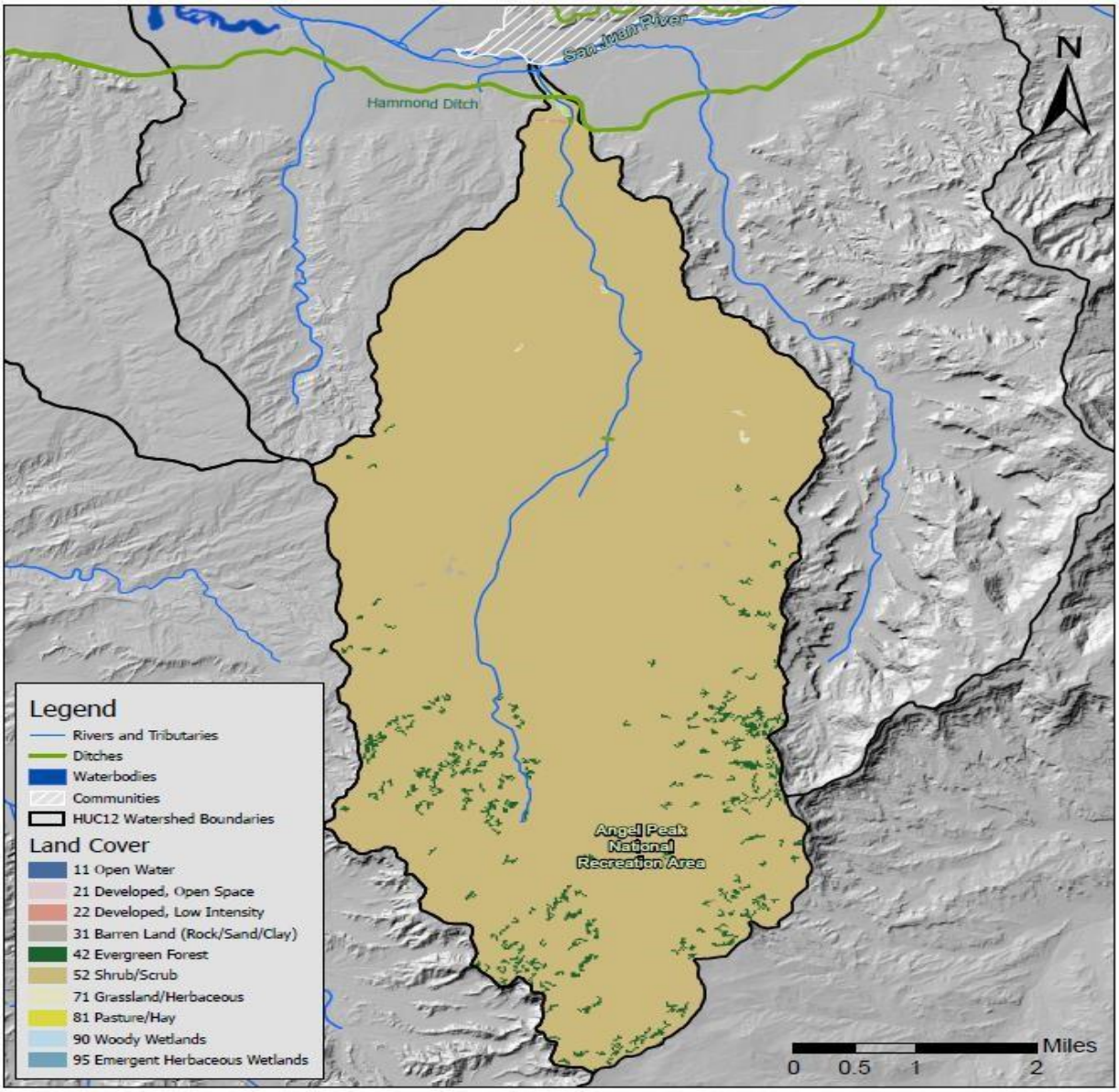
5. Armenta Canyon — San Juan River (HUC 140801011904)

Description: The Armenta Canyon – San Juan River Watershed is west of Manzanares Canyon. Within the three main legs of the watershed, there are tributaries that flow into the San Juan River. The Bloomfield Ditch, Hammond Ditch, development, pasture, wetlands, agriculture, and some water bodies all run along the SJ River through the middle center of the watershed.Evergreen forest stands are most concentrated in the northmost and southernmost ends of the boundary. There are some patches of grasslands concentrated in the mid-section of the watershed, north of the SJ River. Scrub dominates the watershed.
Area: 60 mi^2
Land Use: Pasture, oil & gas, grazing, recreation, and paved transit
Communities: Blanco
Irrigation Ditches: Bloomfield Irrigation Ditch and Hammond Ditch
Impairment Status: The San Juan River (Animas River to Cañon Largo) is currently listed as impaired for *E. coli*, sedimentation/siltation, and pH and does not support the designated uses for primary contact or marginal coldwater aquatic life use. TMDLs have been developed for sedimentation/siltation and *E. coli*.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, petroleum/natural gas activities, animal feeding operations (NPS).
Restoration and Protection Needs: Armenta Canyon — San. Juan River subwatershed, as the city of Bloomfield has noted, has sedimentation issues during stormwater events that negatively affect housing and highway infrastructure from Bloomfield Wash. The project progress during this first HUC12 analysis will be noted to conduct additional analyses throughout the WBP focus area.



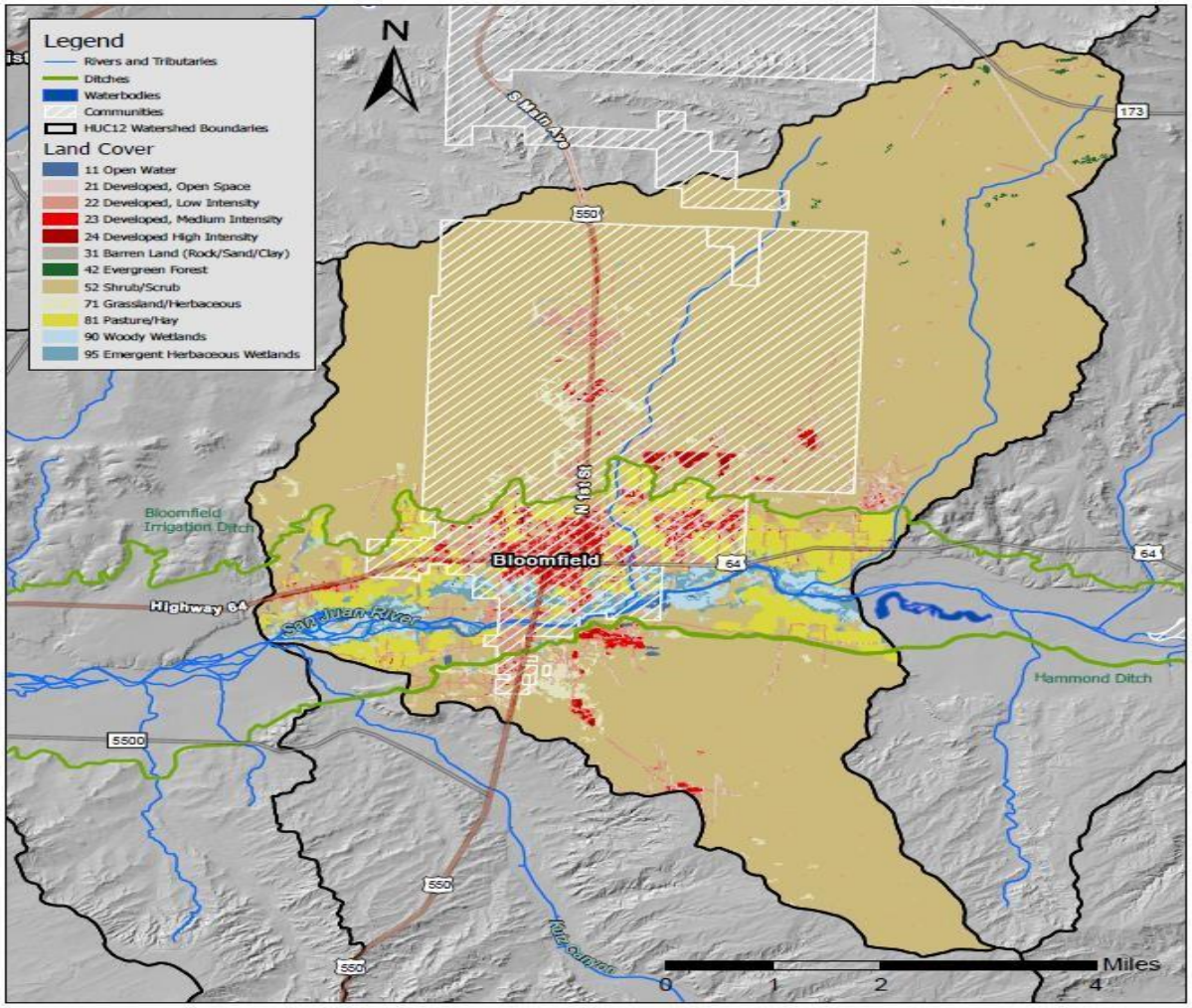
6. Armenta Canyon (HUC 140801011903)

Description: Armenta Canyon has one major tributary down its boundary sits south of the San Juan River which is identified as intermittent in the NHD. Hammond Ditch cross the northern most tip of the watershed. Angel Peak National Recreation area is located on the southern end of the watershed. This watershed fits between the two southernmost portions of the Slane Canyon Watershed. Very minimal patches of evergreen forest and grasslands, heavily dominated by spare shrub. Very low-intensity development and minimal wetlands can be found in the northernmost tip of the boundary.
Area: 27 mi^2
Land Use: Recreation, cattle grazing, and oil & gas
Communities: None
Irrigation Ditches: Hammond Ditch
Impairment Status: Armenta Canyon has not been assessed by NMED SWQB. This may be considered a data gap.
Restoration and Protection Needs: Erosion from oil and gas development, road maintenance, and recreation. Invasive weed removal.



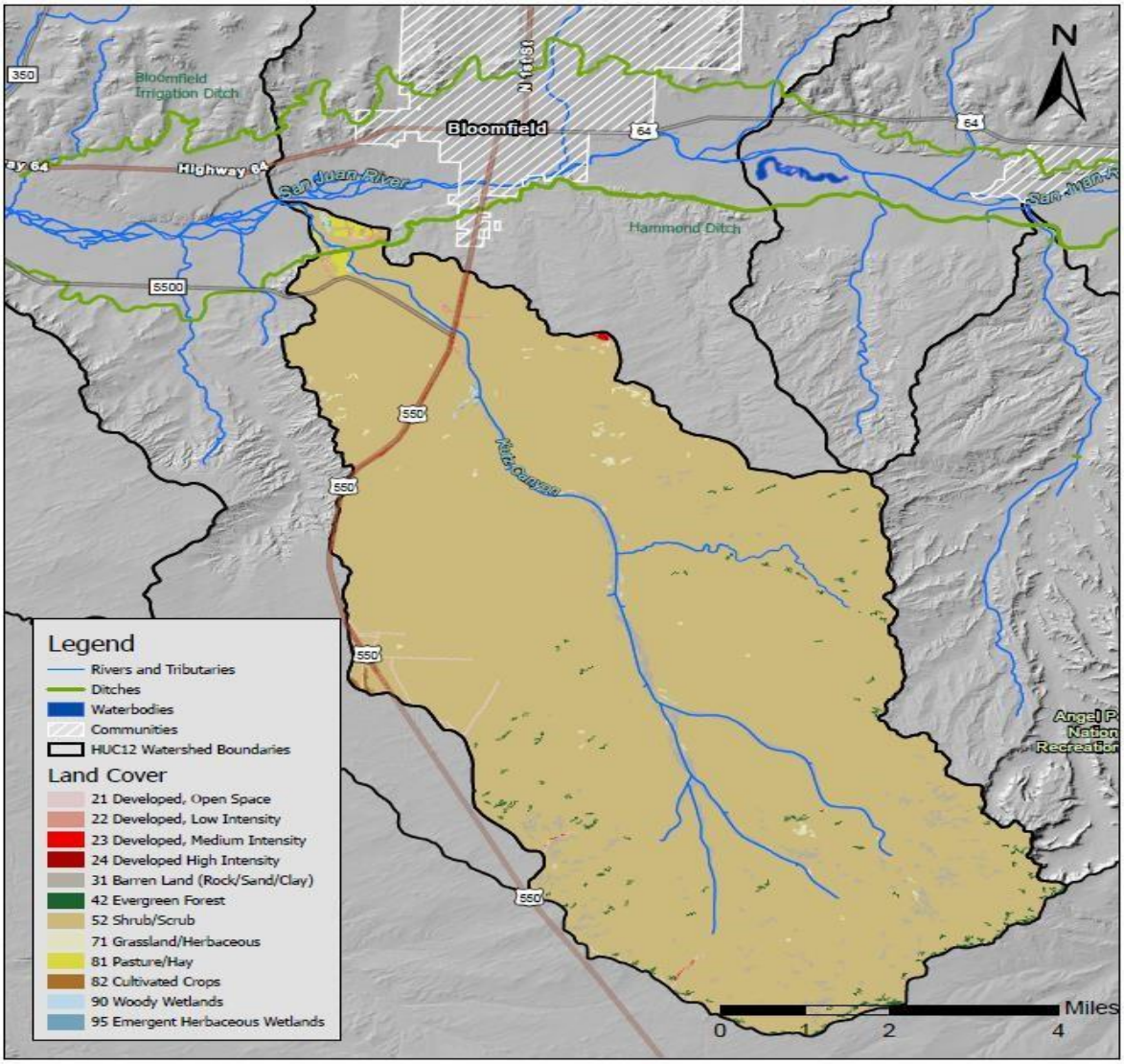
7. Kutz Canyon — San Juan River (HUC 140801012102)

Description: The Kutz Canyon – San Juan River Watershed is northwest of the Armenta Canyon. Almost half of this watershed is developed or part of a community. The City of Bloomfield is located in the center of the watershed. The San Juan River runs east to west through middle of watershed. The Bloomfield Irrigation Ditch runs north along the SJ River and the Hammond Ditch runs south along the SJ River. There are a series of wetlands, and small waterbodies that follow the river downstream. Grassland is spotted throughout the watershed but most dense in the northern square of the Bloomfield community. Very small areas of evergreen forest stand in the northeastern side of the boundary. Grass pastures and scrub dominate the rest.
Area: 53 mi^2
Land Use: Development, pasture, recreation, cattle grazing, oil & gas, and paved transit
Communities: Bloomfield
Irrigation Ditches: Bloomfield Irrigation Ditch and Hammond Ditch
Impairment Status: The San Juan River (Animas River to Cañon Largo) is currently listed as impaired for *E. coli*, sedimentation/siltation, and pH and does not support the designated uses for primary contact or marginal coldwater aquatic life use. TMDLs have been developed for sedimentation/siltation and *E. coli*.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, petroleum/natural gas activities, animal feeding operations (NPS).
Restoration and Protection Needs: Erosion from oil and gas development, road maintenance, recreation, cattle grazing. Mitigation from any human impacts due to proximity to town. Invasive weed removal.



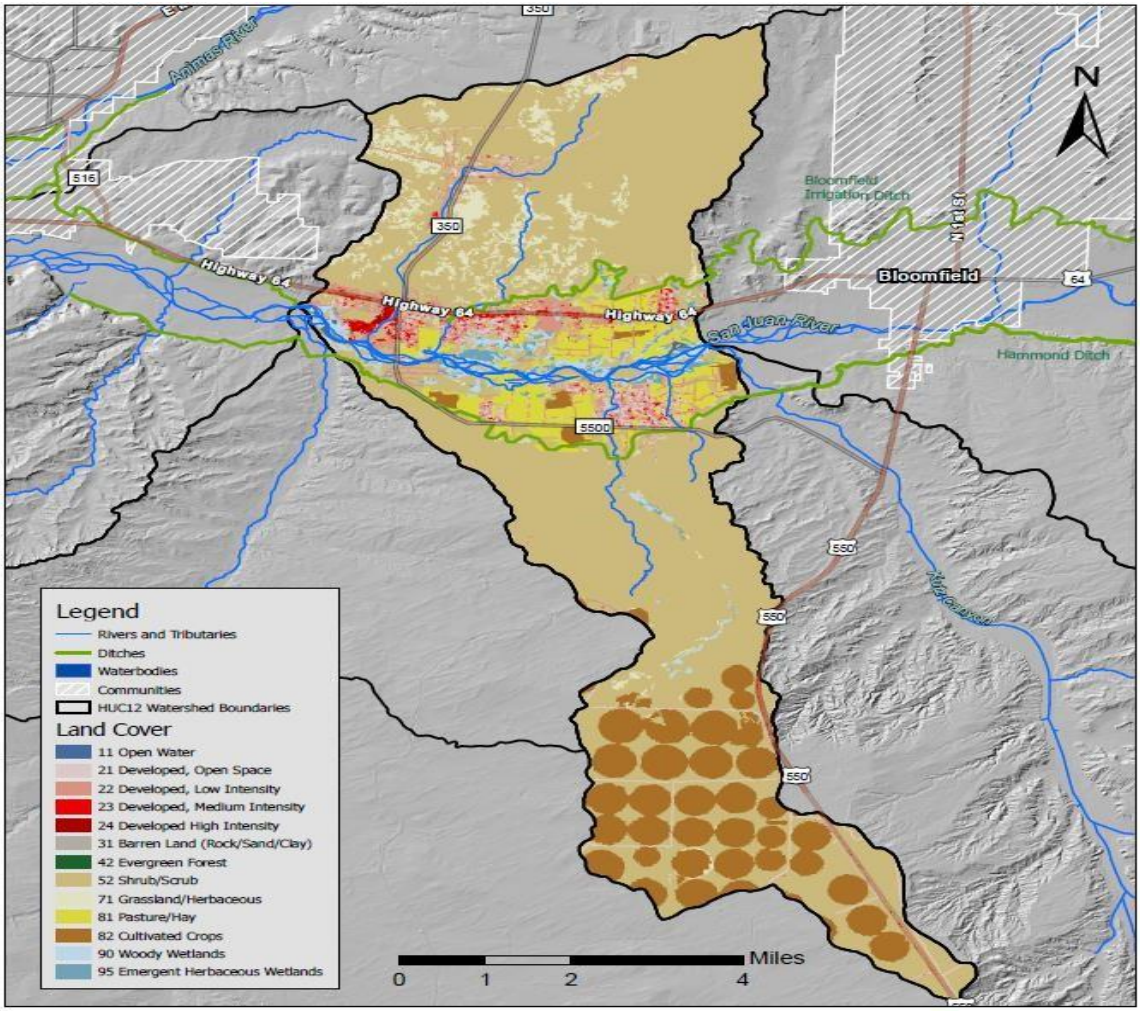
8. Kutz Canyon (HUC 140801012101)

Description: The Kutz Canyon Watershed is located south of Bloomfield/Sullivan Canyon Watershed. The Hammond Ditch runs through the north tip of the watershed boundary, Highway 550 runs through the north end of the watershed a few miles south of the Hammond Ditch. Pasture use can be found at the northeastern most of the boundary. Kutz Canyon is identified as intermittent in the NHD, and there is very sparse evergreen forest spotted throughout the mid-section to the south of the boundary. Spotted grassland, minimal wetland and very little development.
Area: 58 mi^2
Land Use: Oil & gas, pasture, cattle grazing, recreation, and paved transit
Communities: Rural communities southeast of Bloomfield proper, north end of boundary
Irrigation Ditches: Hammond Ditch
Impairment Status: Kutz Canyon has not been assessed by NMED SWQB. This may be considered a data gap.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, petroleum/natural gas activities, animal feeding operations (NPS).
Restoration and Protection Needs: Erosion from oil and gas development, road maintenance, recreation, cattle grazing. Invasive weed removal.



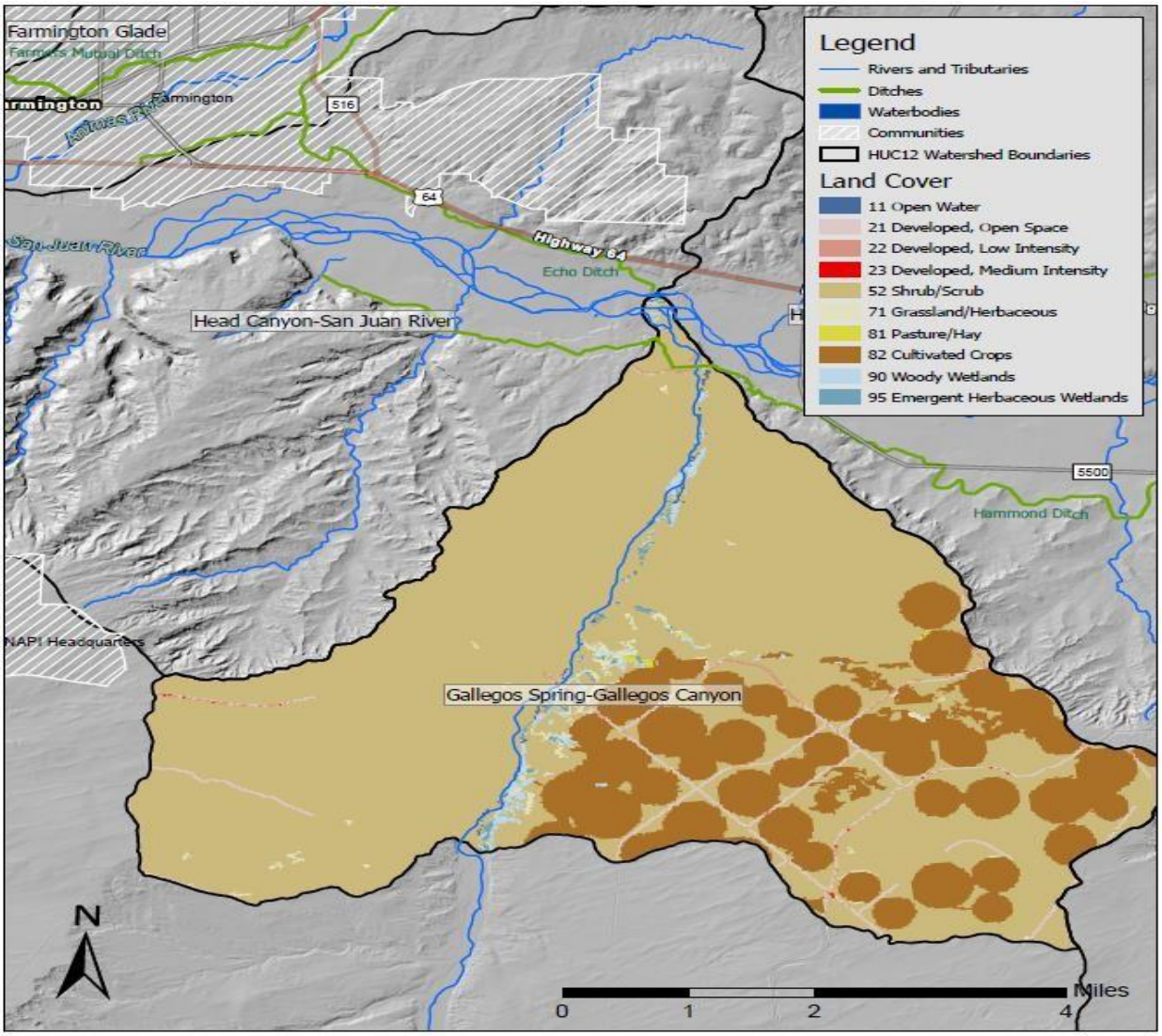
9. Gallegos Canyon — San Juan River (HUC 140801012103)

Description: The Gallegos Canyon — San Juan River Watershed is west of Sullivan Canyon Watershed/Bloomfield. The San Juan River runs west through the middle of this watershed. The eastern edge of Navajo Agricultural Products Industry (NAPI) agricultural fields fill the southern end of the boundary along Highway 550. Quite a bit of development, agriculture, wetlands and pasture can be found through the mid-section of the watershed following along the SJ River. The Hammond Ditch and the Bloomfield Irrigation Ditch run the same course. The northern end of the boundary includes some grassland. No evergreen forest stands of note.
Area: 44 mi^2
Land Use: Oil & gas, recreation, cattle grazing, agriculture, development, paved transit, and pasture
Communities: Peripheral Bloomfield, Farmington, and Navajo Nation
Irrigation Ditches: Bloomfield Irrigation Ditch and Hammond Ditch
Impairment Status: The San Juan River (Animas River to Cañon Largo) is currently listed as impaired for *E. coli*, sedimentation/siltation, and pH and does not support the designated uses for primary contact or marginal coldwater aquatic life use. TMDLs have been developed for sedimentation/siltation and *E. coli*.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, flow alterations from water diversions, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, and urbanization.
Restoration and Protection Needs: Erosion from oil & gas, development, road maintenance, and recreation, invasive weed removal, agricultural BMPs., urban stormwater management, septic system management.



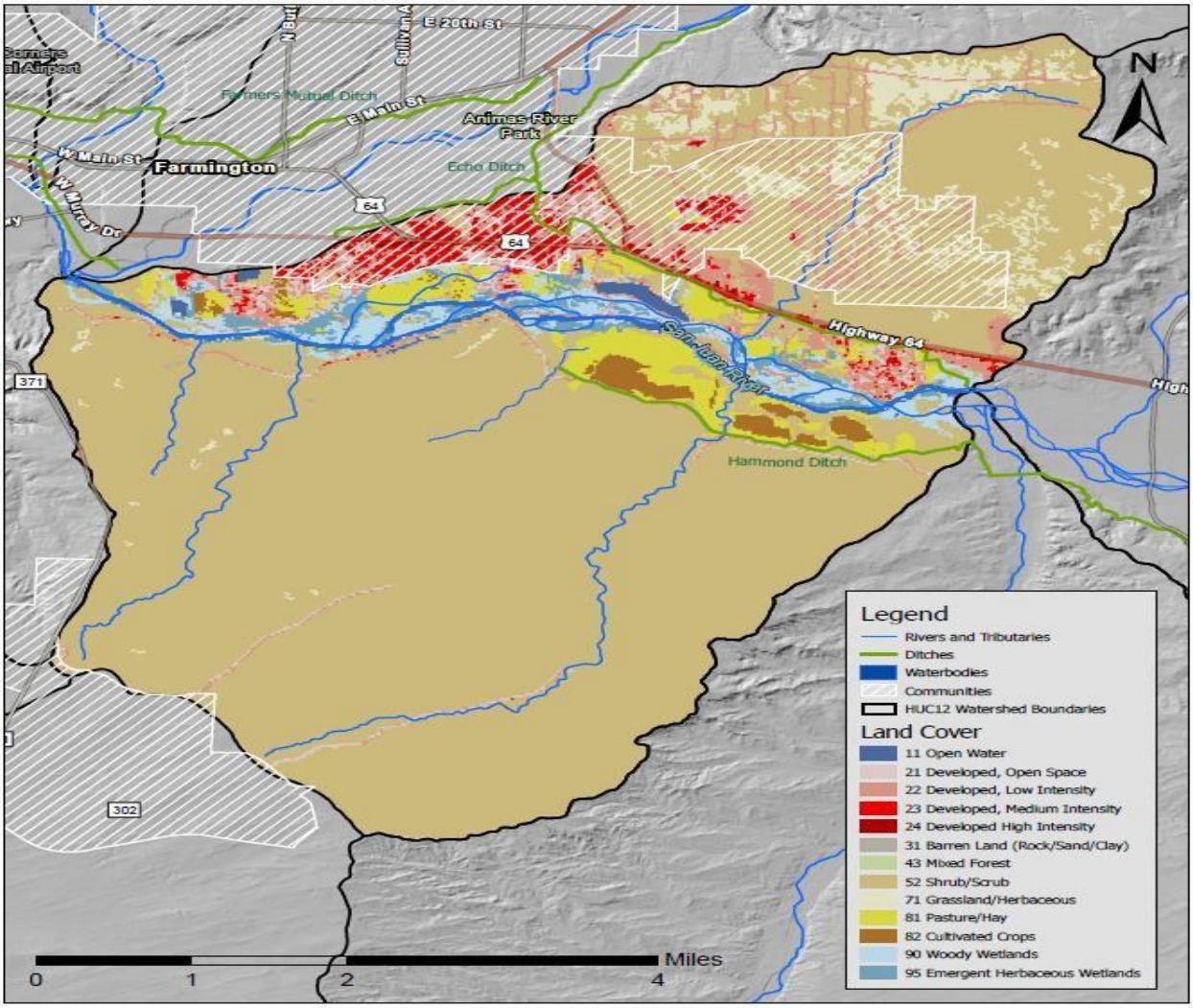
10. Gallegos Spring — Gallegos Canyon (HUC 140801012009)

Description: The Gallegos Spring Canyon is west of the Horn Canyon Watershed and south of Farmington; this watershed contains a significant portion of agriculture in the southeastern portion of the boundary. Along the Gallegos Spring and down the middle of the watershed, a good portion of wetlands hold space. The Hammond Ditch runs across the north tip of the boundary. Minimal grassland and development, no pasture or evergreen forest of note, and scrub is dominant otherwise.
Area: 28 mi^2
Land Use: Agriculture, oil & gas, recreation, cattle grazing, and paved transit
Communities: Navajo Nation
Irrigation Ditches: Hammond Ditch
Impairment Status: Gallegos Canyon (San Juan River to Navajo Nation Boundary) is currently listed as impaired for *E. coli*, total selenium, and temperature. Gallegos Canyon has a TMDL for selenium. Addressing the selenium impairment is outside the current focus of this WBP, but it may be addressed in future updates to the WBP.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, flow alterations from water diversions, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization.
Restoration and Protection Needs: Erosion from Ag, grazing, recreation, and oil & gas roads, potential agricultural run-off, invasive weed removal.



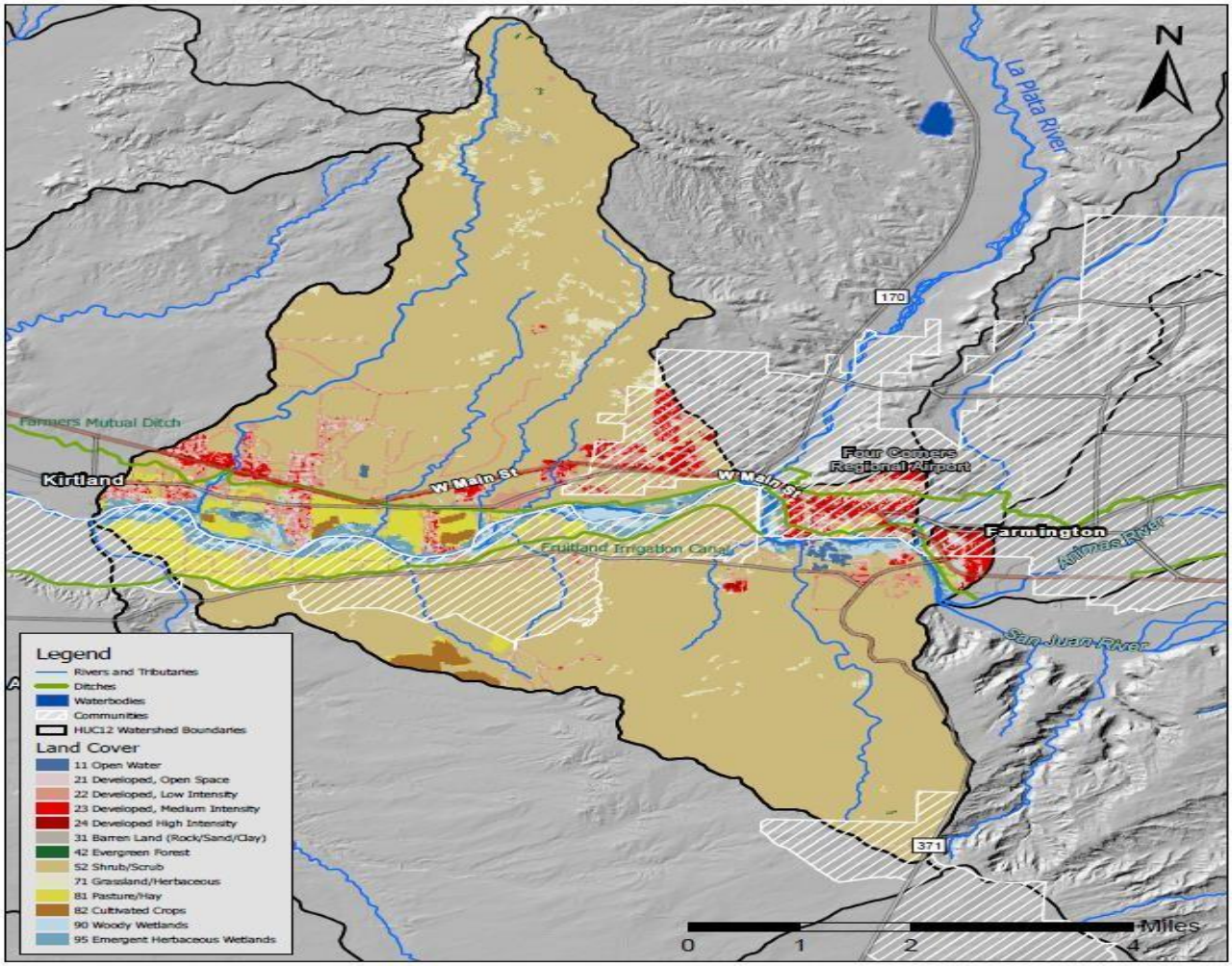
11. Head Canyon — San Juan River (HUC 140801012104)

Description: The Head Canyon Watershed edges the southwest and west areas just outside of Farmington. Several tributaries contribute to the San Juan River in this watershed. High intensity development, wetlands, pasture, and agriculture follow the San Juan River and Highway 64 through the middle of the watershed. The largest portion of the watershed to the south is mostly scrub. There is some grassland amongst the scrub on the northeast corner of the watershed. No evergreen forest stands of note.
Area: 31 mi^2
Land Use: Development, pasture, agriculture, cattle grazing, oil & gas, and paved transit
Communities: Farmington
Irrigation Ditches: Hammond Ditch and Echo Ditch
Impairment Status: The San Juan River (Animas River to Cañon Largo) is currently listed as impaired for *E. coli*, sedimentation/siltation, and pH and does not support the designated uses for primary contact or marginal coldwater aquatic life use. TMDLs have been developed for sedimentation/siltation and *E. coli.*
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, flow alterations from water diversions, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, and urbanization.
Restoration and Protection Needs: Mitigation from possible contaminates from town (e.g. urbanization and septic systems), erosion from roads with for oil & gas, recreation, and cattle grazing. Invasive weed mitigation.



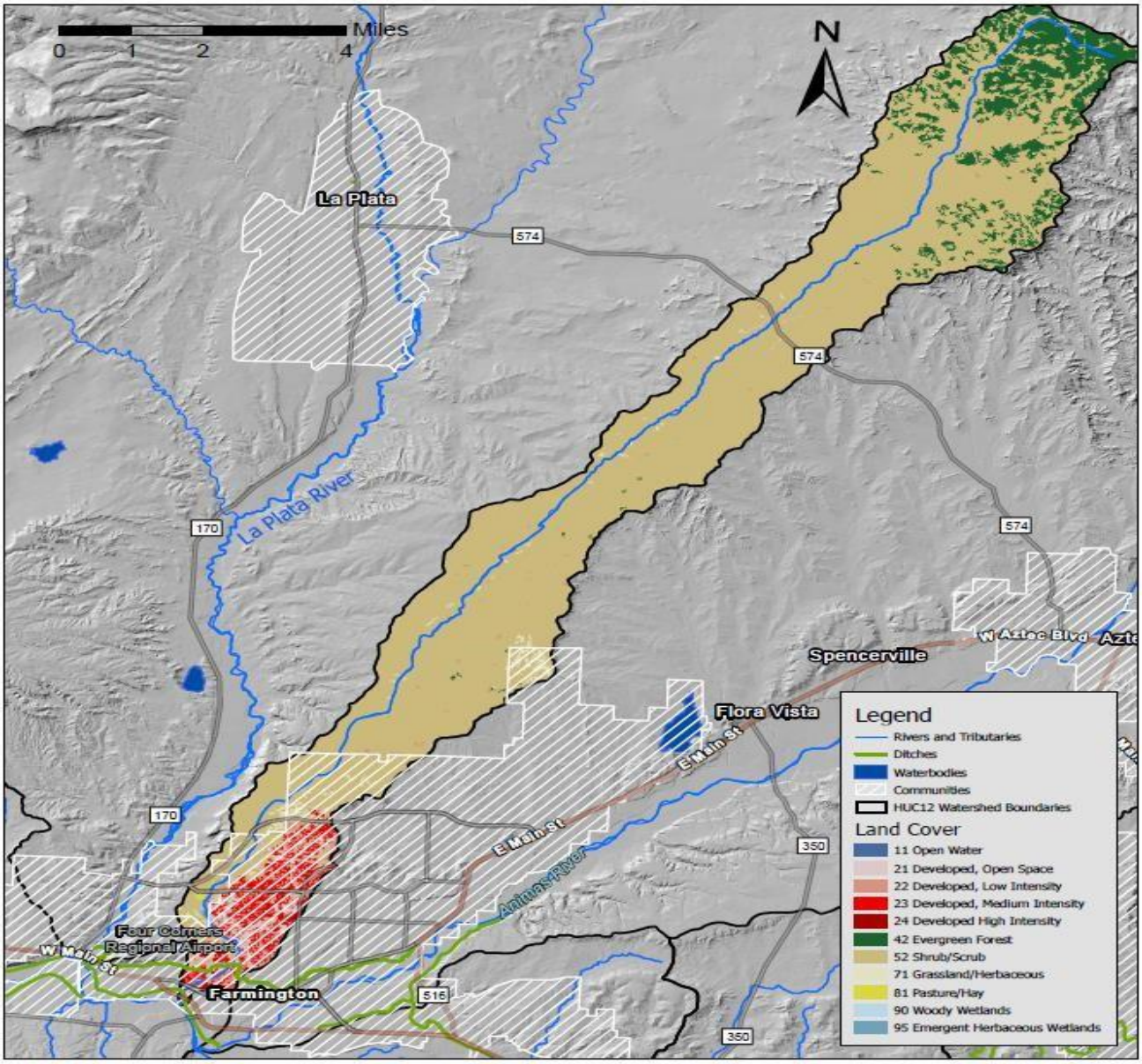
12. Ojo Amarillo Canyon — San Juan River (HUC 140801050505)

Description: The Ojo Amarillo — San Juan River Watershed edges the southeast to the northeast of Farmington proper and the east end of Kirtland proper. A mosaic of development, pasture, agriculture, wetland, scrub, and various communities run through the middle of the watershed along the San Juan River, Fruitland Irrigation Canal, Farmers Mutual Ditch, and Highway 64. There are several tributaries that meet the SJ River in this watershed. Some grassland can be spotted across the northern stretch of the watershed. Another group of communities are located on the southern end on the boundary. Mostly scrub with minimal spotting of grassland between community groups.
Area: 40 mi^2
Land Use: Development, pasture, agriculture, and paved transit
Communities: Kirtland to Farmington and Navajo Nation
Irrigation Ditches: Farmers Mutual Ditch, Fruitland Irrigation Canal
Impairment Status: The San Juan River (from the Navajo Nation Boundary at the Hogback to the Animas River) is currently impaired for *E. coli* and sedimentation/siltation. A TMDL has been developed for *E. coli*.
Probable Source of Impairment: Crop production, drought-related impacts, sedimentation, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, petroleum/natural gas activities, animal feeding operations (NPS), and urbanization.
Restoration and Protection Needs: Mitigation from possible contaminates from town, erosion from roads for oil & gas, recreation, and cattle grazing. Invasive weed mitigation.



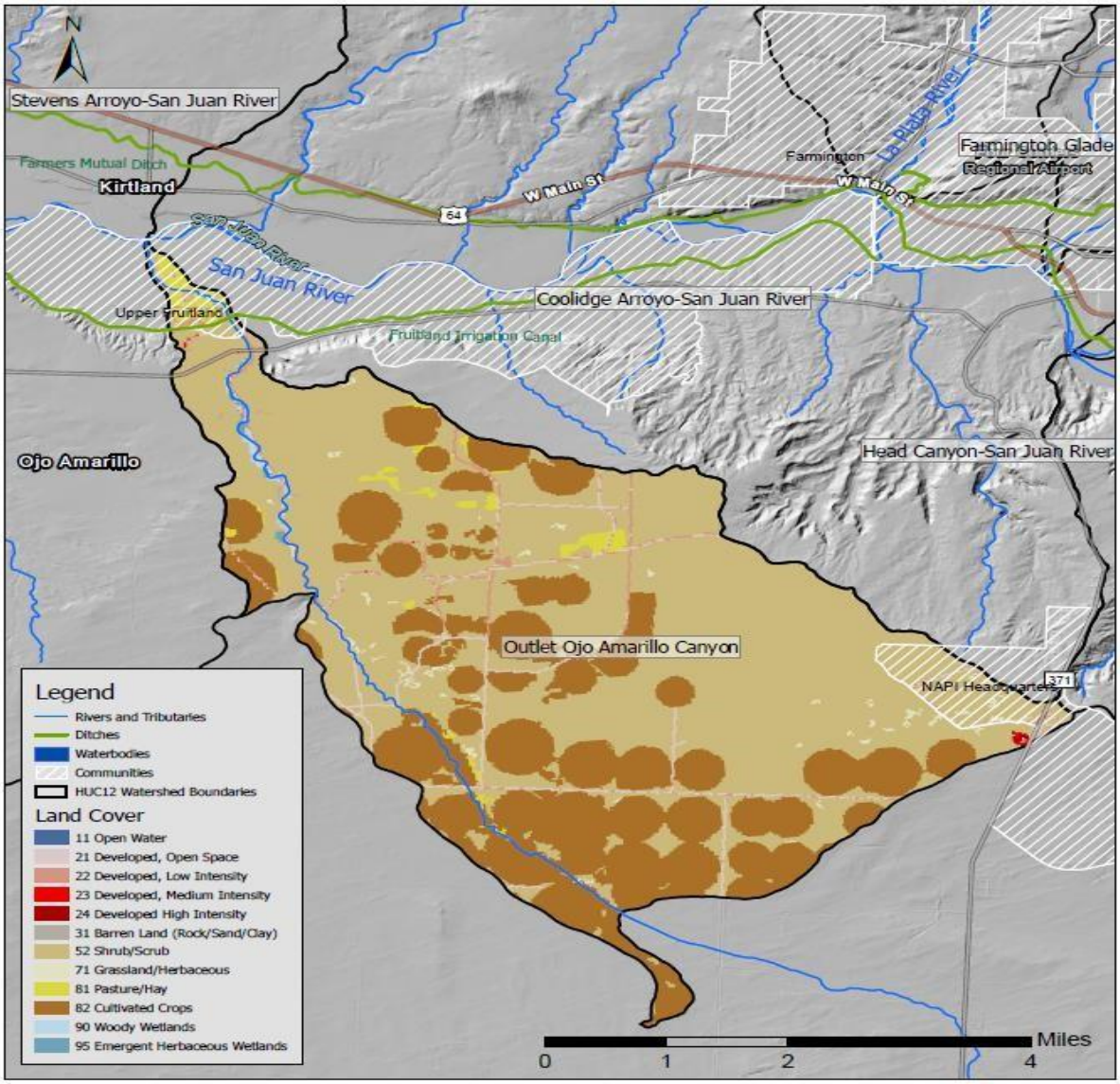
13. Farmington Glade (HUC 140801050501)

Description: The Farmington Glade is the narrowest among the watersheds in our area. The northern end contains notable evergreen forest while the southern end includes medium-intensity development. One main intermittent tributary runs down the narrow middle of this watershed dominated by scrub with minimal spotting of grassland. Nestled between the La Plata River and the Animas River, only one ditch intersects the watershed on the south end. Highway 574, which meets the towns of Aztec and La Plata, runs across the boundary toward the north end before the prominent evergreen forest.
Area: 37 mi^2
Land Use: Development, cattle grazing, oil & gas, recreation, and paved transit
Communities: Farmington
Irrigation Ditches: Farmers Mutual Ditch
Impairment Status: The Farmington Glade has not been assessed by NMED SWQB. This may be considered a data gap.
Restoration and Protection Needs: Mitigation of erosion from urbanization, roads for oil & gas, recreation, and cattle grazing. Invasive weed mitigation.



14. Outlet Ojo Amarillo Canyon (HUC 140801050504)

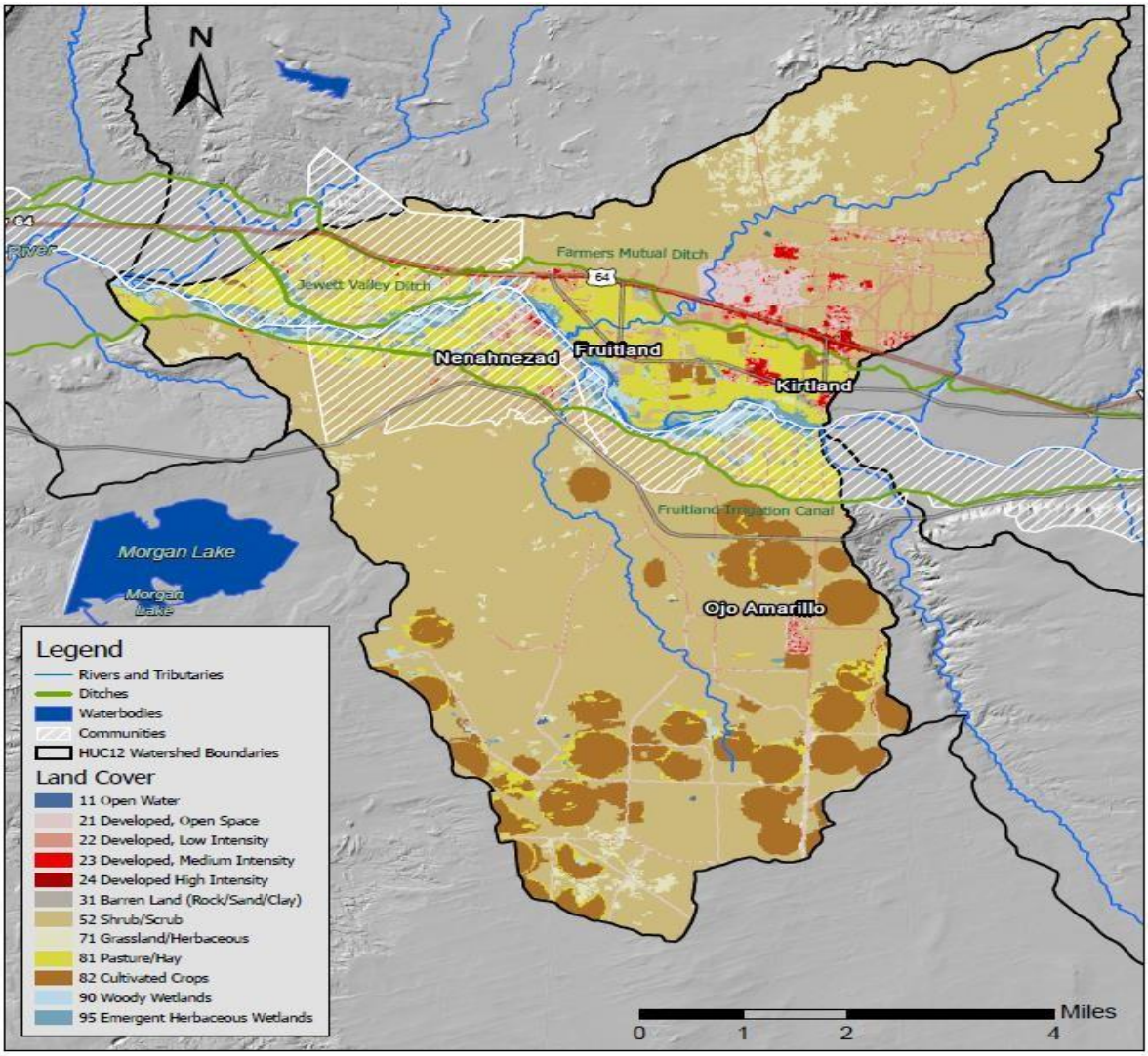
Description: Outlet Ojo Amarillo Canyon Watershed is southwest of the Farmington Glade Watershed, one end reaching the Upper Fruitland Community, and the other end stretching out to the NAPI headquarters community. The very northwest tip of the boundary meets the San Juan River. A significant portion of this watershed is dedicated to agriculture, with some pasture in between, and sparse grassland across the otherwise scrub dominant boundary. One main tributary runs along the eastern edge of the boundary. As for development, there is a small concentration of high-intensity development in the southeast corner. No main ditches cross this watershed, and there are no evergreen stands of note.
Area: 23 mi^2
Land Use: Agriculture, pasture, development, paved transit, cattle grazing, and oil & gas
Communities: Upper Fruitland, Navajo Nation, and NAPI Headquarters
Irrigation Ditches: Fruitland Irrigation Canal
Impairment Status: Ojo Amarillo Canyon is entirely within the Navajo Nation and is outside of NMED SWQB's jurisdiction and is therefore not assessed by NMED SWQB.
Restoration and Protection Needs: Agricultural best management practices (BMPs). Mitigation of erosion from roads for oil & gas, recreation, and cattle grazing. Invasive weed mitigation.



15. Stevens Arroyo — San Juan River (HUC 140801050506)

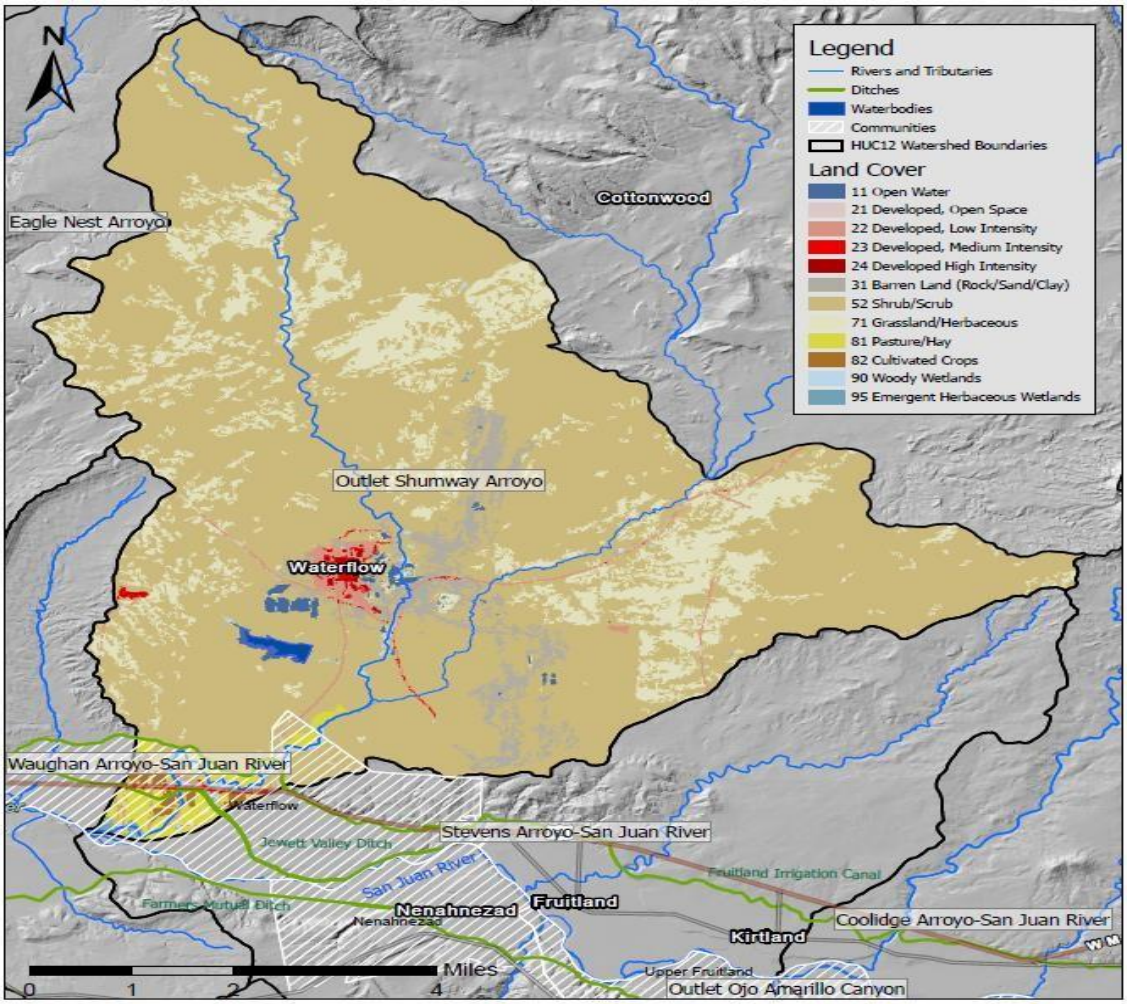
Description: The Stevens Arroyo Watershed includes the communities of Fruitland, Kirtland, Nenahnezad, and Ojo Amarillo. There is agriculture, pasture, and development present. A series of various wetlands follow the San Juan River, along with the Fruitland Transition Canal, the Jewett Ditch, the Farmers Mutual Ditch, and Highway 64. Both main stretches of the watershed (north and south) contain one main tributary down the center of each. No significant amount of evergreen forest.
Area: 50 mi^2
Land Use: Cattle grazing, agriculture, pasture, recreation, and paved transit
Communities: Fruitland, Kirtland, Nenahnezad, Ojo Amarillo, and the Navajo Nation
Irrigation Ditches: Jewett Valley Ditch, Farmers Mutual Ditch, and Fruitland Irrigation Canal
Impairment Status: Stevens Arroyo is listed as impaired due to *E. coli*. The San Juan River (from the Navajo Nation Boundary at the Hogback to the Animas River) is currently impaired for *E. coli* and sedimentation/siltation. A TMDL has been developed for *E. coli*.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, petroleum/natural gas activities, animal feeding operations (NPS), and urbanization.
Restoration and Protection Needs: Animal feeding operations (NPS), drought-related impacts, flow alterations from water diversions, loss of riparian habitat, rangeland grazing, streambank modifications/destabilization, and septic system management.

16.



Outlet Shumway Arroyo (HUC 140801050403)

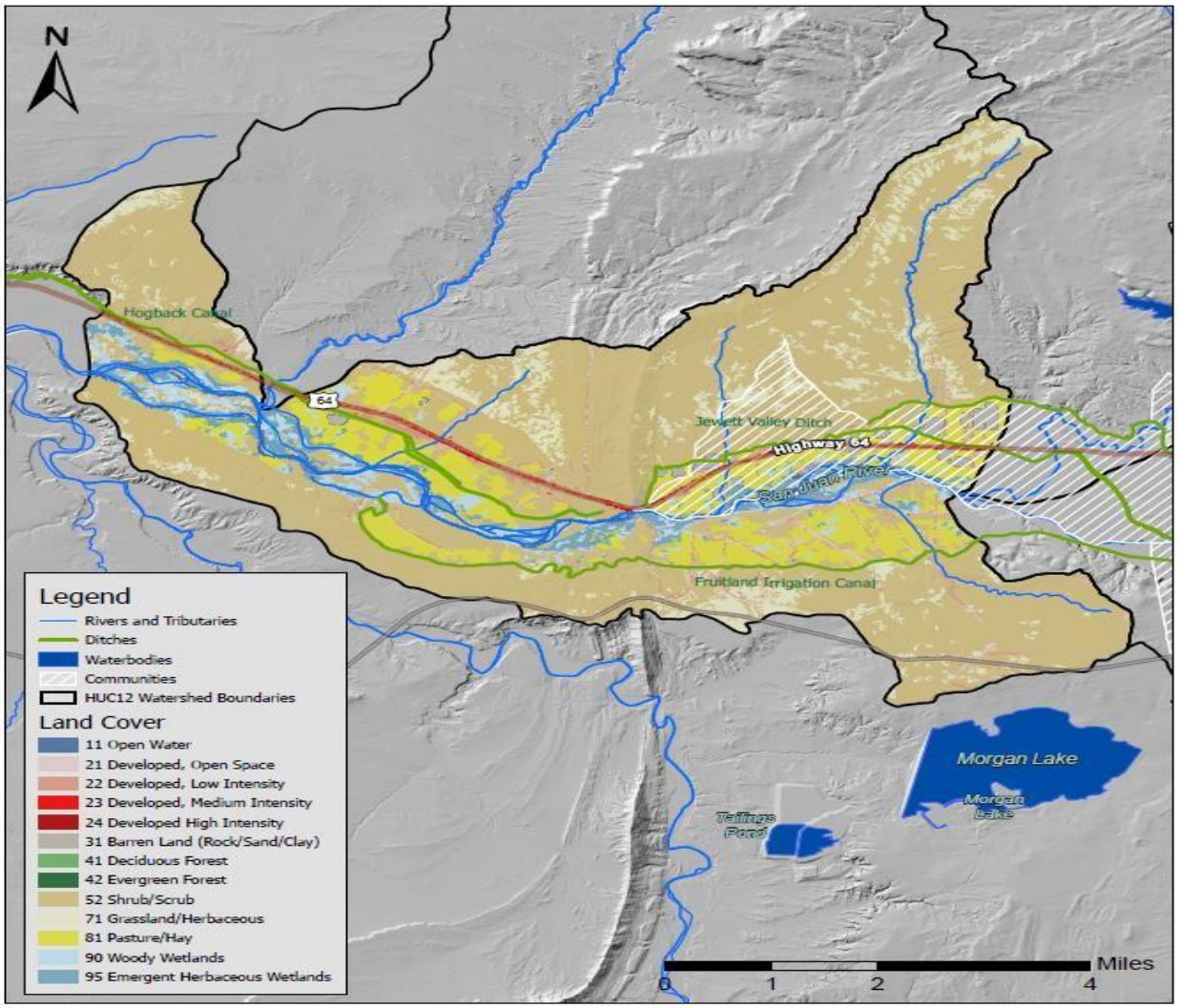
Description: The Outlet Shumway Arroyo Watershed is located northwest of Fruitland. A large portion of the watershed is covered by grassland and is otherwise dominated by scrub. Evergreen forest is not found in this watershed. The community of Waterflow holds high-intensity development in the center of the watershed. There is some open water: the Frank Chee Willetto Reservoir, which is southeast of the Public Service Company of New Mexico (PNM) Power Plant that PNM recently sold to the US BOR. Jewett Ditch and Highway 64 run through the southwestern corner of the boundary, which is covered by pasture and some development in the Waterflow community.
Area: 51 mi^2
Land Use: Cattle grazing, pasture, recreation, paved transit, and development
Communities: Ute Mountain Ute Tribe
Irrigation Ditches: Jewett Valley Ditch, Fruitland Irrigation Canal, and Farmers Mutual Ditch
Impairment Status: Shumway Arroyo is currently listed as impaired for *E. coli*.
Probable Sources of Impairment: Crop production, drought-related impacts, loss of riparian habitat, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, animal feeding operations (NPS).
Restoration and Protection Needs: Animal feeding operations (NPS), drought-related impacts, flow alterations from water diversions, loss of riparian habitat, rangeland grazing, streambank modifications/destabilization.



17. Eagle Nest Arroyo — San Juan River (HUC 140801050702)

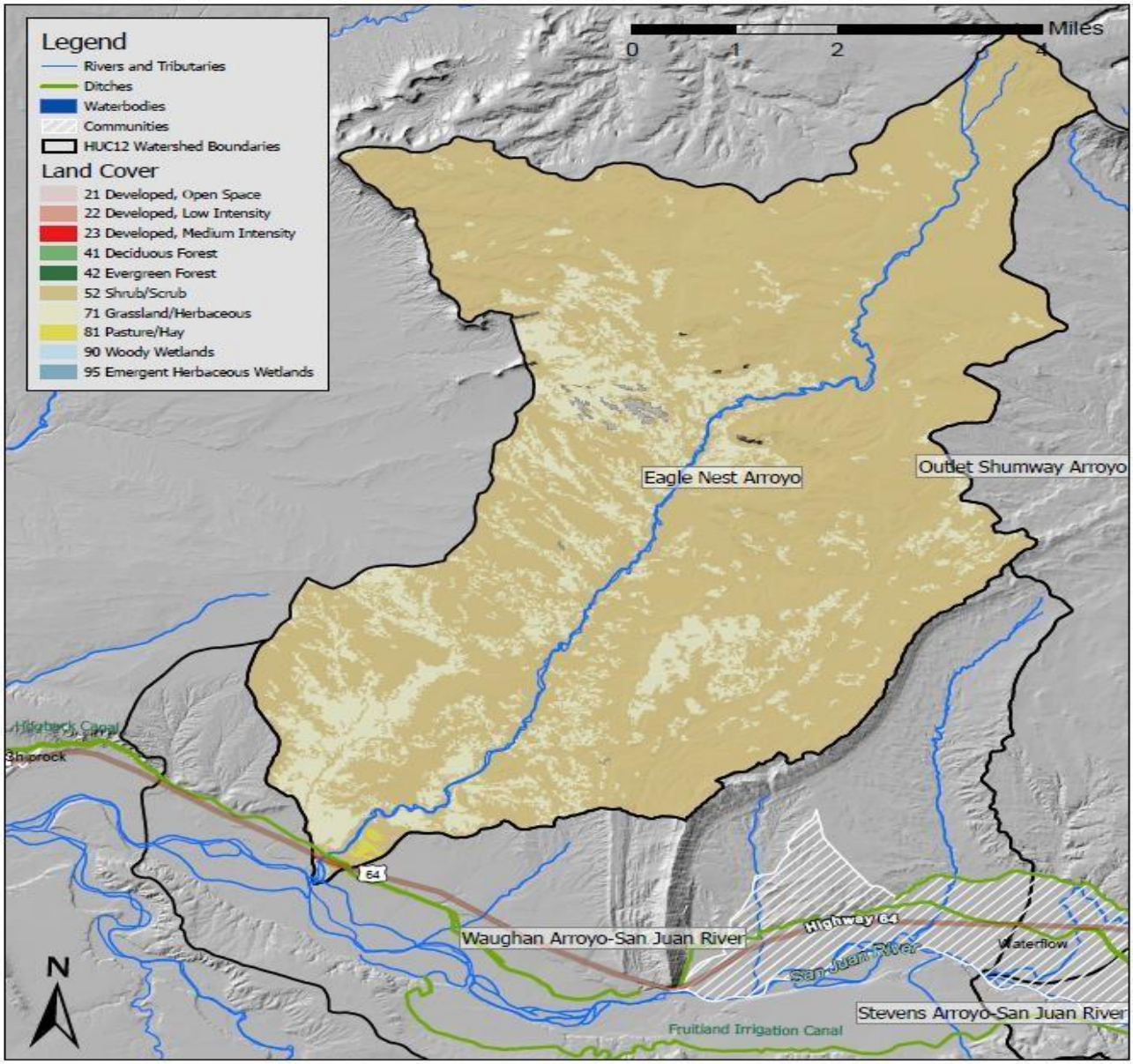
Description: The Eagle Nest Arroyo — San Juan River Watershed is located west of Waterflow and is defined by several distinct characteristics. The San Juan River breaks up into several channels west of Hogback, which run down the center of the watershed. The SJ River, Highway 63, Jewett Valley Ditch, Hogback Canal, Fruitland Irrigation Ditch all run east to west across the mid-section of the watershed.

It is scrub dominate, spotted with grassland. In the thick of the San Juan River tributaries and ditches, there is significant coverage of pasture. No development or evergreen forest of note. There are a couple open water sources of note, however one is a tailing pond.
Area: 35 mi^2
Land Use: Paved transit, pasture, recreation, cattle grazing, and oil & gas
Communities: Waterflow, Fruitland, and Navajo Nation
Irrigation Ditches: Hogback Canal, Jewett Valley Ditch, and Fruitland Irrigation Canal
Impairment Status: The San Juan River (from the Navajo Nation Boundary at the Hogback to the Animas River) is currently impaired for *E. coli* and sedimentation/siltation. A TMDL has been developed for *E. coli*.
Probable Sources of Impairment: Crop production, drought-related impacts, sedimentation, loss of riparian habitat, petroleum/natural gas activities, rangeland grazing, streambank modifications/destabilization, flow alterations from water diversions, animal feeding operations (NPS).
Restoration and Protection Needs: Mitigation of erosion from roads for oil & gas, recreation, and cattle grazing. Invasive weed mitigation. Possible contaminates from town. Potential runoff from small-scale agriculture or pasture operations.



18. Eagle Nest Arroyo (HUC 140801050701)

Description: The Eagle Nest Arroyo Watershed is located north of Highway 64 on the east side of Hogback. One main intermittent tributary makes its way down the center of the watershed. There is minimal pasture in the southern tip of the boundary and no development or evergreen forest. There is a significant amount of grassland in this watershed, especially when compared to the other watersheds.
Area: 47 mi^2
Land Use: Cattle grazing, recreation, oil & gas, and paved transit
Communities: Navajo Nation and Ute Mountain Ute Tribe
Irrigation Ditches: Hogback Canal
Impairment Status: The mainstem of Eagle Nest Arroyo is not within NMED SWQB's jurisdiction and is not assessed by NMED SWQB.
Restoration and Protection Needs: Mitigation of erosion from roads for oil & gas, recreation, and cattle grazing. Invasive weed mitigation. Possible contaminates from town. Potential runoff from small-scale agriculture or pasture operations.



Demographics

San Juan County, New Mexico is the 5th most populated county in a state of 33 counties and encompasses the majority of the focus area of the restoration plan, with an estimated population of 121,661 people in 2020 from the U.S. Census. With two main incorporated communities being Bloomfield and Farmington, all other unincorporated communities in this subsect of the San Juan Watershed include Navajo Dam, Blanco, Fruitland, Kirtland, Nenahnezad, and Waterflow. Table 3 summarizes the estimated populations in 2020 of all these communities. All communities and urban developments within this focus area are concentrated along the San Juan River, with the most populated sections of the San Juan River between Bloomfield and Farmington.

Table 3: County, City, and Town Population Estimates in 2020

County/City/Town	Population Estimate 2020
San Juan County, New Mexico	121,661
Navajo Dam	253
Blanco	491
Bloomfield	7,421
Farmington	46,624
Fruitland	771
Kirtland	585
Nenahnezad	576
Waterflow	1,554

Courtesy of www.data.census.gov

The most predominant ethnic groups in San Juan County are Native American (37.4%) and White (37.4%), followed by Hispanic (21.1%) (New Mexico Demographics, 2022). The Navajo Nation is the largest Native American nation in the United States, the surface area comparable with the state of West Virginia. One third of the Diné (Navajo) community live in New Mexico (City of Farmington, 2022). Being that the Navajo Nation encompasses 23% of the WBP focus area (Table 2), it is critical to intertwine the perspectives and priorities of the Navajo Nation into this WBP through future outreach in a culturally sensitive and inclusive manner. A chapter is the most local form of government on the Navajo Nation; they are semi-self-autonomous with locally elected officials that determine

the priority concerns of the chapter through the input of the local community. The Nation is broken into five agencies, each containing chapters that cumulatively add to 110 local chapters. There are five chapters within the focus area of this WBP, with eight in total along the San Juan River in New Mexico. Community outreach through Navajo Nation chapters is not only recommended, but necessary to represent the perspectives and needs of the Navajo Nation. Outreach has been ongoing and will continue throughout the creation and implementation of the MSJWBP.

Table 4: Diné Chapters within the San Juan Watershed of New Mexico

Chapter	Contact Information
Huerfano	huerfano@navajochapters.org
Doolkai (Upper Fruitland)	upperfruitland@navajochapters.org
Nenahnezad	nenahnezad@navajochapters.org
San Juan	sanjuan@navajochapters.org
Tse Daa K'aan (Hogback)	tsedaakaan@navajochapters.org
Shiprock	shiprock@navajochapters.org
G'adii'ahi/Tokoi (Cudei)	gadiiahi@navajochapters.org
Bit"aa bito (Beclabito)	beclabito@navajochapters.org

Physical and Natural Features

Geology & Soils

Within the MSJWBP, all of the Upper and Middle San Juan River and its contributing drainages are located within the San Juan Basin, a large circular geological depression. The center of this basin is primarily located in San Juan and Rio Arriba Counties of New Mexico and La Plata and Archuleta Counties in Colorado. Known for its rich oil and gas, uranium, and coal deposits that historically have been an energy production hub for the Four Corners Region, the San Juan Basin within the WBP area is composed of primarily Triassic through Tertiary sedimentary rocks that compose the principal aquifers and confining units in the basin (Craigg, 2001).

The San Juan River corridor consists of Quaternary alluvium (NMBCMR, 2003). The sedimentary rocks that fill the San Juan Basin contain both source rocks and natural reservoirs for oil and gas found from 550 to 4,000 feet below the surface (Campbell and Brew, 1996). The San Juan Basin contains over 35,000 well sites and a vast network of connecting roads and pipelines, which contribute to erosion issues in the uplands (SJWG, 2021). Due to the geology in this plan, high sediment loads are normal during certain times of the year, especially during the later summer monsoon season. Both the naturally erodible geology and upland uses (both energy extraction and grazing) contribute to occasionally high sediment loads.

Vegetation

The vegetation communities of the MSJWBP and greater San Juan River Watershed of New Mexico are dominated by Colorado Plateau shrublands, with *Artemisia tridentate* (big sagebrush), *Chrysothamnus sp.* (rabbitbrush), *Yucca sp.*, Sarcobatus vermiculatus (greasewood) *Atriplex canescens* (saltbush), *Gutierrezia lucida* (snakeweed), and various dryland grasses making up much of this shrubland community (Harris et al., 1963). While characterized as "Forest" in land-use models, this vegetative community differs in both form and function from closed canopy forests. Riparian vegetation communities in favorable water courses and moist sheltered canyons exhibit more water determined vegetation, including *Populus angustifolia* (cottonwood), *Rhus trilobata* (skunkbush), *Forestiera neomexicana* (New Mexico Olive, *Salix exigua* and *S. lasiandra* (willows), *Acer negundo* (box elder), sedges, *Equisetum sp.* (horse- tails), *Typha latifolia* (cattails), and several grasses occurring in various combinations. (Harris et al., 1963).

Due to both historic and recent grazing pressures in the uplands and human alteration within the riparian corridor throughout much of the San Juan River, the native plant communities of upland grasslands and lowland riparian species are no longer present in many areas. The San Juan Watershed has been observed to be deficient in the herbaceous components as identified by Ecological Site Descriptions (Homer et al., 2015). These herbaceous components, historically consisting of perennial grasses and annual forbs, have a key role of slowing down surface water flow and promoting infiltration which in turn reduces the overall erosion and its subsequent problems. Uplands identified to have a reduced herbaceous component have been observed to be susceptible to erosion and accelerated soil loss.

The woody invasive species *Elaeagnus angustifolia* (Russian olive) and *Tamarix* (salt cedar), have changed the historic fire regimes of the riparian ecosystems and have taken over the flood zones, irrigation canals, and local arroyos to the point of creating an extreme fire hazard to residents and firefighting agencies (SJB CWPP, 2021). Historically, these ecosystems supported low-frequency, low-intensity fires that did not adversely affect the cottonwoods, as they are not fire-adapted (USFWS, 2002) and generally intolerant of fires (Quigley, 2013). Current conditions show a higher intensity and severity of fires; with all species consequently burning, including the cottonwood, which are less resilient to

fires compared to salt cedar (USFWS 2002). Fires tend to reduce cottonwood populations and allow the establishment of more fire-tolerant species such as salt cedar (Smith, 2009).

Climate and Hydrology

The climate in the watershed is characterized by a declining precipitation gradient where average annual precipitation ranges from 20 inches in Pagosa Springs, Colorado (7,100 ft) to 8 inches in Farmington, New Mexico (5,300 ft) (WRCC, 2015). Winter snowfall and late summer monsoonal thunderstorms are the primary sources of precipitation in the watershed, and winter snowpack is an essential element of water storage. Navajo Dam on the San Juan River, a water storage unit of the Colorado River Storage Project (CRSP), was built to store runoff from snowmelt and precipitation after the snowmelt season. The CRSP was authorized on April 11, 1956 to regulate the flow of the Colorado River (which the San Juan River flows into), provide for flood control and for storage and delivery of water for irrigation, municipal, industrial, and other beneficial purposes, generate electrical power, and provide recreation opportunities.

Streamflow in the Middle San Juan River is dominated by a combination of releases from Navajo Dam and the inflow from the Animas River, the major tributary to the San Juan River. Other smaller tributaries and washes include the Cañon Largo, La Plata River, McElmo Creek, and Chaco Wash.

Navajo Dam releases contribute streamflow to the San Juan River and is the primary driver of flows above the confluence with the Animas River. Releases are made in accordance with Reclamation's Record of Decision (ROD, 2006), which was developed in response to the Fish and Wildlife Service's 2006 Biologic Opinion. The BOR operates Navajo Reservoir with the goal of meeting the Endangered Species Act (ESA) related flow. Recommendations for the San Juan River, as developed by the SJRIP, or a reasonable alternative to those recommendations, should be implemented in a manner which enables both current and future water depletions to proceed in compliance with the ESA.

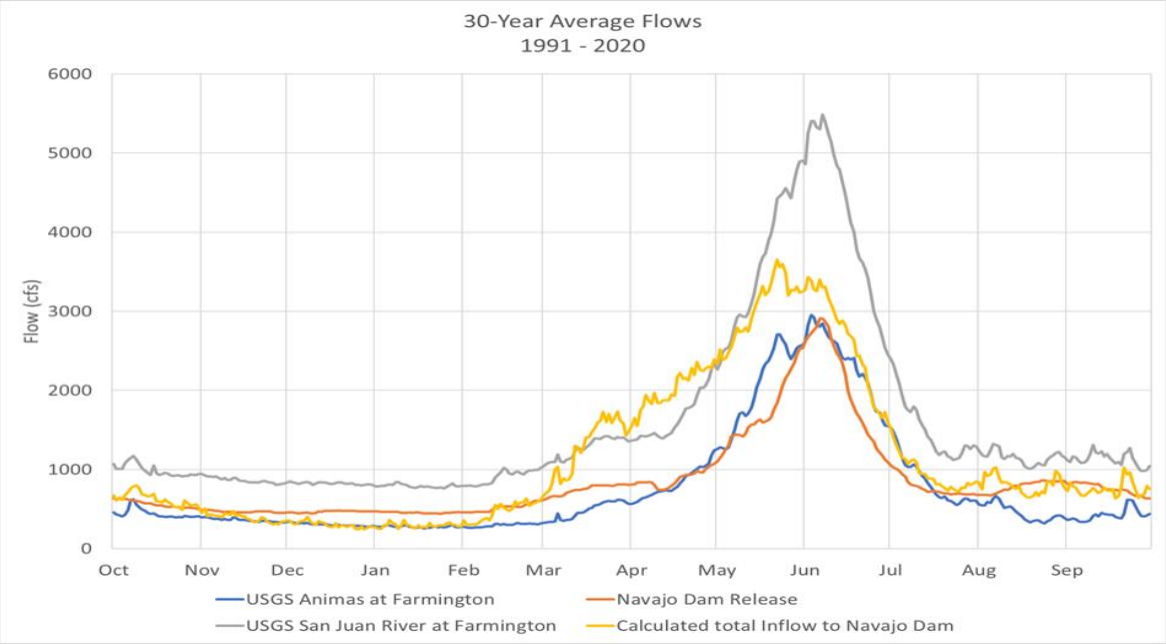
In accordance with the ROD, the release from Navajo is made to target a year-round baseflow in the critical habitat reach of the San Juan River of 500 – 1,000 cfs. The critical habitat is a 180-mile stretch of the San Juan River from the confluence with the Animas River in Farmington to the outfall to Lake Powell. The baseflow is calculated as the weekly average of the four main USGS gauges between Farmington and Lake Powell. During spring runoff, a prescribed spring peak release is conducted if a sufficient water volume, after accounting for forecast inflows, contracted water use, expected downstream releases, and minimum carryover storage, is calculated to be available. This release is timed to coincide with the Animas River spring snowmelt peak to meet the SJRIP's desired flow targets in the critical habitat reach.

Historical and live streamflow conditions for the San Juan River can be found at: https://waterdata.usgs.gov/state/New%20Mexico/

Water in Navajo Lake is dominated by snowmelt runoff, which typically occurs between April and July, peaking in late May or early June, and decreasing in July. Snowmelt runoff is augmented by monsoonal storm events from July through September.Monsoonal precipitation events can be very small in area and short in duration, but often produce high volumes of precipitation in a short period of time. These high-intensity, short-duration storms cause flashy peaks in the hydrograph and vary greatly from year to year.

Monsoonal events in the San Juan River Basin below Navajo Dam can also have the effect of bringing in large volumes of sediment and suspended solids that settle out in the main channel and reduce its conveyance capacity. Routine high-flow releases from Navajo Dam on a consistent basis will keep the channel clean and clear of sediment and maintain aquatic habitat and channel capacity for flood control. However, with the persistent drought in the southwest, less water has been available on a consistent basis to maintain channel capacity in this manner.

Figure 2: Average Flows of the Animas and San Juan Rivers in comparison to Navajo Dam Release Flows



There is a network of seven total irrigation ditch main canals and countless laterals that provide surface water for the community in the MSJWBP. Each of these irrigation systems are fed by diversion structures along the San Juan River and Animas River in various locations and levels of condition. Like the Animas River and other rivers throughout the Southwest, water is diverted from the San Juan River for a variety of uses including irrigated agriculture, commercial and public drinking water, irrigated lawns and golf courses, and other municipal and industrial uses (San Juan Basin Regional Water Plan, 2016).

Agriculture

The San Juan Watershed has a deep history of agriculture. First flourishing in the predominant form of dry farming by Ancestral Puebloan and Navajo communities, agriculture transitioned to acequia-based farming during the Spanish colonization period. In the modern day, agriculture in San Juan County, New Mexico is composed of a blend of acequia (surface water irrigation) and traditional agriculture methods both in the Anglo-American community of San Juan County and the Navajo Nation.

San Juan County has the second highest farm acreage, is the largest producer of pumpkin, squash, cantaloup, honey dew, and sweet corn, and is a significant producer of hay (predominantly alfalfa), forage for livestock (predominantly cattle, goats, horses, sheep, and lamb), sunflower, safflower, and Pinto and Anasazi beans in the state of New Mexico (Four Corners Economic Development, 2022). Based on the 2017 Census of Agriculture by the United States Department of Agriculture (USDA), San Juan County hosts a total of 2,965 farms encompassing 2,551,470 acres of land in farming production. Approximately 30% of these farms are between 1 to 9 acres, 26% between 10 to 49 acres, 22% between 50 to 999 acres, and 21% above 1,000 acres (USDA, 2017).

Hay and pasture encompass 3.39% and cultivated crops 3.5% of the MSJWBP (Figure 5). While agricultural lands make up 33.1% of land use within the focus area, all of this land use is directly within the floodplain and lower valley along the San Juan River, creating a short path for edge of field runoff and erosion potential from agricultural lands. Farms within San Juan County, on average, utilize no till (6%), reduced till (4%), and cover crop (4%) soil health best management practices (BMPs), with approximately 9% of farms using intensive till practices (USDA, 2017).

Threatened and Endangered Species

Table 5. Threatened and Endangered Species with Potential to Occur along the Middle San Juan River (USFWS 2014, 2015)

Species	***Status***	***Habitat***
Colorado Pikeminnow *(Ptychocheilus Lucius)*	Endangered; Critical Habitat is designated on the San Juan River, but not the Animas River	

Razorback Sucker *(Xyrauchen texanus)*	Endangered; Critical Habitat is designated on the San Juan River, but not the Animas River	
Zuni Bluehead Sucker *(Catostomus discobolus yarrow)*	Endangered; Critical Habitat is not designated on the Animas River or the San Juan River	
New Mexico Meadow Jumping Mouse *(Zapus hudsonius luteus)*	Endangered	Riparian habitat dominated by tall, herbaceous species (especially sedges, and reed canary grass) with adjacent, intact upland areas.
Southwest Willow Flycatcher *(Empidonax traillii extimus)*	Endangered	Dense, shrubby riparian vegetation; usually in close proximity to surface water or saturated soil.
Yellow-billed Cuckoo *(Coccyzus americanus)*	Threatened; Critical Habitat is designated on the San Juan River, but not the Animas River	Riparian woodlands in arid to semi-arid landscapes. Preferred nesting habitat includes mature woodland with dense understory at least 42 acres with a minimum of 7 acres being closed-canopy broad-leaved trees.

The United States ESA provides a collaborative program framework for the conservation of threatened and endangered plants, animals, and the habitats in which they are found (EPA, 2021). The USFWS and the National Oceanic Atmospheric Administration (NOAA) are the lead agencies implementing the ESA on a national level. Populations are monitored for presence and recovery, critical habitat areas are defined where these endangered species are present, and recovery plans are developed and implemented in coordination with federal, state, tribal, and local officials to support recovery and prevent extinction (WWF, 2022).

Critical habitat along the San Juan River extends from Farmington, New Mexico to its confluence with Lake Powell. There are four endangered species that occur in the critical habitat within the MSJWBP: Colorado Pikeminnow (*Ptychocheilus lucius*), Razorback Suckerfish (*Xyrauchen texanus*), Yellow-Billed Cuckoo (*Coccyzus americanus*), and Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (USFWS, 2022). The New Mexico Department of Game and Fish (NMDGF), SJRIP, and USFWS are the management agencies primarily involved in the monitoring and habitat restoration for these species. All federal agencies must comply with the National Environmental Policy Act (NEPA) to disclose impacts in addition to complying with the ESA.

As described in the "Climate and Hydrology" section, releases from Navajo Reservoir were developed in response to the USFWS 2006 Biological Opinion and are intended to meet the SJRIP's Flow Recommendations to support the recovery of Colorado Pikeminnow and Razorback Sucker. The Colorado Pikeminnow is an anomalous minnow species, as it is the largest in North America and consumes other fishes, which is not the typical diet of a minnow. The Razorback Sucker is a sucker fish with a bottom mouth that it uses to scrape food from the river bottom. Both species are considered "Big River" fishes because they can grow to be large (Colorado Pikeminnow maximum size is about 6 feet and Razorback Sucker can grow the 3.5 feet) and live in mainstem rivers or large tributaries such as the Animas and San Juan rivers. These two fishes are endemic to the Colorado River Basin, meaning they evolved in and are native only to the Colorado River Basin. Historic habitat for both species ranges throughout the entire Colorado River Basin; However, habitat has been reduced, and populations have declined due to fragmentation, migration barriers (i.e., dams), and the introduction of non-native fishes.

Due to population declines, Colorado Pikeminnow was included in the 1967 List of Endangered Species as endangered, and Razorback Sucker received federal protection in 1991. In the 1990s, populations of both species were thought to be gone from the San Juan River Basin. Efforts to repopulate the basin with hatchery produced fish was the first step taken. Additional support such as flow management, alleviation of impediments to passage, and removal of nonnative fishes that can cause mortality or compete for resources soon followed. As of this watershed plan, adults of both species now inhabit the San Juan River mainstem from Farmington to Lake Powell. However, federal and state protections are still needed for both species, as the Colorado Pikeminnow is no longer present in the Lower Colorado River Basin, and recruitment from juveniles to adults for populations in the Upper Colorado River Basin is just sustaining the species. As for the Razorback Sucker, reintroductions of the species to both the Lower and Upper Colorado River basin habitats have been successful, but only one population persists without the need for continual stocking.

The Southwest Willow Flycatcher is listed as endangered, and the Yellow Billed Cuckoo is listed as threatened. These species exclusively inhabit vegetation adjacent to streams and seek out dense native willow thickets (or *Tamarix sp.* in their absence), old growth cottonwood stands, and dense herbaceous areas. Destruction and modification of riparian habitats, through reduction of surface and subsurface water due to diversion and groundwater pumping, changes in flood and fire regimes, vegetation removal, livestock grazing, changes in water and soil chemistry, and establishment of non-native vegetation, have led to extensive loss and modification of breeding habitat and subsequent reductions in population levels (USFWS, 2002). Actions that could lead to further disruption of habitat for these species must follow the Southwest Willow Flycatcher Final Recovery Plan and ESA compliance with prior coordination with the USFWS.

CHAPTER 2: Element A: *Identifying Impairments*

San Juan River Water Conditions

The San Juan River is listed on the state's 303(d) list of impaired waters for bacteria (as indicated by excessive concentration of *E. coli*) and sedimentation. The stretch of the river from Cañon Largo to the Hogback of the Navajo Nation has been listed as impaired since at least 2004. In 2005, the NMED SWQB developed Total Maximum Daily Loads (TMDLs) for bacteria, an impairment that was also characterized in the first San Juan Watershed Restoration Plan, which was finalized by the SJWG during the same year. The SJWG conducted microbial source tracking to differentiate between sources of bacteria over the course of 2013, 2014 and 2021. The 2013-2014 study found that 46% of San Juan River *E. coli* samples exceeded the single sample standard for primary contact (i.e., swimming). The microbial source tracking study also found that 90% of samples were positive for ruminant source bacteria, and 94% of samples tested positive for human source bacteria.

The 2021 study found that the quantities of human source bacteria reflect a drastic improvement in the reduction of human source bacteria since the 2013-2014 study which is hypothesized to be a result of the decommissioning of the Harper Valley WWTP, expansion of sewer infrastructure to the Farmington WWTP, and community outreach on septic care and illegal dumping; However, 48% of the water quality samples still exceeded the 410 cfu/100mL single grab exceedance limit for *E. coli* during the 2021 study. Bacteria can come from a variety of sources (wildlife, on-site sewage systems, illegal dumping, livestock manure mismanagement, or livestock in waterways). The ruminant source bacteria was expected due to livestock production in the river corridor (cattle, sheep) and the presence of wildlife (deer, elk). However, the near-constant presence of human sewage in the river is less expected and is concerning.

The findings of the 2021 study support the link between storm events and increased concentrations of *E. coli* which saw 80% of samples between Bloomfield and the Hogback exceeding the *E. coli* limit after a storm event while only 13% of the same samples were in the quantifiable range for human bacteria. Of the 52 *B. dorei* HF183 (DNA marker for human source bacteria) surface water samples collected during four sampling events in 2021, 29% were quantifiable - ranging between 437 to 4,400 copies/100mL. Only one of the samples, SJ-Fruitland during the October 28th, 2021 sampling event, was over the 4,200 copies/100mL illness benchmark, with a concentration of 4,400 copies/100mL. Sampling locations San Juan River-Bloomfield, San Juan River-Wildhorse, Animas River-Boyd, Tributary-La Plata River, Tributary-Stevens Arroyo, and Tributary-Shumway Arroyo had Non-Detect or Detected-Not-Quantified results for all sampling events. While all tributaries, and several San Juan River sampling locations, had no detectable human source bacteria via *B. dorei* HF183, all tributaries and various San Juan River sampling locations had one to three *E.coli* exceedances during these sampling events, indicating that bacteria contributions from these waterways are from non-human sources. The 2021 study did not find consistent geographical hotspots for human source bacteria which indicates that inputs of human source pollution may be from nonpoint sources and are episodic in nature (Richmond, 2022).

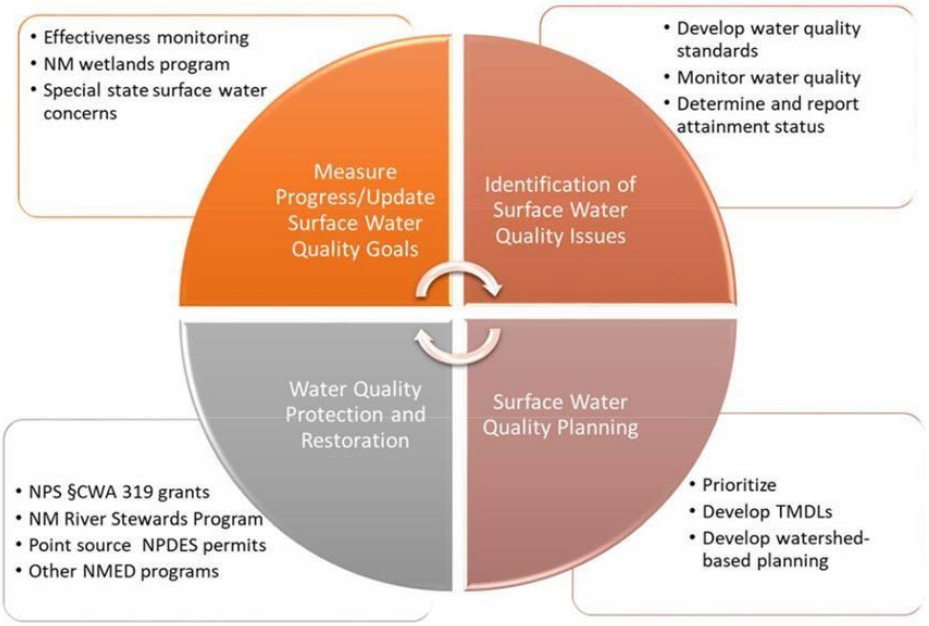
Water Quality Data and Trends

New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) Monitoring and Impairment History

The protection of water quality is vitally important to the health and well-being of communities, aquatic life, and wildlife. To work towards this goal in coordination with the EPA, New Mexico uses a variety of mechanisms, including state, federal, and local programs to protect and restore the quality of its surface and ground waters (NMED, 2021). The authority of the Clean Water Act (CWA) and New Mexico Water Quality Act (WQA) provides the framework for surface water quality protection as implemented by the NMED SWQB. This integrated process generally includes the identification of designated uses for surface waters of the state, monitoring of water quality criteria (parameters)

necessary to protect these designated uses, establishment of TMDLs of specific pollutants, surface water quality planning by local stakeholders to collaboratively develop and implement solutions to improve water quality, and the assessment of progress to adaptively manage watershed-based plans and a statewide antidegradation policy (NMED, 2020).

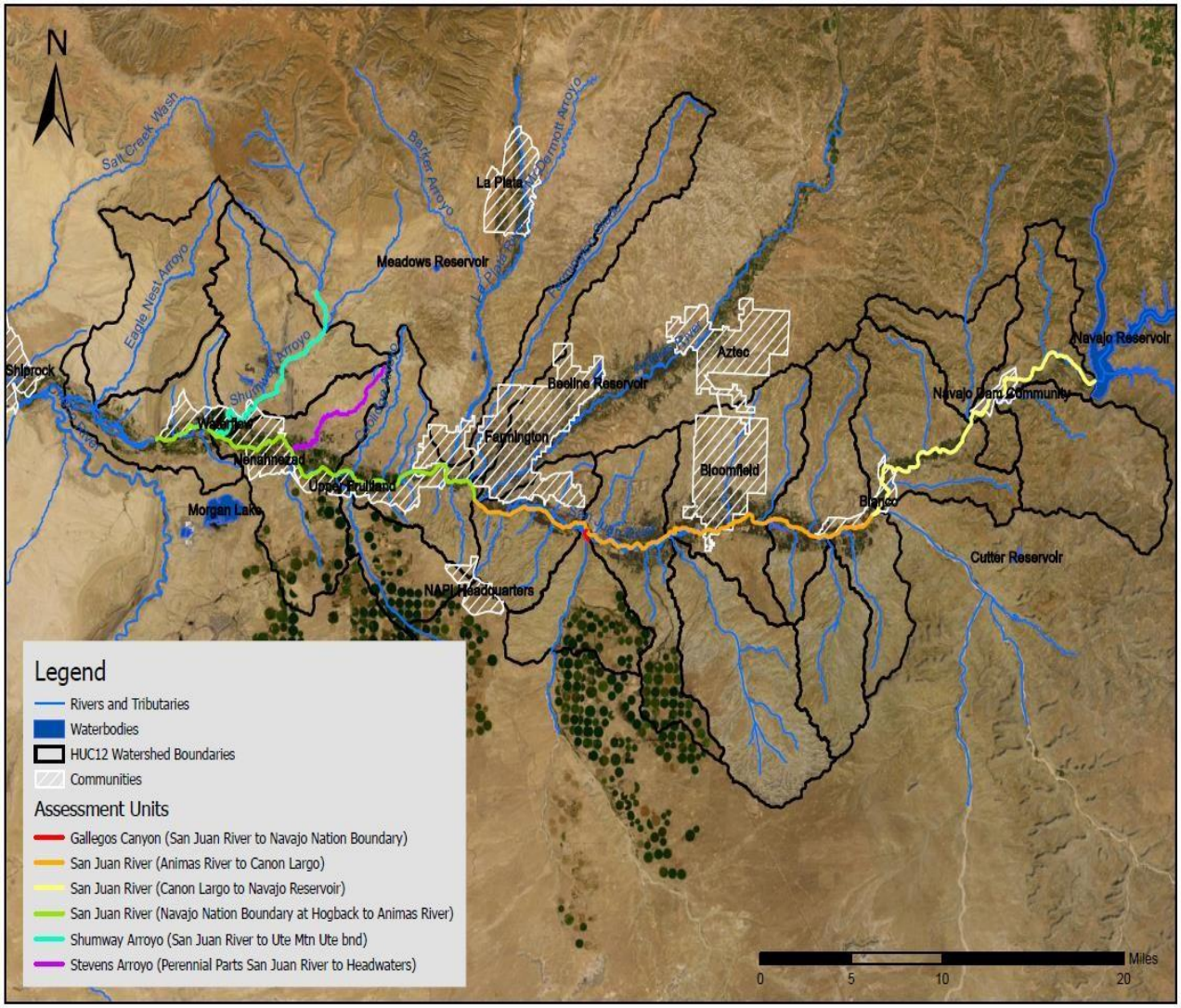
Figure 3: New Mexico Environment Department General Framework for Identifying and Restoring New Mexico's Surface Waters



Courtesy of NMED SWQB

As part of the effort to report on the status of water quality in New Mexico, SWQB implements a 10-Year Monitoring and Assessment Strategy to evaluate watersheds throughout New Mexico on a rotational basis (SWQB Water Quality Monitoring, 2024). The rotational survey allows for two-year water quality surveys throughout New Mexico. For assessment purposes, streams are divided into Assessment Units (AUs) which are designed to represent waters with assumed homogeneous water quality. Typically, there is one monitoring station (sampling location) per AU and each station is sampled 4 to 12 times during a watershed survey. It takes approximately 8-10 years to survey the entire state. The AUs that encompass the MSJWBP focus are provided in the map below.

Figure 4: New Mexico Environment Department Surface Water Quality Bureau Assessment Units in the Middle San Juan River Watershed Plan Focus Area



Sections 303(d) and 305(b) of the CWA require integrated reports that identify and list impaired waterbodies for which water quality is not meeting a water quality standard for each applicable designated use (NMED, 2020). The designated uses in New Mexico include aquatic life, fish culture, primary and secondary contact (including cultural, religious or ceremonial purposes), public water supply, industrial water supply, domestic water supply, irrigation, livestock watering, and wildlife habitat. Each designated use has a unique set of water quality standards that have been established to protect each designated use. The focus area for this WBP was last surveyed by NMED SWQB in between 2018 and 2020 and is summarized in the 2021 EPA Approved 2020-2022 State of New Mexico Clean Water Act Section 303(d)/305(b) Integrated Report. Designated uses for the AUs in the WBP focus area are provided in Table 7.

These water quality impairments are matched with best management practices, which are implemented by NMED SWQB through engaging in water quality planning in partnership with local entities to address these concerns. The first step in surface water quality planning is to prioritize impairment listings for subsequent TMDL development or alternative plans to implement best management practices with a more holistic approach. A TMDL is defined as the "calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. A TMDL determines a pollutant reduction target and allocates load reductions necessary to the source(s) of the pollutant." All existing TMDL values for the AUs within the focus area of this WBP are provided in Table 7. The full list of TMDLs and links to the TMDL documents are available at NMED SWQB's Total Maximum Daily Load Webpage.

Specifically regarding water quality in the MSJWBP, the figures 5-7 provide a graphical representation of the listing and delisting history for the AUs of San Juan River in NMED SWQB's jurisdiction. The years highlighted in gray indicate the years in which water quality surveys were conducted. The turbidity or sedimentation impairments are regarding the marginal cold-water aquatic life designated use. The bacteria impairments are regarding the primary contact use (ie. swimming) designated use. The metals and salinity impairments are regarding the aquatic life designated use.

Figure 5. History of CWA Section 303(d) Impaired Waters for the San Juan River: Assessment Unit: Navajo Nation Boundary at Hogback to Animas River

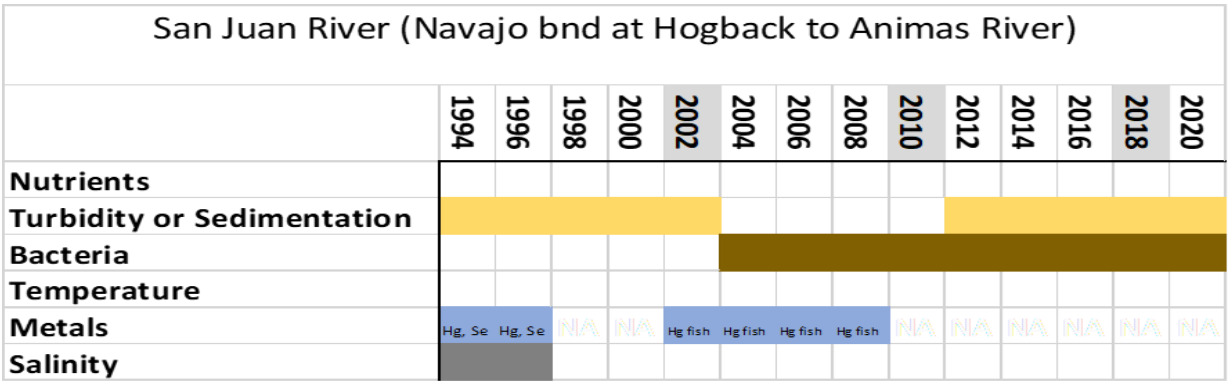


Figure 6: History of CWA Section 303(d) Impaired Waters for the San Juan River Assessment Unit: Animas River to Cañon Largo Confluence

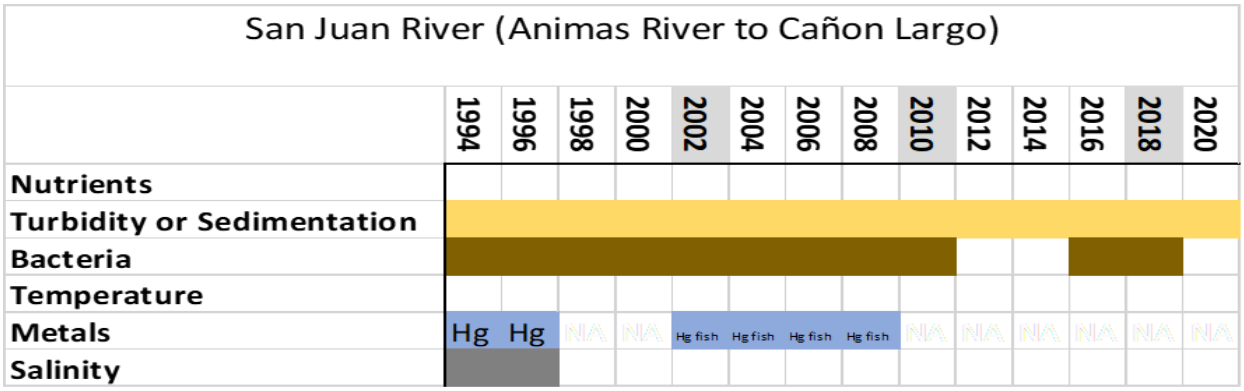
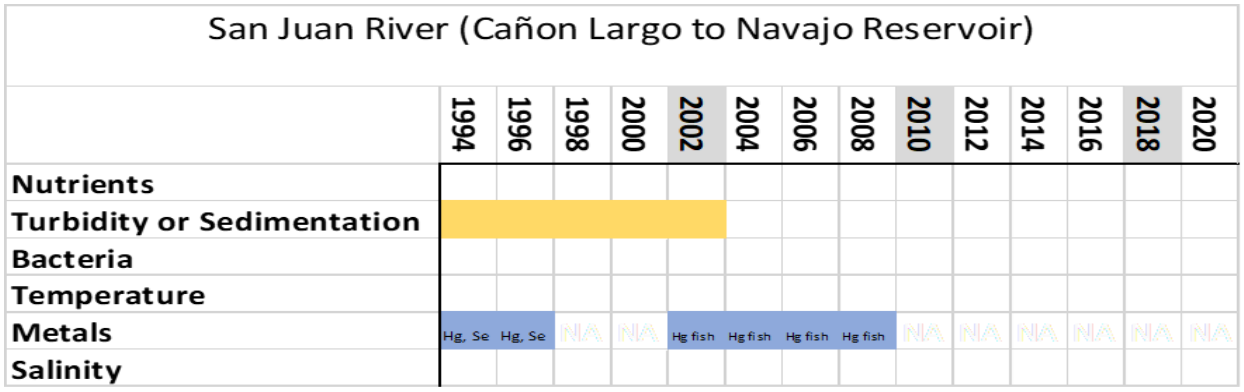


Figure 7: History of CWA Section 303(d) Impaired Waters for the San Juan River Assessment Unit: Cañon Largo Confluence to Navajo Reservoir



The San Juan River, especially between the confluence of Cañon Largo to the Navajo Nation boundary at Hogback, has had a long history of bacteria, sediment/turbidity, and metals impairments via SWQB and collaborator monitoring efforts since 1994. As can be

seen from the impairment history figures above, select AU's have undergone a (de)listing cycle for bacteria and sediment for a variety of reasons, including limited sampling resources, new water quality data including additional data provided by the SJWG, SJSWCD, and US BOR, updated listing methodologies such as the 2004 SWQB and USDA's National Sedimentation Laboratory's sedimentation study, and potential watershed changes overtime. A full history and rationale for the listing/delisting history is provided in SWQB's Assessment Rationale which available at SWQB's CWA Section 303(d) website: https://www.env.nm.gov/surface-water-quality/303d-305b/. Continued collaboration by all stakeholders regarding pollution source identification, watershed planning, and implementation of restoration strategies is needed to sustain a healthy watershed. SWQB's next water quality monitoring survey for the San Juan River is scheduled for 2027.

San Juan Soil & Water Conservation District and San Juan Watershed Group Bacteria Monitoring

Due to the long history of bacteria impairments on the San Juan River (as described above) and the Animas River (as described in the LAWBP) the SJSWCD and SJWG have partnered with NMED SWQB since 2003 to collect, analyze, and interpret fecal bacteria surface water data.

Under the CWA, pathogenic bacteria contamination in fresh surface water is one of the main parameters monitored specifically for primary and secondary contact (i.e., swimming and fishing) designated uses by state environment departments. High quantities of pathogenic bacteria increase human health risk for gastrointestinal, respiratory, eye, ear, nose, throat, and skin diseases (Tetra Tech & Herrera, 2011). Since pathogenic bacteria can be diverse and difficult to measure, *Escherichia coli* (*E. coli*) and *enterococci* are used as a fecal indicator bacteria (FIB) for other more harmful pathogens. In excess quantities, the NMED SWQB uses 126 cfu/100mL for geometric monthly mean (more than 4 samples a month in a given AU) and 410 cfu/100mL as the grab exceedance limit for *E. coli*. FIBs are an indicator of sewage and animal waste pollution that increases the probable presence of pathogens at elevated risk for water users (Richmond, 2022).

While utilizing FIB's is a cost-effective surrogate for determining human health risk, *E. coli* is plentiful in the feces of all mammals and many cold-blooded animals, and it is impossible to differentiate between host organisms (Harwood et al., 2014). It is critical to have a firm understanding of the sources of pollution in a watershed to plan and implement best management practices that effectively mitigate this human health risk. Microbial source tracking (MST) was developed to determine the dominant sources of fecal contamination in environmental waters. Certain fecal microorganisms are strongly associated with specific hosts. Using qualitative polymerase chain reaction (qPCR) lab methods, host-associated mRNA sections of specific microorganisms can be quantified and used as an indicator of fecal pollution from their specific host (Harwood et al., 2014).

While there are various techniques for MST, the DNA profile technique is most commonly used for large scale watersheds (Simpson et al., 2002).

In 2013, 2014, and 2021 the SJWG and SJSWCD conducted an in depth *E.coli*, nutrient, and MST study, with support from CWA Section 604b funding, throughout the San Juan Watershed, specifically along the Animas and San Juan Rivers within NMED's jurisdiction to hone in on bacteria host sources. On a weekly basis between April and October throughout 2013 and 2014, five locations (three on the Animas River and two on the San Juan River) were sampled for *E. coli* and human, dog, bird, and ruminant (including cattle, deer, elk, goats, and sheep) MST analysis. Regarding human sources, two independent human markers were adaptively managed mid-study for quality assurance and quality check (QA/QC) (May, 2015).

Figure 5: Sampling Locations from 2013 and 2014 San Juan Watershed MST Study

From this study, ruminant sources were detected in 94% of all samples, and human sources were detected in 77% of all samples. Cattle sources could not be distinguished from other ruminants, and bird sources were present about a third of the time. The San Juan River showed a more consistent bacteria problem than the Animas River, with 94% of samples testing positive for human bacteria, and 46% of *E. coli* samples exceeding the single sample maximum. Maximum concentrations of *E. coli*, total nitrogen, and total phosphorus were all seen between July and October, and are likely influenced by monsoonal storm events (May, 2015). The majority (79%) of all samples were quantifiable for human source bacteria and were analyzed for magnitude of concentrations, revealing a seven-fold increase in human source bacteria along the San Juan River between Farmington and Hogback (jurisdictional boundary of the Navajo Nation).

While ruminant source bacteria were expected due to livestock production in the river corridor (cattle, sheep) and the presence of wildlife (deer, elk), the near-constant presence of human sewage in the river was unexpected and is alarming (Richmond, 2022). The *E. coli* data from this study was provided to NMED SWQB for incorporation into their 2016 listing cycle for waterways within their jurisdiction. More information on this study is available on the SJSWCD website at https://www.sanjuanswcd.com/watershed.

Figure 6: Percent of Samples Positive per Host Organism for 2013 and 2014 Results

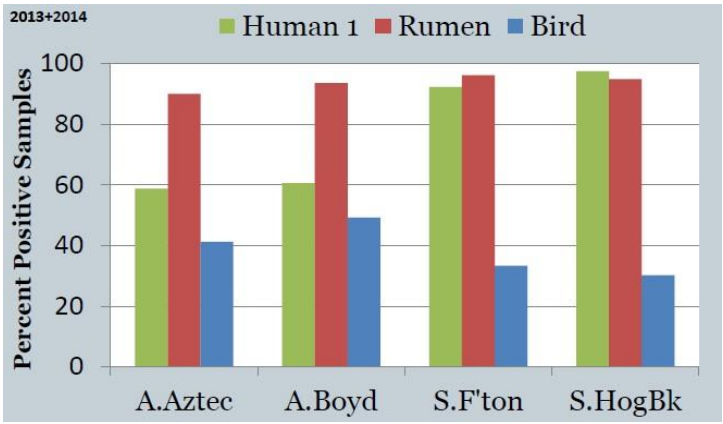
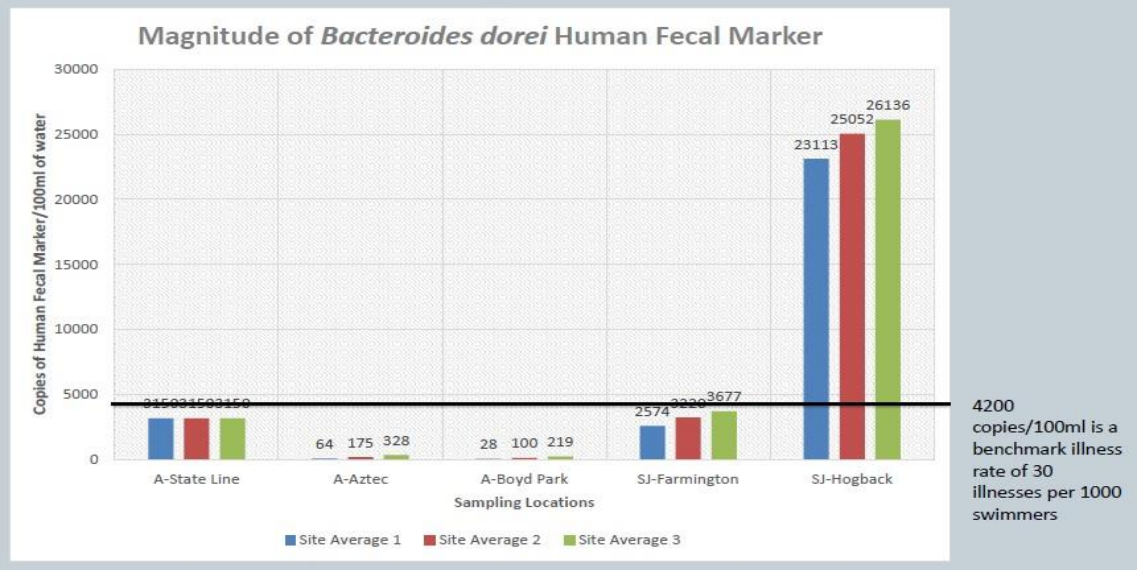


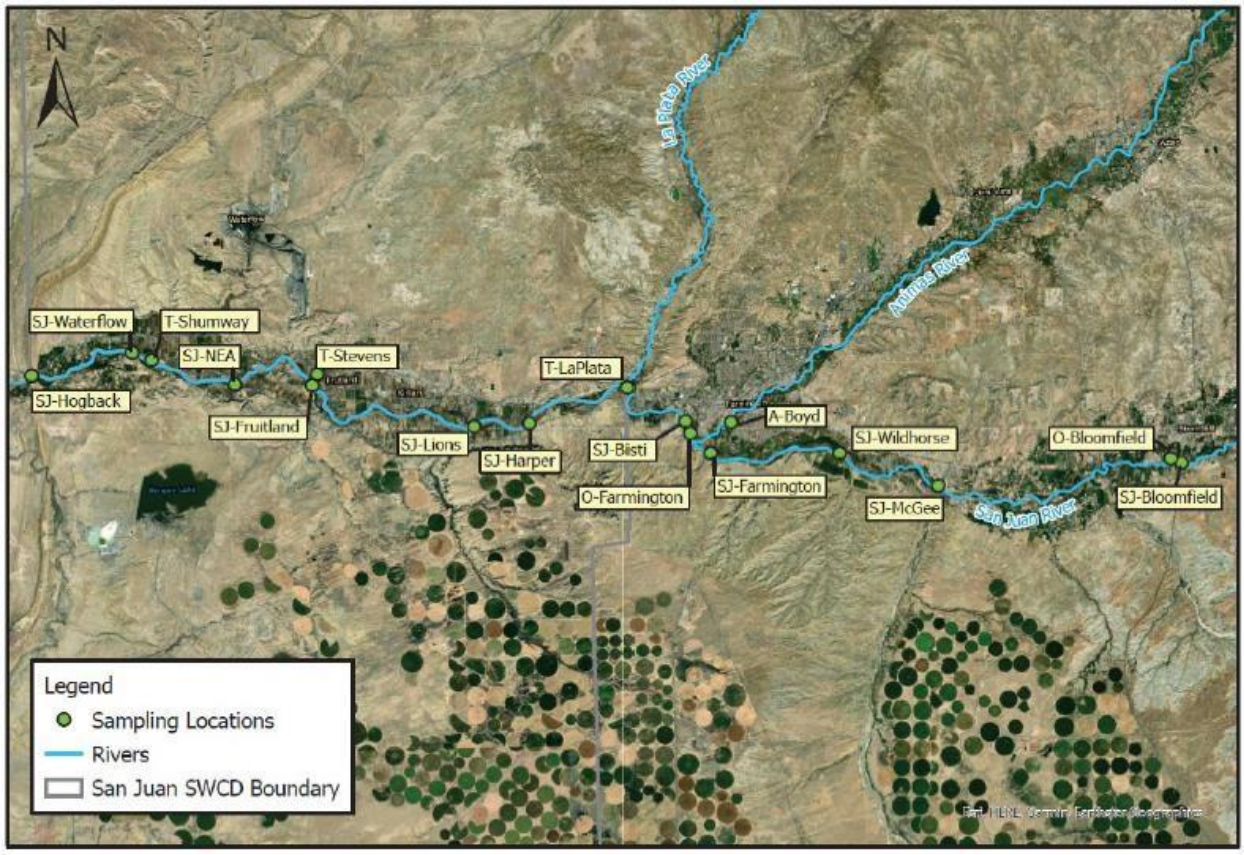
Figure 7: Site Averages of Quantified Bacteroides dorei HF183 Human Marker vs. EPA Illness Benchmark Using 3 Methods of Average Raw qPCR Data



While the 2013-2014 MST study provided a baseline for determining the presence of human fecal bacteria in the San Juan Watershed within NMED's jurisdiction, specific nonpoint sources of human bacteria to the San Juan River, especially within the watershed plan focus area, were undetermined. To continue watershed planning efforts pertaining to the MSJWBP and mitigating the human source pollution concern, the SJWG and SJSWCD conducted a 2021 follow up study using NMED 604(b) funding of both *E. coli* and human source MST concentrations. This study was designed with opposite

framework as the previous study (high sampling location density and low sampling frequency) to investigate the following goals: (1) provide a surface water quality update on bacteria remediation efforts since the 2013-2014 MST Study, (2) further characterize spatial distribution of hotspot sources of human bacteria pollution, (3) investigate impacts of contributions from wastewater treatment plants on surface water quantities detected, and (4) provide data to inform concurrent investigations into opportunities to reduce human source bacteria pollution.

Figure 8: Sampling Locations during the 2021 San Juan Human Bacteria Investigation and Sampling Study



Bacteriological sampling for both *E. coli* culture and human marker *B. dorei* HF183 qPCR quantification were conducted at 17 sampling locations along the San Juan River, at two WWTP outfalls (Bloomfield and Farmington WWTP), and at the mouth of key tributaries, including the Animas River, La Plata River, Stevens Arroyo, and Shumway Arroyo. Sampling was conducted four times between August and October of 2021. Of the 60 *E.coli* surface water samples collected, 48% were over the 410 cfu/100 mL single grab exceedance limit, with the most exceedances seen at SJ-Waterflow, T-Stevens, and T-Shumway locations; However, a single exceedance was documented at every sampling

station along the San Juan except at the La Plata River (see Figure 12, below). Distribution of *E. coli* results for each sampling location were widely distributed, indicating high variability in concentration based on environmental factors such as storm events which may have transported *E. coli* into the river and Navajo Dam releases which may have reduced *E. coli* concentrations (Richmond, 2022).

Regarding the human source tracking results, 29% of the 52 *B. dorei* HF183 surface water samples collected were quantifiable for human bacteria, which of these were between 437 to 4,400 copies/100mL. Only one of the samples at SJ-Fruitland was over the 4,200 copies/100mL illness benchmark at 4,400 copies/100mL. Sampling locations SJ-Bloomfield, SJ-Wildhorse, ABoyd, T-LaPlata, T-Stevens, and T-Shumway did not have any quantifiable human source bacteria during sampling indicating non-human *E. coli* sources. Geographic locations for detections of human source bacteria were highly variable between sampling events, indicating changes in concentrations based on environmental factors (e.g. timing of storm events and dam releases). At the same time, based on the Farmington and Bloomfield WWTP outfalls samples and the proceeding downriver sampling location, treated wastewater from these WWTPs did not appear to have an effect on human source concentrations seen in surface water samples (Richmond, 2022).

Figure 9: E. Coli Concentrations at all Surface Water Sampling Locations and Events during 2021 San Juan Human Bacteria Sampling and Investigation Study

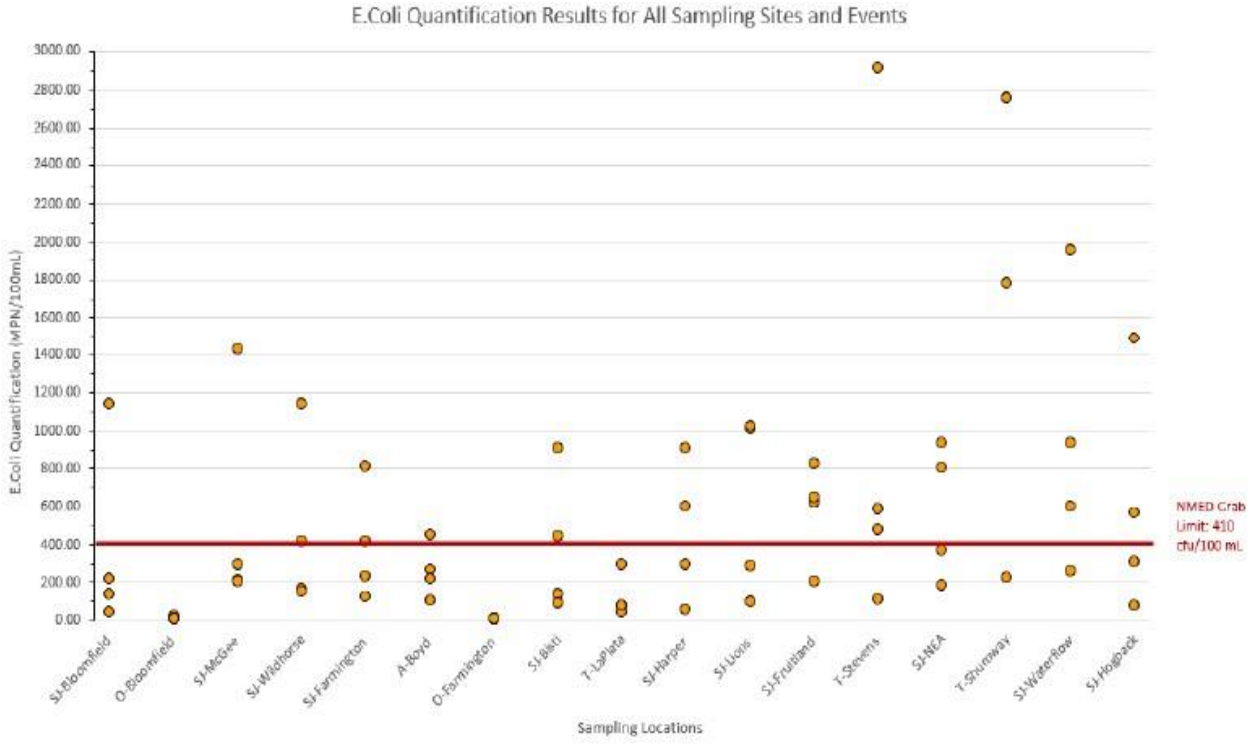
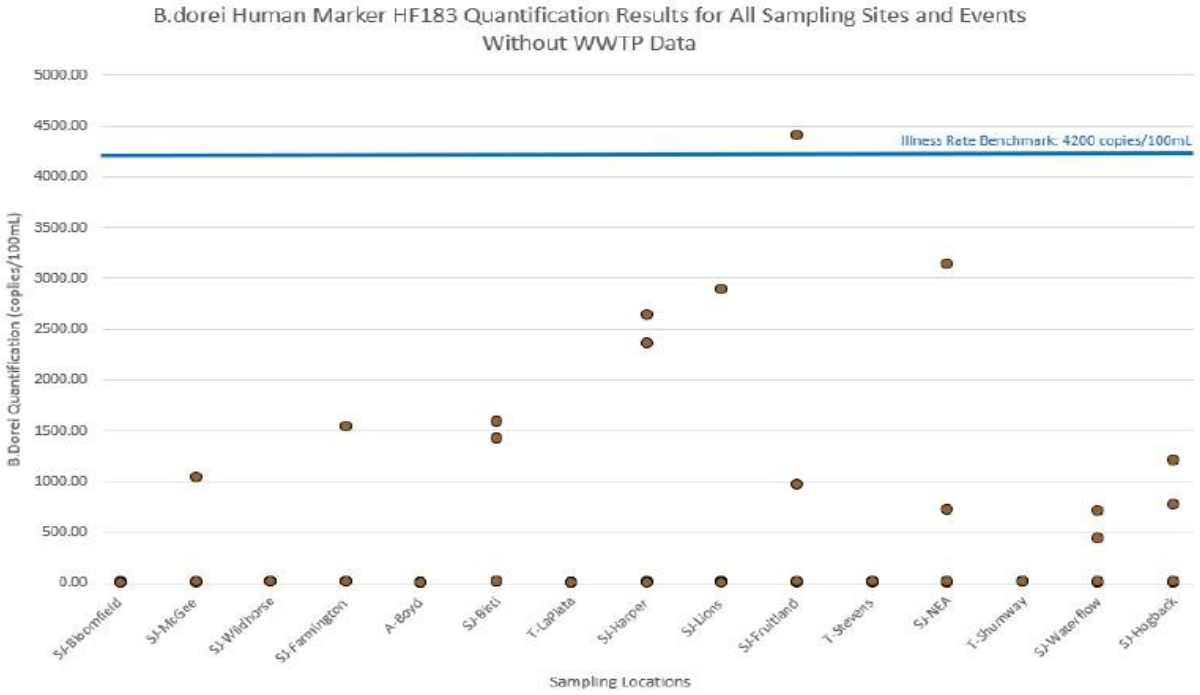


Figure 10: Human Source Concentration Results for all Surface Water Sampling Locations and Events during 2021 San Juan Human Bacteria Sampling and Investigation Study



In the 2013-2014 study, over 90% of the 80 samples were quantifiable for *B. dorei* HF183. Whereas the 2021 study quantified *B. dorei* HF183 in 29% of the 52 samples. This stark improvement in human source pollution detection bodes well for actions taken to reduce human source pollution, including improvements in sewer infrastructure condition and

availability and education and outreach. While there appears to be a vast improvement, more monitoring is recommended to continue to improve bacteria throughout the WBP focus area. Recommendations include:

- Expanded bacteria monitoring within the Navajo Nation. Due to funding limitations and the jurisdiction of funding sources used, bacteria sampling on the Navajo Nation has not been incorporated into SJWG and SJSWCD monitoring. As of 2021, Diné College has begun *E. coli* sampling in the waterways of the Navajo Nation within the shared geography of New Mexico and could be incorporated into future planning efforts.
- Continued *E. coli*, human source, and ruminant source MST tracking. Due to high *E. coli* concentrations during the 2021 study, host organisms other than humans were indicated but remained a data gap. Based on the 2013 and 2014 MST study, ruminant sources are hypothesized to be a lead contributor to bacteria pollution that can be best actively mitigated in the future.

The *E. coli* results from this study have been provided to NMED to incorporate into the 2024 listing cycle. More information on this study is available on the SJSWCD website at https://www.sanjuanswcd.com/watershed.

San Juan River Sedimentation

In order to understand why sedimentation is an issue, one must first examine the immediate climate for the affected area. Freshwater quality and climate are interconnected. Thus, climate system changes will affect freshwater ecosystems and the areas surrounding them. As reported by Fant (2017), viable effects include: changes in streamflow, rises in water temperature, and changes in biochemical reactions. These changes can have a considerable effect on the rate of sedimentation. Sources of sediment can include discharges from municipal and private wastewater treatment, cropland, livestock waste, urban storm water runoff, and natural decay of vegetation.

Sedimentation is a natural occurrence and does not usually cause harm to natural ecosystems. Due to human intervention (i.e. human-accelerated climate change and human-accelerated erosion from land use changes), this natural system has become harmful to water bodies. The sediments cause increased suspended solids in stream water, which gradually fill several vital layers in the water body. The suspended solids decrease sun light penetration through the water column, which can reduce the amount of photosynthesis needed by oxygen producing plants in the stream. When the sediments finally settle to the bottom of the stream, they suffocate life there. Sedimentation can lead to 'sediment loading.' Furthermore, many water contaminants including *E. coli*, DDT, PCBs, chlordane, the pesticide bifenthrin, flame retardant chemicals, polycyclic aromatic hydrocarbons, and most metals such as lead, zinc, and cadmium have the capacity to adhere and attach to sediment particles and can be co-transported with sediment (USGS, 2017). Reducing accelerated erosion may also reduce the transport of these other

contaminants to waterbodies in addition to the sediment particles themselves. According to Keller et. al. (2018), sediment loading is “possibly the highest risk for deteriorating quality” (p. 11).

Pastureland and cropland are 29.7% and 3.4% of the total land use in the watershed, respectively. Nonpoint source pollution from pastureland is potentially the greatest land use source of water pollution due to sedimentation (Table 8). Increasing land consolidation and intensification of agricultural production practices increase nutrient runoff and sedimentation risks in the watershed. BMPs such as health soil practices can be used to limit sedimentation associated with agriculture. Causes of sedimentation include agricultural practices, roads, eroding streambanks, stream access by livestock, lack of riparian and drainage buffer strips, and drought. A limitation and data gap of using the PLET to estimate sediment loads is that the network of roads associated with oil and gas production areas may fall within grassland and shrubland areas identified by the National Land Cover Dataset shown in Figure 1, and PLET only considers four land classification types: urban, cropland, pastureland, and forest.To address this data dap, an alternative model, such as WEPP roads, could potentially be used to estimate the amount of erosion and sediment that may be associated with dirt roads located within grasslands and shrub/scrub lands. Another data gap is that the “Cañon Largo—San Juan River” HUC12 does not represent the entire Largo Cañon watershed, which is made up of over 40 HUC12 watersheds and needs to be addressed in a future WBP update as discussed in Chapter 1 — Watershed Characteristics.

The PLET modeling exercise supports the need to include Cañon Largo and the La Plata River in a future WBP update if the sediment load reduction is to be achieved. The TMDL target sediment load reduction of ~9,000 tons of sediment per year (Table 10, page 63) cannot be achieved by focusing only on the HUC12 watersheds currently included in the MSJWBP. PLET estimates a total sediment load contribution of ~2,000 tons of sediment per year, which if fully prevented would still fall short of the TMDL’s load reduction target.

Table 6: PLET Sediment Contributions by Land Use Type and HUC12 Watershed

HUC12 Name	Total Sediment Load from Urban (No BMP) [tons/year]	Total Sediment Load from Cropland (No BMP) [tons/year]	Total Sediment Load from Pasturelan d (No BMP) [tons/year]	Total Sediment Load from Forest (No BMP) [tons/year]	Total Sediment Load (No BMP) [tons/year]
Eagle Nest Arroyo-SJ River	17.7	24.0	42.9	6.6	91.2
Eagle Nest Arroyo	0.9	0.6	16.0	12.1	29.5
Outlet Shumway Arroyo	4.6	6.2	30.6	11.0	52.4
Shumway Arroyo-SJ River	39.4	152.2	62.3	6.6	260.4
Outlet Ojo Amarillo	6.2	166.7	48.1	2.1	233.1
Ojo Amarillo Canyon-SJ River	42.7	16.9	63.1	5.6	128.3
Farmington Glade	41.6	0.7	38.8	7.5	88.5
Head Canyon-San Juan River	23.2	14.6	64.5	3.8	106.0
Gallego Spring-Gallegos Canyon	7.1	147.9	66.0	2.4	223.4
Gallegos Canyon	39.7	126.8	85.2	4.1	255.9
Kutz Canyon	8.0	1.3	67.4	10.3	86.9
Kutz Canyon -San Juan River	47.2	12.9	87.6	6.9	154.6
Armenta Canyon-San Juan River	17.9	5.2	75.8	9.7	108.7
Armenta Canyon	0.2	0.0	50.6	5.1	56.0
Pump Canyon - San Juan River	13.2	0.4	2.5	9.9	26.0
Lower Gobernador Canyon	13.7	0.1	4.2	25.3	43.4
Lower Pump Canyon	0.3	0.2	7.2	7.2	14.8
Canon Largo-San Juan River	13.5	4.4	39.5	10.1	67.5
Grand Total [% Total Sediment Load, No BMP]	337.2 [16.6%]	681.0 [33.6%]	852.3 [42.1%]	146.2 [7.2%]	2,026.6

Pollutant Causes and Sources

The San Juan TMDL identifies *E. coli* and sedimentation as impairments. The survey helped verify a need for management practices to control sediment which would also

benefit potential nutrient loading. Soil characteristics and land management practices strongly influence the potential for sediment runoff from agricultural fields in the San Juan watershed.

Intensification of agricultural production contributes to runoff and sedimentation risks in this watershed. These changes provide producers with additional opportunities to enhance productivity, but they also present challenges for implementing conservation practices. However, the variable rainfall patterns in northwestern New Mexico often provide producers with a very short window of opportunity for planting cover crops in the fall or the main crop in the spring.

On row crop fields, sediment runoff is generally associated with intensive spring and fall tillage, which can cause stream and gully erosion. The erosion can cause the extension of crop fields to the edge of rivers and creeks, fall application of nutrients and pesticides for spring and summer crops, minimal use of cover crops, and limited funds for installing terraces and other practices. On grazed pastures, natural resource concerns result from uncontrolled livestock access to stream banks, heavy grazing, and limited buffering of heavy use areas from riparian areas. Livestock grazing in pastures deposit manure onto land surfaces, making it possible for both bacteria and nutrients to enter surface water with runoff. In addition, livestock often have direct access to water bodies. During dry periods when stream flows are low, livestock concentrate around streams which increases streambank trampling which can increase erosion and direct deposition of waste into the water. These wastes can cause low levels of dissolved oxygen, high levels of ammonia, and excessive algal growth.

The TMDLs for the San Juan River in New Mexico (NMED, 2006 and 2013) list many potential pollutant sources that contribute to the impairments discussed above. This section expands on these sources in more detail and discusses which sources across the Middle San Juan are contributing the most bacteria and sediment and thus, are most important to remediate. Briefly, any sources of bacteria pollution are also sources of nutrients, and are a top priority to address. Table 7 lists potential pollution sources.

Table 7: Potential Pollution Sources within the MSJWBP Focus Area

Pollutant	**Potential Sources**
Sediment	• Crop Production (Irrigated and Dry Land)

	• Drought-Related Impacts • Increased Fire Intensity • Flow Alterations from Water Diversions • River Channelization and Loss of Riparian Habitat • Petroleum/Natural Gas Activities (Legacy and Permitted) • Rangeland Grazing • Urban Development • User Created Recreation • Pinon Juniper Encroachment • Noxious Weed Invasion • Reduction in Vegetation Biodiversity • Natural Geologic and Hydrologic Processes
Bacteria (Fecal Coliform)	Municipal Point Source Discharges (WWTP) • Faulty On-site Liquid Waste Treatment • Systems (e.g. septic systems), Aging Sewer • Infrastructure • Loss of Riparian Habitat and River Channelization • Drought-Related Impacts • Rangeland Grazing • Irrigated Pasture • Socioeconomic Inequities • Illegal Dumping • Pet waste • Growing Tourism without Supporting Infrastructure • Wildlife

Potential Pollution and Watershed Health Degradation Sources

With facility discharges and human development activities being regulated by the CWA and other legislation, non-point source pollution is the leading cause of water quality degradation in the United States. Non-point source pollution is defined as the mobilization of natural and human made pollutants through runoff from snowmelt and precipitation across the landscape to rivers, streams, wetlands, and other water bodies (NMED, 2021). Based on the initial framework provided by NMED, Table 7 provides a brief outline of the potential sources and contributing factors of pollution specifically regarding

bacteria and sediment within the Watershed-Based Plan focus area. This list was compiled with the expertise of various stakeholders. While metal contributions are of high concern for stakeholders, metal sources are not a current impairment on the San Juan River and are not outlined in the MSJWBP but may be incorporated in future editions if a new metals impairment is identified.

Each of these potential pollution sources and strategies to further quantify and mitigate their impacts are described in various degrees of detail throughout the remainder of MSJWBP. It is noteworthy to address that the MSJWBP does emphasize water quality concerns but also incorporates other restoration aspects that do not have a direct correlation to water quality, but are a priority for stakeholders throughout the watershed, such as recreation initiatives and building community connections.

Human Sewage

The results of the MST study were very surprising, in that human source bacteria was not initially suspected to be a primary source of bacterial contamination in the river. The persistent human bacteria problem on the San Juan River raises concerns about recreation and the possible increased risk of illness from ingesting human-hosted pathogens make sources of human fecal pollution a primary concern. Nearly all homes and businesses in the Farmington city limits are connected to the municipal sewer systems and wastewater treatment plants for wastewater disposal.

All homes and businesses not connected to city sewers use on-site liquid waste disposal (LWD) systems, commonly referred to as septic systems, for domestic wastewater disposal. Possible sources of human bacteria to the San Juan River fall into the categories of: On-site liquid waste systems, illegal dumping, municipal wastewater infrastructure, and outdoor defecation. The prevalence of each of these sources is discussed in the following sections.

Illegal Dumping

The contents of a septic tank must be removed periodically to prevent overflow of grease or sludge to the drain field. This septage has a very high concentration of *E. coli* bacteria (10,000 to >1,000,000 cfu/100ml) in addition to high concentrations of biological oxygen demand (BOD), and total suspended sediment (TSS). The only legal septage disposal facility in San Juan County is the Farmington Wastewater Treatment Plant (WWTP). Illegal dumping of septage and portable toilet waste by commercial septage haulers has been documented in San Juan County, and due to the remote nature of much of the landscape, there are numerous available locations to dump without being seen. Direct discharge of septage to the San Juan River, an irrigation canal, or uplands near watercourses would be

a substantial source of bacteria, though it is impossible to quantify exactly how much loading comes from this source

Upon discovery of the human bacteria problem in 2014, the San Juan Watershed Group initiated an outreach effort with the NMED Liquid Waste Program (LWP), NMED Clean Water Act Section 319 Program, the City of Farmington, and San Juan County. As of 2024, there were 8 septage hauling companies listed in the phone book. Tourism is popular in the area, with RVs frequently visiting and stopping en route to other national parks in the region. Anecdotal evidence suggests that RVs may discharge waste into irrigation canals on a fairly regular basis (personal communication with ditch riders). It is unknown how much RV waste dumping contributes to bacteria loading, but like septage, the concentrated nature of the waste makes it a priority to prevent.

Outdoor Defecation

The contribution of human bacteria that comes from people defecating outdoors in the Middle San Juan watershed is unknown. Farmington has a fairly constant homeless problem, and makeshift camps without bathroom facilities are often found tucked into the riparian areas along the river corridor in Farmington. Any efforts to provide more suitable housing to the homeless population would address this issue and would be more important for social reasons than for water quality concerns. Camping for recreation on public lands is scattered sparsely throughout the uplands in the watershed (hunting camps, etc.) but is not likely to be a major contributor of bacteria

Table 8: Possible Sources of Human and Ruminant Bacteria to the San Juan River

Biological Source	Source Activity Pathway to River:	Ground water	Direct Discharge	Irrigation Returns	Storm water
Human	Faulty septic tanks	X			X
	Illegal septic (straight pipes, cess pits, etc.)	X	X	X	X
	Illegal dumping – waste disposal companies		X		X
	Illegal dumping – recreational vehicles		X		X
	Leaking sewer pipes	X	X		
	Wastewater treatment plants		X		
	Outdoor defecation				X
Ruminant – (includes cattle, deer, elk, sheep, goats)					
	Animals with direct access to river		X		X
	Grazing on irrigated fields			X	X
	Grazing in uplands and riparian areas				X
	Improper manure disposal		X	X	X

Summary of Causes & Sources of Impairment

While the water quality impairments and pollutant sources may seem overwhelming to address, there is also a great deal of overlap, where a single source activity is contributing to multiple impairments. There are also instances where addressing one problem (ie: barriers to assimilative capacity) will mitigate for other source activities. In summary, there are numerous opportunities to plan projects which will have multiple benefits to water quality in the San Juan River.

Current Pollutant Loads

The calculated loads of *E. coli* and sedimentation and the most recent datasets available can be found in table 9 below.

Table 9: Current San Juan River Impairments, Load Reduction Goals, and TMDLs

Assessment Unit ID	**Assessment Unit Name**	**Current Impairment Parameters**	**Load Reduction Goals in TMDLs (if available)**	**TMDL Notes**
NM-2401_00	San Juan River (Animas River to Cañon Largo)	*E. coli* Sedimentation/ Siltation pH	*E. coli*: 2.05 x 10^{12} cfu/day. 22.5% *percent fines* Load Reduction No TMDL for pH at this time	64% *E. coli* Load Reduction The *percent fines* reduction target is converted to a 29.9% Sediment Load Reduction (2024 SWQB communication) First listed as impaired in 2024, additional data are needed before TMDL can be scheduled (2024-2026 NMED Integrated Report and List)
NM-2401_10	San Juan River (Navajo Boundary at Hogback to Animas River)	*E. coli* Sedimentation/ Siltation	*E. coli*: 3.82 x 10^{12} cfu/day	73% *E. coli* Load Reduction 29.9% Sediment Load Reduction (2024 SWQB communication)
NM-9000.A_021	Shumway Arroyo (San Juan River to Ute Mountain Ute Boundary)	*E. coli*	No TMDL at this time	First listed as impaired in 2020
NM-2401_11	Stevens Arroyo (Perennial prts San Juan River to headwaters)	*E. coli*	No TMDL at this time	First listed as in impaired in 2020
NM-9000.A_060	Gallegos Canyon (San Juan River to Navajo Boundary)	*E. coli*, Selenium, Temperature	*N/A*	Selenium TMDL prepared 2005. Not addressed in this project

SWQB converted the load reduction goal from %fines to tons/year to accommodate the PLET model load reduction estimates which are given in terms of tons/year (Table 10).

Table 10: Sediment Load Reduction Targets

Assessment Unit	TMDL (lbs/day)	Measured load (lbs/day)	Target Load (lbs/day)	Target Load (tons/year)	Percent Reduction
San Juan (Animas River to Cañon Largo)	134,314.86	153,296.75	107,451.89	19,610	29.90%
San Juan River (Navajo bnd at Hogback to Animas River)	146,049.02	166,877.08	116,839.22	21,323	29.90%

The Target Load = TMDL – Margin of Safety (MOS). The MOS is 20% (10% to account for uncertainty in the relationship between TSS and deposition of excess sediment and 10% to account for error inherent to flow estimation. Percent reduction is the percent the existing measured load must be reduced to achieve the target load and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100. SWQB calculated the measured load using data from the 2017/2018 SWQB Survey and flow data from 2003-2024.

Chapter 3: Element B: *Estimating Load Reduction*

Point Sources

As defined by the U.S. Environmental Protection Agency (EPA), point source pollution is "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship, or factory smokestack" (EPA, 2024) Point source discharges are permitted through the National Pollutant Discharge Elimination System (NPDES) and can be grouped into three subcategories: municipal and industrial wastewater treatment dischargers (WWTPs), municipal and industrial storm water dischargers, and concentrated animal feeding operations (CAFOs).

Septic and Sewer Infrastructure

Surface water bacteria studies have indicated a significant improvement in human source bacteria along the San Juan River within the MSJWBP. However, it is highly recommended to continue watershed planning, outreach, and project implementation to further reduce human source bacteria, ensure that human source pollution is not a concern in the future, and support the socioeconomic need to support managing human waste.

Nearly all homes and businesses within Farmington and Bloomfield's city limits are connected to municipal sewer systems and wastewater treatment plants for proper wastewater processing before being reintroduced to the San Juan River (see NPDES permits in the Discharge Permits section). There are a several instances of housing developments noted to still be using improperly functioning on-site liquid waste systems, such as the Totah Vista Subdivision within San Juan County jurisdiction, which has been identified for remediation given the high groundwater table and well use for drinking water supply (more information on this initiative is provided below). Agencies and municipalities such as San Juan County, the city of Farmington, and the city of Bloomfield actively conduct routine maintenance through in-house funding to reline sewer lines and WWTP facility upgrades to decrease the likelihood of leaks and improve facility efficiency in accordance with NPDES permits. All homes and businesses not connected to city sewer systems use on-site liquid waste systems (hereafter referred to as septic systems) for domestic wastewater disposal (SJWG, 2021).

Properly functioning septic systems are an asset to water quality and come in various varieties depending on site conditions, and should be individually designed per housing unit and location. Categories of septic systems including advanced treatment systems (ATS), which incorporate additional aerators and/or disinfection devices, lagoons, evaporation ponds, lined holding tanks, and traditional septic systems. The type of system utilized is determined by soil conditions, lot size, groundwater table depth, and other factors. Traditional septic systems are the most common in the MSJWBP, particularly because liquid waste treatment and disposal regulations were not officially implemented in New Mexico until the 1970s. These systems typically include a pipe from the house or business, a septic tank for solid settling and separation of oils and grease, and a drain field for treatment by the soil microbiome (EPA, 2002).

Maintaining septic systems is the responsibility of the landowner and business. However, permitting of septic systems is maintained by different agencies depending on the volume of effluent being processed by the system. Septic systems that produce 5,000 gallons per day (GPD) or less are permitted through the NMED Environmental Health Bureau. Systems discharging over 5,000 GPD are permitted by the NMED Groundwater Quality Bureau (including lagoons and evaporation ponds that predominantly discharge to groundwater), and point sources discharging to waters of the United States are permitted through the EPA's NPDES program (see Discharge Permit section). The EPA Region 9 issues all NPDES permits on the Navajo Nation tribal lands. The NMED Environmental Health Bureau is currently in the process of reviewing, conducting QA/QC, and confirming historical records of septic system permits and inspection records to make said information publicly accessible through an interactive web map to septic professionals, homeowners, planning organizations, agencies, and local municipalities.

While surface water quality has shown a significant decrease in human source bacteria in the San Juan River within the MSJWBP, several stakeholders, such as Navajo Nation Chapter Houses, realty companies, and private landowners have voiced a need to provide additional technical and financial assistance for septic system inspections, maintenance, and replacements. Given that septic systems inspections and pumping (which should be conducted every three to five years depending on the volume produced) is at least $200 and several thousand for replacement and/or new septic systems installation, this creates a significant financial barrier for many landowners.

In San Juan County, New Mexico the median household income in 2023 inflation-adjusted dollars was $57,324 with 21.1% of the population below the poverty level compared to $62,268 and 17.8% for New Mexico and $77,719 and 12.5% for the United States (US Census Bureau, 2023 American Community Survey 1-Year Estimate).

Sewage Best Management Practices

To meet the program and community needs described above and to further support sewer infrastructure, the aspects below are recommended for future planning and implementation. Inspiration for conducting these activities can be drawn from the bacteria focused projects conducted through the Lower Animas Watershed Based Plan, which is available on the SJSWCD website at https://www.sanjuanswcd.com/watershed.

1. **Increasing access to existing sewer infrastructure from housing developments**
    a. Between 2014 and 2017 the Harper Valley WWTP in Kirtland, New Mexico was decommissioned, the Farmington WWTP was expanded, and a sewer extension from the Farmington WWTP was installed through to the Harper Valley Subdivision that previously used the Harper Valley WWTP. While this infrastructure is available, several landowners within the subdivision and

surrounding communities continue to use septic systems to manage their septic systems to circumvent sewer connection fees (as reported by the Valley Water Sanitation District). The city of Farmington offers an extended payment program to support connections to the city's sewer infrastructure. This program will continue and could be collaboratively supplemented under a grant funded initiative including CWA Section 319 funding to further remove the financial barrier for homeowners willing to connect to sewer infrastructure.

b. This could provide a framework for other municipalities to adapt, including the city of Bloomfield, who has expressed interest in exploring this potential. Further outreach, review of addresses not connected to the sewer extension, site specific cost estimates, and stakeholder coordination is needed to investigate the viability of this partnership.

2. Continued revitalization of sewer lines identified to be in need of repair

a. As mentioned previously, the city of Farmington routinely conducts sewer "lining " projects to prevent future leaks of existing sewer infrastructure. This is currently supported through city of Farmington funds but could be supplemented with grant funded initiatives including CWA Section 319 funding pending partner coordination.

3. Targeted design and implementation of septic system and/or sewer infrastructure installation, such as the Totah Vista Subdivision

a. The Totah Vista Subdivision is located south of the City of Farmington and bounded by Sycamore Street, South Miller Avenue, and South Butler Avenue. The subdivision plat date is March 1957. The subdivision has a total of 138 parcels with 119 developed and 19 undeveloped. While the subdivision is located within San Juan County, it is in close proximity to the city's limits. The subdivision's drinking water is supplied by many small, domestic ground water wells that either serve a single house or a cluster of houses. The subdivision's wastewater is disposed of with septic systems that serve individual parcels. The septic systems have been observed to have leakage above the ground surface due to poorly drained soils and aging on site infrastructure, posing a human health risk. The recommended design alternative includes a centralized wastewater collection system that connects the Totah Vista Subdivision to the City's existing wastewater collection and treatment system.

b. The proposed centralized wastewater collection system, prepared in 2016, consists of an eight-inch collection system line to connect each parcel in the subdivision and a lift station with a four-inch force main to connect to the City's 24-inch collection trunk line.

c. The recommended design alternative for the water system includes a centralized water distribution system that connects the Totah Vista

Subdivision to the existing City of Farmington drinking water system. The centralized water system includes a looped eight-inch system with fire protection to serve the community. Drinking water will be provided from the City's surface water plants. Currently the design phase of this project has been funded and additional municipal and grant funding could support the implementation of the future finalized plans.

4. **Utilization of the soon to be finalized NMED Environmental Health Bureau permit database to identify septic systems in need of inspection/potential repair and strategize a septic cost share campaign**
    a. As stated previously, the NMED Environmental Health Bureau is currently reviewing and transitioning their current and historical permit and inspection records into a GL solutions database. Once this information is available, a research project could be conducted to review unpermitted vs permitted systems or systems in need of inspection in comparison to aerial imagery, San Juan County parcel data, and proximity to the river to identify housing developments and businesses in need of future septic system work. From this information, grant funding could be utilized to establish a septic cost share campaign that provides financial assistance to collaborating landowners to maintain, repair, and/or replace septic systems. A similar campaign has been conducted by the Culpeper Soil and Water Conservation District of Virginia and could be used as a framework to be adapted for the MSJWBP and surrounding San Juan Watershed. More information on Culpeper's Soil and Water Conservation District Program is available at http://www.culpeperswcd.org/residential-cost-share-program/.

5. **Septic professional training and technical assistance**
    a. Septic pumper, haulers, installers, and inspectors are the front-line workers addressing septic system concerns. In a sense, they are the conduit between the NMED Environmental Health Bureau, landowners, and the Farmington WWTP. To continue to identify strategies and needs of the local community regarding septic systems, a relationship built on trust is required. At the same time, septic professionals need certification, training, and technical skills support, especially for new and rising businesses and professionals. To support them, a key group of stakeholders and professionals in the San Juan Watershed, similar to the SJWG Liquid Waste Committee, can be assembled to tailor a training program that offers troubleshooting, operations, and on-the-ground training for responding to septic systems in various conditions. This curriculum could be based on trainings conducted in other states, such as the National Association of Wastewater Technicians based in Colorado. More information on NAWT is available at their website at https://www.nawt.org/.

b. Incentives should be provided for professionals to participate in this process, including but not limited to certifications, continuing education credits, and vouchers to prepaid dumping fees for septic waste disposed of at the Farmington WWTP.

6. Public outreach and education on the importance and avenues to maintain septic systems, including:

a. ***Sending septic smart care guide flyers to all homeowners in San Juan County via utility bill mailings***
   i. Education reference flyers may be sent to homeowners, especially those exclusively using septic systems, to mitigate septic system malfunction before it happens. An example of these flyers was developed and distributed by the SJWG Liquid Waste Committee through the Farmington Electric Utility Service in 2020 with CWA 319 funding to implement this strategy as described in the LAWBP. Information included the basic components of septic systems, tips and tricks on proactive system maintenance, state regulations on proper permitting and inspections, and contact information to report cases of illegal dumping to the NMED Farmington Field Office. These flyers should be sent on an annual basis to help keep preventative septic system maintenance in the forefront of the public mind.

b. ***Septic system operations and maintenance workshops, educational booths, and free webinars***
   i. Hands-on workshops are one of the most impactful outreach strategies to describe how a septic system works and be proactive on system maintenance. Such workshops can be hosted in partnership with the NMED Liquid Waste Program and certified installer specialists and strategically advertised to neighborhoods and Navajo Nation Chapter houses with high concentrations of septic systems, such as the Kirtland, Waterflow, and Shiprock communities.
   ii. Such workshops can also be hosted as educational booths at local events, such as the annual San Juan County Home Builders Expo. The Rural Community Assistance Corps (RCAC) provides free Septic System Operations and Maintenance Webinars regionally throughout the country. The SJWG Liquid Waste Committee partnered with RCAC to advertise these programs to landowners through 2020 and such efforts should be further implemented and developed in the future. Complimentary inspections and house visits by trained professionals could be provided to improve workshop effectiveness.

c. ***Realty company septic system care resources to new homeowners***
   i. Realty companies throughout San Juan County have expressed the need to provide septic system maintenance information and contacts for professional services to new homeowners during property transfers. Information should be compiled and distributed in coordination with

realty companies and the San Juan County Board of Realtors in future outreach campaigns.

d. ***Septic Professional septic system care resources to homeowners***
    i. Septic professionals and the NMED Liquid Waste Program have expressed the need to provide care, tips, tricks, and a list of resources to homeowners to manage their septic systems between inspections and pumping. These resources can be compiled and distributed to septic professionals in coordination with the NMED Liquid Waste Program.

Discharge Permits

Pursuant to the Clean Water Act of 1972 under Section 402, the National Pollution Discharge Elimination System (NPDES) is a permit program operated by the Environmental Protection Agency that regulates point sources of discharge pollutants that are directly deposited to waters of the United States (EPA, 2022). The Clean Water Act prohibits anybody from discharging "pollutants" through a "point source" into a "water of the United States" unless they have an NPDES permit. The permit will contain limits on what you can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or people's health (EPA NPDES Permit Basics, 2025). NPDES permits are separated into two categories: individual permits that reflect site-specific conditions of a single discharger and general permits that cover multiple dischargers that operate under that permit once issued. All individual NPDES-permitted facilities are required to obtain and report effluent samples (and not stream samples).

In general, wastewater treatment plants (WWTP) are required to monitor for E. coli bacteria, total residual chlorine, total suspended solids, total dissolved solids, pH, flow, and 5-day biological oxygen demand. Industrial dischargers monitor for a variety of parameters depending on the activity in which the facility is engaged. These facilities generally monitor total suspended solids (TSS), total dissolved solids (TDS), pH, and aluminum. Some facilities may also monitor for a suite of metals, radionuclides, flow, and biomonitoring (SJWG, 2005).

NPDES permits for the state of New Mexico are regularly updated and publicly available at https://www.epa.gov/npdes-permits/new-mexico-npdes-permits.

Table 11 below lists the WWTP and industrial facilities that discharge to the San Juan River or its tributaries within the focus area for this Restoration Plan. This list does not include facilities with general permits (Stormwater General Permit: Construction, Industrial Activities, Municipal Separate Storm Sewer, etc.)

Table 11: San Juan County NPDES Permits within the MSJWBP Focus Area

NPDES No.	Facility Name	Permit Type	Effective Date	Expiration Date
NM0020770	City of Bloomfield Wastewater Treatment Plant	WWTP	11/01/2020	10/31/2025
NM0020583	City of Farmington Wastewater Treatment Plant	WWTP	12/01/2021	11/30/2026
NM0031135	Farmington Electric Utility	Industrial	8/01/2019	07/30/2024
NM0030953	Navajo Dam DWC & NSW, Inc.	Industrial	11/01/2014	10/31/2019
NM0031194	Cutter Lateral Water Treatment Plant	Industrial	02/01/2024	01/31/2029
NM0028746	Westmoreland San Juan Coal Mine, LLC	Industrial	02/01/2024	01/31/2029

Table 12: Navajo Nation NPDES Permits within the MSJWBP Focus Area

NPDES No.	Facility Name	Permit Type	Effective Date	Expiration Date
NN0028193	Navajo Coal Mine	Industrial	06/01/2025	05/31/2030

NNG990001	General Permit for Low-Threat Discharge on Navajo Nation	Industrial	05/01/2024	04/30/2029
NN0030343	Northern Edge Navajo Casino	Industrial	12/01/2022	11/30/2027
NN0000019	APS Four Corners Power Plant	Industrial	12/01/2020	11/30/2025
NN0020800	Nenahnezad Community School	Industrial	11/01/2019	10/31/2024
NM0028746	Westmoreland San Juan Coal Mine, LLC	Industrial	02/01/2024	01/31/2029

Drinking Water Sources

Surface water from the San Juan River is the primary source of drinking water for the communities of Bloomfield, Kirtland, and La Plata Valley. There are several smaller rural water districts located downstream of Navajo. Water is delivered to Bloomfield via the Bloomfield Irrigation District (BID) ditch or river water directly diverted into the Citizens Ditch and then transported to the Aragon Reservoir, a “Secondary Source” of supply, which acts as a settling basin for turbid river water. Reducing sediment in the San Juan River would improve turbidity in Aragon Reservoir. The communities of Kirtland and La Plata Valley derive their water via the Farmers’ Mutual Ditch.

The San Juan River’s source of turbid river water is sediment from Cañon Largo, located between Bloomfield and Navajo Dam. During periods of minimal river flow, or periods of high river water turbidity, Bloomfield can receive Animas River water from Aztec via a pipeline connecting the communities. The San Juan River also supplies water to smaller rural water districts of Lee Acres Water Users Association, Navajo Dam Domestic Water, and West Hammond Domestic Water. Each of the smaller rural water districts have limited storage capacity. The City of Farmington does supply Kirtland with treated water from the Animas River to supplement its water supply. In times of water emergency, the San Juan River can serve as a supplemental source of drinking water for the City of Farmington.

The San Juan River passes through the community of Kirtland. Kirtland receives drinking water from the Lower Valley Water Users’ Association. The San Juan River also passes

through the community of Shiprock. Shiprock receives its drinking water from the Animas River via a pipeline from the City of Farmington.

Coordinating the protection of drinking water and overall watershed health can lead to unique partnerships with entities like NMED-Drinking Water Bureau's Source Water Protection Program and Drinking Water State Revolving Fund, which are funded through the EPA under the Safe Drinking Water Act, also benefiting surface water quality.

Irrigation Infrastructure and Water Use

There is a network of seven total irrigation ditch main canals and countless laterals that provide surface water for the community in the MSJWBP. Each of these irrigation systems are fed by diversion structures along the San Juan and Animas River in various locations and levels of condition. Like the Animas River and other rivers throughout the Southwest, water is diverted from the San Juan River for a variety of uses including irrigated agriculture, commercial and public drinking water, irrigated lawns and golf courses, and other municipal and industrial uses (San Juan Basin Regional Water Plan, 2016).

There are seven main irrigation canals through the MSJWBP that provide surface water to the community for various uses. Surface water is the predominant source of water in the San Juan Watershed. A February 2025 review of The NM Office of the State Engineer (OSE) "Point of Diversions" (POD) database for all of San Juan County found that of the total 2,785 active PODs allowing a grand total diversion amount of 185,940 acre-feet, there are 90 PODs from surface water diversions that account for 112,282 acre-feet and 2,682 PODs with a groundwater source accounting for 21,634 acre-feet. There are 15 ambiguous San Juan County PODs in the database that do not indicate a surface or groundwater source including one POD belonging to the San Juan Coal Company with a total diversion amount of 51,600 acre-feet.

Table 13: OSE POD Database, Total Diversion Amount by Water Right for San Juan County

Specific Water Right Use	**Total Diversion (amount of water in acre-feet allowed to be diverted)**
Commercial	3.2
Community type use - mutual domestic water	10,434.5
Construction of public works	6.0

Dairy operation	5.0
Domestic construction	1.0
domestic and livestock watering	461.0
domestic one household	5,206.0
Exploration	25.0
Fish and game propagation	2.2
Highway construction	4.9
Industrial	1,173.5
Irrigation	111,425.0
livestock watering	380.0
Mining or milling or oil	55,062.5
multiple domestic households	43.0
Municipal	1,043.5
Oil production	10.0
Petroleum processing plant	275.9
Recreation	3.7
Sanitary in conjunction with a commercial use	70.3
Storage	286.4
Total	185,922.5

Once water is diverted, some of it returns to the river via irrigation return flows (tailwater), seeps into the groundwater table and recharges local aquifers, or remains in the ditches at the end of their length. Most ditches and laterals within the MSJWBP are earthen and unlined leading to a water volume loss due to seepage; this affects the groundwater hydrology, soil health and mineralization in adjacent lands, and may support a larger zone of riparian vegetation and wetland areas (SJWG, 2021). Various irrigation ditch associations have voiced a need to work with funding sources, such as the NM ISC 90/10 Acequia Cost Share Program and Capital Outlay, to cement line or pipe ditches, thus reducing water revenue loss, increasing soil health, and improving irrigation efficiency in a water quantity tight time for the West.

To stay in accordance with the 1978 New Mexico Water Law (Chapter 72 of New Mexico Statutes, the New Mexico Office of State Engineer (OSE) is responsible for working with irrigation districts and other water users to regulate surface and groundwater water use through water rights transactions and water use metering. In 2016, the New Mexico Office Of State Engineer (OSE) and other partners completed an Acequia Mapping Project - including all irrigation ditches, canals, and laterals - to safeguard, preserve, and provide aid to ditch infrastructure and operation (SJWG, 2021). This information will be critical for planners and irrigation ditch associations to refer to how water users get access to the main canal and prioritize ditch maintenance. The interactive map and additional background data is available at https://ose.maps.arcgis.com/home/index.html.

In 2016, the U.S. Bureau of Reclamation worked with the American Southwest Ichthyological Researchers and The Nature Conservancy to conduct a study compiling information on diversion structure condition and their potential entrainment to native and endangered fish along the San Juan and Animas Rivers (more information on this is provided in the Aquatic Habitat and Endangered Species section). This study found several structures that did and did not create ideal conditions for fish entrainment and included a variety of recommendations on further investigation studies, projects, and funding sources based on their findings (BOR, 2016). The average diversion rates and diversion structure conditions of structures within the MSJWBP from this report and coordination with the OSE is provided below.

Table 14: Average Diversion Flow and Condition for Structures within the Middle San Juan Watershed-Based Plan Focus Area

Diversion	Average Diversion (cfs)	Diversion Description
Bloomfield	141	Push-up cobble dam at inlet of diversion channel
Turley-Manzanares	6.7	Concrete and boulders across most of river channel
Hammond	75	Concrete weir across river channel
Jewett Valley	31.71	Boulders and native bed material across river channel (no fish passage)
Hogback	~100	Unknown
Fruitland	100	Boulders placed in river channel adjacent to diversion
Farmers Mutual - San Juan	106	Unknown
PNM San Juan Generating Station	Rates Vary*	Concrete dam across river channel
APS Four Corners Units 4 & 5	Rates Vary*	Concrete weir and steel pilings across river channel
Williams Field - Kutz Plant	Rates Vary*	Unknown

Chapter 4: Element C: *NPS Management Measures*

Watershed Restoration Goals

Watershed restoration goals were discussed at San Juan Watershed Group public meetings in order to make sure the direction of the MSJWBP was compatible with the needs and values of the community. Watershed restoration goals include the following:

- Remediate all sources of human waste in river
- Ruminant bacteria reduced by half
- Storm flow bacteria reduced by >10%
- Soil health improved on range, crop, and pasturelands
- Native grass, shrub, and tree buffers along river in all subwatersheds
- Riparian areas free from invasive phreatophytes
- Reduce loading of fine sediment originating from roads and disturbed areas

- Barriers to assimilative capacity removed
- Floodplains reconnected in reaches compatible with current land use
- Invasive weeds replaced with native grasses

Soil Health and Agriculture Best Management Practices

Crop production and livestock grazing is a deep-rooted legacy, cultural identity, and revenue source within the MSJWBP. 33.1% of its land use is categorized as cropland or pasture. Most of all irrigated agriculture activity is concentrated within the bottom valley of the San Juan River for ease of surface water access and has a direct impact on water quality and floodplain management depending on the management practices adapted by the landowners. Agricultural land has a unique ability to be an asset to water quality and watershed health when properly managed and is not a negative land use (SJWG, 2021).

Within the MSJWBP, agriculture occurs in many forms including backyard gardens, community gardens, green houses, hobby farms, intermediate sized pastures, large production operations, hay fields, feedlots, and more. The specific number, size, and pollutant load of agricultural land use has been estimated using the Pollutant Load Estimation Tool (PLET) (Table 6, pg. 56). PLET is a publicly available spreadsheet tool used for estimating pollutant load and correlating load reductions based on a variety of BMPs, and is available at https://www.epa.gov/nps/plet. The PLET estimation could be verified and further investigated in coordination with various partners, such as the SJSWCD, NMSU San Juan County Extension Office, the NMSU Agriculture Science Center, NAPI, Irrigation Associations, and Natural Resource Conservation Service (NRCS) through on the ground inventories. Irrigation practices, pending access and site-specific infrastructure, vary, but flood irrigation, gated pipe and furrow irrigation, and side roll sprinklers are the most common. According to the NRCS Aztec Field Office and OSE, most landowners irrigate predominantly based on water availability and water rights, which can lead to overuse of water and an increased rate of excess soil nutrient leaching and erosion.

In extension of surface water availability, a high concentration of irrigated pastures are known to use river and ephemeral tributaries as the primary drinking water source for livestock. While these systems best meet the infrastructure that is currently available, livestock with unrestricted access to riparian areas can degrade riparian and wildlife habitat, alter river and stream morphology, and increase bacteria, nutrient, and sediment contributions (Kauffman & Krueger, 1984). BMPs such as alternative watering sources, restricted or controlled access to rivers and tributaries, winter grazing in riparian areas, rotational grazing, and rehabilitation of overgrazed riparian zones can offer long-term management benefits to water quality and watershed health.

In a drought impacted climate and soil conditions that tend to have high sand/clay content with low organic matter, incorporating healthy soil and water conservation practices to improve water infiltration capacity, high soil organic matter, deep root

systems and good plant biodiversity is critical to improve water quality, land sustainability, and regenerative agriculture production. These BMPs come in a variety of forms and can include:

- Regular soil tests
- Minimal or no till systems
- Rotational cover crop and forage systems
- Inorganic and organic mulching
- Fertilizer management
- Manure management away from waterways
- Rotational grazing systems
- Contour buffer strips of native plants and/or specialty crops
- Prescribed burning of noxious weeds
- Integrated pest management
- Conversion to efficient irrigation systems
- Soil moisture monitoring to avoid over irrigating
- Tree and shrub establishment for wind breaks and erosion control

Table 15: PLET Estimated Sediment Load Reductions by BMP

BMP	**PLET estimates for MSJWBP**
Urban BMP	
Concrete Grid Pavement (commercial) [tons/yr/1-acre of BMP drainage area]	0.02
Concrete Grid Pavement (transportation) [tons/yr/1-acre of BMP drainage area]	0.06
Concrete Grid Pavement (single-family) [tons/yr/1-acre of BMP drainage area]	0.01
Porous Pavement (commercial) [tons/yr/1-acre of BMP drainage area] requires 0.021-acre BMP area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.02

Porous Pavement (transportation) [tons/yr/1-acre of BMP drainage area] requires 0.021-acre BMP area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.06
Porous Pavement (single-family) [tons/yr/1-acre of BMP drainage area] requires 0.021-acre BMP area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.01
Grass Swales (commercial) [tons/yr/1-acre of BMP drainage area]	0.01
Grass Swales (transportation) [tons/yr/1-acre of BMP drainage area]	0.04
Grass Swales (single-family) [tons/yr/1-acre of BMP drainage area]	0.01
Infiltration Basin (commercial) [tons/yr/1-acre of BMP drainage area] requires 0.014-acre basin area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.01
Infiltration Basin (transportation) [tons/yr/1-acre of BMP drainage area] requires 0.014-acre basin area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.05
Infiltration Basin (single-family) [tons/yr/1-acre of BMP drainage area] requires 0.014-acre basin area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.01
LID/Infiltration Swale (commercial) [tons/yr/1-acre of BMP drainage area] requires 0.021-acre BMP area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.02
LID/Infiltration Swale (transportation) [tons/yr/1-acre of BMP drainage area] requires 0.021-acre BMP area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.06
LID/Infiltration Swale (single-family) [tons/yr/1-acre of BMP drainage area] requires 0.021-acre BMP area to capture 0.5 inches of runoff from 1-acre of 100% impervious surface	0.01
Wetland Detention (commercial) [tons/yr/1-acre of BMP drainage area]	0.02
Wetland Detention (transportation) [tons/yr/1-acre of BMP drainage area]	0.05

Wetland Detention (single-family) [tons/yr/1-acre of BMP drainage area]	0.01
Cropland BMPs	
Buffer - Forest (100ft wide) [tons/year/1-acre]	0.02
Buffer -Grass 35ft wide [tons/year/1-acre]	0.02
Conservation Tillage 2 (more than 59% residue) [tons/year/1-acre]	0.03
Contour Farming [tons/year/1-acre]	0.02
Cover Crop 2 (normal planting time for high till only) [tons/year/10-acre]	0.04
Land Retirement/Fallow Field [tons/year/1-acre]	0.04
Streambank Stabilization and Fencing [tons/year/1-acre]	0.03
Pastureland BMPs	
Forest Buffer (minimum 35 feet wide) [tons/year/10-acre]	0.03
Grass Buffer (minimum 35 feet wide) [tons/year/10-acre]	0.04
Critical Area Planting [tons/year/10-acre]	0.03
Alternative Water Supply [tons/year/10-acre]	0.01
Livestock Exclusion Fencing [tons/year/10-acre]	0.04
Streambank Protection w/o fencing [tons/year/10-acre]	0.04
Streambank Stabilization and fencing [tons/year/10-acre]	0.05
Prescribed Grazing [tons/year/10-acre]	0.02
Winter Feeding Facility [tons/year/10-acre]	0.02
Forest BMPs	
Forest BMP -Critical Area Planting [tons/year/50-acre]	0.01
Road grass and legume seeding [tons/year/25-acre]	0.01
Gully and Streambank	
Gully (dimension = Length x Top Width x Bottom Width x Height = 100x1x1x1, 25-yr to form, BMP 0.5 efficient, Loam sandy clay) [tons/year]	0.90
Stream Bank (dimensions = Length x Height = 100x3, lateral recession = severe, BMP 0.5 efficiency, Loam sandy clay) [tons/year]	2.70

A drawback of PLET is that PLET is limited by the types of BMPs. Although PLET does allow for "user defined" BMPs, developing new BMPs in PLET is challenging. Table 15, above, includes a number of PLET BMPs that may be applicable to the MSJWBP. A valuable take-away, is that acre for acre, ton for ton, a project would have to cover 25x-50x more acres in a forest and 10x more acres in a pasture to achieve a comparable load reduction for treating just 1-acre of cropland or 1-acre of urban area. This is because erosion rates are much greater in urban and croplands than they are in pastures and forests. The gully and streambank load reductions can be achieved by implementing a

number of BMPs such as grade control, one-rock-dams, revegetation, etc. which are described in more detail the sections below. The estimates above are for a general gully or streambank which can be revised as needed for specific projects. It is tempting to see the large sediment reductions that can be achieved through streambank "stabilization" – streams naturally meander; preventing any movement will cause greater harm to the fluvial system. The goal (and the challenge) is to identify streambanks that have accelerated erosion rates, address the root cause, and support natural fluvial processes and meander rates as much as possible. The major benefit of PLET that it is user-friendly and is not a resource intensive model to use.

Agricultural BMPs

There are a wide variety of agricultural conservation practices that can be applied and that are currently being applied in the project area. The NRCS is instrumental in local efforts and provides a wealth of knowledge and support for designing and implementing conservation practices. The NMSU Ag Extension Office and Farmington Field Office of the Bureau of Land Management are other local resources for conservation practices in relation to livestock and land management. Forms of agricultural conservation practices include:

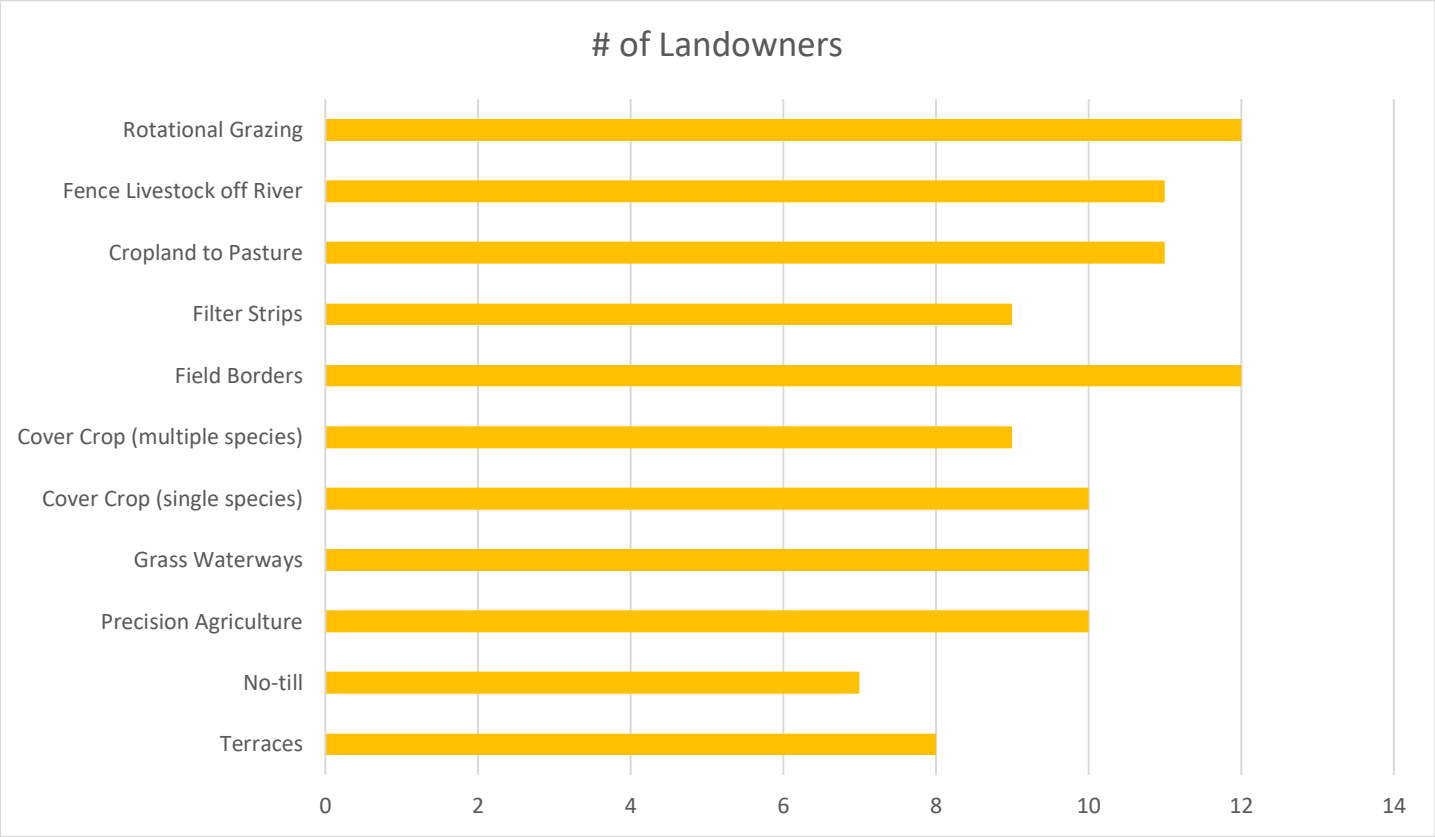
- Soil conservation BMPs (residue and tillage management, cover crop, crop rotation, etc.)
- Rotational grazing management
- Vegetated buffers and edge-of-field runoff control
- Fertilizer management
- Manure management
- Riparian access management for livestock
- Soil moisture monitoring to avoid over-irrigating
- Conversion to efficient irrigation systems

San Juan SWCD will work with other sister agencies to develop "BMPs" flyer to distribute via mail including a description of the ruminant bacteria problem and how landowners can help. In the same mailing, priority landowners will be notified of the NRCS EQIP sign up period. NRCS will provide landowners with technical assistance in developing individual conservation plans, with certain projects possibly eligible for reimbursement cost-share funding through the EQIP program. The funding source mentioned above could be used as match to leverage additional funding from a Clean Water Act Section 319 grant, administered by the New Mexico Environment Department Surface Water Quality Bureau.

The San Juan Soil and Water Conservation District (SWCD) has identified several priority areas for Best Management Practices (BMPs) within the Middle San Juan River

watershed. These include: 3,818 acres designated for critical area planting, 9,764 acres for cover crops, 210 acres for conservation tillage, 3,134 acres for forest buffer zones, 202 acres for grass buffer zones, and 374 acres of streambank stabilization with fencing. Properties that currently have high concentrations of livestock, bare soil, and no buffers fall into the highest priority. Acreage and linear feet of river frontage were also used to prioritize projects, since working with a single landowner to address a large area leads to easier implementation. Based on calculations using the Pollutant Load Estimation Tool (PLET), implementation of these BMPs is projected to reduce sediment loading by approximately two tons per year. To better understand landowner interest and feasibility, a survey was conducted with 14 property owners along the San Juan River to determine which BMPs they would be willing to implement on their land. The survey results are summarized in the figure below:

Figure 11: Landowner Implementation Survey



Rotational grazing: is a pasture management technique where livestock are moved between paddocks to allow forage to recover. This method improves soil health, reduces erosion, supports plant regrowth, and enhances pasture productivity. It is an effective conservation practice often used to protect watersheds and sustain land over time.

Stream Exclusion: involves fencing livestock out of streams reduces nonpoint source pollution by reducing stream bank erosion and eliminating the bacteria associated with livestock waste. When the cattle have access to streams, they can deposit manure directly into the water.

Filter Strips: are defined as a strip or area of herbaceous vegetation that removes contaminants from overland flow. The purpose of filter strips is to reduce suspended solids and associated contaminants in runoff, reduce dissolved contaminant loading in runoff, and reduce suspended solids and associated contaminants in irrigation tailwater. Filter strips are established where environmentally-sensitive areas need to be protected from sediment, other suspended solids, and dissolved contaminants in runoff. According to PLET,

Field Borders: are defined as a strip of permanent vegetation established at the edge or around the perimeter of a field. The purpose of field borders is to reduce erosion from wind and water, protect soil and water quality, manage pest populations, provide wildlife food and cover, increase carbon storage, and improve air quality. This practice is applied around the perimeter of fields. The use of field borders is to support or connect other buffer practices within and between fields. This practice may also be applicable to recreation land or other land uses where agronomic crops including forages are grown.

Cover Crops: are defined as crops including grasses, legumes and forbs that are used for seasonal cover and other conservation purposes. The purpose of cover crops is to reduce erosion from wind and water, increase soil organic matter content, capture and recycle or redistribute nutrients in the soil profile, promote biological nitrogen fixation, increase biodiversity, suppress weeds, provide supplemental forage, manage soil moisture, reduce particulate emissions into the atmosphere and minimize and reduce soil compaction. This practice is applicable on all lands requiring vegetative cover for natural resource protection and/or improvement.

Grass Waterways: are defined as a shaped or graded channel where suitable vegetation is established to carry surface water at a non-erosive velocity to a stable outlet. The purpose of grass waterways is to convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding, to reduce gully erosion, and to protect/improve water quality. This practice maybe applied in areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff.

Precision Agriculture: is a farming approach that uses technology—such as GPS, sensors, drones, and data analytics—to monitor and manage crops and livestock more efficiently. By collecting real-time data on soil conditions, moisture levels, crop health, and more, farmers can make targeted decisions to optimize inputs like water, fertilizer, and pesticides. This leads to increased productivity, reduced environmental impact, and more sustainable use of resources.

No-Till: is defined as managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year round and limiting soil-disturbing activities to those necessary to place nutrients, condition residue, and plant crops. The purpose of no-till is to reduce sheet/rill erosion, reduce wind erosion, improve soil organic matter content, reduce carbon dioxide losses from the soil, reduce energy use, plant-available moisture, and provide food and escape cover for wildlife. This practice applies to all cropland and other land where crops are planted. No-till is not a BMP option in PLET, so the exact load reduction is yet to be determined.

Terracing: is defined as an earth embankment, or a combination ridge and channel that is constructed across the field slope. A terrace is applied as part of a resource management system for one or more of the following purposes: to reduce erosion by reducing slope length and to retain runoff for moisture conservation. This practice is applicable where: soil erosion caused by water and excessive slope length is a problem, excess runoff is a problem, there is a need to conserve water, and soils and topography are such that terraces can be constructed and reasonably farmed and a suitable outlet can be provided.

Streambank Stabilization: This practice is complicated because the eroding streambank is often a symptom of a larger problem occurring elsewhere within the watershed. Consequently, finding an effective erosion control method can be difficult for a landowner unless they receive appropriate professional assistance. The limitations of currently available methods in terms of high cost, difficult installation, or inapplicability to larger stream systems have caused landowners to try techniques that are ineffective and may lead to increased instability.

Maps of Identifies Areas of Need:

Figure 12: Animas River to Navajo Boundary

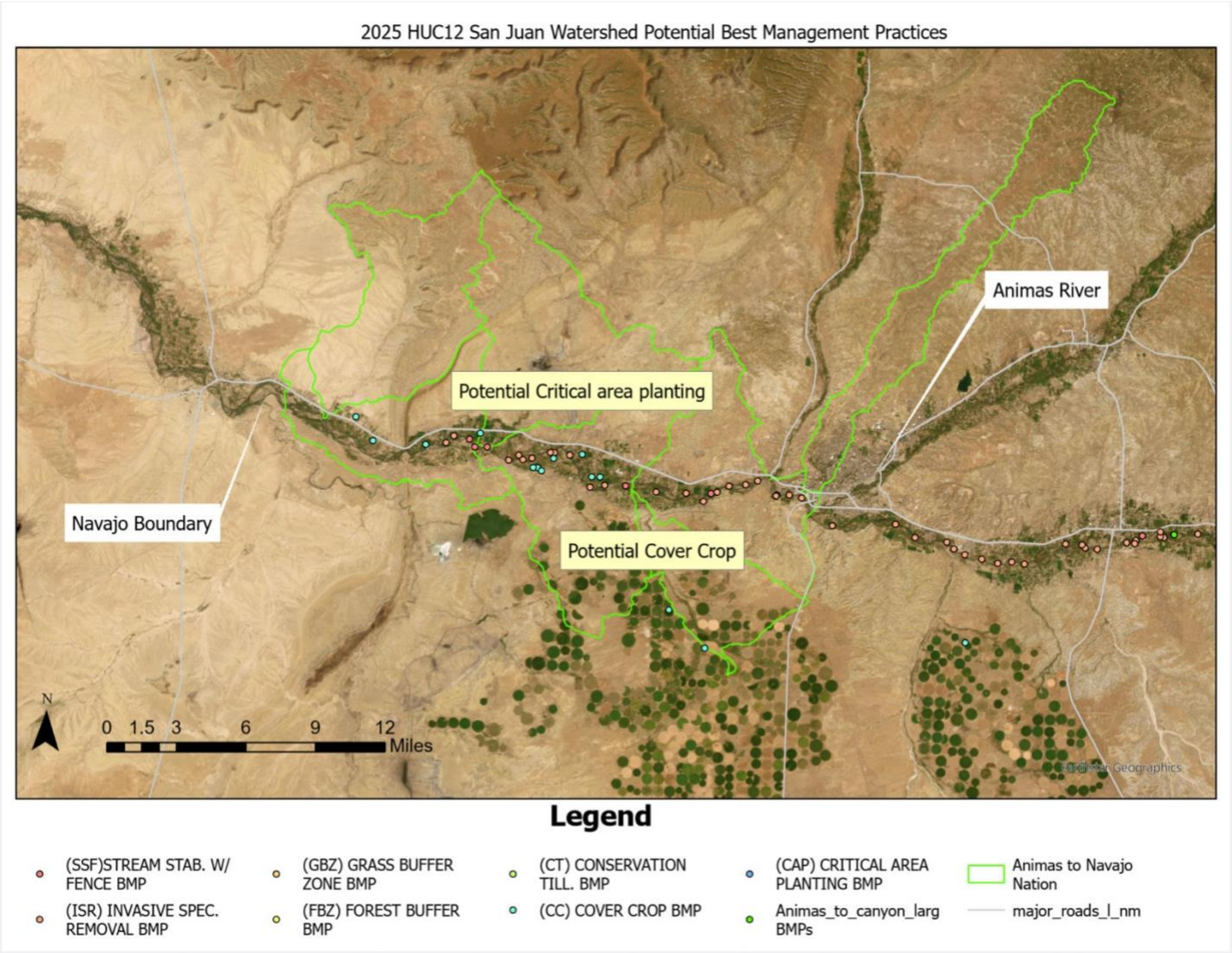


Figure 13: Cañon Largo to Animas River

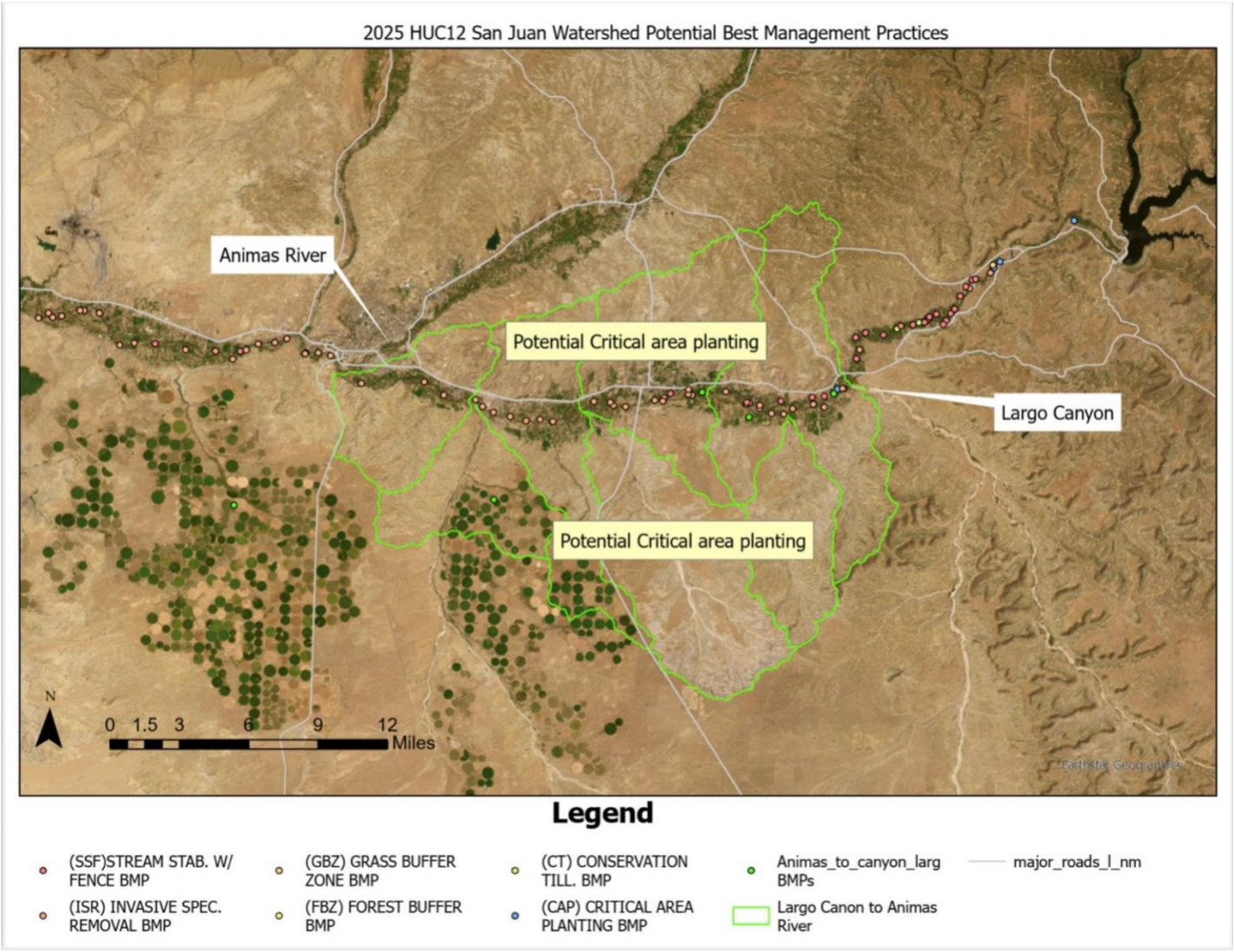
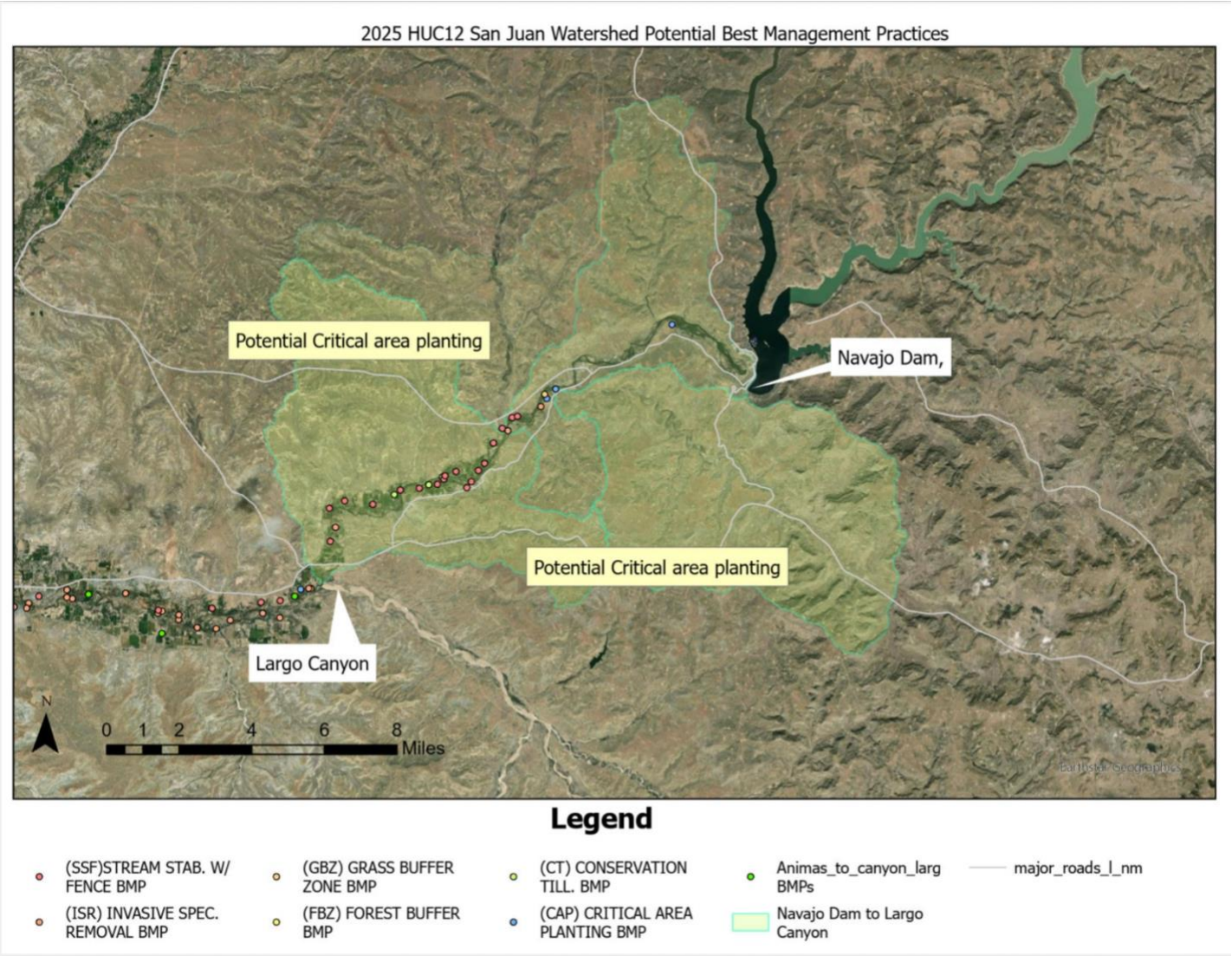


Figure 14: Navajo Dam to Cañon Largo



Oil & Gas BMPs

There are also land use activities that may also be contributing additional amounts of sediment to the river. There are an abundance of unimproved roads in the San Juan River basin associated with oil and gas development. Sediment loads from this potential source may be reduced through improved enforcement of the terms of coal bed methane leases on BLM and Carson National Forest lands, revision of standard conditions of approval language to improve drainage (and reduce erosion) from well access roads, and development of more effective reclamation techniques for well sites, roads, and pipelines (SJWG, 2005). The BLM and several oil and gas operators formed the San Juan Basin Public Roads Committee in 2001 to address these issues. The approach is to cost-share road maintenance on BLM lands by dividing the oil and gas field into 14 road maintenance units with each unit having a designated supervisory operator. BLM contributes 10 percent of the total annual costs. The goal is to bring the primary access roads that receive the highest volume of traffic up to proper road standards and maintain them for years to come (USBLM 2002 and 2004).

BMPs in this land use mainly focus on minimizing erosion from roads, well pads, and pipelines. These practices and goals include:

- Properly aligned, graded, constructed, and drained gas field roads, and restoring old roads that are no longer in service.
- Alleviate the impact of borrow ditches, which intercept sheet flow and mainline it to the river - the exact opposite of infiltration basins
- Stabilize and revegetate erosional features and disturbed lands using features such as: dry seeding, hydromulch, weed-free straw, grade control structures, Zuni bowls, one rock dams, or silt traps (BLM 2007). These goals will be addressed through a combination of outreach and specific projects.
- Outreach to San Juan Basin Roads Committee Work with BLM, oil and gas companies, ranchers, road graders and all members of the San Juan Basin Roads Committee to promote best practices to reduce sediment and erosion impacts from oil and gas infrastructure, in a way that also reduces road maintenance and improves oil and gas field operations.
- Change road specs to prevent use of fine-grained sediment cleaned out from ponds for road base (erodes at a higher rate)
- Enforce BLM surface use requirements for silt fences during construction
- Hold a workshop on proper road design, grading, drainage, and maintenance (use Zeedyk principals where possible; model after 319 workshop held in 2008)
- Have a booth or presentation at the NM Oil & Gas Association (NMOGA) meeting to promote best practices for roads, pipelines, and well pads.
- Encourage installation of simple, low cost, small-scale erosion structures (ie: one rock dams, Zuni bowls, etc.) in degrading or unstable channels, especially upstream from areas prone to washouts

- Encourage/fund revegetation and recontouring of old roads and well pads
- Open lines of communication for identifying priority areas, project needs, and additional funding sources.
- Develop GPS enabled form for field crews to easily record and photograph locations with active erosion problems.
- Plan a future monitoring project evaluating the effectiveness of various road and well pad BMPs in reducing runoff and erosion.

The WEPP road model should be used to calculate load reductions on these projects in the future. http://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/wr/wepproad.pl. The WEPP road model demonstrates the important role that buffer distance between the road and the stream plays in determining sediment loading. A 200-ft section of gravel road with an in slope, a bare ditch and only a 10-ft buffer can deliver an estimated 40.39 pounds per year of sediment to a stream, whereas the same road with a 150-ft buffer will deliver an estimated 6.96 lbs of sediment, and increasing the buffer distance to 240-ft drops the sediment load to zero. A higher priority should be placed on improving road conditions for those roads that are in close proximity to streams and arroyos.

Sediment Fences & Detention Basins

While it is difficult to plan individual erosion control projects for the immense road and well pad network in the uplands of the MSJWBP, sediment fences are a way to address sediment transport at a point further downstream but before it reaches the San Juan River. Sediment fences are a series of parallel wire-mesh fences that extend from the channel bank out into the channel a short distance, angled downstream, that reduce water velocities in the near-bank region and promote the deposition of sediment between and downstream of the fences. The fences help stabilize eroding sand-bed wash and arroyo banks, capture sediment from upland flows, allow for vegetation establishment, and reduce sediment and associated nutrient loads to the receiving stream. This technique was developed by local BLM staff to address the challenges of sand-bed arroyos in the San Juan Basin and have been used successfully by the BLM in several watersheds including Cañon Largo. The sediment fence installed in Kiffen Creek under the 2011 Section 319 Phase III Grant has proven effective at retaining 4,000 tons of sediment per year (LAWBP, 2014). Costs to design and install $38,000 for sediment fence similar to the 2011 Kiffen Canyon 319 Project. It cost $400,000 for 20 acre-foot dry retention basin and $30,000 for 5 acres of mixed erosion control structures. Estimated pollutant load reduction of sediment to the river: 4,000 tons.

General Stormwater & LID Outreach

Because stormwater was found to be a main pathway for pollutants in urban areas, agricultural lands, and upland environments, it opens an opportunity to conduct outreach that spans multiple land uses. In conjunction with the stakeholders previously mentioned, the goal will be to

sell the idea that pollution from stormwater is everyone's problem, and everyone can be part of the solution. It will promote that with smart management, water should be a resource (growing food, healthy rivers), not a problem (causing flooding and erosion). The more water stays where it falls instead of running off, the better.

- Minimize impervious surface
- Maintain natural drainage patterns
- Filter strips on edges of roads, driveways, pastures, corrals, cropland
- Promote soil health and water holding capacity by planting cover crops
- Reduce bare ground wherever possible (helps control weeds too)
- Minimize transport of pollutants (proper septic care, manure management, containment of construction materials, disposal of hazardous wastes)
- A stormwater BMP workshop that incorporates Low Impact Development techniques will also be incorporated into the outreach campaign. Speakers with experience in stormwater BMP design will be invited to share their success stories. The Paseo Del Norte watershed plan and subsequent workshops held in Las Cruces by Stream Dynamics is an excellent example and possible speaker. The workshop will include hands on work to implement a demonstration project.

In 2017 the Bureau of Reclamation published a report titled Technical Memorandum No. 86-68210-2017-08 Evaluation of Irrigation Infrastructure in the San Juan River Basin, New Mexico Western Colorado Area Office Upper Colorado Region. This over 600-page document addresses the needs, designs, and cost estimates of infrastructure on all ditches in the San Juan Basin. Which if used properly will be a much-needed tool for ditches and water managers.

In the summer of 2023, the San Juan SWCD entered into a contract with the Office of Natural Resource Trustee to replace Headworks and /or diversion dams on five ditches on the Animas and San Juan River, with two being on the San Juan River, which includes the Jewitt Valley Ditch and the Farmers Mutual Ditch.

While there is a vast amount of agricultural land still in production within the MSJWBP, the aging farmer crisis throughout the west and events that have left a distrust for water safety, such as the Gold King Mine Spill of 2016, have correlated to properties being left fallow, susceptible to erosion, and contributing to the spread of noxious weeds, further exacerbating soil health. To remedy these conditions, a collaborative effort to provide technical assistance to new and experienced farmers looking to bring fallow agricultural lands back into production and destigmatize the hesitancy in purchasing produce grown Animas and San Juan River water is recommended. This strategy can be further developed and implemented by the variety of agricultural specialists in the area, including the SJSWCD, NRCS Aztec Field Office, NMSU San Juan County Extension Office, and the NMSU Agriculture Science Center.

Two such projects have been initiated to accomplish this effort by the SJSWCD. The first is a four-year regenerative farmer project on the Navajo Nation near Shiprock aimed at bringing back land that was left fallow after the Gold King Mine Spill. This involves 15 Navajo Farmers and is funded through the Office of Natural Resource Trustee using the mine settlement monies. The second

project is funded through the Attorney General's Office and provides farmers with money to re-establish crops on currently fallow land within the Gold King Mine Spill area.

Upland BMPs

Upland Vegetation Management Projects

Uplands dominated by piñon/juniper and/or sagebrush make up the majority of the land area of the MSJWBP, and managing these lands for optimal water storage and runoff control will be essential to overall watershed health. BLM, NRCS and others have had success in restoring grasses and reducing erosion by thinning these trees and shrubs. Selective grazing can increase sagebrush by reducing competition from other plants. Manual thinning is the primary method for reduction of piñon/juniper. Sagebrush can be mowed or mulched in small areas but is more effectively treated with an aerial application of tebuthiuron. Anecdotally, this type of project has led to increased water infiltration rates in upper watersheds, to the extent that water runoff during storms went down enough to reduce the amount of water reaching detention structures, or "dirt tanks" set up to trap water for livestock and wildlife (BLM staff, personal communication). These projects are often combined with pasture fence infrastructure to allow revegetation and to implement grazing rotation (fencing projects and water sources development), as well as replanting with native grasses. These projects have the additional benefit of abating fire hazards at the top of the watershed.

Funding needs are difficult to anticipate and will likely change over time. Currently, in 2025, with the uncertainties associated with federal agency budgets and reauthorization of the Farm Bill, NRCS is restricted to operating only the programs that were authorized under the existing continuing budget resolution. Therefore, the best way to be prepared for changes in availability of funds is to build partnerships and identify the funding needs for implementing BMPs in the watershed. San Juan SWCD will work directly with the local SWCD and NRCS offices to secure appropriate funding for general practices. As a possible funding source San Juan River Steering Committee will also look at opportunities through the U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation (e.g. WaterSmart), Regional Conservation Partnership Program (RCPP), CWA Section 319 program, New Mexico River Stewardship Program, Clean Water State Revolving Fund and other potential partners. When funds become available in the future, local stakeholders will be better prepared to develop a funding proposal. Until additional funding opportunities are available, current programs such as CRP, CCRP, General EQIP, and the State Cost-Share Program will be used to address the WBP goals.

This watershed-based plan for the Middle San Juan River will get the watershed into a position to apply for CWA Section 319 funding and any initiatives that may come in the future depending on the new Farm Bill, etc. The key to possible federal funding is having the watershed-based plan in place so that the watershed will be ready when the funding becomes available.

Through the development of the MSJWBP, many contacts, acquaintances, and partnerships have been formed. These partnerships will make it easier to determine funding opportunities and project partners in many of the BMPs that are to be implemented.

The estimated costs associated with the various implementation strategies are highly conservative and will likely change as targeting of the watershed is finalized and further information becomes available. In addition, funding for some of these efforts has already been identified and implementation is already underway; therefore, these figures do not entirely represent additional funds needed.

Current Funding Sources consist of the following:

- Wildland Urban Interface- New Mexico State Forestry- Riparian Restoration
- EPA-NMED CWA Section 319- Water Quality Improvement
- NMED – River Stewardship Program
- NRCS EQUIP- irrigation efficiency and conservation
- New Mexico Department of Agriculture- Legacy Fund- Water and conservation projects
- NMDA- nonnative phreatophyte removal

- BLM restore New Mexico Funding for range improvements
- BLM Riparian Funding
- Inter State Streams – Irrigation improvement through acequias program

At the present time (2025), San Juan SWCD Has over $5,000,000.00 in grant contracts for work in Riparian Restoration, Water Quality, Irrigation structure improvement, Farming and Ranching BMP's and project planning. Over the last 14 years, over 9,000 acres of Russian olive and salt cedar has been removed, and over 2,000 acres has been revegetated by planting cottonwood poles, willows, and seeding with native grasses with grant funding.

NRCS has available approximately $1,000,000 through the EQUIP program this next year and also currently has a $1,000,000.00 RCPP Grant for removal of Russian olive and salt cedar removal and restoration of properties after clearing. San Juan County Extension has available on a yearly basis $123,000.00 for non-native phreatophyte control. BLM has just signed a partnership agreement with San Juan SWCD to do over 17,000 acres of sagebrush at a cost of just less than $500,000.00 and a contract for removing Russian olive and salt cedar and restore over 345 acres along the San Juan River.
Once this plan is approved, projects identified in this WBP will be eligible for future CWA Section 319 funding through the the New Mexico Environment Department and EPA. These are just a few examples of the scope of monies available for possible projects.

Technical Assistance

Presently, the San Juan SWCD has a District Manager, Invasive Weed Coordinator, Healthy Soils and Outreach Coordinator, and a Water Project Coordinator. Natural Resource Conservation Service has anywhere from three to four trained staff at any given time to assist producers. The following agencies also provide professional assistance to landowners and land managers: NMED Environmental Health Bureau, New Mexico State Land Office, San Juan Basin Recovery and Implementation Program, Dine' College: Dine' Environmental Institute, Navajo Nation Chapter Houses, US Bureau of Reclamation, US Geological Survey, NMED Wetlands Program, City of Farmington, City of Bloomfield, NM Interstate Stream Commission, Navajo Nation Environmental Protection Agency, Bureau of Land Management, Bureau of Indian Affairs Natural Resources Department, River Reach Foundation, and NMED Surface Water Quality Bureau.

Chapter 6. Element E: Public Information and Education

Outreach to Agricultural Producers

Agricultural producers are some of the most valuable stakeholders to engage for implementation of this plan. As active land managers, this group has a wealth of knowledge about the land and has an opportunity to make a substantial impact to water quality.

Additionally, the social connections made through irrigation ditch associations, livestock boards, county fair, and other organizations mean information on BMPs, funding opportunities, and successful (or unsuccessful) projects can be easily shared throughout the community at a grassroots level. Agricultural producers will be one of the main audiences solicited for the implementation of BMPs on their land, given the potential for bacteria and sediment load reductions.

Values commonly associated with agriculture include:

- Water quantity, with a substantial focus on water rights
- Infrastructure/technology for efficient irrigation water delivery and management
- Maximizing yields
- Livestock health
- Reducing inputs, costs, and labor
- Water quality, mainly as it affects crop yields (e.g., salinity) and required inputs (nutrients)
- Soil health characteristics, including organic matter, drainage, water holding capacity, compaction, preventing soil loss on erosion
- Control of invasive weeds
- Land stewardship for future generations
- Private property rights

Outreach events are crucial for advocating conservation practices that are beneficial for both landowners and other stakeholders in the watershed. Agricultural workshops have been held in the past for minimal costs. Staff from NM and CO NRCS are usually able to present free of charge. Facility rental is less than $200 (often free for government or non-profits), with only additional costs being food, amenities for participants (books, soil samples, etc.), or bus rental for field tours.

These workshops should be held annually, in conjunction with NRCS, NMSU Ag Extension, the NMSU Ag Science Center, Farm Bureau, 4H, Cattleman's Association, National Young Farmers Coalition, San Juan Agricultural Water Users Association, and the ditch associations where possible.

Personnel from the San Juan SWCD will initiate contact with farmers to encourage installation of agricultural BMPs. This one-on-one contact will facilitate communication of the water quality problems and the corrective actions needed. The technical staff from the San Juan SWCD office will conduct a number of education and outreach activities in the watershed to raise local awareness and encourage community support and participation in reaching the implementation plan milestones. Such activities will include information exchange through newsletters, postcard mailings, field days, presentations at local events, and a display at the San Juan County Fair. The technical staff will work with organizations such as the San Juan County Extension Office and NRCS to sponsor farm tours and field days.

Public meetings will be held to increase awareness of local watershed management issues. One field day per year will be held to highlight the benefits of implementing BMPs; semi-annual radio programs will be utilized to provide updated information on BMP's and watershed issues; and a quarterly newsletter will be published by the San Juan County Extension Service, San Juan SWCD and New Mexico State Agricultural Science Center at Farmington. Five educational workshops will be held and public service announcements will be published in local newspapers. Annual meetings of local SWCD's and other community-based groups such as the San Juan Watershed Group Inc. will also be utilized to obtain public input. In conjunction with the New Mexico Environment Department a survey will be developed for use within the watershed concerning use of septic systems. A workshop will be offered on the proper maintenance of septic systems.

Along with these three information awareness practices, the San Juan SWCD will work in cooperation with the local University and Extension specialists and the Natural Resource Conservation Service personnel to offer the following educational events:

- Cover crop program on proper use and selection to secure nutrients in the soil. This will include information on management, economics and proper planting procedures.
- Field day on cover crop use within the watershed
- Testing for Plant Nutrient Program that would contain information on the different ways of testing to determine nutrient levels. Including information on soil testing, plant leaf testing, stalk nitrate testing and what each one means to plant growth and to economic return.
- Regenerative Farming Workshop
  Healthy Soils Workshops: Conduct workshops on proper Soil Testing and interpretation, Composting, Invasive Weed Control, Irrigation efficiency and bringing fallow land back into production Pesticide Safety Indicators of Water Quality Program – connection between soil, nutrients and water quality – focusing on management practices that are designed to protect water quality and help long-term soil health and development. Recognizing who determines the water quality issues and the role the landowners and producers play in protecting water quality.
- Managed grazing management practices for nutrient management which include feeding habits, grazing along the stream, watering of livestock, and economic benefits of improving pasture management.

Table 16: Public Information and Education Schedule

Venue	**Schedule**	**Contact**	**Completion Date**	**Cost**
Radio	Two per year	San Juan Extension	On Going	No Cost

San Juan SWCD Newsletters	Semi-Annually	SWCD, Extension Ag. Science Center	On Going	No Cost
Educational Workshops	Annually	SWCD Extension NRCS	2025-2031	$500.00 each 13 programs
Field Demonstrations	One per year	SWCD Extension NRCS	2025-2031	$1000.00 each
Local Newspaper	Two articles per year	SWCD Extemsion NRCS	On Going	$100.00 per year
Individual Contacts	Weekly	NRCS, SWCD & Extension Staff	On Going	No Cost

Chapter 7. Element F: Schedule for BMP Implementation and Responsible Organizations

Implementation Schedule

Implementation of BMPs is essential to reduce load reductions and to reach the goals identified in this plan. There will need to be a concerted effort by all involved to make a difference in river impairments. Many projects have been started and planned as discussed in this document and later in this chapter while others have been ongoing. New projects will need to be implemented, and these implementation efforts are described in more detail in this chapter.

Prioritizing individual projects involves many factors but the main factors are funding and availability of staff to assist in outreach and implementation efforts by our many partners. San Juan SWCD will use this document as its guide in seeking new fundingand working towards its goal of removing sources of water quality impairment in the San Juan Watershed, with the eventual goal of removing the Middle San Juan River from the 303(d) list of impaired waters.

Implementation Strategy

The first goal of this project will be to get BMPs implemented at all of the priority sites. San Juan SWCD will collaborate with NRCS, NMSU Ag Extension, BLM, State Land Office, Navajo Nation, Land managers other land management agencies to identify additional priority areas for implementation. San Juan SWCD will work with NRCS, and NMSU Cooperative Extension to develop a "pasture BMPs" flyer to distribute via mail including a description of the ruminant bacteria problem and how landowners can help. In the same mailing, priority landowners will be notified of the NRCS EQIP sign up. NRCS will provide landowners with technical assistance in developing individual conservation plans, with certain projects possibly eligible for reimbursement cost-share funding through the EQIP program. San Juan SWCD will be used as additional cost-share funding to incentivize the most efficient livestock related BMPs (riparian buffer zones, filter strips). The funding sources mentioned above could be used as match to leverage additional funding from a Clean Water Act Section 319 grant, administered by the EPA through the NMED.

Irrigated Cropland

There are a wide variety of agricultural conservation practices that can be applied and that are currently being applied in the project area. The NRCS is instrumental in local efforts and provides a wealth of knowledge and support for designing and implementing conservation practices. The NMSU Ag Extension Office and Farmington Field Office of the Bureau of Land Management are other local resources for conservation practices in relation to livestock and land management.

Forms of agricultural conservation practices include:

- Soil conservation BMPs
- Vegetated buffers and edge-of-field runoff control
- Fertilizer management
- Manure management
- Riparian access management for livestock
- Soil moisture monitoring to avoid over-irrigating
- Conversion to efficient irrigation systems

Specific priority BMP sites have been identified for this land use.

The outreach described in the next section should continue on a regular basis and be used to identify specific project needs that will reduce the water quality impacts of cropland in the Middle San Juan River Valley. These projects should be incorporated into future iterations of the watershed plan.

Riparian Restoration

Riparian vegetation is a crucial part of the river ecosystem, and has the potential to either improve functioning capacity and water quality, or in its current disturbed state (e.g., dominated by nitrogen-fixing Russian olive) it can disrupt these functions. Native vegetation can sequester nutrients, filter runoff, and provide habitat for wildlife. Where riparian vegetation is entirely absent (e.g., mowed or grazed up to river's edge), there is a high potential for bank erosion. This WBP has identified numerous properties within the San Juan River corridor that are in varying states of riparian disturbance. Many have already removed invasive Russian olive as part of San Juan SWCD's ongoing Wildland Urban Interface firebreak program through NM State Forestry (CWPP 2014), but have not gone the next step to revegetate these buffer areas. Since 2014 San Juan SWCD has incorporated revegetation of these areas through the grants that have been written to help establish Riparian Buffer Zones

1. Remove N-fixing invasive Russian olive and invasive Salt cedar from along waterways
2. Treat weeds and invasive re-sprouts for 1-2 growing seasons
3. Install fencing to keep livestock out of revegetation zone
4. Revegetate buffer zone with native grass, willows, native shrubs, and cottonwoods
5. Enhance aquatic habitat

San Juan SWCD has shapefiles of all properties along the San Juan River that have already completed either of the first two steps above. Since 2010 more than 9,000 acres of Russian olive and salt cedar has been removed by San Juan SWCD with a large percentage of it along the San Juan River. Outreach Activities: the following strategy will be undertaken to promote improvements in the Middle San Juan River riparian corridor.

Implementation Strategy:

- Develop riparian buffer management flyer/guide to distribute via mail to landowners that border the Animas River.
- Target mailings to contiguous landowners along the San Juan river corridor.
- Conduct site visits assessing the current state of a landowner's riparian area in comparison to a reference site. Discuss restoration options that fit landowner's management goals.
- Match landowners with funding sources to assist with invasive removal, fence building, purchase of native seed, and purchase and planting of native trees.

Sources of Financial & Technical Assistance:

- Partner with agencies that have overlapping restoration goals, such as NM State Forestry and San Juan County (fire breaks and hazardous fuel removal), NM Game and Fish (wildlife and fish habitat)
- Wildland Urban Interface (WUI) grants fund removal of woody invasives for hazardous fuel reduction on private lands as well as Water Trust Board grants from the State of New Mexico.

- San Juan County Non-Native Phreatophyte Fund is available annually through San Juan County and administered by San Juan SWCD, and could fund invasive tree removal or revegetation with native riparian species.
- New Mexico State Forestry provides Severance Tax money for removal and restoration on Public Land and Land scape scale restoration grants.
- NRCS can provide landowners with technical assistance, as well as reimbursement funding through the EQIP and Resource Conservation Partnership program.

Chapter 8. Element G: Milestones

The long-term goals of implementation are restored water quality of the Middle San Juan River and removal from New Mexico's Section 303(d) list of impaired waters while ensuring water quality is protected to support all designated uses including aquatic life, primary contact, livestock watering, irrigation, wildlife habitat, public water supply, and industrial water supply. Progress toward long-term goals will be assessed during implementation through tracking of BMP installations and continued water quality monitoring. Water quality will be monitored by NMED on an approximately 8-year schedule. Those attending workshops and field days will be asked to sign-in so that participation maybe tracked. An evaluation tool will be developed and used at workshops and field

days to determine increased awareness and knowledge of specific practices and concerns, including pre and post knowledge of water quality issues. A producer survey will also be developed to ascertain the willingness to change behaviors or adopt specific practices. These will either be given out at the workshop/field days or three to six months after the event to see if producers have followed through on changing behavior and adopting practices. Public request for information concerning water quality and BMPs will be tracked. The number of BMPs implemented versus the amount planned will be monitored. The amount of cost-share dollars spent within the watershed will be tracked.

Annual status reports of progress on the implementation of milestones are detailed in the table below and will be shared with the Steering Committee and San Juan SWCD. A comprehensive review and evaluation of progress will occur every two years by the Steering Committee and San Juan SWCD. If it becomes apparent that these milestones are not being met, the goals set forth in the plan will be re-evaluated and appropriate remedial action will be determined at that time. The Steering Committee is committed to ensuring that funding will target the appropriate areas.

Milestones: See Tables

- Track water quality (every eight years): monitor for *E. coli* bacteria and to achieve target of 400 or less CFU/100ML for *E. coli*
- Land use/Land cover: implementation of this WBP will result in an increase in the number of cropland acres being no tilled by 500 acres. An increase in number of acres of cover crop by 1000 acres, planed grazing systems by 1000 acres, pastureland improvement by 2000 acres.
- Riparian Condition: increase use exclusion by 200 acres, increase number of wetlands by 10 acres, and filter strips/riparian buffer by 1000 acres and 20 miles of riverbank. Plan and implement streambank stabilization projects.

- San Juan River Basin Recovery Implementation Program (US Fish and Wildlife): assessment of the condition of fish and benthic macro invertebrate communities related to reference streams and Bio criteria. Aquatic invertebrate monitoring by San Juan Recovery has been completed.
- BMP and other implementation efforts: track and map BMP implementations, indicate location of BMPs installed; track load reduction achieved by BMPs based on PLET predictions
- Education/Information: track Info/Ed activities to determine if landowners are implementing proposed BMP installations, to determine increase in landowner knowledge of the water quality problem, to determine if landowner and operators are adapting to new technology, such as increased use of cover crops.

Table 17: Milestones for E. Coli

Task	Current Year	
Programmatic Milestones		
San Juan SWCD meetings held – How many? # of attendees? # organizations present		
Grant applications submitted – Which ones? For which projects? How much $?		
Funding secured – What source? How much $?		
Literature/brochures created or purchased – Septic care & management, Pasture BMPs, Who Pooped in the River?, When It Rains It Drains, Riparian Buffer Management. How many distributed?		
Workshops organized – Soil health, Low Impact Development, Road BMPs, etc.		
Outreach/Education meetings with landowners regarding BMP implementation – How many? With who? For which projects?		
Presence in the media - # of newspaper articles, Facebook shares, etc.		
Booth/activities promoting watershed issues at public events - Beef Symposium-Feb, Invasive Weed Symposium-Mar, Aztec Ruins Earth Day-Apr, Fmtn River Fest-Memorial Day, Aztec Fiesta Days-Jun, Durango Animas River Days-June, Fmtn Freedom Days-July 4th, Farm Bureau meeting -Oct, SJSWCD meeting-Dec, Irrigation Ditch Meetings-Dec/Jan		
Permits and designs completed – 404 permits, engineering designs, CRMPs, NRCS conservation plans		
Implementation Milestones		
# Failing septic tanks pumped		
# Failing septic tanks repaired/replaced		

# Septic tanks hooked to sewer or treatment utility		
# of properties implementing pasture BMPs		
Linear feet of riparian areas fenced		
# of livestock removed from direct river access, # of corrals moved away from riparian areas		
Linear feet of riparian area planted with willows and cottonwoods		
Acres seeded with native grasses (riparian seeding, cover crops, filter strips, upland revegetation)		
Acres invasive phreatophytes removed		
Acres pinon/juniper thinned		
Acres of sagebrush aerially treated		
# Sediment fences installed		
# Detention basins installed		
# Ditch diversions repaired/replaced		
Linear feet of riverbank w/ rip-rap removed		
Linear feet of streambank stabilization and floodplain reconnection (where appropriate)		
# of in-stream structures installed in river to support aquatic habitat		
Monitoring Milestones		
# of times completing this checklist (1x/year min.)		
# of monthly baseline water quality monitoring runs, # of sites, # of samples/constituents collected		
Data entered into Colorado Data Sharing Network		
# of BMP implementation projects with photo points, before and after water quality sampling		

Table 18: Milestones for Conservation Practices.

Category	BMP	Units	Implementation Goal	By Year
Sediment Control Structures	Grade Stabilization Structures	Practices	10	Year 1 10% Year 2 20% Year 3 30% Year 4-6 70% Year7-10 100%
Streambank Stabilization	Demo Project	Acres	100	

Run-Off Filtration Practices	Filter Strips Wetlands Riparian Buffers Cover Crop	Acres Acres Acres Acres	100 10 1000 1000	Year 1 5% Year 2 10% Year 3 20% Year 4-6 55% Year 7-10 100%
Livestock Management Strategies	Alternative Watering Systems Use Exclusion Planned Grazing Systems Pasture Improvement	Practices Acres Acres Acres	6 200 1000 2000	Year 1 2% Year 2 5% Year 3 15% Year 4-6 40% Year 7-8 100%
Conservation Tillage	No Till/Reduced Tillage	Acres	500	Year 1 10% Year 2 10% Year 3 40% Year 4-6 70% Year 7-10 100%
Streambank Stabilization	Demo	Project	1	Year 5 100%
Water Quality	Monitoring for E-coli			Yearly

Table 19: Milestones for Information/Education

Venue	Schedule	Completion Date
Radio	Two per year	On Going
Extension SWCD Newsletter	Semi-Annually	On Going
Educational Workshops	Annually	On Going
Field Demonstrations	One per year	On Going

Local Newspaper	2 articles per year	On Going
Individual Contacts	Weekly	On Going

Chapter 9. Element H: Performance

Excessive sedimentation can overwhelm aquatic ecosystems, smothering freshwater breeding substrates. Sediments can transport attached pollutants such as nutrients, bacteria, and toxic chemicals from agriculture into our streams.

PLET modeling has been done to show the hydrologic response areas (HRA) that are most likely to contribute to sedimentation.These areas will be selected as priority areas for implementing practices and offering cost-share for practices that should reduce bacteria and sedimentation impairments.

The San Juan River Steering Committee hopes to achieve the success of the Little Elk Creek Watershed Plan in Oklahoma. The installed cropland and grazing land BMPs decreased the amount of erosion, which in turn reduced may reduce *E. coli* loading, as *E. coli* can be co-transported with soil particles.

The Middle San Juan River from the Hogback of the Navajo Nation to Cañon Largo is impaired for *E. coli* bacteria. No single, direct source has been identified for the bacteria. Observations of present livestock practices do not indicate poor manure management or heavy loading by livestock being in the waterways. Improved stormwater management and reduced runoff will reduce erosion and bacteria transport. This should improve water quality by reducing bacteria loading in the waterways.

The Steering Committee feels that the best and quickest way to achieve their goals of reducing bacteria levels is to work with landowners to install BMPs that reduce sediment loading in the watershed. Bacteria can attach to sediment, so reduced erosion and sediment loading will likely reduce bacteria loading, as well.

Other popular practices such as riparian reestablishment and stream bank protection will also be considered. Short- and long-term goals for watershed management will be contingent upon available funding and personnel resources.

Effects of implementation programs in the watershed on sediment loading to the Middle San Juan River from known sources (pasture, row crop, stream bank erosion), and any new sources will be evaluated every eight years by the steering committee and San Juan SWCD to determine if changes may be needed to the plan. Following that evaluation, the WBP will be revised by the steering committee and San Juan SWCD to reflect new information and address any short comings identified.

The plan is a rolling plan and will be reviewed every 3 years by the Steering Committee and adjusted if it is seen that established goals will not be achieved over the 10 year period of the plan. If necessary, the Steering Committee will revise the plan in order to extend its completion date.

Attainment of these load reduction goals will be measured using water quality monitoring data, PLET calculations for sediment load reductions; visual assessments using before and after pictures; tracking of the total number of practices implemented, especially in critical areas along streams and if funding is available additional modeling.

The San Juan SWCD, County Extension, and NRCS will provide outreach, technical and financial assistance to farmers and homeowners in HUC 12 areas. Their responsibilities will include promoting implementation goals; available funding and the benefits of BMPs; and providing assistance with the survey, design, layout, and approval of agricultural BMPs and education and outreach activities. Specific education and outreach methods recommended by the steering committee are described in element E.

Successful implementation depends on stakeholders taking responsibility for their role in the process. While the primary role falls on the landowners, local, state and federal agencies also have a stake in seeing that San Juan River waters are clean and provide a healthy environment for its citizens. While it is unreasonable to expect that the natural environment (*e.g.* streams and rivers) can be made 100% free of risk to human health, it is desirable to minimize NPS problems and meet water quality standards.

Chapter 10. Element I: Monitoring

Monitoring Plan

Follow-up monitoring will be crucial to achieve two objectives: 1) track the overall health of the watershed over time; and 2) directly measure the effectiveness of remediation projects and Overall Watershed Health. There is substantial baseline data available for the river including multiple years of data on water quality, and aquatic life. Water quality data is the easiest and cheapest to collect, though it still requires a significant ongoing investment to collect enough samples to distinguish trends over time from natural variability. Funding will be sought for a long-term water quality monitoring scheme, to collect samples monthly with a minimum of four sample sites. Sampling should be at the same locations and follow the same protocols that were used for the 2021 *E. coli* data. Therefore, these locations should be targeted for collection of *E. coli*. Baseline data should be collected annually for at least a three-year period to account for natural variability in the data. These monitoring costs will be calculated based on previous studies in the watershed. Follow up Microbial Source Tracking (MST) sampling would also be beneficial to track the prevalence of different bacteria sources over time. This is an expensive undertaking ($500 per site per sampling day to test for five markers and quantify two), and should be coordinated with comprehensive upstream (Animas in Colorado) and downstream (San Juan River) sampling if conducted. A reduced cost way to monitor this would be to measure and quantify only the two most prevalent Bacteroides markers, human and ruminant, but bulk sample discounts may cancel out these savings. Lab details for previous studies are in the QAPP for the 2013-2014 MST and nutrient study 9TUhttp://sanjuanswcd.com/sjwg/mst/U9T. The other "data gaps" discussed under Water Quality Trends will all also be targeted for future monitoring projects. Costs and responsible parties have not been identified at this time, but these projects represent an opportunity for academics to get involved in the watershed and assist with water quality monitoring. Avoiding winter sampling could be a reasonable adjustment to this sampling scheme, however it would be beneficial if samples diverted from the 3 winter months (Dec-Feb) were moved to the monsoon season to increase the likelihood of catching at least one storm flow per year.

NMED will continue monitoring sediment in the San Juan River. NMED's monitoring schedule is conducted on an approximately 8-year rotating schedule where it takes approximately 8-years for NMED to monitor the entire State. NMED has been developing a new protocol for sampling sedimentation of New Mexico's boatable rivers which will likely be used the next time NMED conducts a water quality survey of the San Juan River in 2027. This monitoring method may be used to assess changes in sediment loading and can be used to evaluate the effectiveness of implementation projects. Individual CWA Section 319 funded restoration projects may also include funding for additional effectiveness monitoring. Entities other than NMED may also collect and submit additional sediment data to NMED provided that the data meets NMED's data standards and can be used for NMED's water quality assessment purposes. More information about submitting additional data to NMED is available at NMED's website: https://www.env.nm.gov/surface-water-quality/data-submittals/.

San Juan River Remediation Project Monitoring

The direct load reduction effects of individual remediation projects are often very hard to measure, but are worth monitoring nonetheless. Inflow locations monitored in the 2021

San Juan River Targeted Sampling and BUGS 2011 watershed surveys will be used as baselines in the tributaries and drainage networks where on-the-ground projects are taking place. The following monitoring strategy will be used for measuring progress on projects:

- Identify the nearest baseline water quality monitoring point from previous studies
- Establish additional water quality monitoring locations immediately upstream and immediately downstream of the remediation project.
- Our goal will be to collect at least one season of monthly upstream/downstream water quality sample before project implementation and then sample in the same season for three years following completion of the remediation project.
- Establish GPS photo points at each site to monitor changes over time that may not show up in water quality data. Due to the 2015 Gold King Mine spill that occurred in the San Juan River, EPA and NMED have conducted extensive sampling along the San Juan River which show that by September 2, 2015 metal concentration levels were back to and maintaining pre-event levels.

This monitoring plan will be actively adjusted based on NMED's efforts so that any redundancy of resources is avoided. As mentioned under milestones above, San Juan SWCD will review the progress to this plan every two years and will formally review the effectiveness of the MSJWBP to determine whether we are achieving stated objectives and milestones. If milestones are not being achieved, we will use adaptive management to implement course correction measures. For example, if specific BMPs are found to not be effective, we will refocus efforts on BMPs that prove to be more effective in the region. The Watershed Based Planning process is ongoing and iterative, and it is expected that changes will need to be made as we learn from this process over time.

References

Animas Environmental Services. (2007). NPDES phase II stormwater management plan. http://fmtn.org/DocumentCenter/View/64/stormwater_management_plan?bidId=.

Campbell, J. A. & Brew D. C. (1996). *The western san juan mountains their geology, ecology, and human history*. University press of Colorado, Niwot, Colorado, USA.

Committee on Reducing Stormwater Discharge Contributions to Water Pollution. (2009).Urban stormwater management in the US. The National Academic Press. https://nap.nationalacademies.org/catalog/12465/urban-stormwater-management-in-the-united-states.

Craigg S. D. (2001). *Geologic framework of the san juan structural basin of new mexico, colorado, arizona, and utah, with emphasis on triassic through tertiary rocks*. U nited States Geological Survey. https://pubs.usgs.gov/pp/1420/report.pdf.

Creighton, K., Michaud, C., Ulibarri, M., & Platania, S. (2021). *Colorado pikeminnow broodstock collection from the green and colorado rivers, utah fiscal year 2021 scope of work*. https://coloradoriverrecovery.org/sj/wp-content/uploads/sites/3/2022/03/SOW_45_FY21.pdf.

Furr W., & Davenport, S. (2021). *Colorado pikeminnow and razorback sucker augmentation in the san juan river basin: fiscal year 2022 project proposal*. https://coloradoriverrecovery.org/sj/wp-content/uploads/sites/3/2022/03/SOW_8_FY22.pdf.

Furr, W. (2021). *Augmentation plan for razorback sucker (xyrauchen texanus) in the san juanriver basin*. The San Juan River Basin Recovery Implementation Program.

Golden Shovel Agency, www.goldenshovelagency.com. (n.d.). Agriculture in San Juan County, NM. https://www.4cornersed.com/target-industries/agriculture#:~:text=San%20Juan%20County%20has%20the,safflower%2C%20Pinto%20and%20Anasazi%20beans

Golden Shovel Agency, www.goldenshovelagency.com. (n.d.). Recreation in San Juan County, N M. Four Corners Economic Development. https://www.4cornersed.com/life/recreation.

Harris, A., Koster, W. J., & Niles, D. M. (1963). *Ecological distribution of some vertebrates in the san juan basin, new mexico*. Museum of New Mexico Press. https://www.utep.edu/leb/pdf/curators/ecologicaldistribution.pdf

Harwood, V. J., et al. (2013, August). Microbial source tracking markers for detection of fecal contamination in environmental waters: relationships between pathogens and human health outcomes. https://pubmed.ncbi.nlm.nih.gov/23815638/.

Heins, A., Simon, A., Farrugia L., & Findeisen, M. (2004). Bed material characteristics of the san juan river and selected tributaries, new mexico: developing protocols for stream bottom deposits. USDA-ARS National Sedimentation Laboratory Channel and Watershed Processes Research Unit. https://www.env.nm.gov/wp-content/uploads/sites/25/2019/04/SJR_REPORT-Heins-2004.pdf.

Homer, C.G., Dewitz, J. A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N. D., Wickham, J. D., and Megown, K. (2015). *Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information*. Photogrammetric Engineering and Remote Sensing.

Invasive Plants. (2022, January 1). U.S. Forest Service. https://www.fs.fed.us/wildflowers/invasives/index.shtml.

Kauffman, J. B., & Krueger, W. C. (1984). *Livestock impacts on riparian ecosystems and streamside management implications: a review*. https://journals.uair.arizona.edu/index.php/jrm/article/viewFile/7758/7370.

Loos, J. & Shader, E. (2016). *Reconnecting rivers to floodplains: returning natural functions to restore rivers and benefit communities*. https://www.americanrivers.org/wp-content/uploads/2016/06/ReconnectingFloodplains_WP_Final.pdf.

Lyons, T. l., Farrington, M. A., Platania, S. P., & Gori D. (2016). San juan and animas rivers diversion
study final report. United States Bureau of Reclamation and the San Juan River Basin Recov ery Implementation Program.

Matherne, A. M. (2006). *Effects of roads and well pads on erosion in largo canyon watershed, new mexico, 2001-02*. United States Geological
Survey. https://pubs.usgs.gov/sir/2006/5039/pdf/sir2006-5039.pdf.

May, M. (2015). *Animas and san juan concurrent nutrient & bacteria monitoring project.* https://www.sanjuanswcd.com/watershed.

McKinstry, M. (2020). *SJRIP pit antenna installation at hogback fish passage 2020 project proposal*. https://coloradoriverrecovery.org/sj/wp-content/uploads/sites/3/2022/03/SOW_32a_FY20.pdf.

Navajo Nation Environmental Protection Agency Water Quality Program. (2017). *Navajo nation surface water quality standards 2015*. https://www.epa.gov/sites/default/files/2014-12/documents/navajo-tribe.pdf.

Navajo Nation Environmental Protection Agency
Water Quality Program. (2016). *Navajo nation san juan river watersheds preliminary surface water quality assessment report (integrated 305(b) report and 303(d) listing)*.

New Mexico Bureau of Geology and Mineral Resources. (2003). Geologic map of new mexico. https://geoinfo.nmt.edu/publications/maps/geologic/state/home.cfm.

New Mexico Environment Department Surface Water Quality Bureau. (2021). *2020-2022 State of new mexico clean water act 303(d)/305(b) integrated report*.

https://www.env.nm.gov/wp-content/uploads/sites/25/2018/03/2020-2022-IR-Appendix-A-Integrated-List_012221.pdf.

New Mexico Environment Department Surface Water Quality Bureau. (2019). *New mexicono npoint source management plan*. https://www.env.nm.gov/wp-content/uploads/sites/25/2019/08/2019-NPS-Management-Plan-Final-web.pdf.

New Mexico Water Quality Control Commission. (2005). *Final approved total maximum dail y load for the san juan watershed part one navajo nation boundary at the hogback to navajo dam*. https://www.env.nm.gov/surface-water-quality/wpcontent/uploads/sites/25/2017/07/SJR_Pt1TMDLs.pdf

New Mexico Water Quality Control Commission. (2006). *Final approved total maximum daily load for the san juan watershed part two navajo nation boundary at the hogback to navajo dam*. https://www.env.nm.gov/surface-water-quality/wp-content/uploads/sites/25/2017/07/SJR_Pt2TMDLs_final.pdf

New Mexico Water Quality Control Commission. (2020). *New mexico statewide water quality management plan and continuing planning process*. https://www.env.nm.gov/wp-content/uploads/sites/25/2018/08/WQMP-CPP-20201023b-EPA-APPROVED-with-Appendices_Dec2020update.pdf.

Putz1, T. R., & Restaino, C. M. (2021). *Pinyon-juniper encroachment: effects on hydrology*. University of Nevada, Reno Extension. https://naes.agnt.unr.edu/PMS/Pubs/2021-4635.pdf

Randle, T., & Varyu, D. (2016). San juan river channel processes and flow conveyance below navajo dam, NM. Technical Report No. SRH-2016-33.

Richmond, A. (2022). *San juan human bacteria sampling and investigation study technialrepo rt.* https://www.sanjuanswcd.com/watershed.

Rock, C. & Rivera, B. (2014). *Water quality, E.coli and your health*. https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1624.pdf

San Juan Basin Recovery Implementation Program. (2012). *San juan river basin recovery implementation program monitoring plan and protocols*.

San Juan Watershed Group. (2005). *San juan basin watershed management plan*. https://www.sanjuanswcd.com/watershed.

San Juan Watershed Group. (2021). *Lower animas watershed based plan*. https://www.sanjuanswcd.com/watershed.

Simpson, J. M., Domingo, J. S., & Reasoner D. J. (2002, November). Microbial source tracking: state of the science. https://pubmed.ncbi.nlm.nih.gov/12521151/.

Sites Southwest. (2021). New mexico's statewide comprehensive outdoor recreation plan: strategic plan for 2022-2026. https://www.emnrd.nm.gov/spd/wp-content/uploads/sites/7/SCORP-Final-2022-2026.pdf.

Smith, D. M., Finch D. M., Gunning, C., Jemison, R., & Kelly, J. F. (2009). *Post-wildfire recovery of riparian vegetation during a period of water scarcity in the southwestern USA*. Fire Ecology.

Southwestern Willow Flycatcher Recovery Team Technical Subgroup. (2002). *Final recovery plan southwestern willow flycatcher (empidonax traillii extimus).* https://www.srs.fs.usda.gov/pubs/35557.

State of New Mexico Interstate Stream Commission Office of the State Engineer. (2016). *San juan basin regional water plan*. https://www.ose.state.nm.us//Planning/RWP/Regions/02_SanJuan/2016/Reg%202_San%20Juan%20Basin_Regional%20Water%20Plan_September%202016.pdf.

Summary of the Endangered Species Act. (2021, September 28). US EPA. https://www.epa.gov/laws-regulations/summary-endangered-species-act.

Tamarisk Coalition. (2009). *Colorado river basin tamarisk and russian olive assessment*. https://riversedgewest.org/sites/default/files/files/TRO_Assessment_FINAL%2012-09.pdf.

Tetratech, Inc. & Herrera Environmental Consultants. (2011, April). Using microbial source tracking to support TMDL development and implementation. https://www.epa.gov/tmdl/using-microbial-source-tracking-support-tmdl-development-and-implementation.

The Endangered Species Act. (n.d.). World Wildlife Fund. https://www.worldwildlife.org/pages/the-us-endangered-species-act#:%7E:text=Passed%20with%20bipartisan%20support%20in,a%20species%20should%20be%20protected.

U.S. Fish and Wildlife Service – Ecological Services Division of Budget and Technical Support. (2019*). A system for mapping riparian areas in the western united states*. https://www.fws.gov/sites/default/files/documents/a-system-for-mapping-riparian-areas-in-the-western-united-states-2019.pdf.

United States Department of Agriculture. (2017). *2017 Census of agriculture san juan county, new mexico county profile*. https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/New_Mexico/cp35045.pdf.

United States Department of Interior Bureau of Land Management. *Record of decision for the nav ajo reservoir operations, navajo unit - san juan river new mexico, colorado, utahfinal environmental impact statement*. https://www.usbr.gov/uc/envdocs/eis/navajo/pdfs/NavWaterOpsROD2006.pdf.

United States Environmental Protection Agency. (2002). *Homeowner's guide to septic systems*. https://www3.epa.gov/npdes/pubs/homeowner_guide_long.pdf.

Wozniak, S. S., Strand, E. K. (2019). *Fuels guide for sagebrush and pinyon-juniper treatments: 10 years post-treatment*. BLM Technical Guide. https://www.blm.gov/sites/blm.gov/files/documents/files/Tech_Note_451.pdf

Zeigler, M. P., Barkalow, A. L., Wick, J. M., & Ruhl M. E. (2021). *Final report alternative strategies for stocking colorado pikeminnow in the san juan river basin*. The San Juan River Basin Recovery Implementation Program.