

DRAFT ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT

Farmers Mutual Ditch Rehabilitation

Farmington, San Juan County, New Mexico

Section 1113 Water Resources Development Act of 1986



14 AUGUST 2020

US Army Corps of Engineers
Albuquerque District
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Albuquerque, New Mexico, 87109

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U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

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The U.S. Army Corps of Engineers, Albuquerque District (USACE) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The Draft Environmental Assessment (DEA) dated 14 August 2020, for the Farmers Mutual Ditch Rehabilitation addresses acequia rehabilitation in the Farmers Mutual Ditch (Acequia, ditch), Farmington, San Juan County, New Mexico. The USACE recommendation is contained in Section 4 of this DEA.

The DEA, incorporated herein by reference, evaluated various alternatives that would provide a reliable, efficient, low-cost, and low-maintenance system for the continued distribution of water for use by the members of the Farmers Mutual Ditch Association in the project area. In addition to a “no action” plan, one other alternative was evaluated, the Buried Pipe Alternative (recommended plan). The recommended action includes:

- Rehabilitation of approximately two miles of earthen channel by placing a 4.5 ft diameter reinforced concrete pipe.
- Use of an approximately 1.5-acre area located on private land on the north side of the ditch as a staging area.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the recommended plan are listed in Table 1:

Table 1: Summary of Potential Effects of the Recommended Plan			
Resources	Insignificant Effects	Insignificant Effects as a Result of Mitigation	Resource Unaffected By Action
Physical Landscape			
<i>Climate and Climate Change</i>			X
<i>Physiography, Geology, and Soils</i>			X
<i>Water Resources and Water Quality</i>	X		

<i>Floodplains and Wetlands</i>			X
<i>HTRW</i>			X
Air Quality	X		
Noise	X		
Biological Resources			
<i>Vegetation</i>	X		
<i>Fish and Wildlife</i>	X		
<i>Invasive/Exotic Species</i>	X		
<i>Special Status Species</i>		X	
Cultural Resources		X	
Socioeconomic Considerations			
<i>Socioeconomics</i>			X
<i>Land Use</i>			X
<i>Environmental Justice and Protection of Children</i>			X

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the EA will be implemented, if appropriate, to minimize impacts and are listed below:

- Project activity would occur between November and the end of February, outside the migratory bird nesting season and most reptiles and amphibians are less active during this timeframe.
- If a bald eagle is present within 0.5 mile of the work in the morning before the project activity starts, or following breaks, the contractor would suspend all activity until the bird leaves of its own volition. However, if a bald eagle arrives during construction activities or if an eagle is beyond that distance, construction would not be interrupted.
- The contractor would be required to cover trenches at the end of each work day to prevent entrapment of small animals.
- Sediment and erosion controls would be in place during the construction period. Following construction, the soil would be stabilized and all disturbed areas would be revegetated with appropriate native species.
- All construction equipment would be cleaned before entering and upon leaving the study area to prevent introduction or spread of invasive species. Equipment that was previously used in a waterway or wetland would be disinfected to prevent spread of aquatic disease organisms.
- Access roads and disturbed soil will be wetted. Stockpiles of debris, soil, sand, or other materials that could produce dust will be wetted or covered. All fill material, rubble, and spoil will be covered while being transported to or from the project site.

- All servicing and fueling of equipment would be conducted in a designated area hydrologically isolated from surface waters. Emergency spill kits will be placed in the designated fueling area.
- A Spill Control Plan will be required for this project. All heavy equipment will carry a spill kit and the operator shall be knowledgeable in the use of spill containment equipment.

Indirect impacts of piping the ditch include potential loss of ditch bank riparian vegetation as seepage from the ditch would be eliminated. We estimate that indirect loss of approximately 2,400 feet of ditch bank willows and 2-3 mature cottonwoods may result from elimination of seepage. This minimal loss of vegetation would be partially offset by the decreased need for maintenance with the ditch placed into pipe. Native vegetation would be reseeded in areas, such as the staging area, once construction is completed.

The recommended plan will result in unavoidable adverse impact to the aesthetic of Farmers Mutual Ditch. The current state of the Farmers Mutual Ditch is an open earthen ditch along its entire length, with the exception of a short section which has already been piped near the diversion structure at the east end. The undertaking involves the removal and replacement of several of the Farmers Mutual Ditch associated features, and the conversion of the acequia from an earthen ditch to partially piped ditch. The original materials, design, and workmanship will be compromised by the use of pipe in the ditch. The feeling of water running openly through an earthen ditch system in the rural countryside will also be compromised by the partial piping of the ditch. The piping will look modern. For all of these reasons, it was determined by USACE and New Mexico State Historic Preservation Office via e-mail dated 20 April 2020, that the proposed project will have an adverse effect on the aesthetic of Farmers Mutual Ditch.

To mitigate for the unavoidable adverse impacts to the ditch a full Class III cultural resource inventory and photo documentation of the Area of Potential Effect for the current project, and oral history interviews regarding historic use of the ditch will be conducted.

Public review of the DEA and FONSI will be completed from 14 August 2020 to 14 September 2020. All comments submitted during the public review period will be responded to in the Final EA and FONSI.

Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, the USACE has determined that the recommended plan may affect, but is not likely to adversely affect federally listed species or their designated critical habitat.

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the USACE determined that historic properties may be adversely affected by the recommended plan. A Memorandum of Agreement is currently being drafted for SHPO

review and activities will be conducted through contract or utilizing in-house cultural resources staff.

Pursuant to the Clean Water Act of 1972, as amended (CWA), certain discharges associated with the construction and maintenance of irrigation ditches are exempt from Section 404 permit requirements (33 CFR 323.4(a), Exemption No. 3). Therefore, a Department of the Army permit under section 404 of the CWA is not required.

All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Implementation of the proposed action is expected to economically benefit the Farmers Mutual Ditch Association community members by reducing long-term maintenance costs.

The planned action is being coordinated with Federal, State, and local agencies with jurisdiction over the biological and cultural resources of the project area. Based upon these factors and others discussed in the following Draft Environmental Assessment, the proposed action is recommended and would have negligible effects on the human environment. Therefore, an Environmental Impact Statement will not be prepared for the proposed rehabilitation work on the Farmers Mutual Ditch.

Date

DRAFT

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DRAFT ENVIRONMENTAL ASSESSMENT

Farmers Mutual Ditch Rehabilitation

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LIST OF ACRONYMS USED

APE	Area of Potential Effect
ARMS	New Mexico Archaeological Record Management Section
BDANWR	Bosque del Apache National Wildlife Refuge
BMPs	Best Management Practices
CAR	Coordination Act Report
CPR CoP	Climate Preparedness and Resilience Community of Practice
CWA	Clean Water Act
EA	Environmental Assessment
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
HCPI	Historic Cultural Properties Inventory
HTRW	Hazardous, Toxic, and Radioactive Waste
IPaC	Information for Planning and Consultation system
ISC	New Mexico Interstate Stream Commission
LERRDs	Lands, Easements, Rights-of-way, Relocations, and Disposal Areas
MOA	Memorandum of Agreement
MRGCD	Middle Rio Grande Conservancy District
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NM EMNRD	New Mexico Energy, Minerals, and Natural Resources Department
NMCRIS	New Mexico Cultural Resources Inventory System
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Registry of Historic Places
SHPO	State Historic Preservation Office
SWPPP	Storm Water Pollution Prevention Plan
TCP	Traditional Cultural Property
THPO	Tribal Historic Preservation Office
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WOTUS	Waters of the United States
WRDA	Water Resources Development Act

1. BACKGROUND

Section 1113 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), as amended, authorizes the Acequia Rehabilitation Program for the restoration and rehabilitation of irrigation ditch systems (acequias) in New Mexico. Under Section 1113, Congress has found that New Mexico's acequias date from the eighteenth century and, due to their significance in the settlement and development of the western United States, should be restored and preserved for their cultural and historic values to the region. The Secretary of the Army, therefore, has been authorized and directed to undertake, without regard to economic analysis, such measures as are necessary to protect and restore New Mexico's acequias. The Act also recognized community acequias as public entities, allowing acequia officials to serve as local sponsors of water related projects through the Department of Defense. The program is a multi-year program that is designed to promote the continued operation of these important agricultural facilities.

The Farmers Mutual Ditch (Acequia, ditch) was chartered in the 1880s and supplies irrigation water for 600 users located along its approximate 22 mile length as it courses through the north floodplain of the San Juan River beginning at Farmington, New Mexico (see Figure 1). The Farmers Mutual Ditch is a part of the Acequia Rehabilitation Program and managed by the Farmers Mutual Ditch Association (Association). Acequias are "ditch" type irrigation systems, consisting of a diversion and a simple earthen-ditch conveyance channel.

The ditch has two diversion points: one on the Animas River south of Farmington just below the municipal sewage treatment plant; the second diversion point is on the San Juan River about ½ mile downstream of the State Highway 371 bridge. The Acequia irrigates 4,200 acres of land at an allotted rate of 3.1 acre-feet per acre, annually. Two previous USACE projects rehabilitated the ditch heading (diversion) below the State Highway 371 bridge (USACE 1988) and improved conveyance on 3.2 miles of the ditch in the vicinity of Kirtland by lining it with concrete and replacing gates (USACE 2002).

1.1. Purpose and Need for Action

Currently, a portion of Farmers Mutual Ditch that runs along steep, unstable bluffs close to the river is affected by rock and debris slides. In the past, the rock slides have completely filled the irrigation ditch, reducing the water supply to Association members and necessitating frequent, expensive maintenance.

The purpose of this Draft Environmental Assessment (DEA) is to evaluate the environmental impacts of the proposed construction project, which will improve approximately two miles of the Acequia and prevent rock and debris slides from filling the irrigation canal.

Section 1113 of the WRDA 1986 (P.L. 99-662), as amended, authorizes the Acequia Restoration Program and directs the Secretary of the Army:

...to undertake, without regard to economic analysis, such measures as are necessary to protect and restore the river diversion structures and associated canals attendant to the operations of the community ditch and Acequia systems in New Mexico that are declared to be a political subdivision of the State of New Mexico...The non-Federal share of any work undertaken under this section shall be 25 percent.

[and] ...to consider the historic Acequia systems (community ditches) of the southwestern United States as public entities, if these systems are chartered by the respective State laws as political subdivisions of that State. This public entity status will allow the officials of these Acequia systems to enter into agreements and serve as local sponsors of water related projects of the Secretary.

This DEA was prepared by the USACE in compliance with all applicable Federal statutes, regulations, and Executive Orders (EO), as amended, including, but not limited to, the following:

- Migratory Bird Treaty Act of 1918 (16 U.S.C. § 703 *et seq.*)
- Fish and Wildlife Coordination Act of 1934 (48 Stat. 401; 16 USC § 661 *et seq.*)
- Clean Water Act of 1948, 1966, 1972, Sec. 10 Rivers & Harbors Act of 1899
- Watershed Protection and Flood Prevention Act of 1954 (16 U.S.C. § 1001 *et seq.*)
- Flood Control Act of 1958 (P.L. 85-500), 1962 (P.L. 87-874, Sec. 101)
- National Historic Preservation Act of 1966 (16 U.S.C. § 470 *et seq.*)
- National Environmental Policy Act of 1969 (NEPA) (42 U.S.C § 4321 *et seq.*)
- EO 11593: Protection and Enhancement of the Cultural Environment, 1971
- Clean Air Act of 1972 (42 U.S.C. § 7401 *et seq.*)
- Endangered Species Act of 1973 (16 U.S.C. § 1531 *et seq.*)
- Federal Noxious Weed Act of 1975 (7 U.S.C. § 2814)
- EO 11988: Floodplain Management, 1977
- EO 11990: Protection of Wetlands, 1977
- Archaeological Resources Protection Act of 1979 (16 U.S.C. §§ 470aa-470mm)
- Farmland Protection Policy Act of 1981 (7 U.S.C. § 4201 *et seq.*)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001 *et seq.*)
- EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 1994
- American Indian Religious Freedom Act (42 U.S.C. § 1996)
- EO 13112: Invasive Species, 1999
- Water Resource Development Act of 1986 (P.L. 99-662, Sec. 1113)
- Plant Protection Act of 2000 (7 U.S.C § 7701 *et seq.*)
- EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (2001)

- Energy and Water Resources Development Appropriations Act of 2004 (P.L. 108-137, Sec. 117)
- Protection of Historic and Cultural Properties (36 CFR Part 800 *et seq.*)
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Part 1500 *et seq.*)
- U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR Part 230; ER 200-2-2)
- EO 13751: Safeguarding the Nation from Impacts of Invasive Species, 2016
- EO 13834: Efficient Federal Operations, 2018

2. DESCRIPTION OF ALTERNATIVES

This section describes the two alternatives considered for NEPA analysis, a No Action Alternative and a Buried Pipe Alternative.

2.1. Alternative A: No Action Alternative

No work would be performed to address the current problems associated with the existing open, earthen irrigation ditch. Rockfalls and a drier climate, due to climate change, will continue to compromise the water delivery through the ditch.

2.2. Alternative B: Buried Pipe

Under Alternative B, approximately two (2) miles of earthen ditch would be replaced with an irrigation pipe. The two miles are split between a Reach 1 and a Reach 2 (see Figure 1). Irrigation pipe eliminates material eroding into and blocking the ditch, public safety concerns associated with open ditches, and channel blockages from external debris. Pipe provides for more efficient distribution of irrigation water to the users and reduces the current amount of maintenance required to keep the system clear of debris.

Construction would occur from November to the end of February, when the ditch is dry. The existing channel would be replaced with a 4.5-foot diameter reinforced concrete pipe. The pipe would be installed in the existing channel alignment to the greatest extent possible. All pipe would be placed within the Ditch Association easement. (Figure 2)

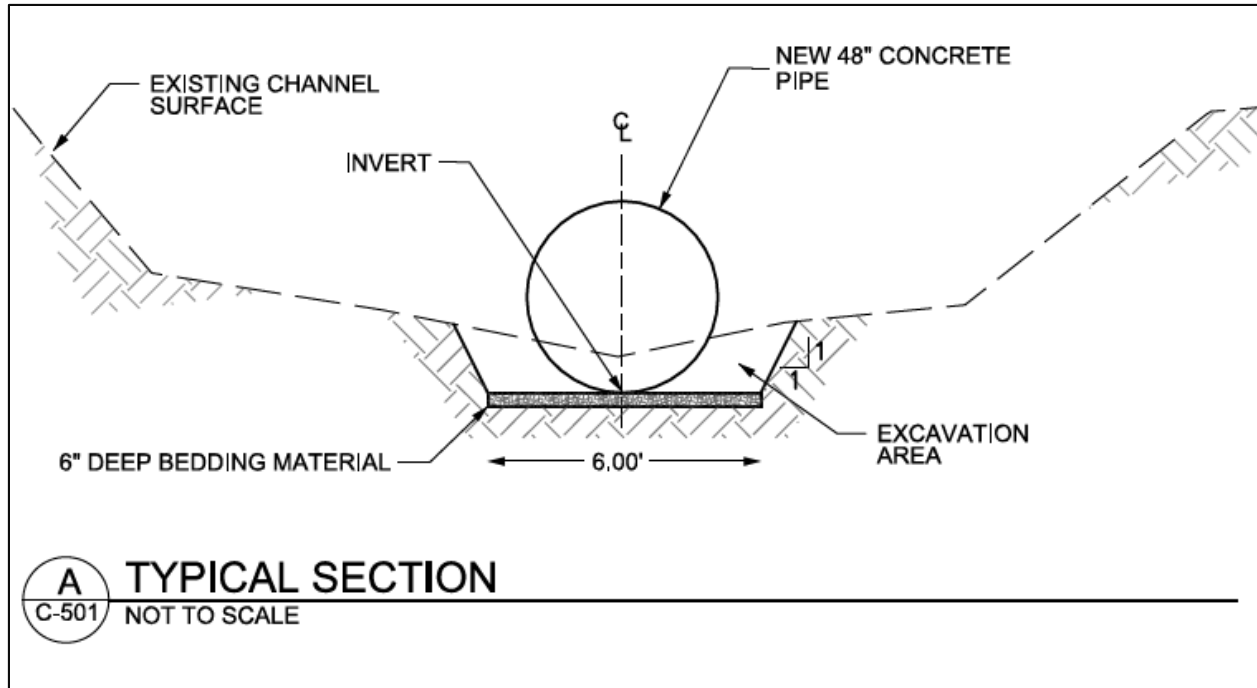


Figure 2: Concrete pipe drawings

Existing sluice gates would be replaced by a new manhole with sluice gate and pipe that would tie into the existing sluice structure. A minimum of 15 new manholes would be installed along the alignment to allow access into the pipe for future maintenance purposes (Figure 3).

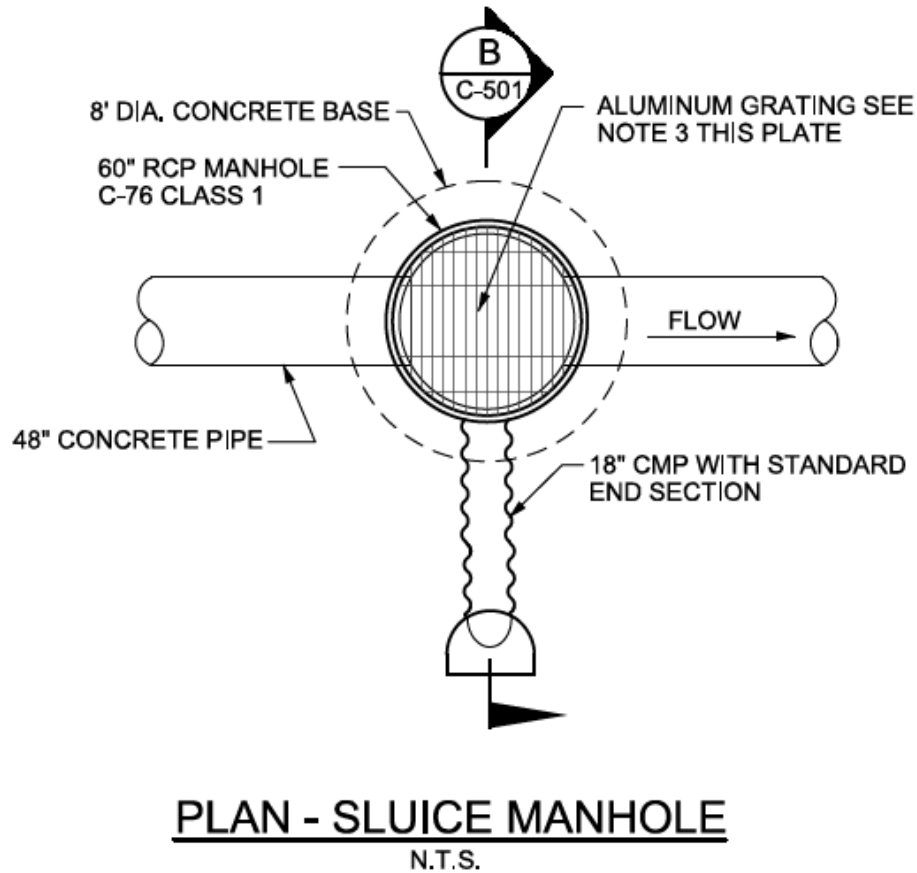


Figure 3: Sluice manhole drawings

The Area of Potential Effects (APE) for this proposed alternative includes a 100-foot easement centered on the Farmers Mutual Ditch center line for a combined distance of approximately 2.5 miles, including the section between Reaches 1 and 2 and one 1.5-acre staging area located on private land on the north side of the ditch in between the two reaches (Figure 1). Equipment would access the ditch by paved roads, existing unpaved maintenance roads paralleling the ditch, or on the adjacent graded ditch berm.

3. EXISTING ENVIRONMENT AND FORESEEABLE EFFECTS

3.1. Physical Environment

3.1.1. Climate and Climate Change

The Project Area is located in the northwestern corner of New Mexico within the Colorado Plateau physiographic province. Located almost a mile above sea level, it has a temperate desert climate characterized by cool summers (mean maximum temperatures below 90°F), mild winters (average temperature of the coldest month is 30.5°F) and mean annual precipitation of 8.6 inches (National Climatic Data Center

1981-2010 Monthly Normals for the Farmington Agricultural Science Center Cooperative Observer site (<https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm3142>)). During the July-October wet season, monthly precipitation averages about one inch, typically falling during localized convective storms; winter precipitation is generally sparse.

Over recent decades, warming is evident in the project area: average temperatures have increased more than 1.8°F between 1910 and 2009, with most of this rise occurring after 1993 (Nydick et al. 2012). Warming has occurred in all seasons. There has been no trend in the quantity of precipitation received (Bennett et al. 2019). However, warmer winter and spring temperatures and dust on snow have contributed to reductions in snowpack snow water equivalence in the adjoining San Juan Mountains, and an advance in the timing of spring runoff by two weeks (Clow 2010, Painter et al. 2007, Nydick et al. 2012).

These trends are anticipated to continue into the foreseeable future. Temperatures are anticipated to increase by as much as 6°F over present values by the mid-21st Century but precipitation is likely to remain similar to today (Bennett et al. 2019). Warmer temperatures are likely to contribute to smaller spring snowpack volumes both directly by causing snowpack melt in the winter months and indirectly by causing a greater share of winter precipitation in mountain regions to fall as rain rather than snow, especially at lower elevations (Bennett et al. 2019).

The net result may be significant reductions in water availability in the project area, especially in the summer months. Warmer temperatures are also likely to increase surface water evaporation rates and increase plant water demand, and therefore reduce available soil moisture. See Appendix A for more information on climate and climate change.

Alternative A: No Action Alternative

Under the No Action Alternative, the negative impacts of climate change, including reduced flows and increased evaporation in the ditch, would be further exacerbated by rockfalls and other erosion issues.

Alternative B: Buried Pipe

Under the Buried Pipe Alternative, the negative impacts of climate change, including reduced flows and increased evaporation in the ditch, would be reduced by enclosing the water flow in a pipe thus reducing evaporation and the chance of sediment or rocks blocking the flow.

3.1.2. Physiography, Geology, and Soils

The project is located within the Colorado Plateau Physiographic Province of northwestern New Mexico (Williams 1986). This region is characterized by erosional landscapes carved on relatively undeformed sequences of sedimentary and volcanic rocks. The San Juan Basin of the Navajo Section contains thick sequences of gently dipping Mesozoic and lower Cenozoic sedimentary rocks, mainly shale, mudstone, and sandstone with extensive coal seams. The Basin lies between the Southern Rockies, the Four Corners platform, and the Zuni-Defiance uplift. The Shiprock volcanic neck is situated west of the project site. This prominent formation results from exhumation of feeder conduits at middle Cenozoic volcanic centers. Another prominent feature west of the project site, the Hogback, is a sharp ridge comprised of more resistant Cretaceous sedimentary rocks (Pictured Cliff Sandstone, Lewis Shale, Point Lookout Sandstone, Menefee Formation and Cliff House Sandstone) (New Mexico Bureau of Geology and Mineral Resources 2003). The City of Farmington and the San Juan valley downstream through Fruitland are situated on the Fruitland and Kirtland formation, which is an important fossil-bearing formation (Hunt and Lucas 1992).

Aside from narrow hogback belts eroded on steeply dipping strata of monoclines flanking major structural upwarps, this Section is characterized by broad rolling plains carved on easily eroded rocks, and cuestas and tablelands capped by gently dipping resistant sandstone beds. Canyonlands and escarpments of moderate local relief occur mainly in the eastern part of the San Juan Basin. However, most stream valleys are broad, with relatively short canyon reaches; areas of high cliffs and escarpment are of limited extent. The lowest part of the New Mexico portion of the Navajo Section is the San Juan River channel near the Four Corners area at the boundary between the Navajo and Canyonlands sections of the Colorado Plateau. The major perennial streams in the Navajo Section are the San Juan, the Animas, and La Plata rivers, and the upper Rio Chama (Williams 1986).

The Farmers Mutual Ditch is situated at the upper limit of the San Juan River floodplain on the north side of the river at an elevation of 5,200 feet. The project area is within the San Juan/Chaco Tablelands and Mesas subdivision of the Arizona/New Mexico Plateau U.S. Environmental Protection Agency (EPA) Level III ecoregion (Griffith et al., 2006). The Arizona/New Mexico Plateau ecoregion occupies a significant portion of the southern half of the Colorado Plateau and is covered predominantly in a mosaic of sparse semiarid grassland and desert scrub vegetation (Ruhlman et al. 2012). The San Juan/Chaco Tablelands subdivision (Level IV ecoregion) of plateaus, valleys, and canyons contains a mix of desert scrub, semi-desert shrub-steppe, and semi-desert grasslands. Typical vegetation is shadscale, fourwing saltbush, mormon tea, Indian ricegrass, galleta, and blue and black gramas. It is more arid, has generally lower elevations, and less pinyon-juniper than the other subdivisions of the Arizona/New Mexico Plateau. It is mostly composed of gently dipping Tertiary and Cretaceous sedimentary rocks. Oil and gas production occurs mostly in the northern part of the

region. It contains the upper reaches of the Rio Puerco, an area of severe erosion due to geology, topography, and human influences (Griffith et al., 2006).

Two general vegetation assemblages dominate the Farmington area - a riparian community in the floodplain, and the desert, basin, and plains community in the adjacent uplands. Vegetation is described in more detail in Section **Error! Reference source not found.**

Soils in the floodplain fall within the Riverwash and Werlog loam soil series (Figure 4). Riverwash is a hydric soil derived from stream alluvium from igneous and sedimentary rock and has sandy, clayey and gravelly components. It is poorly drained and frequently flooded. Werlog loam is classified as farmland of state importance. It is a deep soil that does not flood or pond and is very slightly to slightly saline and somewhat poorly drained (Soil Survey Staff, Natural Resources Conservation Service (NRCS), 2020).

Soils above the floodplain fall in the Fruitland series and the very steep Haplargids-Blackston-Torriorthents complex. Fruitland loam, 1-3 percent slopes and Fruitland sandy loam, 2-5 percent slope are deep, well-drained soils derived from sandstone and shale alluvium. These soils are nonsaline to very slightly saline and are also classified as farmland of state importance. The Haplargids-Blackston-Torriorthents complex consists of very well drained cobbly sandy clay loam derived from alluvium. It is nonsaline to slightly saline, well-drained, and is not suitable for farming because of its steepness (slopes of 8 to 50 percent) (Soil Survey Staff, USDA-NRCS, 2020). The soil survey classifies the bluffs that confine one side of Farmers ditch as Haplargids-Blackston-Torriorthents complex; however, these bluffs appear to consist of bedrock outcrops more than soil.

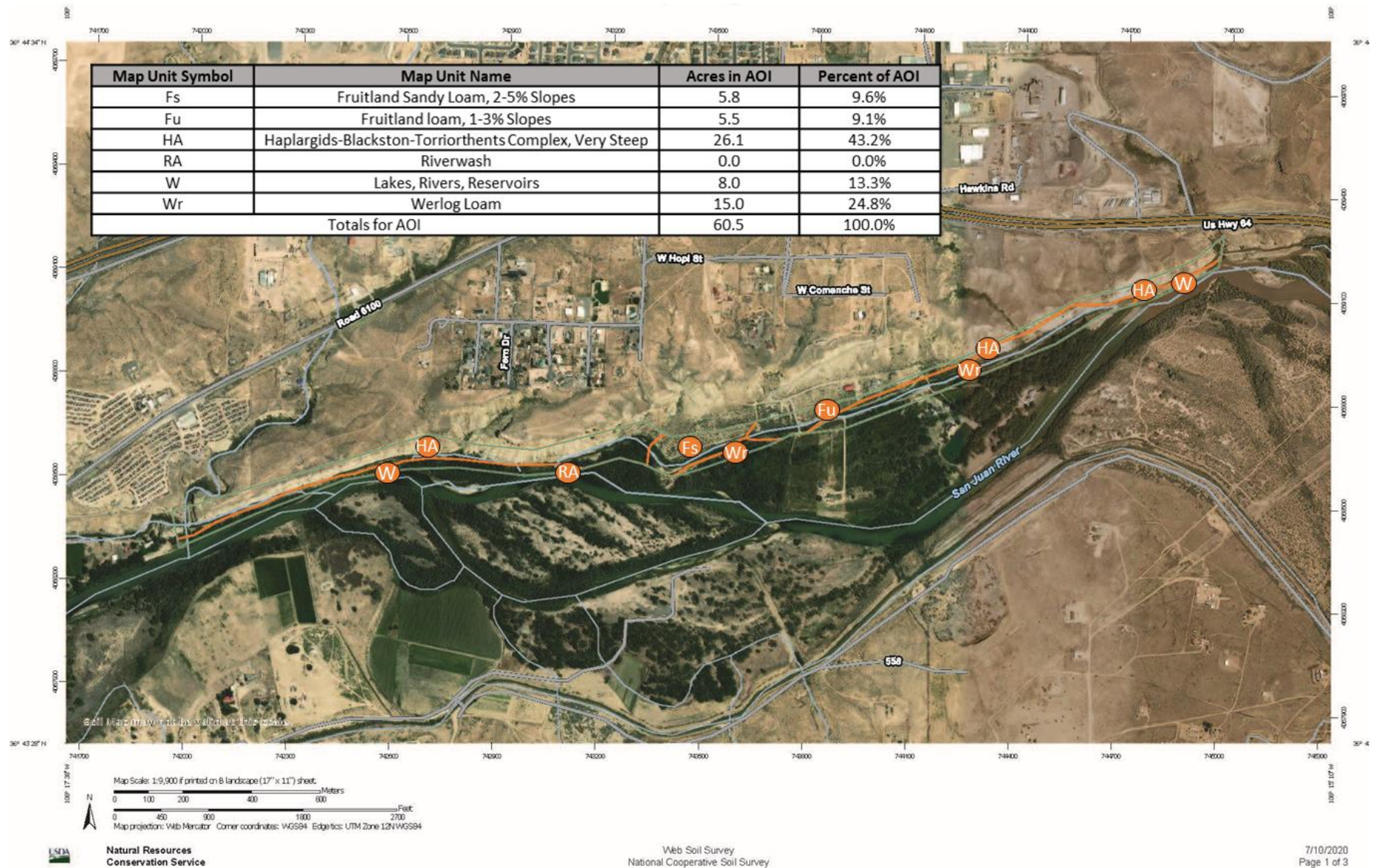


Figure 4: Soil Survey for the Study Area

Alternative A: No Action Alternative

The No Action Alternative would not address or resolve the problems outlined in section 1.2. Rockfalls and erosion would continue to be an issue along the project area.

There would be no significant impacts to the local physiography, geology, or soils from a No Action Alternative.

Alternative B: Buried Pipe

Ditch bank erosion and infilling of the ditch with sediment are maintenance problems associated with the existing irrigation system. The Buried Pipe Alternative eliminates these problems and reduces maintenance by replacing the earthen ditch with varying degrees of buried pipe. This alternative would not alter the processes of erosion nor decrease the frequency of rockfall but would alleviate the human problems caused by these processes.

As determined necessary, the contractor shall use Best Management Practices (BMPs), such as mulch application, straw/hay bales, and silt fences to retard erosion from contractor use areas. To protect soils from wind and water erosion, areas with plant cover that are disturbed by project activities would be evaluated as to the feasibility of re-establishing native vegetation by seeding. Areas disturbed by project activities would be seeded if the evaluation determines that seeding could significantly reduce the time for re-establishment of native vegetation. In this event, the species to be seeded, seeding rates, and seeding methods, and if needed, fertilizer regimes, would be determined by site characteristics and potential ability to bind the soil.

There would be no significant impacts to the local physiography, geology, or soils from a Buried Pipe Alternative.

3.1.3. Water Resources and Water Quality

The closest surface water resource near the Project Area is the San Juan River, which feeds the ditch through a diversion. Designated uses of the San Juan River include public water supply, industrial water supply, irrigation, livestock watering, wildlife habitat, primary contact, marginal coldwater aquatic life, and warmwater aquatic life (New Mexico Administrative Code §20.6.4.405). The sampling standard states temperature must not exceed 32.2 degrees centigrade (90 degrees F).

Section 404 of the Clean Water Act (CWA) provides for the protection of waters and wetlands of the United States from impacts associated with discharges of dredged or fill material into waters of the United States (WOTUS), including wetlands. However, the CWA also exempts certain discharges associated with the construction and

maintenance of irrigation ditches from Section 404 permit requirements (33 CFR 323.4(a), Exemption No. 3). Discharges associated with siphons, pump, headgates, wingwalls, weirs, diversion structures, and other facilities functionally related to irrigation ditches are included in this exemption. The planned action involves rehabilitation of an irrigation ditch and is therefore exempt from Section 404 of the CWA. Because no permit for Section 404 of the CWA is required, neither is State water quality certification under Section 401.

Section 402(p) of the CWA regulates point source discharges of pollutants into WOTUS and specifies that storm-water discharges associated with construction activity be conducted under National Pollutant Discharge Elimination System (NPDES) guidance. Storm-water discharge associated with "construction activity" includes discharges from construction activities (clearing, grading, and excavation) that result in disturbance to one (1) or more acres of land. The NPDES guidance would apply to this project because the construction zone is more than five acres. Project construction would comply with the general conditions of NPDES, a Notice of Intent would be filed, and a Storm Water Pollution Prevention Plan (SWPPP) for the project would be developed and be kept on file at the construction site and becomes part of the permanent project record. The Corps would provide NPDES guidance to the contractor.

Alternative A: No Action Alternative

Because the existing open ditch is prone to bank erosion, debris blockages, and sediment infilling, some of these materials are discharged into the San Juan River in the return water from the system.

The No Action Alternative would allow the continued transport and discharge of sediments to the river and potentially adversely affect water quality. The No Action Alternative would result in long-term negative impacts to water quality.

Alternative B: Buried Pipe

The NPDES guidance would apply to the Buried Pipe Alternative because the construction zone would be more than one acre. Project construction would comply with the general conditions of NPDES, a Notice of Intent would be filed, and a SWPPP for the project would be developed and be kept on file at the construction site and becomes part of the permanent project record. USACE would provide NPDES guidance to the contractor.

During construction there is the possibility of increased sediment transport, which could adversely affect water quality of the receiving waters. However, with BMPs in place, this is not likely to happen and overall, the completion of the Buried Pipe Alternative would reduce sediment transport in the system and positively affect water quality in the receiving waters.

Implementation of the Buried Pipe Alternative would result in short-term negative impacts to water quality. These impacts would be *de minimis*. No permanent negative impacts to water quality would occur.

3.1.4. Floodplains and Wetlands

Executive Order 11990 (Protection of Wetlands) requires the avoidance, to the extent possible, of long- and short-term adverse impacts associated with the destruction, modification, or other disturbances of wetland habitats.

Executive Order 11988 (Floodplain Management) provides Federal guidance for activities within the floodplains of inland and coastal waters. Preservation of the natural values of floodplains is of critical importance to the nation and the State of New Mexico. Federal agencies are required "to ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management."

Wetlands are not present within the project area; therefore, E.O. 11990 does not apply to this project site.

The proposed work is a rehabilitation of an existing irrigation system without expanding its facilities. The activities would not contribute to or result in any additional development within the San Juan River floodplain; therefore, the project is in compliance with E.O. 11988.

None of the alternatives would have a significant effect on the San Juan River floodplain.

3.1.5. Hazardous, Toxic and Radioactive Waste

The objective of a Phase I Environmental Site Assessment (Phase 1 ESA) is to identify, to the extent feasible pursuant to the processes prescribed in American Society for Testing and Materials (ASTM) E 2247-16, recognized environmental conditions in connection with the rural property. The Phase 1 ESA consists of records review, site reconnaissance, interviews, and reporting. The information below documents the records review, site reconnaissance, and interviews conducted by environmental professional possessing sufficient training and experience necessary to conduct a Phase 1 ESA. Due to the similarities in reporting requirements, a separate Phase 1 ESA report was not generated.

Environmental regulatory records, historic aerial photographs, site reconnaissance, and an interview were used to assess the historic and existing environmental conditions within the project area and buffer. The investigation has revealed no evidence of recognized environmental concerns within or near the proposed construction project. The investigation did not identify the presence or likely presence of any hazardous substance, or petroleum products on or near the property that indicate an existing

release, a past release, or threat of a release into the ground, groundwater, or surface water of the property.

Alternative A: No Action Alternative

The No Action Alternative will have no effect on known hazardous, toxic, or radioactive waste (HTRW), as there are no recognized environmental concerns within or near the proposed construction project.

Alternative B: Buried Pipe

The Buried Pipe Alternative will have no effect on known HTRW, as there are no recognized environmental concerns within or near the proposed construction project. If areas of concern or contaminants are identified, construction shall be postponed and USACE will coordinate with the Ditch Association to determine the appropriate course of action. No HTRW releases are expected from the proposed action; therefore, no significant effects are expected.

3.2. Air Quality

San Juan County, New Mexico, is in attainment status for State and Federal Ambient Air Quality Standards for criteria pollutants (particulate matter less than 10 microns, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead; NMED 2020). In the State's Prevention of Significant Deterioration (PSD) program administered by the New Mexico Environment Department (NMED), the project is located within an area designated as Class 11, which allows for moderate development and its associated air emissions. There are no PSD Class I (pristine) areas near the project area.

Alternative A: No Action Alternative

Implementation of the No Action Alternative would not result in any impacts to air quality.

Alternative B: Buried Pipe

Implementation of the Buried Pipe Alternative result in the operation of vehicles and construction equipment, which may produce localized and ephemeral increases in concentrations of dust and combustion emissions. BMP's for air quality would include keeping heavily trafficked areas and materials stockpiles watered using truck mounted sprinkler equipment to reduce dust from heavy vehicle traffic. All construction vehicles would be required to have emissions controls. Because future maintenance would be reduced, there would be a minor long-term benefit to air quality.

Implementation of the Buried Pipe Alternative would have short-term negative impacts to air quality. These impacts would be *de minimis*. No permanent impacts to air quality would occur.

3.3. Noise

For purposes of regulation, noise is measured in A-weighted decibels (dBA). This unit uses a logarithmic scale to weigh sound frequencies. Table 1 shows typical noise levels and corresponding impressions.

Table 1: Typical Noise Levels and Impressions.		
Source	Decibel Level	Subjective Impression
Normal breathing	10	Threshold of hearing
Soft whisper	30	---
Library	40	Quiet
Normal conversation	60	---
Television audio	70	Moderately loud
Ringing telephone	80	---
Snowmobile	100	Very loud
Shouting in ear	110	---
Thunder	120	Pain threshold

Ambient noise levels at the project site are typical of undeveloped, rural areas. The major noise producers include the running water from the river and the ditch, birds, occasional people, and adjacent residential and commercial areas.

Alternative A: No Action Alternative

Implementation of the No Action Alternative would not result in any impacts from noise.

Alternative B: Buried Pipe

Implementation of the Buried Pipe Alternative may result in some increase in the ambient noise levels from construction-related activities. However, noise levels would remain below State and Federal standards for public safety and would not persist beyond completion of the planned action. While any increase in noise levels would be temporary, the implementation of BMP's would insure they would be minimized to the maximum extent practicable.

Implementation of the Buried Pipe Alternative would result in short-term negative impacts from noise. These impacts would be *de minimis*. No permanent impacts from noise would occur.

3.4. Biological Resources

3.4.1. Vegetation

The ditch banks of the Acequia are vegetated to varying degrees, with patches of sparse to dense coyote willow (*Salix exigua*) intermixed with sparse small tamarisk (*Tamarix* sp.) and Russian olive (*Elaeagnus angustifolia*) trees in a narrow band (less than 10 feet wide), particularly along the bluff side of the ditch. A few large cottonwoods (*Populus deltoides* subsp. *wislizeni*) grow on the spoil bank berm between the ditch bank and the floodplain riparian zone below.

Large stretches of the ditch banks are nearly bare from recent maintenance or have young resprouting growth of willows, or are heavily infested with Russian knapweed (*Acroptilon repens*) and hoary cress (*Lepidium* or *Cardaria* sp.), highly invasive species listed by the State of New Mexico as noxious weeds. A few sections of ditch bank have perennial herbaceous vegetation, including sedges (*Carex* sp.), non-native creeping bentgrass (*Agrostis stolonifera*), showy milkweed (*Asclepias speciosa*), goldentop (*Euthamia occidentalis*), licorice (*Glycyrrhiza lepidota*) and dogbane (*Apocynum cannabinum*). Upland shrubs, including rabbitbrush or chamisa (*Ericameria nauseosa*) and fourwing saltbush (*Atriplex canescens*) are common on the ditch berm slopes.

The adjacent floodplain riparian habitat patches are dominated by Russian olive beneath a mature cottonwood gallery; overstory cottonwood canopy cover is less than 20%. There are occasional Goodding's willows (*Salix gooddingii*), New Mexico olive (*Forestiera pubescens*) and tamarisk in the shrub layer.

On 8 June 2020, tamarisk leaf beetle larvae were observed in tamarisk shrubs along the ditch. By 8 July 2020, about 50 percent of the tamarisk in the project area was brown. Table 2 lists the plant species observed in the Project Area.

Table 2: Plant species observed in the Project Area		
Common Name	Scientific Name	Native or Exotic*
Trees and Shrubs		
Rio Grande Cottonwood	<i>Populus deltoides</i> subsp. <i>wislizeni</i>	Native
New Mexico olive	<i>Forestiera pubescens</i>	Native
Coyote willow	<i>Salix exigua</i>	Native
Gooddings willow	<i>Salix gooddingii</i>	Native
Russian olive	<i>Elaeagnus angustifolia</i>	NM Class C
Tamarisk/Saltcedar	<i>Tamarix</i> sp.	NM Class C
Siberian elm	<i>Ulmus pumila</i>	NM Class C
Woods' Rose	<i>Rosa woodsii</i>	Native
Four-wing Saltbush	<i>Atriplex canescens</i>	Native
Chamisa/rabbitbrush	<i>Ericameria nauseosa</i>	Native
Big sagebrush	<i>Artemisia tridentate</i>	Native
Wolfberry	<i>Lycium</i> sp.	Native
Drummond's clematis	<i>Clematis drummondii</i>	Native
Virginia creeper	<i>Parthenocissus quinquefolia</i>	Native
Herbaceous Plants, Grasses and Forbs		
Navajo/Hopi tea	<i>Thelesperma megapotamicum</i>	Native
Showy milkweed	<i>Asclepias speciosa</i>	Native
Dogbane	<i>Apocynum cannabinum</i>	Native
Licorice	<i>Glycyrrhiza lepidota</i>	Native
Globemallow	<i>Sphaeralcea</i> sp.	Native
Russian thistle	<i>Salsola tragus</i>	Non-native
Yellow sweetclover	<i>Melilotus officinalis</i>	non-native
Russian knapweed	<i>Acroptilon repens</i>	NM Class B
Bull thistle	<i>Cirsium vulgare</i>	NM Class B
Bindweed	<i>Convolvulus arvensis</i>	Non-native
Hoary cress or perennial pepperweed	<i>Cardaria</i> sp. or <i>Lepidium</i> sp.	NM Class A
Halogeton	<i>Halogeton glomeratus</i>	NM Class B
Horsetail/ scouring rush	<i>Equisetum</i> sp.	Native
Creeping bentgrass	<i>Agrostis repens</i>	Non-native
Sedge	<i>Carex</i> sp.	Native
Saltgrass	<i>Distichlis spicata</i>	Native
Squirreltail	<i>Elumus elymoides</i>	Native
<p>*New Mexico Noxious Weed Class</p> <p>Class A Species: Currently not present in New Mexico, or have limited distribution. Preventing new infestations of these species and eradicating existing infestations is the highest priority.</p> <p>Class B Species: Limited to portions of the state. In areas with severe infestations, management should be designed to contain the infestation and stop any further spread.</p> <p>Class C Species: Wide-spread in the state. Management decisions for these species should be determined at the local level, based on feasibility of control and level of infestation.</p>		

Alternative A: No Action Alternative

Under the No Action Alternative, no vegetation would be disturbed, and riparian vegetation would continue to grow along the ditch banks, supported by seepage from the ditch. However, periodic rockfall and debris slides cause disturbance to both sides of the ditch. The maintenance required to clear rock and debris from the ditch disturbs

vegetation, resulting in large bare stretches along the ditch. Periodic disturbance of vegetation would continue under this alternative.

Alternative B: Buried Pipe

Under the Buried Pipe Alternative, there would be minor disturbance and loss of riparian vegetation along the ditch when the buried pipe is installed. Indirect impacts of piping the ditch include potential loss of ditch bank riparian vegetation as seepage from the ditch would be eliminated. USACE estimates that indirect loss of approximately 2,400 feet of ditch bank willows and two to three mature cottonwoods may result from elimination of seepage. This loss of vegetation would be partially offset by the decreased need for maintenance with the ditch placed into pipe. The top of the spoil bank ditch berm would continue to serve as a maintenance/access road, the sloping sides of the berm would revegetate with upland species as ground-disturbing maintenance decreases.

Implementation of the Buried Pipe Alternative would have negative impacts to the existing plants along the ditch bank because seepage from the ditch would be eliminated.

3.4.2. Fish and Wildlife

The Biota Information System of New Mexico (BISON-M, 2020) lists eight species of amphibians, 26 reptiles, 281 birds, 76 mammals, 25 fish, and 270 invertebrate species as potentially occurring in San Juan County, New Mexico (Appendix B). Because the ditch is situated at the edge of the riparian zone in the transition zone between riparian and upland habitats, the project area likely includes species from both habitats.

Birds observed during two surveys (20 June and 8 July 2020) are listed below in **Error! Reference source not found.** Most of the bird activity was observed in the floodplain riparian area, with incidental use of the ditch banks vegetation. No bird nests were observed in vegetation on the ditch banks. During the July survey, fledglings of a few species were observed.

Table 3: Birds observed in the Project Area		
Common Name	Scientific Name	Notes
Spotted Towhee	<i>Pipilo maculatus</i>	Common
Black phoebe	<i>Sayornis nigricans</i>	Pair on 6/8, fledglings 7/8
Says' phoebe	<i>Sayornis saya</i>	Adult w-fledglings 7/8/20
Black headed Grosbeak	<i>Pheucticus melanocephalus</i>	--
Blue grosbeak	<i>Passerina caerulea</i>	Pair
Lazuli bunting	<i>Passerina amoena</i>	Pair
Yellow breasted Chat	<i>Icteria virens</i>	Common
Yellow warbler	<i>Setophaga petechia</i>	--
Western wood-pewee	<i>Contopus sordidulus</i>	--
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	nesting colonies on cliffs
Mourning dove	<i>Zenaida macroura</i>	--
American Robin	<i>Turdus migratorius</i>	Adult w-fledglings 7/8/20
Brown-headed Cowbird	<i>Molothrus ater</i>	--
Red-tailed hawk	<i>Buteo jamaicensis</i>	--
Cooper's hawk	<i>Accipiter cooperii</i>	--
Black-chinned Hummingbird	<i>Archilochus alexandri</i>	--
White-breasted Nuthatch	<i>Sitta carolinensis</i>	--

Mammals have not been surveyed in the project area, but are likely limited to those that tolerate human disturbance, due to the proximity of the ditch to the City of Farmington. Mule deer (*Odocoileus hemionus*) is probably the largest mammal that would frequent the area. Among medium-sized carnivores, coyotes (*Canis latrans*) are well adapted to human presence, and red or gray fox (*Vulpes vulpes*, *Urocyon cinereoargenteus*) may occur. Raccoons (*Procyon lotor*) and striped or Western spotted skunks (*Mephitis mephitis*, *Spilogale gracilis*) are likely residents. Porcupine (*Erethizon dorsatum*) and beaver (*Castor canadensis*) frequent riparian areas. Small mammals may include jackrabbit (*Lepus californicus*), desert and Nuttall's cottontail rabbits (*Sylvilagus audubonii*, *S. nuttallii*), a variety of mice, woodrats, and gophers, and Ord's or Banner-tailed kangaroo rats (*Dipodomys ordii*, *D. spectabilis*). Several species of bats have potential to occur in the project area and would find abundant food resources due to proximity to the San Juan River and large populations of insects supported by the riparian area.

Amphibians and reptiles expected to occur include Woodhouse's and red-spotted toads (*Anaxyrus woodhousii*, *A. punctatus*), New Mexico and plains spadefoot (*Spea multiplicata*, *S. bombifrons*); gophersnake (*Pituophis catenifer*), prairie rattlesnake (*Crotalus viridis*), California kingsnake (*Lampropeltis californiae*), garter snakes (*Thamnophis cyrtopsis*, *T. elegans*), whiptails (*Aspidoscelis* species) and several other species of lizards.

Fish were surveyed as part of the NMED Surface Water Quality Bureau's San Juan and Animas rivers watershed survey (NMED SWQB 2012). Fish found in the San Juan River watershed are listed below in **Table 4**. Additionally, a survey prior to the Corps' 1988

Farmers Ditch Heading project found Colorado pike minnow downstream of the project area (USACE 1988)

Table 4: Characteristics of fish species found in wadeable streams in the San Juan watershed with survey results for 2010 sites: La Plata River (La Plata) at Farmington, Navajo River (Navajo) upstream of Jicarilla boundary (NMED SWQB 2012)							
Scientific Name	Common Name	ID'd in 2010 Survey	Native	Temp.	Gravel Spawner	Primary Feeding Guild	Water Quality Tolerance
<i>Salmo trutta</i>	brown trout	Navajo	No	Cold	Yes	Invertivore/Insectivore	Intermediate
<i>Cyprinella lutrensis</i>	red shiner	La Plata	No	Warm	No	Omnivore	Tolerant
<i>Gila robusta</i>	roundtail chub	--	Yes	Cool	No	Omnivore	Sensitive
<i>Rhinichthys osculus</i>	speckled dace	Navajo; La Plata	Yes	Cool	Yes	Invertivore/Insectivore	Intermediate
<i>Pimephales promelas</i>	fathead minnow	--	No	Warm	No	Omnivore	Tolerant
<i>Catostomus commersoni</i>	white sucker	Navajo	No	Cool	Yes	Omnivore	Tolerant
<i>Catostomus discobolus</i>	bluehead sucker	Navajo; La Plata	Yes	Cool	Yes	Herbivore	Tolerant
<i>Catostomus latipinnis</i>	flannelmouth sucker	La Plata	Yes	Cool	Yes	Omnivore	Intermediate
<i>Ameiurus melas</i>	black bullhead	--	No	Warm	No	Invertivore/Insectivore	Tolerant
<i>Fundulus zebrinus</i>	plains killifish	La Plata	No	Warm	No	Invertivore/Insectivore	Tolerant
<i>Lepomis machrochirus</i>	bluegill	--	No	Warm	No	Invertivore/Insectivore	Tolerant
<i>Cottus bairdi</i>	mottled sculpin	Navajo	Yes	Cool	No	Invertivore/Insectivore	Intermediate

Alternative A: No Action Alternative

There would be no effects to wildlife from the No Action Alternative. Wildlife in the area are presumably habituated to the proximity to human activity and able to adjust to the ongoing disturbance from ditch maintenance.

Alternative B: Buried Pipe

Implementation of the Buried Pipe Alternative would occur during the late fall to late winter/early spring when migratory birds are not in the area and most reptiles and amphibians are less active. The contractor would be required to cover trenches at the end of each workday to prevent entrapment of small animals. Bats are generally either hibernating during the winter or have migrated away from the project area. Therefore, there would be no direct adverse effects to migratory birds or other wildlife.

Indirect adverse impacts to wildlife may occur as riparian vegetation along the ditch is lost, as described above. Elimination of seepage from the ditch would result in a minor loss of riparian foraging habitat from this alternative.

Project construction would take place when the ditch is dry and would not affect the river channel or aquatic habitats. There would be no alteration in the diversion, flow, or circulation of water. Therefore, there would be no adverse impacts to fish or other aquatic species.

In summary, implementation of the Buried Pipe Alternative would result in minor loss of riparian foraging habitat but overall would not result in long term negative impacts to fish or wildlife species.

3.4.3. Invasive/Exotic Species

As noted in the plant list above (**Table 2**), 11 non-native species were recorded during botanical surveys of the ditch. Seven of these species are listed by the State of New Mexico as noxious weeds. A particularly large infestation of Russian knapweed exists on the ditch berm throughout the Project Area.

Alternative A: No Action Alternative

There would be no change in invasive species populations from the No Action Alternative. Repeated soil disturbance from ditch maintenance and clearing of debris probably contributes to the spread of noxious/invasive species.

Alternative B: Buried Pipe

Although the Buried Pipe Alternative does not specifically target invasive species, construction disturbance would remove some of the noxious weed population. Because these species are widespread in the area, it is likely that they will re-establish on the ditch berm following construction. To help prevent establishment of noxious weeds, USACE would re-seed the project area with suitable native grass and forb species and would work with the Ditch Association to educate members about the invasive species present.

Implementation of the Buried Pipe Alternative would result in no appreciable change in populations of noxious weeds and invasive species.

3.4.4. Special Status Species

The USACE project biologist obtained a species list from the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation system (IPaC) on 10 January 2020 and an update on 10 July 2020 (USFWS IPaC website, 2020). The BISON-M and the New Mexico Rare Plant Website (New Mexico Rare Plant Technical

Council 1999) were also consulted. Federal and State endangered and threatened species are listed in Table 5. Rare plants that occur in San Juan County and State Species of Greatest Conservation Need are listed in Appendix B.

Table 5: Federal and state endangered and threatened species			
Common Name	Scientific Name	Federal Status	State of NM Status
Canada Lynx	<i>Lynx canadensis</i>	T	---
New Mexico Meadow Jumping Mouse	<i>Zapus hudsonius luteus</i>	E	---
Spotted Bat	<i>Euderma maculatum</i>		T
Southwestern Willow Flycatcher	<i>Empidonax traillii extimus</i>	E	E
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	T	---
Broad-billed Hummingbird	<i>Cynanthus latirostris</i>		T
Least Tern	<i>Sterna antillarum</i>	E	E
Brown Pelican	<i>Pelecanus occidentalis</i>	E	
Bald Eagle	<i>Haliaeetus leucocephalus</i>	T	
Common Black Hawk	<i>Buteogallus anthracinus</i>	T	
Mexican Spotted Owl	<i>Strix occidentalis lucida</i>	T	
Gray Vireo	<i>Vireo vicinior</i>	T	
Baird's Sparrow	<i>Centronyx bairdii</i>	T	
Peregrine Falcon	<i>Falco peregrinus</i>	T	
Colorado Pikeminnow	<i>Ptychocheilus lucius</i>	E	E
Razorback Sucker	<i>Xyrauchen texanus</i>	E	---
Zuni Bluehead Sucker	<i>Catostomus discobolus yarrowi</i>	E	---
Roundtail Chub (upper basin populations)	<i>Gila robusta</i>	E	
Knowlton's Cactus	<i>Pediocactus knowltonii</i>	E	---
Mancos Milk-vetch	<i>Astragalus humillimus</i>	E	---
Mesa Verde Cactus	<i>Sclerocactus mesae-verdae</i>	T	---
Zubi fleabane	<i>Erigeron rhizomatus</i>	T	E

The potential for these species to occur in the project area was evaluated following a reconnaissance visit on 8 June 2020. Based on the reconnaissance visit, habitat along the ditch itself was deemed marginally suitable for riparian bird species, and likely not utilized for nesting; whereas patches of riparian habitat in the San Juan River floodplain adjacent to but below the ditch were moderately suitable. Based on the proximity of habitat patches along the ditch to floodplain riparian habitat, and the potential for utilization as foraging habitat, exploratory surveys for yellow-billed cuckoo and willow flycatcher were conducted on 20 June and 8 July 2020. These species were not detected.

The San Juan River has been noted as wintering habitat for bald eagles, which are listed as Threatened by the State and protected federally under the Bald and Golden Eagle Protection Act.

Critical habitat for the Colorado pikeminnow is present in the project area, in the river channel. No other critical habitats are present.

Alternative A: No Action Alternative

There would be no effects to listed species from the No Action Alternative.

Alternative B: Buried Pipe

The USACE has determined that the Buried Pipe Alternative may affect, but is not likely to adversely affect the Southwestern willow flycatcher and yellow-billed cuckoo due to project timing outside of nesting season and minor indirect impacts to riparian vegetation along the ditch. Informal consultation with the USFWS has been initiated and a Biological Assessment submitted (Appendix B)

Bald eagles may occur in the project area during winter when the project is being constructed. If a bald eagle is present within 0.5 mile of the work in the morning before the project activity starts, or following breaks, the contractor would suspend all activity until the bird leaves of its own volition. However, if a bald eagle arrives during construction activities or if an eagle is beyond that distance, construction would not be interrupted. Therefore, there would be no adverse impacts to eagles from this alternative.

There may be minor indirect loss of foraging habitat for State-listed birds that utilize riparian habitats (gray vireo, broad-billed hummingbird). Other State-listed bird species would not be affected by this alternative.

The project would have no effect on other Federally or State-listed species, with potential to occur in the Project Area, or their critical habitats. The project would not affect endangered plants due to absence of suitable habitat (Knolton's cactus, Mesa Verde cactus, Mancos milk-vetch, Zuni fleabane); would not affect endangered fishes or critical habitat due to project and location outside aquatic habitat (Colorado pikeminnow, razorback sucker, Zuni bluehead sucker, roundtail chub); and would not affect endangered mammals due to absence of suitable habitat (Canada lynx, New Mexico meadow jumping mouse).

Spotted bats may occur in the Project Area. This species prefers roosting in cliffs near water and the bluffs along the ditch could provide roosting habitat. A status assessment did not find this species in the northwestern part of the state (Geluso 2006). A NMDGF biologist confirmed that this species likely utilizes cliffs and forages in the San Juan Valley but would not be affected by construction at the base of the bluff (personal communication, M. Conway, NMDGF email to D. Price, USACE, 22 July 2020).

3.5. Cultural Resources

The Farmers Mutual Ditch brings water to approximately 600 users and irrigates approximately 4,200 acres of farmland (Everhart 2002). Prior cultural resources work on the Farmers Mutual Ditch included a Class III cultural resources inventory survey for the

rehabilitation of the ditch's San Juan River diversion, upstream from the current project areas (Rayl 1988). During consultation for that rehabilitation, the New Mexico State Historic Preservation Officer (SHPO) concurred with the USACE determination that the Farmers Mutual Ditch system was potentially eligible for nomination to the National Register of Historic Places (NRHP) under criteria "c" and "d." The Advisory Council on Historic Preservation (ACHP) concurred with that finding and suggested that the Ditch system may also be eligible under criterion "a" (Everhart 2002). In 2001, USACE archaeologist Gregory Everhart conducted a cultural resource survey to the west of the current project area for the proposed conversion of a 3.2-mile segment of Farmers Mutual Ditch from an earthen ditch to a concrete-lined one with new screw-lift field gates. The Everhart investigations found no new archaeological sites or historic properties in that 3.2-mile segment of the ditch, and that project was determined to have no adverse effect to historic properties (Everhart 2002). New Mexico SHPO concurred with that determination on 17 September 2002 (HPD Log No. 65839). In 2012, the ditch was recorded as part of a survey for a transmission line by Marron and Associates for the Bureau of Land Management (Walley and Connor 2012). Marron and Associates recommended the ditch eligible for the NRHP under criteria "a" and "c". New Mexico SHPO concurred with that determination on 17 September 2014 (HPD Log No. 99794). In 2018, the ditch was given a Historic Cultural Properties Inventory (HCPI) number and recorded on HCPI forms by the NRCS, who again determined that the ditch should be eligible to the NRHP (Murrell 2018).

A review of USACE records and an online records check of the New Mexico Office of Cultural Affairs' Historic Preservation Division NMCRIS database was conducted on 15 January 2020. In addition to the ditch itself, which has been determined eligible to the NRHP, there is one known archaeological site near the western end of the APE, a petroglyph panel (LA 10952), which has not been evaluated for eligibility to the NRHP. Two additional historic properties were noted during a February, 2020 reconnaissance visit to the Farmers Mutual Ditch, a trash dump and an abandoned vehicle, neither of which have been recorded or evaluated for eligibility to the NRHP.

Alternative A: No Action Alternative

Without the implementation of a Federal project, the known cultural resources within the proposed project's APE, the Farmers Mutual Ditch itself and the petroglyph panel (LA 10952), as well as the unrecorded trash dump and abandoned vehicle sites, would be expected to remain in approximately the current condition. Under the No Action Alternative, the ditch would not be subjected to the adverse effects to certain aspects of site integrity anticipated from construction of the ditch rehabilitation alternative. However, if the project is not implemented, the ditch will be subject to landslide and rock fall activity that will adversely impact its function as a community water-delivery system, which is its primary aspect of integrity.

Alternative B: Buried Pipe

The APE for the current project includes a 100-foot easement centered on the Farmers Mutual Ditch center line for a combined distance of approximately 2.5 miles, including the section between Reaches 1 and 2 and one 1.5-acre staging area located on private land on the north side of the ditch in between the two reaches (Figure 1). The APE for the current project totals 43.82 acres, of which only the 1.5-acre staging area has been surveyed for cultural resources.

The current state of the Farmers Mutual Ditch is an open earthen ditch along its entire length, with the exception of a short section which has already been piped near the diversion structure at the east end. The undertaking involves the removal and replacement of several of the Farmers Mutual Ditch associated features, and the conversion of the Acequia from an earthen ditch to partially piped ditch. The proposed undertaking will not affect the Acequia's location or setting, or association of the Acequia with its community. In many ways, the proposed undertaking is beneficial in that it allows the Farmers Mutual Ditch Association and surrounding communities to continue their way of life while lowering acequia maintenance costs. That being said, the original materials, design, and workmanship will be compromised by the use of pipe in the ditch. The feeling of water running openly through an earthen ditch system in the rural countryside will also be compromised by the partial piping of the ditch. The piping will look modern. For all of these reasons, it was determined by USACE and New Mexico SHPO via e-mail dated 20 April 2020, that the proposed project will have an adverse effect on the aesthetic of Farmers Mutual Ditch. The ACHP will be notified of the adverse effect and invited to participate in the Section 106 consultation process for the proposed project as soon as tribal consultation is complete. Tribal consultation letters for the proposed project were sent 24 July 2020.

Typically, mitigations for this kind of acequia work include survey and documentation of the acequia length, including preparation of HCPI and Acequia Detail forms, archival photo documentation, and oral history interviews with ditch association members. The Farmers Mutual Ditch has not had a previous cultural resource survey within the APE. Therefore, mitigations for the adverse effect to the ditch will include a full Class III cultural resource inventory and photo documentation of the APE for the current project, and oral history interviews regarding historic use of the ditch. Future ditch improvement projects will require further cultural resource inventory and photo documentation. A Memorandum of Agreement with these stipulations is currently being drafted for SHPO review and activities will be conducted through contract or utilizing in-house cultural resources staff.

3.6. Socioeconomic Considerations and Land Use

3.6.1. Socioeconomics

San Juan County, New Mexico, had an estimated population in 2018 of 127,455 (U.S. Census Bureau, 2020). Over half the area of the County is within the New Mexico boundaries of the Shiprock Agency of the Navajo Indian Reservation. More than one-third of the population of the County is Native American Indian (Table 6). Approximately 23 percent of the population live at or below the poverty line and in March of 2020 the unemployment rate was 7.3 percent (Table 7; NM Workforce Connection, 2020).

Table 6: 2018 American Community Survey 5-Year Estimates of Race (US Census Bureau, 2020).		
Race	Number of People	% of Population
Total	127,455	
White alone	66,357	52.1%
Black or African American alone	816	0.6%
American Indian and Alaska Native alone	50,527	39.6%
Asian alone	988	0.8%
Native Hawaiian and Other Pacific Islander alone	75	0.1%
Some other race alone	5,319	4.2%
Two or more races	3,376	2.6%

Table 7: Median household income and poverty status of San Juan County residents (US Census Bureau, 2020)	
Median household income (in 2018 dollars), 2014-2018	\$50,582
Per capita income in past 12 months (in 2018 dollars), 2014-2018	\$23,206
Persons in poverty, percent	23.1%

The majority of the persons living in the county are employed in retail, construction, health care, mining, manufacturing, and accommodations and food. A significant mining industry is associated with deposits of coal, oil, natural gas, and sand and gravel. Since most of the county is arid, agriculture is restricted to the floodplains of the San Juan, Animas, and La Plata rivers and to irrigated land on the Navajo reservation.

Alternative A: No Action Alternative

The No Action Alternative would result in continued existing high maintenance expenses incurred with the earthen ditch.

Alternative B: Buried Pipe

The Buried Pipe Alternative would ensure the continued socioeconomic benefits currently accruing to the community from the crop production associated with the Farmers Mutual Ditch. The members of the Ditch Association would realize reduced long-term maintenance cost resulting from no longer having to clear the ditch of blockages caused by eroding hillsides.

3.6.2 Land Use

Historic and current land uses in the San Juan River watershed include mineral extraction, forestry, farming, ranching, and recreational activities. Land use/cover above the Hogback within New Mexico includes 56% forest, 42% rangeland, 1% agriculture, <1% urban/residential, and <1% barren soil. Land ownership within the New Mexico portion of the watershed is 46% tribal, 27% BLM, 14% private, 8% USFS, and 5% State (NMED SWQB 2012). The land area served by Farmers Mutual Ditch and in the immediate project area is predominantly agricultural with minor residential and light industrial uses.

Alternative A: No Action Alternative

The No Action Alternative would not directly affect land use; nevertheless, failure to address ongoing rock/debris slides and maintenance issues would pose a great challenge to the viability of agriculture in this part of the San Juan River valley. Without a reliable water supply, farming here would literally dry up, with adverse socioeconomic impacts as described in section **Error! Reference source not found..**

Alternative B: Buried Pipe

No changes in land use would result from the Buried Pipe Alternative. Implementation of this alternative would allow for the viable continuation of agriculture in the area served by Farmers Mutual Ditch.

3.6.3. Environmental Justice and Protection of Children

The goal of environmental justice is to ensure that all Americans are afforded the same degree of protection from environmental and health hazards and have equal access to the decision-making process to maintain a healthy environment in which to live, learn, and work. EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (11 February 1994), directs federal agencies to make environmental justice part of their mission to the greatest extent practicable and permitted by law. In short, this document defines the approaches by which the EPA will ensure that disproportionately high environmental and/or socioeconomic effects on minority and low-income communities are identified and addressed. Further, it

establishes agency wide goals for all Native Americans with regards to Environmental Justice issues and concerns.

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (21 April 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

The WRDA Section 1113 Acequia Program, under which the proposed project is authorized, is largely intended to provide needed technical and financial assistance to acequia and community ditch associations in which water resources are degrading and in need of improvement. Acequia associations find maintenance of these systems increasingly challenging.

Alternative A: No Action Alternative

The No Action Alternative would allow for continued erosion and filling of the ditch with sediment. San Juan County, New Mexico, residents have relatively lower incomes than the average for the State. The No Action alternative likely would adversely affect this low-income community.

The No Action Alternative would not disproportionately affect children's safety or environmental health risks to children or adults, including minority or low-income residents.

Alternative B: Buried Pipe

No changes in demographics, housing, or public services would likely occur as a result of the construction of the Buried Pipe Alternative. With respect to the protection of children, the likelihood of disproportionate risk to children is not significant. No anticipated impacts to low-income or minority populations are expected. Construction of The Buried Pipe Alternative would result in long-term positive affects for all Ditch Association members. The proposed project does not involve activities that would pose any disproportionate environmental health risk or safety risk to children or adults.

Implementation of the Buried Pipe Alternative would not result in any impacts in terms of environmental justice and the protection of children.

4. RECOMMENDED ALTERNATIVE AND CUMMULATIVE IMPACTS

The recommended alternative for the proposed Farmers Mutual Ditch project is Alternative B: Buried Pipe.

NEPA defines cumulative effects as "...the impact on the environment which results from the incremental impact of the action when added to other, past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."

Cumulative effects are analyzed individually for each resource area in Section 3. These analyses address the cumulative impact of the direct and indirect effects of the proposed action when added to the aggregate effects of past, present, and reasonably foreseeable future actions. For all resources, the aggregate effect of past and present actions was considered to be represented by the current, existing conditions of the resource (Council on Environmental Quality 2005). Therefore, the specific effects of individual past and present actions typically were not cataloged in the analysis. In order for direct or indirect effects to incrementally add to the effects of past, present, or reasonably foreseeable future actions, they must overlap with those effects in time or space (Council on Environmental Quality 1997).

The time frame for analysis of cumulative effects varied, depending on the duration of direct and indirect effects. For example, direct effects resulting from construction were expected to persist for relatively short periods of time (about four months). Conversely, indirect effects resulting from operation of the rehabilitated acequia system would persist for the life of the facility. Similarly, the geographic bounds for cumulative effects analysis varied with the resource under consideration, depending on zone of influence of the direct or indirect impact being analyzed.

The proposed project lies within a rural area in San Juan County, New Mexico (Figure 1). The proposed improvements to the ditch would not significantly impact the current conditions of the local environment and would help retain the farming practices of the community. For these reasons, the proposed chosen alternative when combined with past, present, or future activities in the Farmers Mutual Ditch area would not significantly add to or raise local cumulative adverse environmental impacts to a level of significance.

5. CONCLUSIONS

This DEA addresses the potential effects of the proposed rehabilitation of the Farmers Mutual Ditch. Impacts to the environment would be non-significant and short-term. Long-term benefits to the Ditch Association members would result from the proposed

project. The proposed project would not result in any moderate or significant, long-term, or cumulative adverse effects. Therefore, construction of the proposed project, Alternative B: Buried Pipe, would not significantly affect the quality of the human environment and is recommended for implementation.

5.1. Summary of Findings and Impacts

Table 8 provides a summary comparison of the alternatives (Preferred Alternative and No Action Alternative) with respect to the resources discussed in this DEA.

Table 8: Summary of Findings and Impacts.		
Resources	Alternative B: Buried Pipe (Preferred Alternative)	Alternative A: No Action Alternative
Physical Landscape		
<i>Climate and Climate Change</i>	No Impacts	No Impacts
<i>Physiography, Geology, and Soils</i>	No Impacts	No Impacts
<i>Water Resources and Water Quality</i>	Short-term Negative Impacts Long-term Positive Impacts	Long-term Negative Impacts
<i>Floodplains and Wetlands</i>	No Impacts	No Impacts
<i>HTRW</i>	No Impacts	No Impacts
Air Quality	Short-term Negative Impacts Long-term No Impacts	No Impacts
Noise	Short-term Negative Impacts Long-term No Impacts	No Impacts
Biological Resources		
<i>Vegetation</i>	Minor Impacts	No Impacts
<i>Fish and Wildlife</i>	No Impacts	No Impacts
<i>Invasive/Exotic Species</i>	No Impacts	No Impacts
<i>Special Status Species</i>	Minor Impacts	No Impacts
Cultural Resources	Long-term negative and positive impacts	Long-term Negative Impacts
Socioeconomic Considerations		
<i>Socioeconomics</i>	No Impacts	Long-term Negative Impacts
<i>Land Use</i>	Long-term Positive Impacts	Long-term Negative Impacts
<i>Environmental Justice and Protection of Children</i>	No Impacts	No Impacts

5.2. Summary of Conditions to Minimize Potential Adverse Impacts

As determined necessary, the contractor shall use BMPs, such as mulch application, straw/hay bales, and silt fences to retard erosion from contractor use areas. To protect

soils from wind and water erosion, areas with plant cover that are disturbed by project activities would be evaluated as to the feasibility of re-establishing native vegetation by seeding. Areas disturbed by project activities would be seeded if the evaluation determines that seeding could significantly reduce the time for re-establishment of native vegetation. In this event, the species to be seeded, seeding rates, and seeding methods, and if needed, fertilizer regimes, would be determined by site characteristics and potential ability to bind the soil.

BMPs for air quality would include keeping heavily trafficked areas and materials stockpiles watered using truck mounted sprinkler equipment to reduce dust from heavy vehicle traffic. All construction vehicles would be required to have emissions controls. Because future maintenance would be reduced, there would be a minor long-term benefit to air quality.

Construction would occur during the late fall to late winter/early spring when migratory birds are not in the area and most reptiles and amphibians are less active. The contractor would be required to cover trenches at the end of each workday to prevent entrapment of small animals.

To help prevent establishment of noxious weeds, USACE would re-seed the project area with suitable native grass and forb species and would work with the ditch association to educate members about the invasive species present.

If a bald eagle is present within 0.5 mile of the work in the morning before the project activity starts, or following breaks, the contractor would suspend all activity until the bird leaves of its own volition. However, if a bald eagle arrives during construction activities or if an eagle is beyond that distance, construction would not be interrupted. Therefore, there would be no adverse impacts to eagles from this alternative.

To mitigate for the adverse effects to the ditch, a full Class III cultural resource inventory and photo documentation of the APE for the current project, and oral history interviews regarding historic use of the ditch will be conducted.

6. CONSULTATION AND COORDINATION

NEPA Coordination for the construction of a concrete pipe in the Farmers Mutual Ditch was initiated in January 2020 with an email to USFWS, in May 2020 with an email to Bureau of Land Management and in July 2020 with an email to NMDGF. Coordination with Federal, Tribal, State, and Non-Government Agencies is ongoing. Agencies and entities contacted formally or informally in preparation of this DEA include:

- Famers Mutual Ditch Association, Farmington, NM
- NM Department of Game and Fish, Santa Fe, NM
- NM State Historic Preservation Office, Santa Fe, NM

- U.S. Bureau of Land Management, Farmington, NM
- U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, NM

Coordination with the public and interested parties has taken place throughout the DEA. The public will be provided a 30-day review period of this DEA starting 14 August 2020.

USACE consulted with SHPO under Section 106 of the NHPA regarding the adverse effect determination for Alternative B: Buried Pipe and the effect to the staging area on 22 July 2020.

Consistent with the Department of Defense's American Indian and Alaska Native Policy, signed by Secretary of Defense William S. Cohen on October 28, 1998, and based on the State of New Mexico Indian Affairs Department and Historic Preservation Division's 2019 Native American Consultation List, American Indian Tribes that have indicated they have concerns in this portion of San Juan County, New Mexico, were sent tribal consultation letters on July 24, 2020. These tribes include the Navajo Nation, Ohkay Owingeh, the Pueblo of Laguna, the Southern Ute Tribe, the Ute Mountain Ute Tribe, the Hopi Tribe, and the Kiowa Tribe. Responses were received from the Navajo Nation and the Southern Ute Tribe, and both responses indicated that there were no cultural resource concerns with the project. Currently, there are no known cultural resources or traditional cultural properties concerns in the project APE.

Libraries and public locations for DEA

A hardcopy of the DEA is available for public review in the Bloomfield City Government Library in Bloomfield, NM.

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8. REFERENCES

Bennett, K.E., V.C. Tidwell, D. Llewellyn, S. Behery, L. Barrett, M. Stansbury and R.S. Middleton. 2019. Threats to a Colorado river provisioning basin under coupled future climate and societal scenarios. Environmental Research Communications 1 095001. <https://doi.org/10.1088/2515-7620/ab4028>

BISON-M [Biota Information System of New Mexico] 2020. BISON-M home page. <http://www.bison-m.org>. Accessed: July 13, 2020

Clow, D. W. (2010). Changes in the timing of snowmelt and streamflow in Colorado: a response to recent warming. Journal of Climate, 23(9), 2293-2306.

Geluso, K. 2006. Recurrence of the spotted bat and Allen's big eared bat in New Mexico. Share with Wildlife, New Mexico Department of Game and Fish, Contract #06-516.0000.0031.

Griffith, G.E., Omernik, J.M., McGraw, M.M., Jacobi, G.Z., Canavan, C.M., Schrader, T.S., Mercer, D., Hill, R., and Moran, B.C. 2006. Ecoregions of New Mexico (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000). Available: www.epa.gov/wed/pages/ecoregions.htm (accessed 17 July 2020).

Hunt, A.P. and S.G. Lucas. 1992. Stratigraphy, paleontology and age of the Fruitland and Kirtland Formations (Upper Cretaceous), San Juan Basin, New Mexico. *in: San Juan Basin IV*, Lucas, S. G.; Kues, B. S.; Williamson, T. E.; Hunt, A. P.; [eds.], New

Mexico Geological Society 43rd Annual Fall Field Conference Guidebook, 411 p.
Downloaded from: <http://nmgs.nmt.edu/publications/guidebooks/43>

New Mexico Bureau of Geology and Mineral Resources. 2003. Geologic Map of New Mexico. 1:500,000. A division of New Mexico institute of Mining and Technology. Published in cooperation with the U.S. Geological Survey.

New Mexico Environment Department, Surface Water Quality Bureau. 2012. Water Quality Summary for the San Juan and Animas Watersheds (Navajo Nation at the Hogback to the Colorado border) 2010.

New Mexico Rare Plant Technical Council. 1999. Albuquerque, NM: New Mexico Rare Plants Home Page. <https://nmrareplants.unm.edu>. Accessed: 9 July 2020.

Nydick, K., Crawford, J., Bidwell, M., Livensperger, C., Rangwala, I., and Cozetto, K. 2012. Climate Change Assessment for the San Juan Mountain Regions, Southwestern Colorado, USA: A Review of Scientific Research. Prepared by Mountain Studies Institute in cooperation with USDA San Juan National Forest Service and USDO Bureau of Land Management Tres Rios Field Office. Durango, CO.

Ruhlman, J., L. Gass, and B. Middleton. 2012. Arizona/New Mexico Plateau Ecoregion. Chapter 26 in: Status and Trends of Land Change in the Western United States—1973 to 2000 Ed. B.M. Sleeter, T.S. Wilson, and W. Acevedo. U.S. Geological Survey Professional Paper 1794–A, 2012. <https://doi.org/10.3133/pp1794A26>

USACE [U.S. Army Corps of Engineers] 1988. Environmental Assessment: Acequias irrigation system, New Mexico. Farmers Mutual ditch heading, San Juan River and Eledge ditch heading, Animas River, San Juan County, New Mexico. U.S. Army Corps of Engineers Albuquerque District, June 1988.

USACE [U.S. Army Corps of Engineers] 2002. Finding of no significant impact and Environmental Assessment: Conveyance treatment for Farmers Mutual Ditch, San Juan County, New Mexico. U.S. Army Corps of Engineers Albuquerque District, November 2002.

USDA [U.S. Department of Agriculture], Soil Conservation Service, United State Department of Interior, Bureau of Indian Affairs and Bureau of Reclamation, and New Mexico Agricultural Experiment Station. 1977. Soil Survey of San Juan County, New Mexico, Eastern Part. 173 pp.

USDA-NRCS Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at: <http://websoilsurvey.sc.egov.usda.gov/>. Accessed June 23, 2020.

Williams, Jerry L. 1986. New Mexico in Maps. Second edition. University of New Mexico Press, Albuquerque. 409 pp.