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# ABBREVIATIONS

AFY: Acre-Feet per Year
aMSL: Above Mean Sea Level
APE: Area of Potential Effect
bgs: below ground surface
BOR: Bureau of Reclamation
CCR: Consumer Confidence Report
CFR: Code of Federal Regulations
CPB: Construction Programs Bureau
DWB: Drinking Water Bureau
EID: Environmental Information Document
EMNRD: Energy Mineral and Natural Resources Department
EPA: Environmental Protection Agency
FEMA: Federal Emergency Management Agency
gpm: gallons per minute
GWQB: Ground Water Quality Bureau
hp: horse power
IHS: Indian Health Service
LCCA: Life Cycle Cost Analysis
LF: Linear foot
MCL: Maximum Contaminant Level
NECA: Navajo Engineering & Construction Authority
NMDGF: New Mexico Department of Game and Fish
NMDOT: New Mexico Department of Transportation
NMED: New Mexico Environment Department
NMHPD: New Mexico Historic Preservation Division
NMOSE: New Mexico Office of the State Engineer
NN: Navajo Nation
NNDWR: Navajo Nation Department of Water Resources
NNMP: Navajo Nation Municipal Pipeline
NPV: Net Present Value
NRCS: Natural Resources Conservation Service
NTUA: Navajo Tribal Utility Authority
psi: pounds per square inch

PVC: Polyvinyl Chloride
O&M: Operations and Maintenance
PER: Preliminary Engineering Report
PPA: Project Planning Area
ROW: Right of way
RUS: Rural Utilities Service
SDWA: Safe Drinking Water Act
SMA: Souder, Miller & Associates
SHPD: State Historic Preservation Division
SPPW (S): Single Payment Present Worth Salvage value
SWQB: Surface Water Quality Bureau
USACE: United States Army Core of Engineers
USDA: United States Department of Agriculture
USFS: United States Forest Service
USFWS: United States Fish &Wildlife Service
USPW: Uniform Series Present Worth

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# EXECUTIVE SUMMARY

Souder, Miller & Associates (SMA) prepared this Feasibility report for the Navajo Engineering & Construction Authority (NECA) and the US Bureau of Reclamation BOR.

This report evaluates alternatives for the Navajo Nation Municipal Pipeline (NNMP) Feasibility Study for the repair and/or reroute of the waterline failure on Bluff Road in the Upper Fruitland Chapter caused by a landslide.

# I. PROJECT PLANNING AREA

## A. LOCATION

The Upper Fruitland Chapter is located in San Juan County, NM along Indian Service Route 36 west of Bisti Highway 371. The Chapter itself is approximately 7 miles southwest of Farmington, NM. Refer to Figure I-1 below.

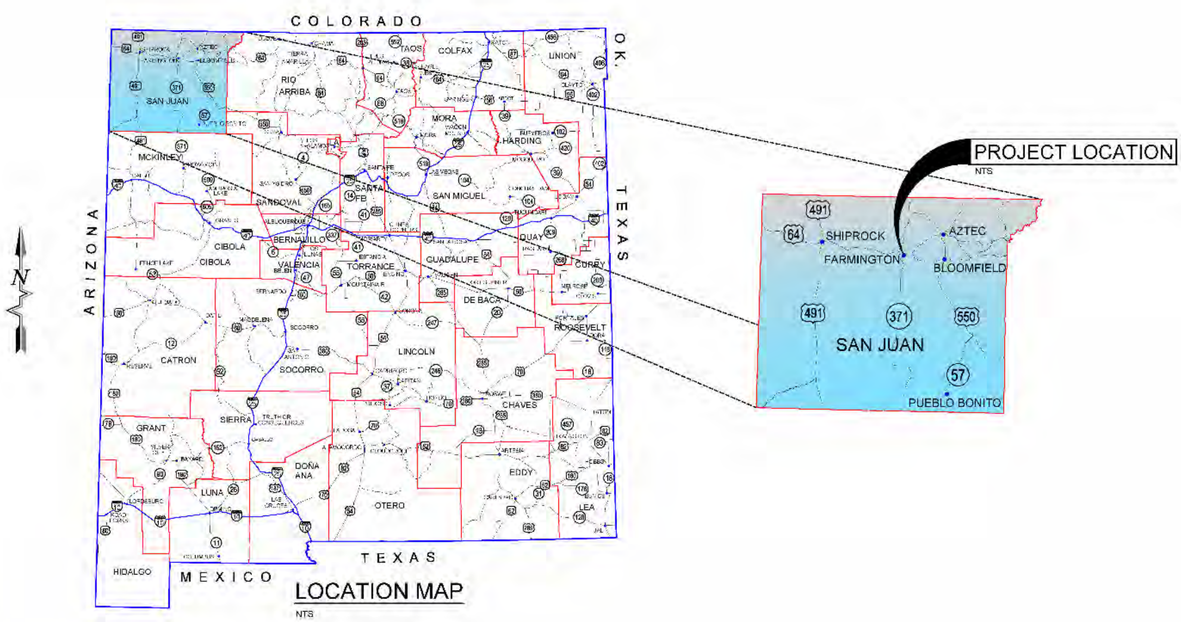


*Figure I-1. Project Location Map.*

The planned project area map is also shown below in Figure I-2.

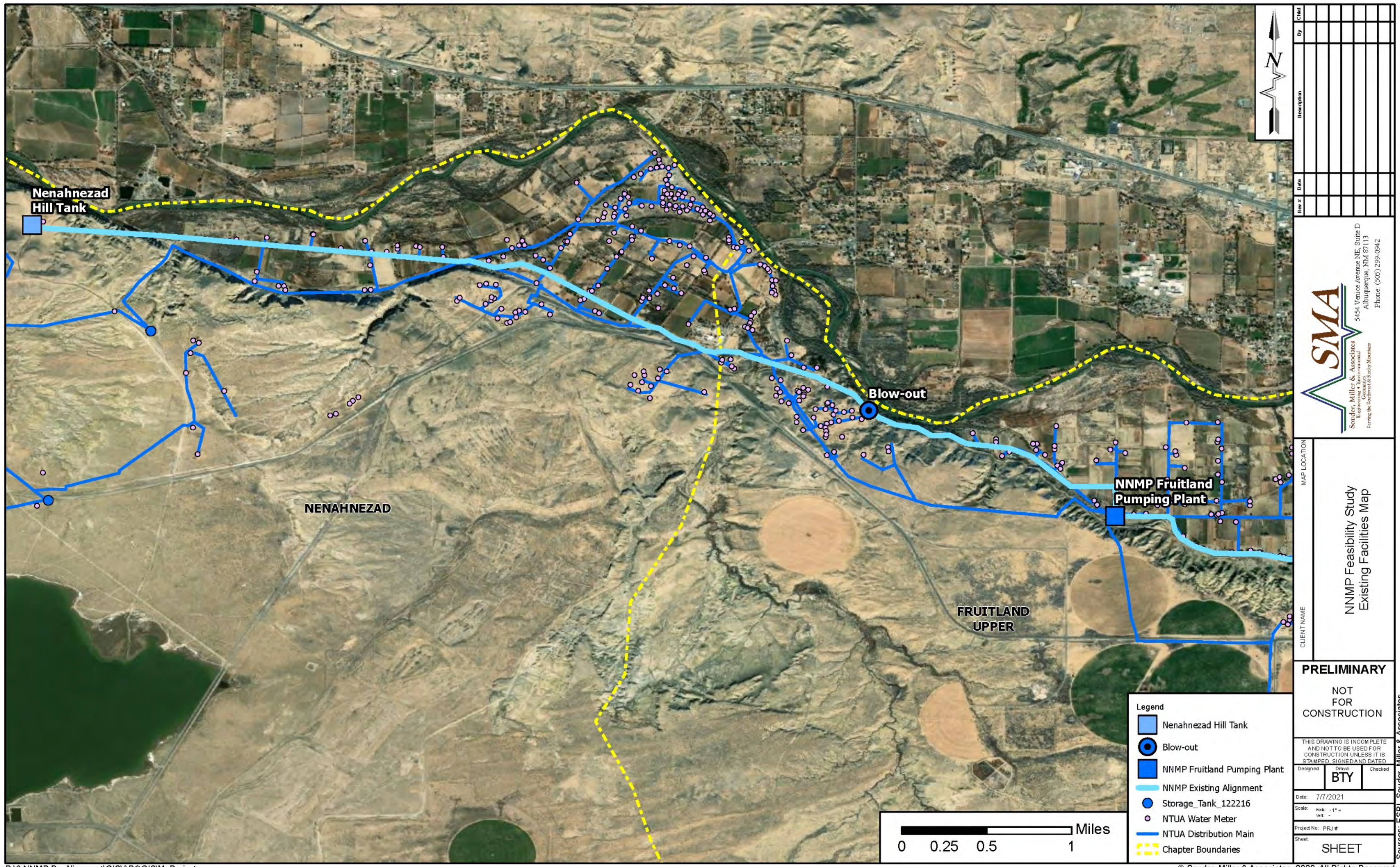


*Figure I*-2. Planned Project Area Map.

## B. Environmental Resources

This section describes the environmental resources present within the PPA. The improvements proposed in this PER will be almost entirely confined to areas that have previously been disturbed.

### 1. Land Status

The PPA is exclusively located on Navajo Tribal Trust (NTT) land according to Navajo Nation Land Department (NNLD) Geographic Information System (GIS) data.

### 2. Floodplains

The United States Department of Homeland Security Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) and National Flood Hazard Layer (NFHL) designate special flood hazard areas, base flood elevations, and insurance risk zones. The PPA is outside of the 100-year flood zone (Zone A), as shown in Figure 2 in Appendix A.

### 3. Historical Sites

The New Mexico Department of Cultural Affairs Historic Preservation Division (HPD) identifies, documents, evaluates, and registers prehistoric and historic properties throughout New Mexico. HPD does not have any records of historic, cultural, or archaeological sites within the APE.

The United States Department of the Interior National Park Service (NPS) maintains the National Register of Historic Places. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources. NPS does not have any records of historic, cultural, or archaeological sites within the APE/PPA.

If any archaeological resources are encountered during construction, work will immediately be stopped, and an archaeologist will be consulted to evaluate the significance of the discovery.

## D. COMMUNITY ENGAGEMENT

The Upper Fruitland Chapter of the Navajo Nation has been involved in the planning process of the realignment of the municipal pipeline. SMA has included the Chapter in the review of the proposed re-alignment alternatives and in official meetings regarding the status of this project. The community has provided feedback regarding their preferred alternatives proposed in this report that SMA has taken into consideration when recommending proposed alternatives.

SMA engages with BOR and NECA every month with updates for the project.

SMA, BOR, NECA, Shiprock Irrigation District, the Geotechnical subcontractor representatives met at the project site June 17th, 2021 to discuss the ongoing Upper Fruitland Canal Improvements project from Shiprock Irrigation District.

# II. EXISTING FACILITIES

The existing Upper Fruitland facilities consist of numerous water storage tanks and transmission and distribution/service pipelines that are depicted in *Figure I*-2 and in Appendix A. These facilities are based on data from previous Hydraulic reports provided by the Bureau of Reclamation, KMZ files provided by previous entities, GIS data from NTUA and field observations by SMA.

## A. Location Map

The existing Navajo Nation Municipal Pipeline system in the Upper Fruitland Chapter was previously depicted in *Figure I*-2 and is also located in Appendix A.

## B. History

The Navajo Nation Municipal Pipeline underwent design and construction in 2008 with the goal of designing and constructing a transmission pipeline to the area of the Navajo Nation encompassing the Farmington and Shiprock area by utilizing waters supplied from the Animas-La Plata (ALP) Project. The water supplied from the Animas-La Plata project would provide additional water for the existing distribution system operated by the Navajo Tribal Utility Authority (NTUA), the entire timeline of the Animas La Plata project is provided in the webpage in Appendix D. Based off previous data from a 1998 IHS design report provided in a 2008 BOR hydraulic study for the NNMP in Appendix D, the 2012 estimation of demand for water from IHS in 1998 was 2.5 million gallons per day (MGD) or 3.87 cubic feet per second (cfs) or 1741.5 gallons per minute (gpm) and after constructing a booster pumping plant in 2006 the flow was increased to a total flow of 3.2 MGD or 4.95 cfs (2227.5 gpm). The BOR report from 2004 updated the design flow criteria for the NNMP to 6.46 cfs (2907 gpm) with a total peak demand multiplier of 2, which corresponds to a final design flow of 12.92 cfs (5814 gpm), the design criteria from the BOR report is provided in Appendix D.

The original municipal pipeline built in the 1960s that runs from Farmington to Shiprock is made up of various pipe sizes ranging from 14 to 18-inch ductile iron pipe reducing in size when teeing off to distribution for residents. The pipeline teeing off from the Farmington reach to the Nenahnezad Tank (originally 500,000 gallons now sized to 1,000,000 gallons) is 18-inch cement lined ductile iron pipe. From the Nenahnezad Tank to the Shiprock/Cortez

Tanks (3,000,000 gallons) is a 14-inch pipe until it crosses the San Juan River outside of Hogback and increases back to 16-inch pipe. The 2008 NNMP Hydraulic Report then proposed a new design turning the entire Farmington-Shiprock reach into 24-inch PVC pipe that would connect to the distribution systems. A pressure-reducing valve (PRV) originally existed downstream of the Nenehnezad Tank that is now out of service as the current service lines have been equipped with individual PRV's. A general map of the NNMP system from the original BOR report is shown in *Figure II*-1 below and is also shown in Appendix D.

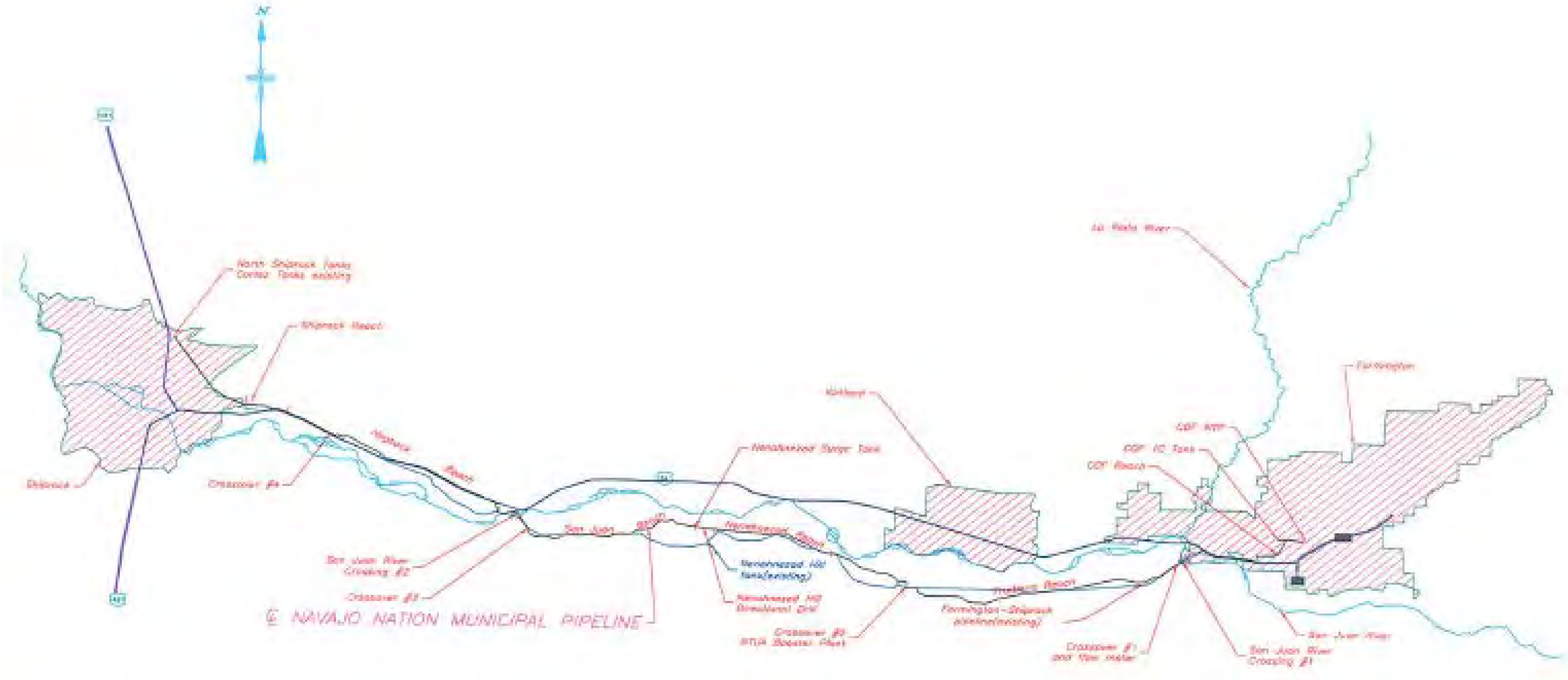


*Figure II*-1. General Map of the NNMP System from the NNMP Hydraulic Report from the Bureau of Reclamation.

A general hydraulic representation of the NNMP transmission system is shown below that displays the general stationing, crossover and booster station locations and tank configuration throughout Farmington and Shiprock reaches of the NNMP Animas La-Plata project in *Figure II*-2, it is also provided in Appendix D.

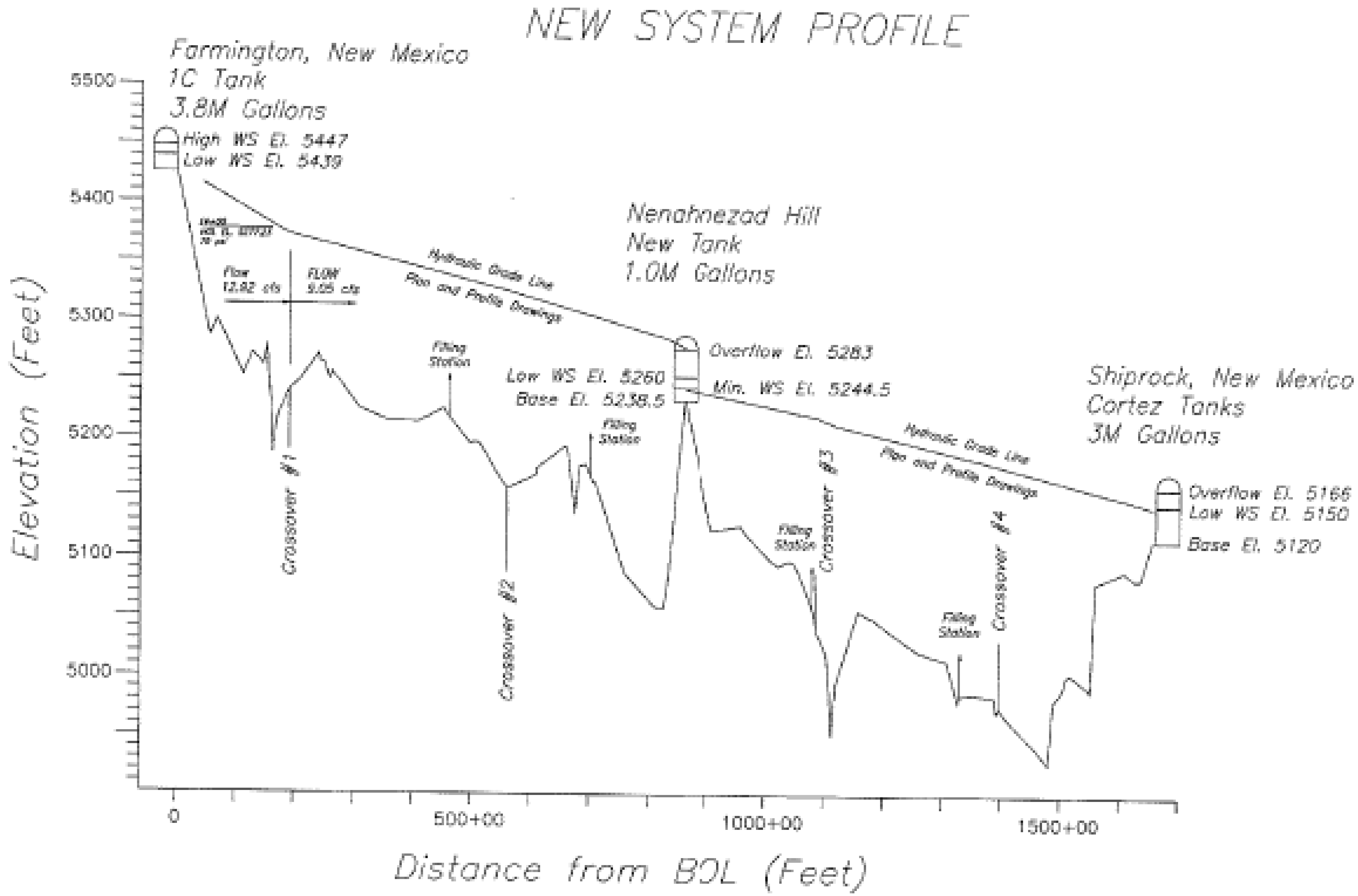


*Figure II-2. Hydraulic Profile of updated NNMP System in 2008 as Proposed by the NNMP Hydraulic Report from the Bureau of Reclamation.*

## C. Condition of Existing Facilities

The following subsections describe the current conditions and capacities of the existing water system components and their suitability for continued use. Descriptions and condition assessments of existing facilities are based on previous reports from various entities, information from the BOR, NECA, and site inspections from SMA and Subcontractors under SMA.

### 1. Water Source

The NNMP System was designed to be an augmentation of source water to the Navajo Nation under the Animas-La Plata Project. The Animas-La Plata Project was a larger project that which is supplied surface water from the Animas-La Plata River flowing south from La Plata that terminates into the west-flowing San Juan River near the East end of the Upper Fruitland Chapter. The Lower Animas River is a hydraulically complex perennial stream whose watershed is made up of numerous different types of streams from the Southern Rocky Mountains down to inflows from Silverton, CO to Farmington, NM, the report of the Animas River Watershed is provided in Appendix D. Historical design criteria from a previous 1998 NDWR report on the design of ALP states that the original amount of water conveyance was designed to be 4,560 acre-feet per year (afy) or 6.60 cubic cfs (2970 gpm) with a peaking factor of 2 for a total of 13.2 cfs (5940 gpm) or 8.53 MGD. Numerous reports changed this criterion throughout the years before the construction of the ALP. The 2008 BOR report settled on a design flow criterion of 4,680 afy or an average daily flow of 6.46 cfs (2907 gpm) with a maximum peak factor of 2. The design peak total demand was then settled on 12.92 cfs (5814 gpm) considering the maximum peak factor of 2, this would apply for the design of NNMP to satisfy IHS standards of water conveyance up to 2012 for the Farmington-Shiprock reach of the NNMP transmission line, the history of the design criteria changes are provided from the BOR hydraulic report in Appendix D.

Considering part of the ALP NNMP project passes through the city of Farmington, a city in San Juan County in with the state of New Mexico, the NMED standards for water sources may also apply. The New Mexico Environment Department (NMED) Construction Programs Bureau (CPB) *Recommended Standards for Water Facilities* (2006 Edition) states that the quantity of water supplied by a surface water source should "be adequate to meet the maximum projected water demand of the service area as shown by calculations based on the extreme drought of record while not significantly affecting the ecology of the water course downstream of the intake." Furthermore, the water source should "have the capacity to meet the system's maximum daily demand (MDD), and the system should be able to supply a minimum of four hours of peak hourly demand (PHD) with source capacity and storage capacity. Both the MDD and PHD requirements should be met in the system as a whole and in each individual pressure zone.".

Using the maximum peak demand flow from the 2008 BOR report of 12.92 cfs (5814 gpm), this can be correlated to the MDD and compared to the Animas rivers' capability of supplying said flow both historically and currently. According to data from the United State Geological Survey the existing gage station holds historical data that can be accessed from their surface water website, the figures are also provided in Appendix D. The Animas River gage station at Farmington is registered under surface water gage Station #09364500. A graph of discharge in cfs over the years 2008-2012 during the original design and construction of NNMP can be seen in the historical graph in *Figure II*-3 below.

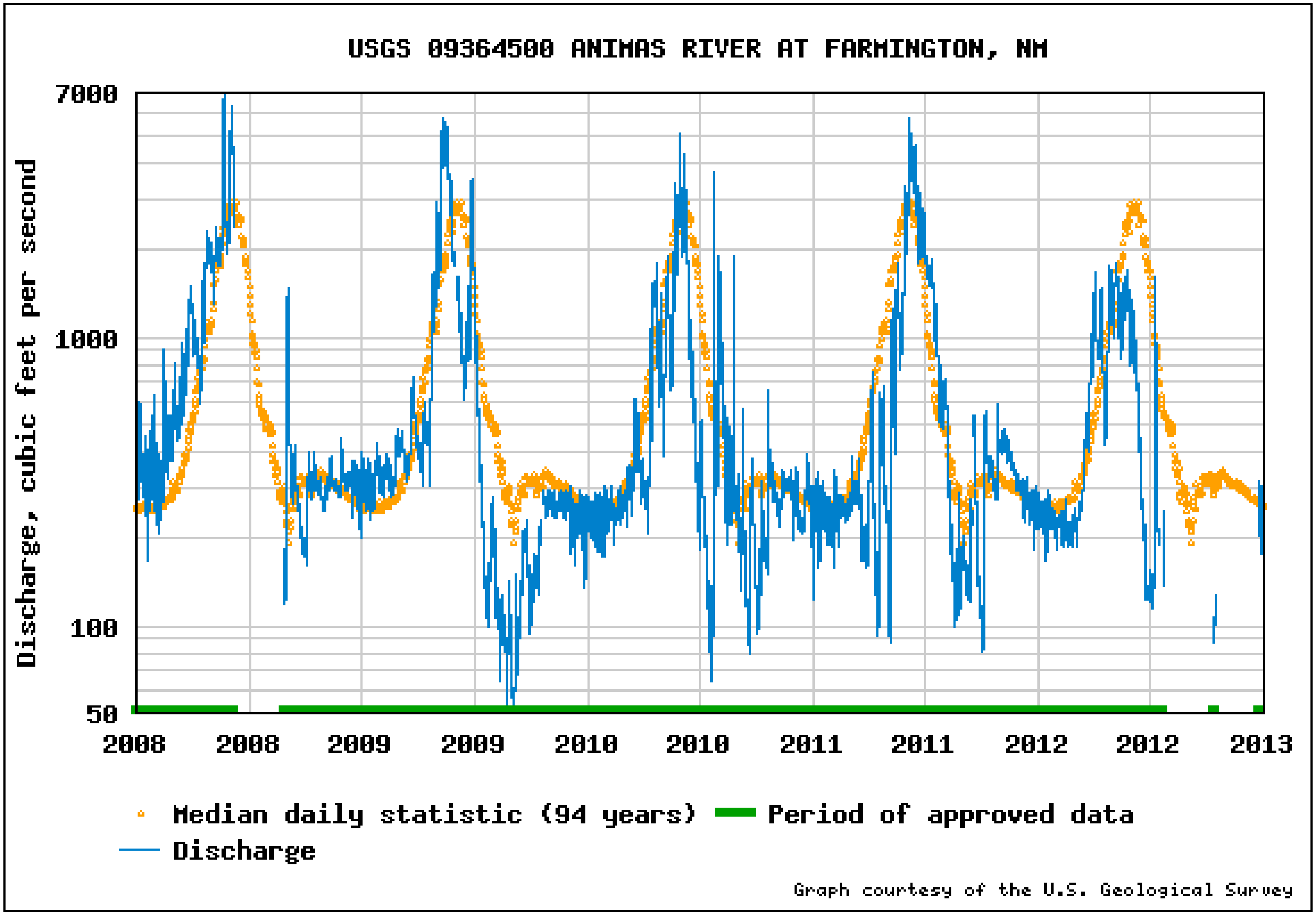


*Figure II-3. Graph displaying the measured and median daily discharge (cfs) of the Animas River at Farmington, NM over the years 2008-2012.*

The median daily discharge from *Figure II*-4 peaks at roughly 2000 cfs (900000 gpm) and bottoms out at roughly 200 cfs (90000 gpm) over the period of 5 years from 2008 and 2012. This graph indicates that the animas river could potentially supply the MDD of 12.92 cfs (5814 gpm) without considering the peak demands from the City of Farmington. A 2021 year-to-date graph of the same nature from USGS is shown below in *Figure II*-4 below for comparison.

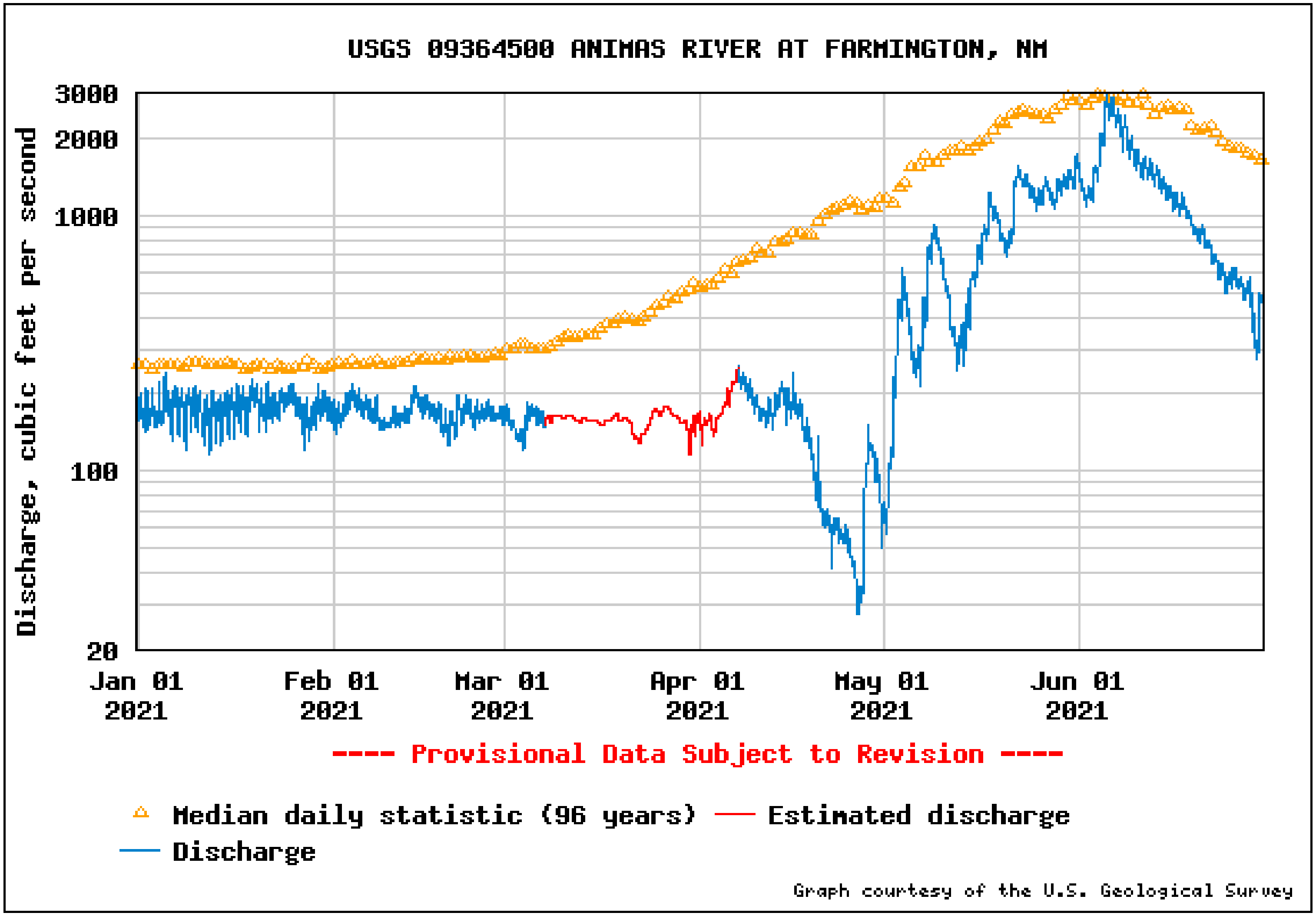


*Figure II*-4. Graph displaying the instantaneous and median daily discharge (cfs) for the Animas River at Farmington, NM for the period of January-June of 2021.

The median daily discharge from the *Figure II*-4 above displays a peak of roughly 3000 cfs (1350000 gpm) and a low of roughly 200-300 cfs (90000-135000 gpm) for the year of 2021 from January to June. According to the median daily discharge, this still meets the criteria of supplying 12.92 cfs (5814 gpm) as the MDD.

## 2. Water Transmission

Surface water for the NNMP was designed to be fed into the water distribution pipeline by way of a 24-inch PVC pipe transmission line previously mentioned that then travels on to serve numerous existing sizes of ductile iron pipe that direct into NTUA's distribution systems for residents in the area. This section that crosses over from Upper Fruitland area to the Shiprock Reach line of the NNMP is where the blowout has occurred on Bluff Road and has led to a halt on the conveyance of water through the NNMP pipeline. There is one existing NTUA pump station constructed in 2008 upstream of the Bluff Road blowout area whose location is shown in *Figure I*-2.

## 3. Water Storage

There are currently two existing water storage tanks on Nenehnezad Hill, one has a 500,00-gallon capacity and the other has a 1-million-gallon capacity (known as the New Nenehnezad Tank). The City of Farmington's 1C tank has a 3.8-million-gallon capacity, the BOR ALP NNMP Steel Tank Details regarding these storage tanks can be found in Appendix D. The New Nenehnezad storage tank has not been in use since the blowout occurred and is slated to be put back into operation once the NNMP is back online.

Previous existing WaterCAD hydraulic models per BOR's Hydraulic Report for the NNMP System can be found in Appendix D.

## 4. Fruitland Irrigation Canal

The Fruitland Irrigation Canal that the NNMP waterline parallels is owned by the Shiprock Irrigation District.

After the slough off occurred, the Navajo Nation made funding available to repair the irrigation canal at the damaged area. The canal is lined in some areas with an HDPE liner.

Per a Shiprock irrigation District representative, subsurface studies have been completed at the canal, and results indicate that only the damaged area showed moisture under the canal, and the rest of Bluff Road was dry. Visual observation shows leakage from the south side of the canal, which may be coming from the housing area above the canal. This leakage and high moisture content needs to be engineered to divert water away from the canal ROW, under the canal. This will restabilize the area for other development.

The Fruitland Canal will be replaced with two (2) 48-inch buried pipelines. The canal will be removed in this area, and the footprint of the new pipelines will follow the location that the canal currently is situated.

Construction drawings are completed for the canal replacement project and construction is scheduled to start in November 2021 after the irrigation season has ended. However, Shiprock Irrigation District personnel have stated that current funding constraints may delay the start of construction.

## 5. N367 Bluff Road

The road that the NNMP pipeline parallels is known as N367 aka Bluff Road. Prior to the slough off occurring, the road was controlled by the BIA road system. After the breach, the BIA removed it from their road system. The ownership of the canal was transferred to the Navajo Nation and the Shiprock Irrigation District. Presently the canal and maintenance road is withdrawn for irrigation purposes by the Navajo Nation.

Prior to the slough off, the road was regularly used by community members. Currently, the road is blocked off by jersey barriers, and can only be accessed for irrigation system maintenance due to safety concerns by the Shiprock Irrigation District. The Upper Fruitland community members would prefer to have the road repaired and open for public traffic.

Other areas along the northern side of the road shows erosion which may also need to be stabilized.

The slough off areas were backfilled, so maintenance vehicles can go back and forth. No armor will be placed on the slope, just backfilled.

A representative from Upper Fruitland Chapter contacted SMA and stated that the elected officials and Chapter staff have been discussing the issues related to the road. The Chapter stated that if the road is not repairable, there is a strong possibility to plan on converting that roadway into a river walk for community members to use.

# III. NEED FOR PROJECT

The existing Municipal Pipeline following the San Juan River Canal on Bluff Road in the Upper Fruitland Chapter was washed out by a landslide. The landslide blew out part of the pipeline and the road resulting in pipe exposure and damage to the paved road. The chapter has relayed to SMA the need for the repair of this pipeline and if possible, the area of Bluff Road that has been damaged since residents had previously utilized the road for travel. This blowout has halted operation of the NNMP that serves as an augmentation of the Animas La-Plata Project.

## A. Aging Infrastructure

Existing facilities within the immediate area of the pipeline blowout include a partially lined canal that conveys irrigation water along Bluff Road for residents in the area and is also paralleled by the San Juan River for a stretch before it deviates north on a bend. The existing NTUA distribution lines have been in operation since their original construction in 1969, and the Animas-La Plata transmission lines have been in operation since construction in 2012 aside from the NNMP portion of the system.

A Geotechnical investigation and report completed by Western Technologies Inc. (WTI) for the blowout area along Bluff Road was submitted to SMA that provides design recommendations for the different alternatives considered for this project following conclusions drawn from the subsurface investigation, the report is provided in Appendix D.

# IV. ALTERNATIVES CONSIDERED

The alternatives considered in this report include:

Alternative 0 – No Action
Alternative 1 – Horizontal Directional Drilling (HDD) for Bluff Road
Alternative 4 – Pipeline Reroute to Fruitland Pumping Plant
Alternative 5 – Pipeline Repair and Fruitland Canal Improvements
Alternative 6 - Horizontal Directional Drilling (HDD) for Mesa

Alternatives 2 and 3 (not listed) were considered for evaluation that involved a longer reroute that would tee off from the NNMP mainline roughly 2.72 miles east of the blowout area. These alternatives involved a pipeline reroute that would travel south and encroach through Navajo Agricultural Products Industry (NAPI) Farmlands and travel west where it would tie back into the western end of NNMP at the Bluff Road crossroads with Navajo Route 36. These alternatives were considered for evaluation in the preliminary stages of project scoping but through correspondence with the chapter, BOR, and NECA, were deemed to not be fully feasible to be analyzed is in this report.

## A. Water Supply Alternative 0: No Action

### 1. Description

Under Water Supply Alternative 0, no improvements will be made, and no construction will take place.

Under this scenario, the NNMP waterline would not be repaired and would continue to be not operational. This alternative would not meet the goals of the ALP NNMP project.

The are no advantages of not repairing the NNMP pipeline.

### 2. Design Criteria

There are no design criteria for this alternative.

### 3. Map

The existing system, without improvements, is shown in *Figure IV*-1 below and in Appendix D.

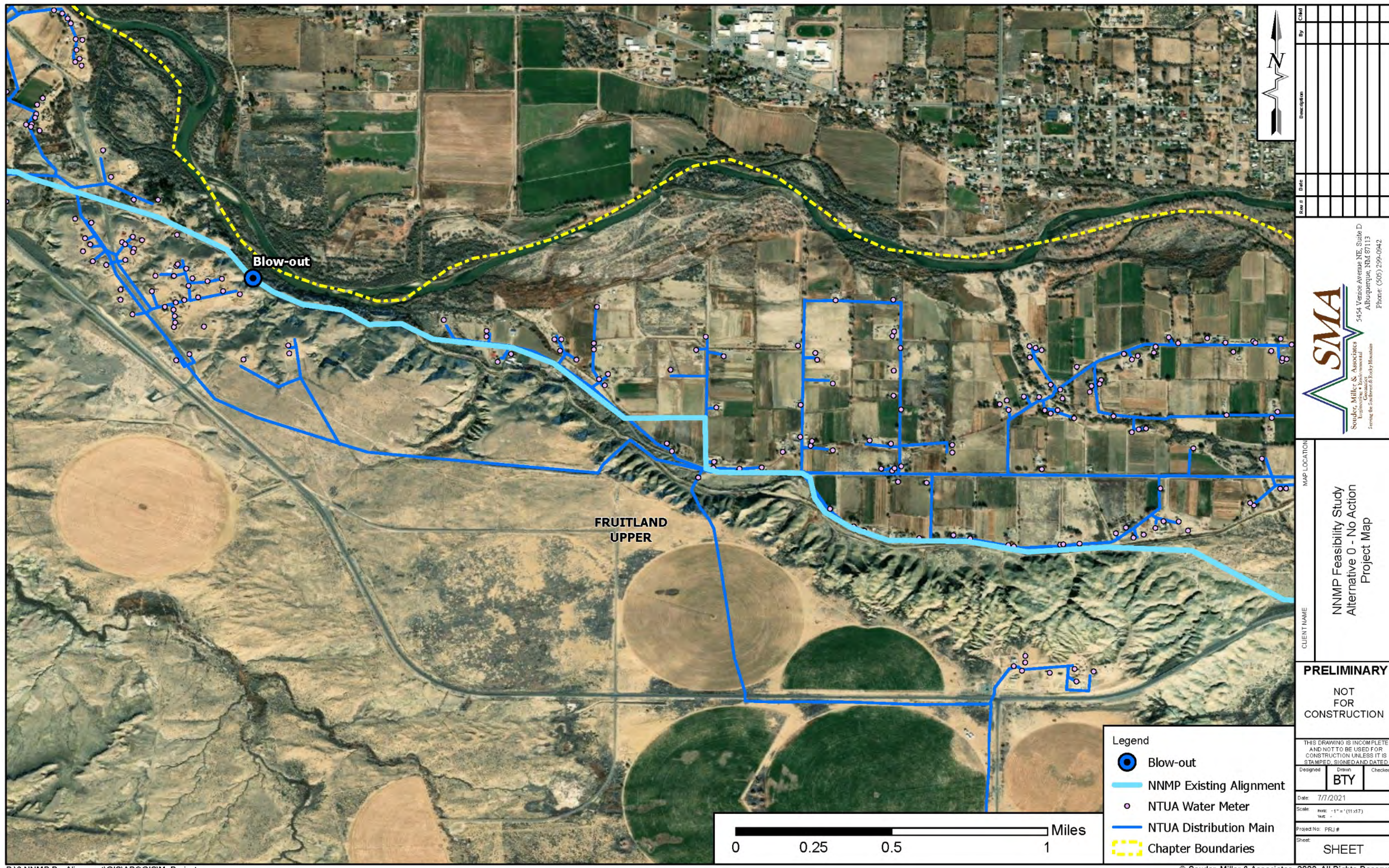


*Figure IV*-I. Map Depicting the Alternative 0 – No Action Alternative for the NNMP Project.

### 4. Environmental Impacts

There are no environmental impacts associated with this alternative as no construction or invasive improvements will take place.

### 5. Land Requirements

There are no land requirements for this alternative.

### 6. Potential Construction Problems

Construction will not occur under this alternative.

### 7. Cost Estimate

The total capital cost for Alternative 0 is $0.00. NTUA's O&M costs are expected to be unchanged.

Under the No Action Alternative, NTUA must continue to plan and budget accordingly for the current O&M costs.

## B. Alternative 1: Horizontal Directional Drill (HDD) for Bluff Road

### 1. Description

For this alternative, the NNMP pipeline on Bluff Road would be installed via HDD to secure the pipe within the underlying bed rock to protect from future risk of landslide. The existing pipeline along Bluff Road would be abandoned.

The NNMP pipeline would be installed via HDD at a depth at which future landslides would not affect the pipeline. Additionally, the HDPE material used for the mainline is fused together and would be more robust than sectionally installed pipe if the pipeline were ever exposed again.

The pipeline will be installed within the current extents of the existing ROW. However, additional ROW for the drill rig, mud pits, setup and laydown area needed for the HDD installation may be required. A Chapter Resolution from the Upper Fruitland Chapter supporting the project might not be required.

Under this alternative, no slope stabilization measures would be required. It is expected that the likelihood of landslides / slough offs in the future will occur.

It is assumed that the Bluff Road repairs made by the Shiprock Irrigation District's future project will occur, and the road will be safe for maintenance vehicles to access the NNMP pipeline, and no additional repairs of the road are required.

The NNMP's hydraulics will remain very similar to the original design. The water pressure coming into and exiting the repaired area will remain very similar to the original design. The system will continue to be operated by gravity and there is no need for a new pump station. However, the pressure inside of the waterline that is installed by HDD will increase from the original design due to the deeper installation.

Proposed total HDD length is roughly 0.96 miles of 24-inch diameter HDPE pipeline with an approximate depth of bury of 50 feet. The inner dimension (ID) of the HDPE pipeline will be designed to match that of the current ID of the installed NNMP waterline.

## 2. Design Criteria

Bureau of Reclamation design criteria will be followed, see Appendix D. AWWA recommended design standards will be applied when applicable, the design will meet all Navajo Nation EPA and US EPA water standards.

The design flowrate for the entire NNMP system is 12.92 cfs (5814 gpm). From the original BOR report for the design of the NNMP system, the City of Farmington was contracted to supply water at the meter vault for NNMP at 60 pounds per square inch (psi). The pressures of the system did vary between two different flows at varying pressures for each Chapter served: 60 and 70 psi. These flowrates (determined by flow being supplied from storage or purely pipeline capacity) were stated to be 1.89 cfs (850.50 gpm) at 60 psi and 2.17 cfs (976.50 gpm) at 70 psi for the Fruitland Chapter. The varied flows for Nenehnezad Chapter were 1.04 cfs (468 gpm)at 60 psi and 1.19 cfs (535.50 gpm) at 70 psi, the table containing this information is provided in Appendix D.

Pipe DR will be sized based upon safe HDD design criteria. Plastics Pipe Institute (PPI) technical guidelines shall be applied. Handbook of PE pipe, 2$^{nd}$ edition Chapter 12 Horizontal Directional Drill operation and installation criteria and methodology.

Six (6) Geotechnical borings were completed along the proposed alignment of the HDD to an approximate depth of 32'. No bed rock was encountered from the geotechnical borings. However, shale was encountered at varying depths between 7 & 40 feet that were inconsistent and difficult to draw conclusions from across the boring areas. Cobble was also encountered.

Correspondence with NECA and HDD drillers tells that for this alternative drilling into solid bed rock would be better to place pipe in, to assure that the areas where soil could be easily compromised can be avoided. Considering the variance in depth to shale and cobble during boring, this would lead to potentially having to drill into the 40 or 50-feet range for HDD to reach bed rock. At 40-50 feet drilling depth, the drilling process becomes complex, usually requiring a special guidance system and software for hydrofracture probability calculation and drilling parameters. The bed rock would also need to be solid enough to withstand the static soil pressure as well as pressures from the drilling process. Cost would increase if this method of drilling were used, and it might be difficult to find local drillers that could employ this method.

### 3. Map

A map depicting the planned project area proposed under Alternative #1 is included in *Figure IV*-2 below.

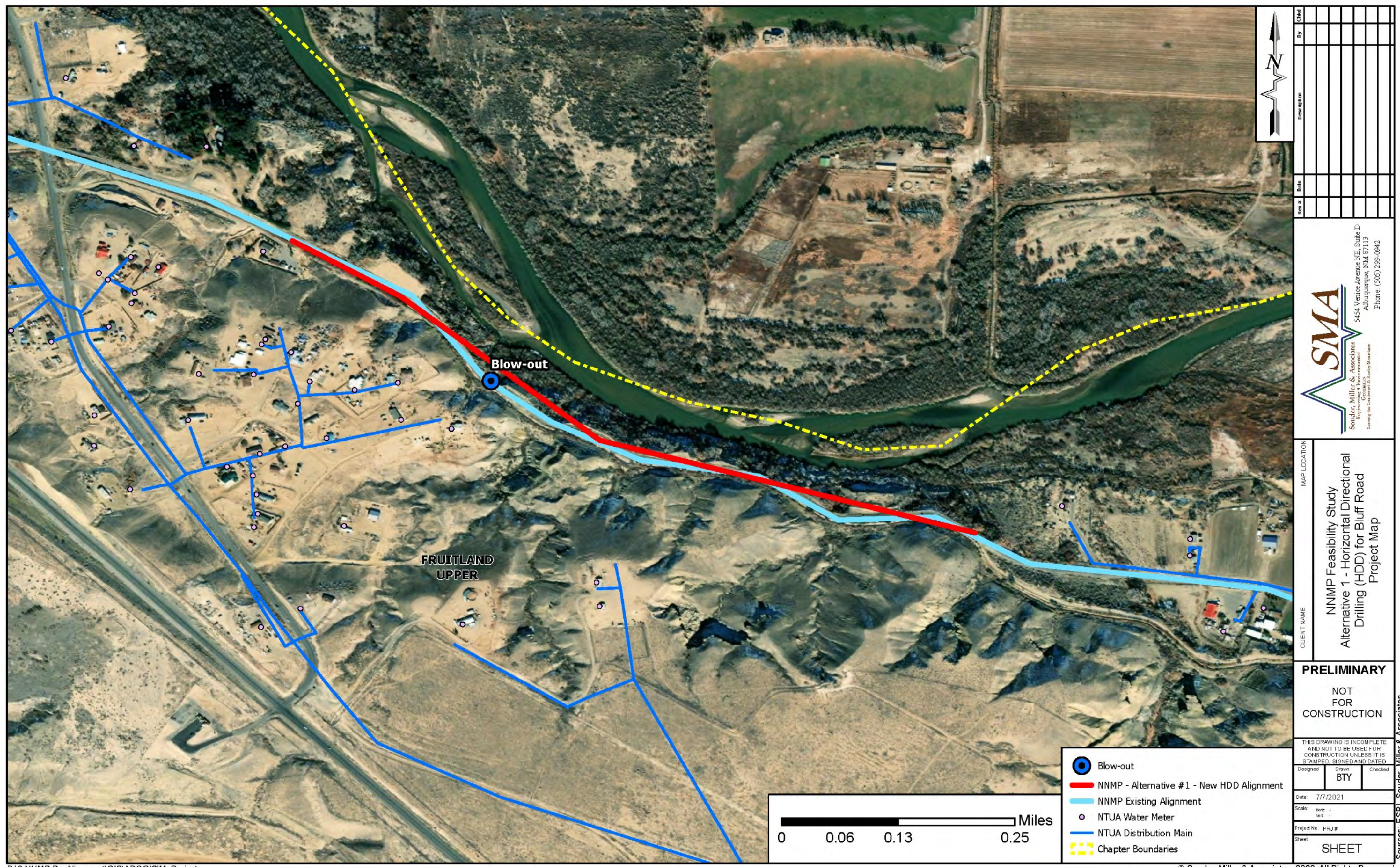


*Figure IV-2. Map Depicting the Alternative 1 – HDD Reroute Alternative for the NNMP Project.*

## 4. Environmental Impacts

HDD Shall be installed within existing NNMP right-of-way (ROW). New disturbance would include areas to be cleared for the HDD equipment, pipe laydown area, and drill pits. Other than disturbances at the beginning and ends of drill, the impacts will be minimal.

Impacts from HDD includes introduction of drilling mud the ground disturbance intensive process of boring through existing shale through the drilling depth area. The HDD process of introducing fluid while drilling could also risk compromising soil integrity.

## 5. Land Requirements

All work will be performed on Navajo Nation Tribal Trust Land all work shall be within existing NNMP ROW. A Stormwater Pollution Protection Plan (SWPP) may or may not be required for this alternative, depending upon the area that will be disturbed by the HDD construction.

Findings from the geotechnical investigation show that the depth to shale. Bedrock was not encountered during drilling.

## 6. Potential Construction Problems

The construction phase of this alternative will potentially encounter cobble during the HDD construction. The Bluff Road blowout area is narrow and highly steep on either side of the road, which could pose a potential safety hazard in getting large construction equipment near the blowout area and workers working near the bottom of the mesa as well as near the steep downward slope. This alternative also will not repair the road which would not fully satisfy the wishes of the chapter who have heavily stated their desire to fix the road in addition to the blowout.

Frac-out is also a potential problem when drilling with HDD. Considering the soft soil composition of the blowout/bluff road area and how easily it can be compromised when exposed to moisture, this could become an access issue for construction vehicles. The lack of space on Bluff Road along with the current condition of the road and hill below the road could elevate the normally minor effect of frac-out.

## 7. Cost Estimate

The total capital cost for the construction and design of Alternative #1 is $#,###,###.##. The anticipated O&M costs are $##,###.##. Capital and O&M costs are summarized in Appendix F.

## 8. Advantages and Disadvantages

Advantages for this alternative are:

1. The NNMP will continue to be a gravity system and no pumping plant will be required.
2. This alternative has a lower O&M cost than Alternative #4 since there is no additional pump station.
3. The pipeline will be installed within the existing Right-of-Way and no additional ROW or TAA will be required for the pipeline.
4. The HDPE pipeline will be a fused pipe system and has potential to withstand future landslides.
5. The pipeline will be buried deep, and future surface landslides might not affect pipe.
6. Improvements to the road not required (assume that Shiprock Irrigation District's project will improve road to be safe for maintenance vehicle traffic.
7. Slope stabilization is not required.

Disadvantages for this alternative are:

1. Additional ROW or TAA may be required to ensure there is enough space to accommodate the HDD drill operations.
2. Upper Fruitland Chapter Resolution may not be required since additional ROW may not be required.
3. There are inherent risks associated with HDD, including encountering cobble and frac of drilling fluids.
4. There will still be a high likelihood of future slough outs.

## C. Alternative 4: Pipeline Reroute to Fruitland Pumping Plant

### 1. Description

For this alternative, the NNMP pipeline would be rerouted to avoid Bluff Road. The waterline alignment would be routed above the current location onto the mesa to the south. The existing pipeline along Bluff Road would be abandoned.

A pumping plant would be required to boost the hydraulic grade line (HGL) of the waterline over the mesa. The location of the pumping plant will be near the existing NTUA distribution pumping plant. A surge tank might be required based upon transients report. The pump station would require a new pump site, a power drop, SCADA, site grading, and fencing.

The pipeline alignment would traverse up the mesa to the south. HDD would be used to install the pipeline up the slope of the mesa. Once on top of the mesa, the alignment parallels existing roads and is routed through a neighborhood. There are many subsurface existing utilities within this area.

Community support is a potential issue with this alternative. Previous attempts at rerouting through this neighborhood was not supported by the community. ROW acquisition through this area could be problematic.

The total reroute length is roughly 1.90 miles of 24-inch PVC pipeline and roughly 0.22 miles of 24-inch HDPE pipeline. Pumping plant horsepower is approximately 20.85 horsepower.

### 2. Design Criteria

Bureau of Reclamation design criteria will be followed (see Appendix D). AWWA recommended design standards will be applied when applicable, the design will meet all Navajo Nation EPA and US EPA water standards.

The design flowrate for the entire NNMP system is 12.92 cfs (5814 gpm). From the original BOR report for the design of the NNMP system, the City of Farmington was contracted to supply water at the meter vault for NNMP at 60 pounds per square inch (psi). The pressures of the system did vary between two different flows at varying pressures for each Chapter served: 60 and 70 psi. These flowrates (determined by flow being supplied from storage or purely pipeline capacity) were stated to be 1.89 cfs (850.50 gpm) at 60 psi and 2.17 cfs (976.50 gpm) at 70 psi for the Fruitland Chapter. The varied flows for Nenehnezad Chapter were 1.04 (468 gpm) cfs at 60 psi and 1.19 cfs (535.50 gpm) at 70 psi, the table containing this information is provided in Appendix D.

### 3. Map

A map depicting the planned pipeline reroute and proposed pumping plant area proposed under Alternative #4 is included in *Figure IV*-3 below.

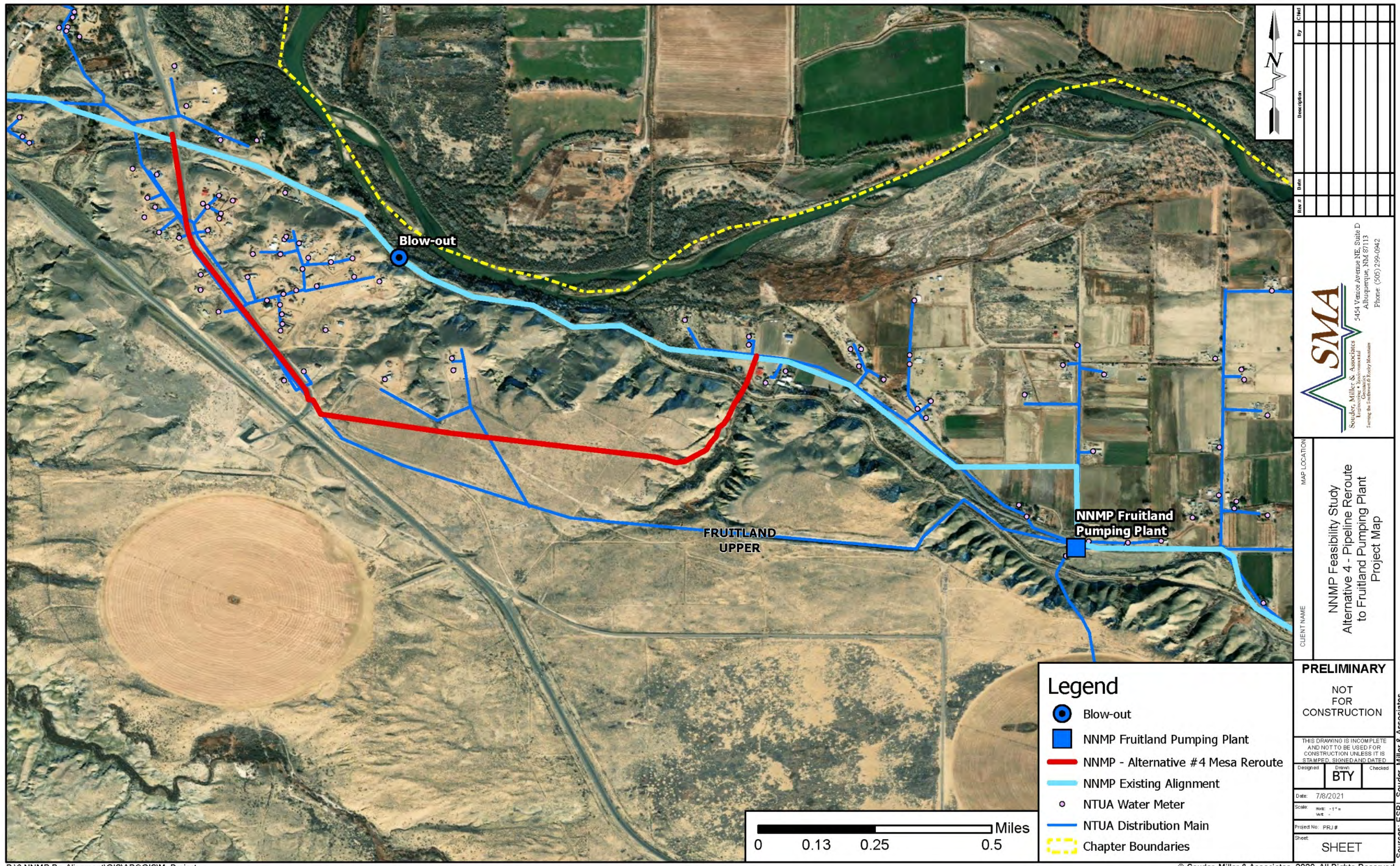


*Figure IV-3. Map Depicting the Alternative 4 – Pipeline Reroute to Pumping Plant Alternative for the NNMP Project.*

## 4. Environmental Impacts

This alternative includes the installation of new pipeline that will encroach from the mesa to the existing Fruitland Pumping Plant lying roughly 1.34 miles East of the blowout area. This pipeline will involve ground disturbance by way of trenching as well as any HDD that might occur up the mesa. The pipeline will also parallel and may cross existing public roadways that are within previously disturbed neighborhoods in the Upper Fruitland area.

## 5. Land Requirements

All work will be performed on Navajo Nation Tribal Trust Land which will require ROW or TAA acquisition. This alternative will also require a SWPPP and water discharging permits depending on the final design. This alternative offers the most new land disturbance and land use out of any of the alternatives.

## 6. Potential Construction Problems

Some potential construction problems include the HDD for the pipeline coming up the mesa would also be a potential issue for this alternative; in addition, cobble may be encountered for the HDD. The possibility of any road parallels or crossings of the pipeline within the ROW of any state roads will require proper NMDOT permits and the submission of traffic control plans, which would require safer and more meticulous conduct in the construction of the pipeline as public roads are approached.

## 7. Cost Estimate

The total capital cost for the construction and design Alternative #4 is $#,###,###.##. The anticipated O&M costs are $##,###.##. Capital and O&M costs are summarized in Appendix F.

## 8. Advantages and Disadvantages

Advantages to this alternative are:

1. Rerouting the waterline away from Bluff Road, the waterline has the potential to be installed in more reliable soil and mitigate the landslide concern along Bluff Road.

2. The pump station has the potential to be sized for a greater future pipeline flowrate demands.

Disadvantages to this alternative are:

1. Pumped system.
    a. Higher Capital Cost.
    b. Pump requires O&M.
    c. Electrical cost.
    d. Adds complexity to design.
    e. Additional site for NTUA to maintain.
2. Right-of-Way or a TAA will need to be acquired.
3. Community support might not exist. Previous attempts at rerouting through this neighborhood was not supported by the community. ROW acquisition through this area could be problematic.
4. A new site will be required and maintained by NTUA.
5. The magnitude of the project is greater, and construction has the potential to take longer.
6. Powerline service will be required.
7. SCADA communications will be required.

## D. Alternative 5: Pipeline Repair and Fruitland Canal Improvements

### 1. Description

For this alternative, the sections of the NNMP pipeline that were damaged from the slough off would be repaired. Damaged sections of the pipeline would be removed and replaced with the same size and type of the existing pipeline.

Due to the nature of the expansive soils present throughout the Bluff Road mesa area, the slope in this area would be stabilized based upon design by the geotechnical engineer.

The Shiprock irrigation District will replace the Fruitland Canal will be replaced with two (2) 48" diameter pipelines in this area. By routing the irrigation water through pipelines, there is the potential that there will be less leakage of irrigation water, which could help the slopes stabilization.

It is assumed that the Bluff Road repairs made by the Shiprock Irrigation District's future project will occur, and the road will be safe for maintenance vehicles to access the NNMP pipeline, and no additional repairs of the road are required.

After a site visit with all entities involved, it was determined that the repair of Bluff Road may not be a possibility due to the danger future landsides and hill erosion pose for the portion of Bluff Road that cuts through the mesa.

Even with the slope stabilization measures in place, there is still a potential for future slough offs to damage the pipeline.

## 2. Design Criteria

Bureau of Reclamation design criteria will be followed (see Appendix D). AWWA recommended design standards will be applied when applicable, the design will meet all Navajo Nation EPA and US EPA water standards.

The design flowrate for the entire NNMP system is 12.92 cfs (5814 gpm). From the original BOR report for the design of the NNMP system, the City of Farmington was contracted to supply water at the meter vault for NNMP at 60 pounds per square inch (psi). The pressures of the system did vary between two different flows at varying pressures for each Chapter served: 60 and 70 psi. These flowrates (determined by flow being supplied from storage or purely pipeline capacity) were stated to be 1.89 cfs (850.50 gpm) at 60 psi and 2.17 cfs (976.50 gpm) at 70 psi for the Fruitland Chapter. The varied flows for Nenehnezad Chapter were 1.04 (468 gpm) cfs at 60 psi and 1.19 cfs (535.50 gpm) at 70 psi, the table containing this information is provided in Appendix D. Due to the nature of this alternative, the hydraulics would remain largely unchanged by any rehab and improvements made for the blowout area.

As commented on for this alternative by the Geotech report, the canal improvements would include adding slope stabilization for the blowout area after rehabilitation on the pipeline, the Geotech report is provided in Appendix D. During a site visit with the entities involved in this project, it was determined that slope stabilization by way of soil nails might be needed for the entirety of the blowout area surrounding if not the whole mesa area with 80-to-100-foot tie backs. Active slides down the hill were also observed during this site visit.

## 3. Map

A map depicting the pipeline rehabilitation and canal improvements proposed under Alternative #5 is included in *Figure IV*-4 below.

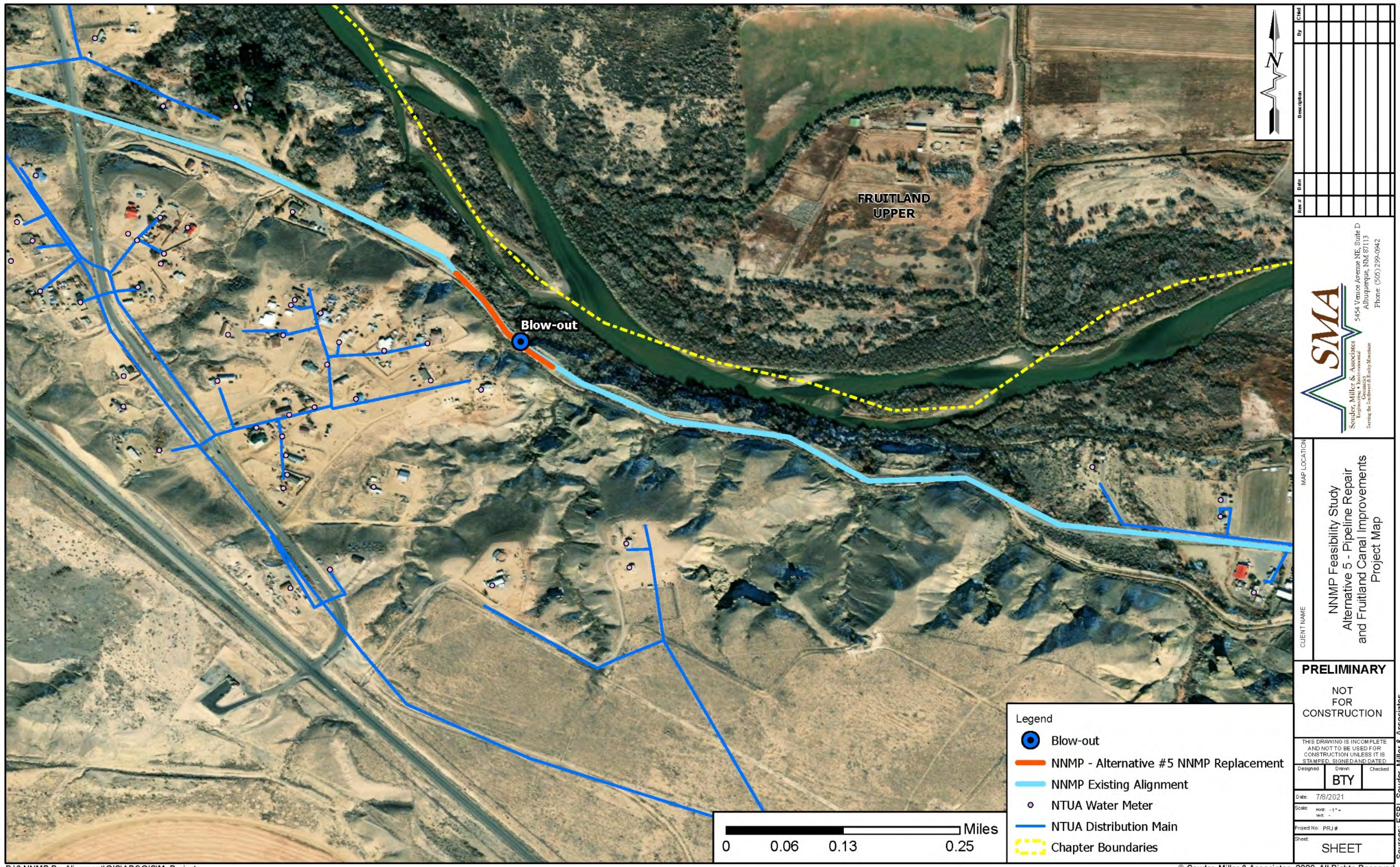


*Figure IV-4. Map Depicting the Alternative 5 – Pipeline Repair and Canal Improvements Alternative for the NNMP Project.*

### 4. Environmental Impacts

All work will be performed on Navajo Nation Tribal Trust Land all work shall be within existing NNMP ROW, there will be no further environmental impacts aside from the rehabilitation and slope stabilization in the blowout area.

### 5. Land Requirements

All work on the pipeline will be performed on Navajo Nation Tribal Trust Land and within existing NNMP ROW. However, the slope stabilization effort will extend beyond the ROW limits and additional land will need to be acquired. A SWPP may not be necessary for this alternative.

### 6. Potential Construction Problems

Potential issues during the construction phase of this alternative would include resolving the coordination of stabilizing the slope near the blowout rehab area. This option would also require approval and cross-coordination with multiple entities such as Navajo Nation Department of Water Resources (NNDWR) and the Bureau of Indian Affairs (BIA) to allow the pipeline rehab and canal improvements.

### 7. Cost Estimate

The total capital cost for the construction and design of Alternative #5 is $#,###,###.##. The anticipated O&M costs are $##,###.##. Capital and O&M costs are summarized in Appendix F.

### 8. Advantages and Disadvantages

Advantages to this alternative are:

1. The NNMP will continue to be a gravity system and no pumping plant will be required.
2. The pipeline itself will stay within existing ROW (however, additional ROW will be required for slope stabilization).
3. The pipeline repair improvements would have shorter construction period.
4. The existing pipeline that was already constructed, would be used and not abandoned.
5. Improvements to the road not required (assume that Shiprock Irrigation District's project will improve road to be safe for maintenance vehicle traffic.

Disadvantages to this alternative are:

1. High Capital Cost due to slope stabilization requirements to prevent future blowouts and erosion.
2. Even with slope stabilization measures in place, there is a possibility of future slough offs in areas which have not been improved.
3. Hill erosion below the pipeline is evident and slope stabilization would be needed.
4. ROW acquisition will be required for slope stabilization.
5. Shale was encountered in varying depths along the different bores performed by the Geotechnical contractor, which makes it difficult to draw conclusions about subsurface composition that would assist the construction process.

## E. Alternative 6: Horizontal Directional Drill (HDD) for Mesa

### 1. Description

For this alternative, the NNMP pipeline would be rerouted to avoid Bluff Road. The waterline alignment would be routed above the current location onto the mesa to the south. The pipeline would be installed via HDD at a depth below the HGL of the tie in. This would allow the system to continue to run by gravity and avoid having to construct the new pump station presented in Alternative 4. This alternative would not require pumping water over the mesa, instead it would flow by gravity through the pipe that cuts into mesa.

In addition to allowing the system to run by gravity, the HDD install would secure the pipe within the underlying bed rock to protect from future risk of landslide. The existing pipeline along Bluff Road would be abandoned.

The pipeline alignment would traverse up the mesa to the south. HDD would be used to install the pipeline up the slope of the mesa and deep bury until the ground elevation is lower than the incoming HGL plus any head loss through the pipe. The pipe would need to be buried between 35 and 53 feet deep under the highest point of the mesa. The pipe could be installed deeper to add more pressure in the waterline and add a factor of safety.

Once on top of the mesa, the alignment parallels existing roads and is routed through a neighborhood. There are many subsurface existing utilities within this area.

Community support is a potential issue with this alternative. Previous attempts at rerouting through this neighborhood was not supported by the community. ROW acquisition through this area could be problematic.

Proposed total HDD length is roughly 1.58 miles of 24-inch diameter HDPE pipeline with an approximate depth of bury of 35 to 53 feet. Proposed total open cut length is roughly 0.54 miles of 24-inch diameter PVC pipeline with an approximate depth of bury of 4 ft. The inner dimension (ID) of the HDPE pipeline will be designed to match that of the current ID of the installed NNMP waterline.

## 2. Design Criteria

Bureau of Reclamation design criteria will be followed, see Appendix D. AWWA recommended design standards will be applied when applicable, the design will meet all Navajo Nation EPA and US EPA water standards.

The design flowrate for the entire NNMP system is 12.92 cfs (5814 gpm). From the original BOR report for the design of the NNMP system, the City of Farmington was contracted to supply water at the meter vault for NNMP at 60 pounds per square inch (psi). The pressures of the system did vary between two different flows at varying pressures for each Chapter served: 60 and 70 psi. These flowrates (determined by flow being supplied from storage or purely pipeline capacity) were stated to be 1.89 cfs (850.50 gpm) at 60 psi and 2.17 cfs (976.50 gpm) at 70 psi for the Fruitland Chapter. The varied flows for Nenehnezad Chapter were 1.04 (468 gpm) cfs at 60 psi and 1.19 cfs (535.50 gpm) at 70 psi, the table containing this information is provided in Appendix D.

Pipe DR will be sized based upon safe HDD design criteria. Plastics Pipe Institute (PPI) technical guidelines shall be applied. Handbook of PE pipe, 2nd edition Chapter 12 Horizontal Directional Drill operation and installation criteria and methodology.

## 3. Map

A map depicting the planned project area proposed under Alternative #6 is included in *Figure IV*-5 below.

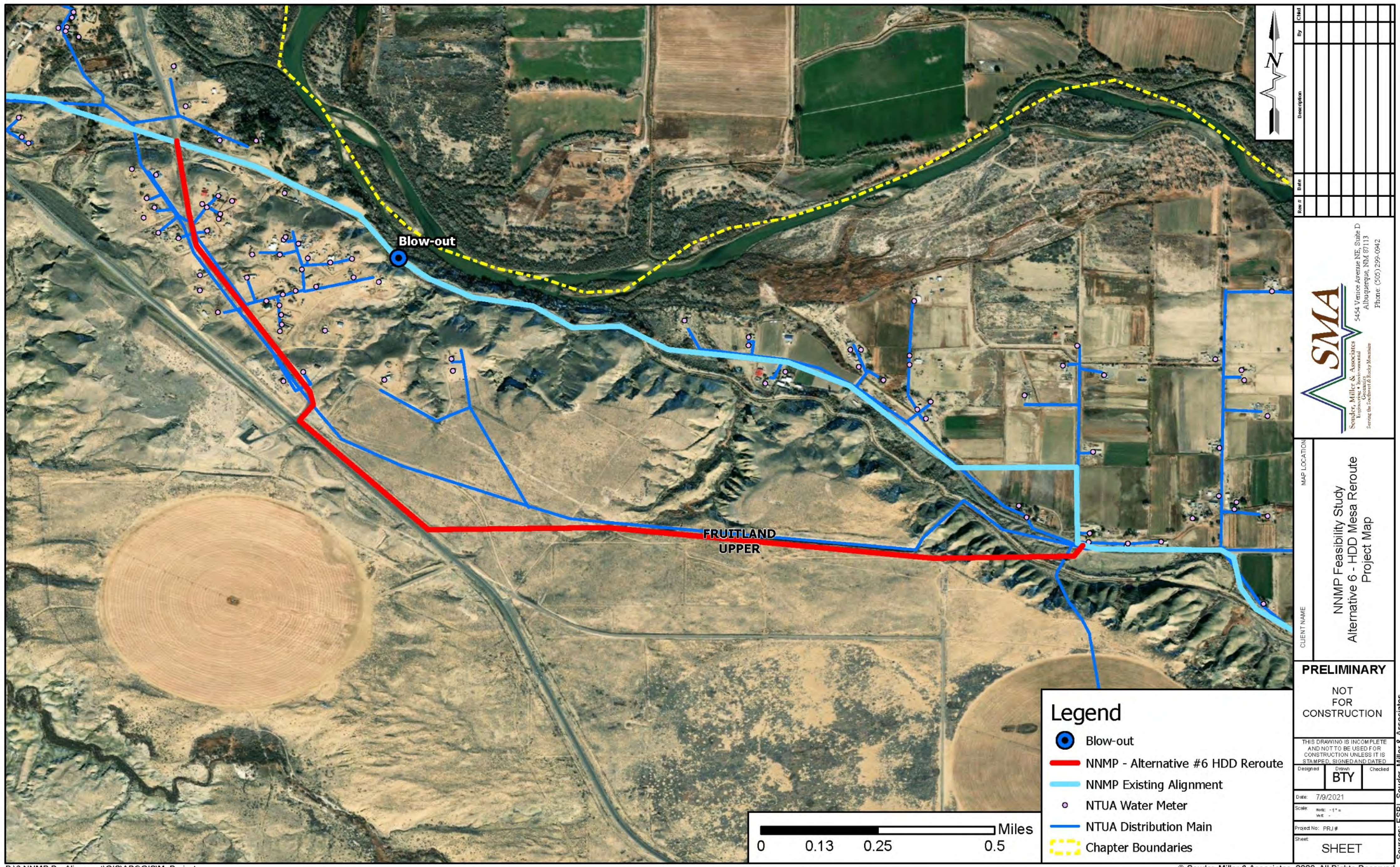


*Figure IV-5. Map Depicting the Alternative 6 – HDD Reroute Alternative for the NNMP Project.*

## 4. Environmental Impacts

This alternative includes the installation of new pipeline that will encroach from the mesa to the existing Fruitland Pumping Plant lying roughly 1.34 miles East of the blowout area. This pipeline will involve ground disturbance by way of trenching as well as HDD that might occur up the mesa. The pipeline will also parallel and may cross existing public roadways that are within previously disturbed neighborhoods in the Upper Fruitland area.

Impacts from HDD includes introduction of drilling mud the ground disturbance intensive process of boring through existing shale through the drilling depth area. The HDD process of introducing fluid while drilling could also risk compromising soil integrity.

## 5. Land Requirements

All work will be performed on Navajo Nation Tribal Trust Land which will require ROW or TAA acquisition. This alternative will also require a SWPPP and water discharging permits depending on the final design. This alternative offers the most new land disturbance and land use out of any of the alternatives.

## 6. Potential Construction Problems

The construction phase of this alternative will potentially encounter cobble during the HDD construction. This alternative also will not repair the road which would not fully satisfy the wishes of the chapter who have heavily stated their desire to fix the road in addition to the blowout.

## 7. Cost Estimate

The total capital cost for the construction and design of Alternative #6 is $#,###,###.##. The anticipated O&M costs are $##,###.##. Capital and O&M costs are summarized in Appendix F.

## 8. Advantages and Disadvantages

Advantages for this alternative are:

1. The NNMP will continue to be a gravity system and no pumping plant will be required.

2. Rerouting the waterline away from Bluff Road, the waterline has the potential to be installed in more reliable soil and mitigate the landslide concern along Bluff Road.
3. This alternative has a lower O&M cost than Alternative #4 since there is no additional pump station.
4. The HDPE pipeline will be a fused pipe system and has potential to withstand future landslides.
5. The pipeline will be buried deep, and future surface landslides might not affect pipe and slope stabilization will not be required.

Disadvantages for this alternative are:

1. Additional ROW or TAA will be required for pipeline alignment and to ensure there is adequate space to accommodate the HDD drill operations.
2. Risks and costs associated with HDD.
3. Community support might not exist. Previous attempts at rerouting through this neighborhood was not supported by the community. ROW acquisition through this area could be problematic.

# V. SELECTION OF AN ALTERNATIVE

Life cycle cost analyses and evaluation of non-monetary factors were performed to illustrate rationale for selection of the alternative and recommendation of the proposed project. Typically, the alternative with the least overall net present value assessed from the life cycle cost analysis are recommended; however, non-monetary factors are also considered to ensure the alternatives recommended meet the needs of the Upper Fruitland Chapter.

## A. Life Cycle Cost Analysis

*LCA's to be completed after cost estimates.*

The lifecycle analysis uses the projected present worth of construction and O&M costs of each alternative to help select the recommended alternative. This is coupled with the non-monetary factors evaluated for a final solution.

To determine the present value of a one-time cost the following equation can be used:

$$PV = A_t\left(\frac{1}{(1+d)^t}\right)$$

Where:
*PV* = Present Value
$A_t$ = Amount of one-time cost at time t
*d* = Real Discount Rate
*t* = Time (expressed in number of years)

To determine the present value of a recurring cost, such as the O&M costs, the following equation can be used:

$$PV = A_0\left[\frac{(1+d)^t - 1}{d(1+d)^t}\right]$$

Where:
*PV* = Present Value
$A_0$ = Amount of recurring cost (Annual O&M)
*d* = Real Discount Rate
*t* = Time (expressed in number of years)

$A_0$ was previously determined in Section V, Part 8 of each alternative considered.

*************************************
*Update the real discount rate based on the current rate in Appendix C of OMB Circular A-94, which can be found here: https://www.whitehouse.gov/omb/information-for-agencies/circulars/. Ensure the rate corresponds to the appropriate project period (typically 20 years).*
*************************************

This Life Cycle Cost Analysis (LCCA) uses a real discount rate of 1.5 percent for a 20-year period (*t*). This real discount rate was taken from Appendix C of the Office of Management and Budget Circular A-94, which can be found on the web page: https://www.whitehouse.gov/omb/information-for-agencies/circulars/. See *Table VI-##* for further details on LCCA for all alternatives.

Refer to *Table VI-1* for a summary of the total present value (PV) for each alternative. The analysis, which considers the financial costs of the project, is used to compare alternatives that will meet the required standard of service. In the absence of other factors, the facility with the least overall net present value (NPV) as determined by cost should also be considered the best alternative; however, there are other factors that are just as important to the selection of the proposed project, such as: Owner preference, increased health benefits, sustainability or community objections/feasibility.

*Table VI-1. Present worth cost comparison for NNMP Alternatives based on a discount rate of 1.5% for a project planning period of 20 years.*

| NNMP Feasibility Study Present Values | | | | |
|---|---|---|---|---|
| **Category** | Alternative 0<br>No Action | Alternative 1<br>HDD Alignment | Alternative 4<br>Pumping Plant Reroute | Alternative 5<br>Rehab and Improvements |
| **Total Capital Cost (Construction & Non-Construction)** | $ 0.00 | $ 0.00 | $ 0.00 | |
| **Annual O&M Costs** | $ 0.00 | $ 0.00 | $ 0.00 | |
| **NPV of Annual O&M Costs** | $ 0.00 | $ 0.00 | $ 0.00 | |
| **NPV of Salvage Value (S)** | $ 0.00 | $ 0.00 | $ 0.00 | |
| **Net Present Value (NPV)** | $ 0.00 | $ 0.00 | $ 0.00 | |

## B. NON-MONETARY FACTORS

Non-monetary factors are considered with the life cycle cost analysis (LCCA) to ensure the recommended alternative encompasses the needs of the Upper Fruitland Chapter. Some of the factors that determine the selection of the alternative are project sustainability, health and security, construction feasibility and ease of operation and maintenance. These are described in further detail below.

### 1. Sustainability

Sustainability is considered one of if not the most important non-monetary selection criterion for alternative selection. The Upper Fruitland Chapter desires a solution that will increase the resiliency and longevity of the system considering that the blowout has happened once already and has caused the issues it has that have persisted until now.

#### 2. Health and Security

Bolstering health and safety is also the most important option next to sustainability. Reactivating this pipeline improves water resource redundancy that would in turn promote health, security, and trust within the community, this is considered a priority by SMA and the Owner.

#### 3. Feasibility of Construction

Feasibility of construction is the third most important non-monetary selection criterion for alternative selection. It is in the best interests of all parties involved in this project to implement a solution that may be constructed primarily within existing rights-of-way and easement.

#### 4. Ease of Operation and Maintenance

Ease of O&M is a very important non-monetary selection criterion for alternative selection. The Upper Fruitland Chapter wishes to reduce current O&M resulting from the blowout of the pipeline and to reduce any costs from potential risks down the line while NTUA does not wish to drastically increase the number of facilities and appurtenances to oversee and maintain, it is important to satisfy the criteria both wish to be fulfilled.

### C. Decision Matrix

*Table VI-2* includes a developed decision matrix used to assist in selecting the most favorable alternatives. Monetary and non-monetary factors are weighted (lowest=1; highest=3) depending upon their deemed impact upon the Upper Fruitland Chapter and water system. High scores indicate a more favorable alternative.

*Table VI-2. Alternative decision matrix NNMP Feasibility Study Alternatives.*

| | **NNMP Feasibility Study Decision Matrix** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Criteria** | **Weight** | **Alternative 0 No Action** | | **Alternative 1 HDD Alignment** | | **Alternative 4 Pumping Plant Reroute** | | **Alternative 5 Pipeline Rehab and Improvements** | |
| | | | **Rank** | **Score** | **Rank** | **Score** | **Rank** | **Score** | **Rank** | **Score** |
| Monetary | Capital Cost | 3 | $ | 0.00 | $ | 0.00 | $ | 0.00 | $ | 0.00 |
| | | | <rank> | <score> | <rank> | <score> | <rank> | <score> | <rank> | <score> |
| | Life-Cycle Cost (NPV) | 3 | $ | 0.00 | $ | 0.00 | $ | 0.00 | $ | 0.00 |
| | | | <rank> | <score> | <rank> | <score> | <rank> | <score> | <rank> | <score> |
| Non-monetary | Sustainability | 3 | <rank> | <score> | <rank> | <score> | <rank> | <score> | <rank> | <score> |
| | Health and Security | 2 | <rank> | <score> | <rank> | <score> | <rank> | <score> | <rank> | <score> |
| | Feasibility of Construction | 1 | <rank> | <score> | <rank> | <score> | <rank> | <score> | <rank> | <score> |
| | Ease of O&M | 2 | <rank> | <score> | <rank> | <score> | <rank> | <score> | <rank> | <score> |
| | **Total Score** | | **<total score>** | | **<total score>** | | **<total score>** | | **<total score>** | |

# VI. RECOMMENDED ALTERNATIVES

*This section to be finished upon further evaluation of Alternative 6*

SMA recommends that the Upper Fruitland Chapter of the Navajo Nation implement the following project:

- Alternative #:

As previously outlined in the advantages and disadvantages section of this alternative there are equal if not more advantages to this option than there are disadvantages. Although the decision matrix denotes that this is not necessarily the option that is in the chapter's highest priority interests, it is more sustainable overall compared to the O&M and Capital Cost for the other alternatives aside from the no action alternative.

## A. Preliminary Project Design

Standard engineering and construction practices will be used in design of this project. SMA will follow standard engineering practices to design this project. State and federally recommended standards that we will adhere to include NMED-CPB's *Recommended Standards for Water Facilities*, the New Mexico Administrative Code (NMAC), RUS design guidelines (7 CFR 1780.57), the 10 State Standards, American Water Works Association (AWWA) guidelines, the Uniform Building Code, and other local applicable code requirements.

### Hydraulic Analysis of the Proposed Alternative

A hydraulic analysis of the recommended alternative was performed and expected flows and pressures in the fusible PVC pipeline that will replace the blown-out pipe on Bluff Road are shown in the XX below considering the current NNMP system condition.

<Insert WaterCAD Hyraulic Analyses>

## B. Project Schedule

*Table VII-1* includes a tentative schedule for the proposed project. Please note that many of these tasks, such as securing funding, are outside of SMA's control and may take longer than anticipated.

*Table VII-1. Estimated project schedule.*

| Task | Date |
|---|---|
| Submit Preliminary PER to NNDWR, BOR and Owner | July 2021 |
| Receive NNDWR, BOR and Owner Comments | August 2021 |
| Submit Final PER to NMED and Owner | September 2021 |
| Complete Preliminary Design | September 2021 |
| Complete Final Design | December 2021 |
| Begin Construction | January 2022 |
| Complete Construction and Project Closeout | July 2022 |

## C. Permit Requirements

The permits required for the proposed project vary depending on the chosen alternative as the amount of disturbed land varies, a list of the potential permits needed are shown in Table VII-# below.

*Table VII-2. Estimated project schedule.*

| Permits | Agency | Review Schedule Estimates |
|---|---|---|
| **Nationwide Permit Pre-Construction Notification Form** | US Army Corps of Engineers | 90 to 180 days |
| **MBTA Bird Surveys** | US Fish and Wildlife Service, Migratory Bird Treaty Act | Continuous during construction if in breeding season (survey is valid for 10 days) |
| **Biological Resource Compliance Form** | Navajo Nation Fish and Wildlife | Estimated 90 days |
| **Cultural Resource Compliance Form** | Navajo Nation Historical Preservation Department, State Historical Preservation Office | Estimated 90 days |
| **Temporary Water Use Permit** | Navajo Nation Water Code Administration | 30 days |
| **Encroachment/Crossing Permit – if required** | Utility Companies | Estimated 90 days |
| **Permission to Tap** | Navajo Tribal Utility Authority | 90 days |
| **Construction Permit** | Navajo Nation EPA | 60 days |
| **Water Use Permit** | Navajo Nation Department of Water Resources | 60 days |
| **Road Crossing Permit** | Bureau of Indian Affairs | 90 days |

## D. Sustainability Considerations

The recommended alternative will entirely avoid the Bluff Road mesa area and therefore eliminate any large concerns regarding landslides and hillside erosions that could possibly compromise the waterline. The pipe will be rerouted around the mesa and will minimize the amount of constructed pipeline to be retired and scrapped as opposed to the larger reroute considered in the un-evaluated Alternatives 2 and 3. the O&M on this stretch of pipe would be reliant on factors such as: the attention to soil reinforcement during construction beneath the booster station, the quality and proper use of the booster station when in operation, operation of any SCADA communication equipment installed, valving quality and consistency of exercising, pipeline manufacturing and joint connection quality and topsoil compaction. This alternative would potentially parallel tribal and/or NM state roads within existing highway ROW and would need to follow proper standards for buried utilities that parallel or cross roads.

## E. Total Project Cost Estimate

*NECA will perform these cost estimates*

*Table VII-#* provides a summary of estimated professional and construction costs for the unphased recommended project.

*Table VII-#. Recommended project cost estimate.*

| Item | Alternative 0<br>No Action | Alternative 1<br>HDD Alignment | Alternative 4<br>Pumping Plant Reroute | Alternative 5<br>Blowout Rehab and Improvements |
|---|---|---|---|---|
| Professional Services: Design Phase | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| Professional Services: Design Phase | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| Construction Costs | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| Total Project Costs | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |

## F. Annual Operating Budget

### 1. Income

After construction has been completed for the proposed project, ownership and operation and maintenance will be assigned to NTUA. NTUA's 2020 Residential Water Service Rates are included in Appendix D. An increase in revenue by way of water connections is not anticipated for this project as they will stay largely the same, rather a decrease in current costs to route NNMP water supply and distribution around the blowout is the target method of increase in revenue.

## 2. Annual Operations and Maintenance (O&M) Costs

The estimated annual O&M costs for the recommended project are shown in Table VII-##.

*Table VII-##. Recommended project estimated O&M.*

| O&M EXPENSE DESCRIPTION | | AMOUNT |
|---|---|---|
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **<Insert>** | $ | 0.00 |
| **TOTAL ANNUAL O&M COSTS** | **$** | **0.00** |

## 3. Debt Repayments

*************************************
*USDA-RUS Bulletin 1780-2 guidance:*
*"Describe existing and proposed financing with the estimated amount of annual debt repayments from all sources. All estimates of funding should be based on loans, not grants."*
*************************************

<Summarize any outstanding debts owed by the Owner and include details of the repayment structure>.

Financing of the proposed project has already been outlined through ## and

*************************************
*Update the table below to reflect your project. Other funding sources may be considered, but WTB and Capital Outlay are the ones we most commonly help our clients apply for. If your project will be phased, you must complete this analysis for both phases and add a second summary table.*
*************************************

*Table VII-#. Recommended Project debt repayment and monthly base rate estimates for Capital Outlay and WTB funding.*

| Water System Improvements | | | | | |
|---|---|---|---|---|---|
| | Grant/Loan Amount (20-year period) | | | | |
| | Capital Outlay (0%) | Water Trust Board (0.25%) | | | |
| | 100/0 | 90/10 | 80/20 | 75/25 | 60/40 |
| **Loan Amount** | $ 0.00 | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> |
| **Annual Payment** | $ 0.00 | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> |
| **Expenses** | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> |
| **Reserve** | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> |
| **Projected Average Monthly Base Rate** | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> | $ <Insert> |

## 1. Reserves

*************************************

*USDA-RUS Bulletin 1780-2 guidance:*

*"Describe the existing and proposed loan obligation reserve requirements for the following: Debt Service Reserve and Short-Lived Asset Reserve."*

*************************************

### *a. Debt Service Reserve*

A Debt Service Reserve will not be required unless the Upper Fruitland Chapter seeks USDA funding, which they do not presently intend to do.

### *b. Short-Lived Asset Reserve*

A short-lived asset reserve is a deposit reserved for items such as replacement or overhaul of paint, pumps/motors, and small equipment not covered under O&M; however, this does not include long-lived assets such as a water tank or treatment facility replacement that should be funded with long-term financing. The equipment and facilities provided in the proposed project are expected to have a life up to 20 years or longer, apart from any NTUA distribution water meters.

# VII. CONCLUSIONS AND RECOMMENDATIONS

*This section to be finished upon further evaluation of Alternative 6.*

SMA evaluated options in this PER to address several priorities that have been identified by the Upper Fruitland Chapter, namely:

- Alternative 0 – No Action
- Alternative 1 – Horizontal Directional Drilling (HDD) for Bluff Road
- Alternative 4 – Pipeline Reroute to Upper Fruitland Pumping Plant
- Alternative 5 - Pipeline Rehab and Upper Fruitland Canal Improvements
- Alternative 6 – Horizontal Directional Drilling (HDD) to Mesa

Based on the analysis presented in this report, SMA recommends the implementation of Alternative #. *Figure VIII*-I below shows the proposed project.

Figure VIII-1. Map of Alternative # -XX.

The capital costs to implement the proposed alternative are:

<insert NECA cost estimates>

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American Water Works Association (https://www.awwa.org/).

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Hydraulic Report, Navajo Nation Municipal Pipeline Animas La-Plata Project, New Mexico Upper Colorado Region, Bureau of Reclamation.

Navajo Nation Municipal Pipeline Fruitland Reach Construction Plans, Bureau of Reclamation

USGS National Water Information System (USGS Water Data for the Nation)

Plastics Pipe Institute BoreAid (Plastics Pipe Institute + Boreaid (ppiboreaid.com))

Total Maximum Daily Load (TMDL) for the Animas River Watershed (San Juan River to Southern Ute Indian Tribe Bend) (Animas River Watershed TMDL - US EPA-Approved - September 30, 2013)

Animas La Plata Project (Animas-La Plata Project | UC Region | Bureau of Reclamation (usbr.gov))

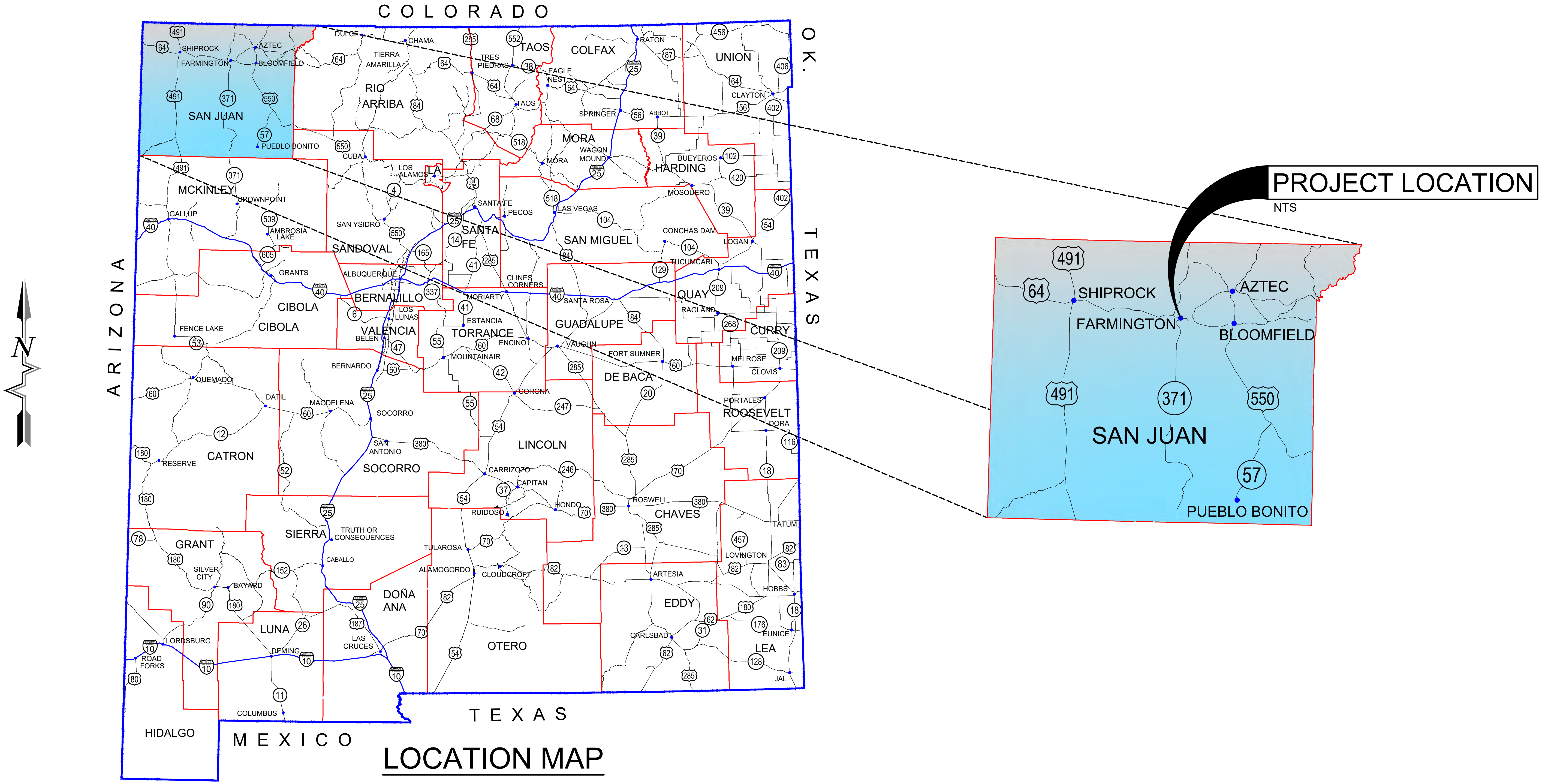
University of New Mexico Bureau of Business and Economic Research (http://www.unm.edu/~bber/).

US Inflation Calculator (https://www.usinflationcalculator.com/inflation/current-inflation-rates/).

Engineering Toolbox, Pump Power Calculator (Pump Power Calculator (engineeringtoolbox.com))

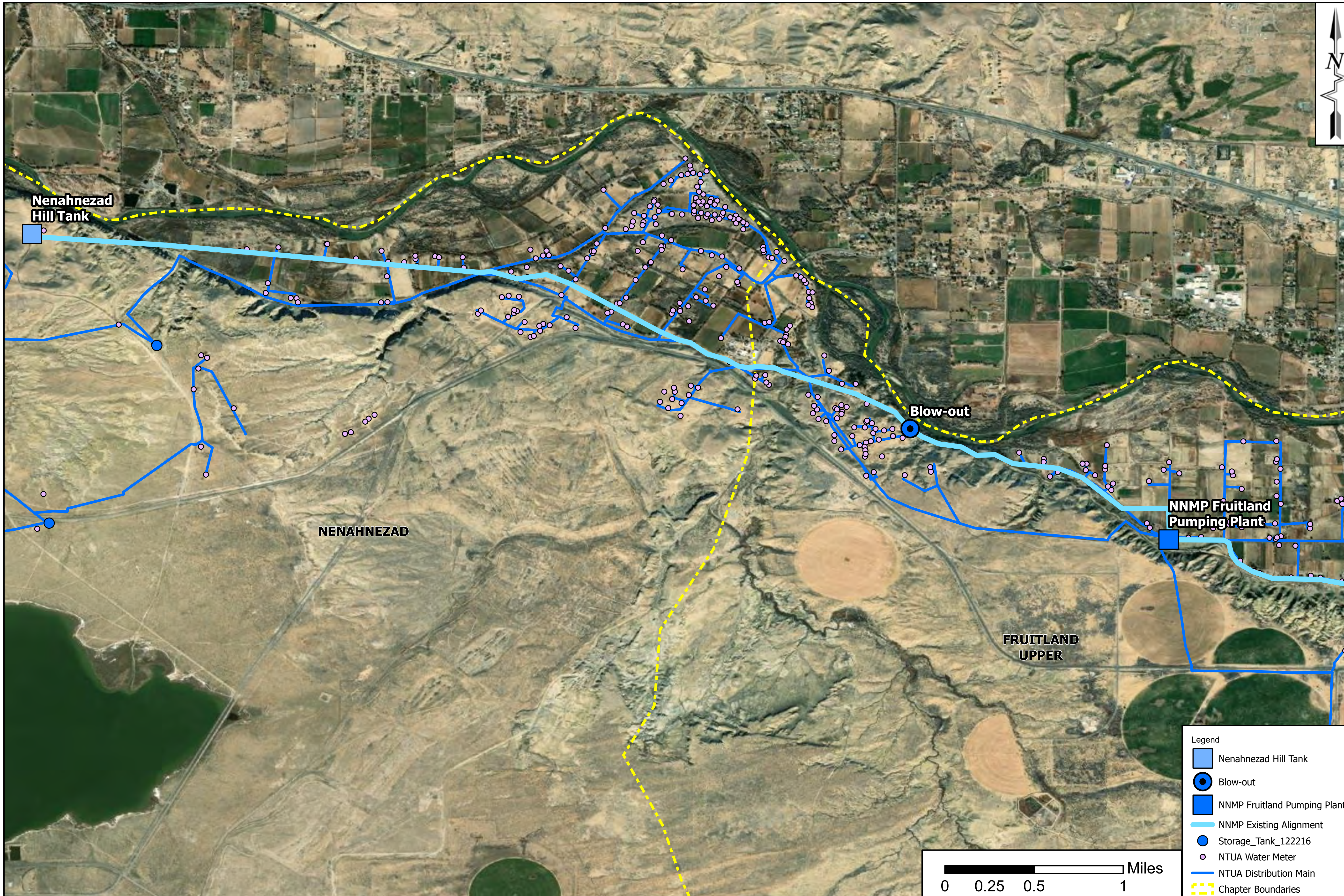
Engineering Toolbox, Hazen-Williams Calculator (Hazen-Williams Equation - calculating Head Loss in Water Pipes (engineeringtoolbox.com))

# Appendix A
# Project Planning Resources




LOCATION MAP

NTS




| Rev # | Date | Description | By | Chkd |
|---|---|---|---|---|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Phone: (505) 299-0942


MAP LOCATION

CLIENT NAME

NNMP Feasibility Study
Project Planning Area

**PRELIMINARY**

NOT
FOR
CONSTRUCTION

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

| Designed | Drawn | Checked |
|---|---|---|
| | BTY | |

Date: 7/8/2021

Scale: Horiz: - 1" =
Vert: -

Project No: PRJ #

Sheet:
SHEET

Sources: ESRI, Souder, Miller & Associates

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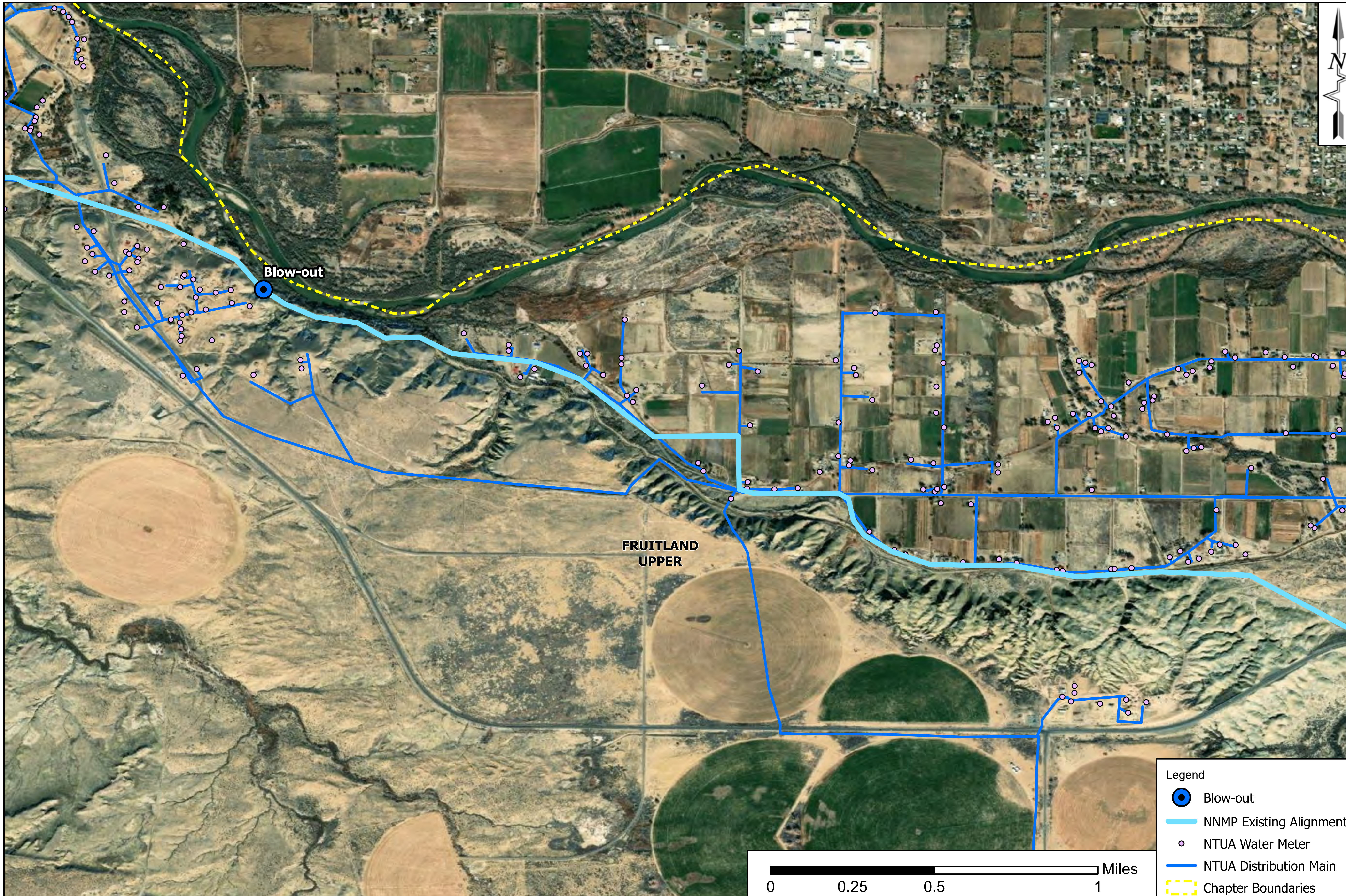


| Rev # | Date | Description | By | Chkd |
|---|---|---|---|---|


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5454 Venice Avenue NE, Suite D
Albuquerque, NM 87113
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MAP LOCATION

CLIENT NAME

# NNMP Feasibility Study
## Alternative 0 - No Action
## Project Map

**PRELIMINARY**

NOT
FOR
CONSTRUCTION

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| Designed | Drawn | Checked |
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| | BTY | |

Date: 7/7/2021

Scale: Horiz: - 1" = ' (11x17)
Vert: -

Project No: PRJ #

Sheet: SHEET

Sources: ESRI, Souder, Miller & Associates

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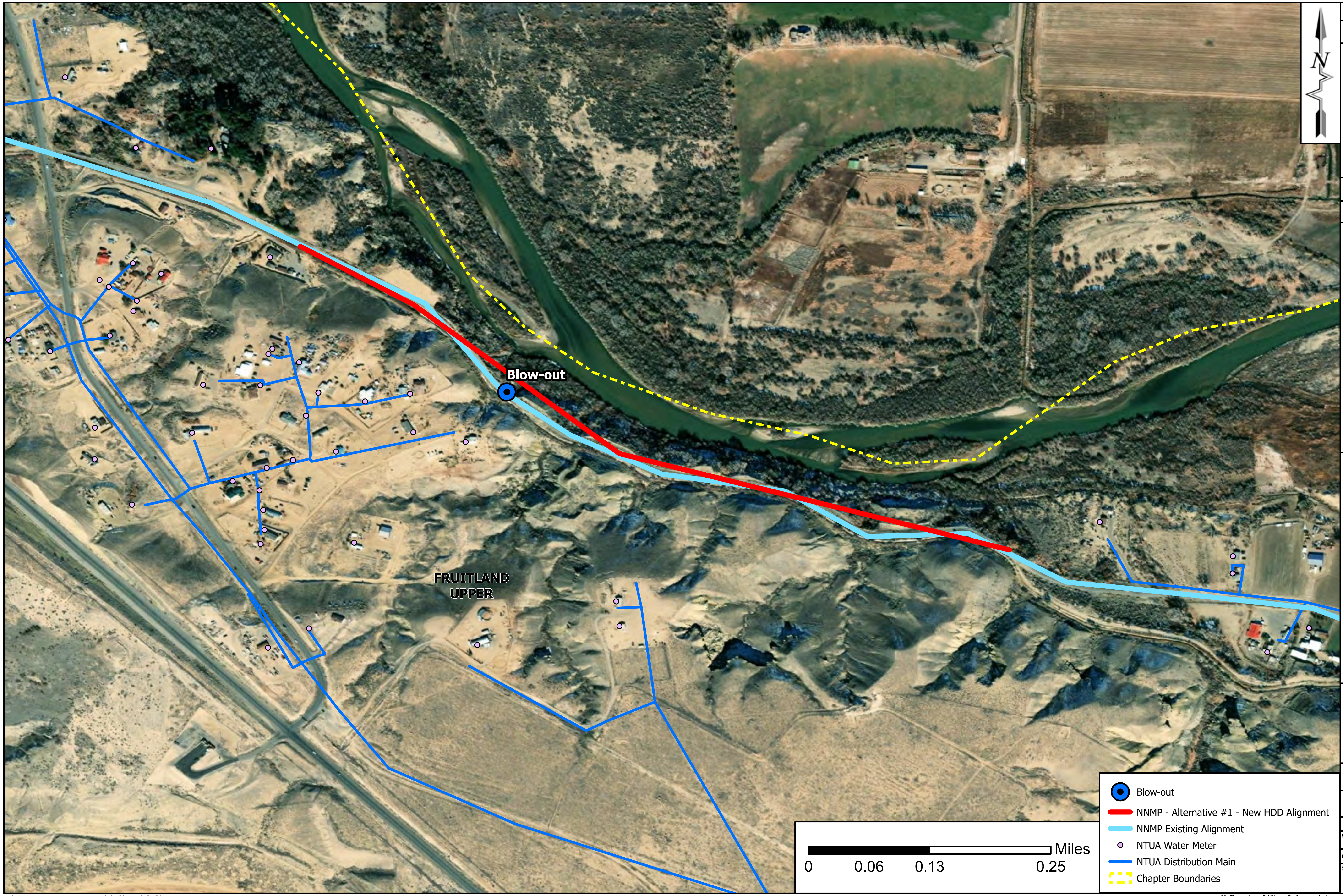


| Rev # | Date | Description | By | Chkd |
|---|---|---|---|---|
| | | | | |

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Albuquerque, NM 87113
Phone: (505) 299-0942

MAP LOCATION

CLIENT NAME

NNMP Feasibility Study
Alternative 1 - Horizontal Directional
Drilling (HDD) for Bluff Road
Project Map

**PRELIMINARY**

NOT
FOR
CONSTRUCTION

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

| Designed | Drawn | Checked |
|---|---|---|
| | BTY | |

Date: 7/7/2021

Scale: Horiz: - Vert: -

Project No: PRJ #

Sheet: SHEET

Sources: ESRI, Souder, Miller & Associates

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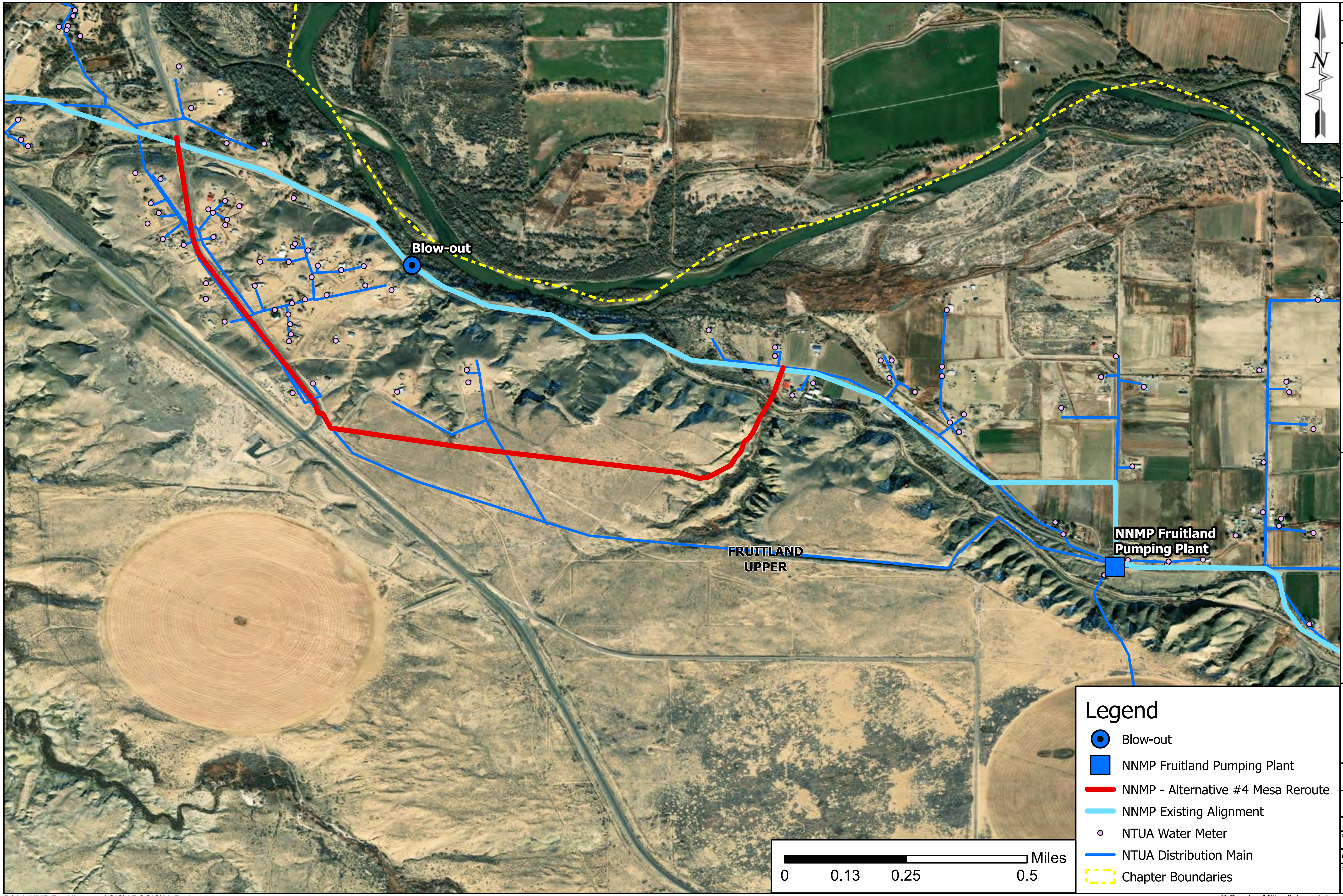


| Rev # | Date | Description | By | Chkd |
|---|---|---|---|---|
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Albuquerque, NM 87113
Phone: (505) 299-0942


MAP LOCATION

CLIENT NAME

# NNMP Feasibility Study Alternative 4 - Pipeline Reroute to Fruitland Pumping Plant Project Map

**PRELIMINARY**

NOT FOR CONSTRUCTION

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

| Designed | Drawn | Checked |
|---|---|---|
| | BTY | |

Date: 7/8/2021

Scale: Horiz: - 1" = Vert: -

Project No: PRJ #

Sheet: SHEET

Sources: ESRI, Souder, Miller & Associates

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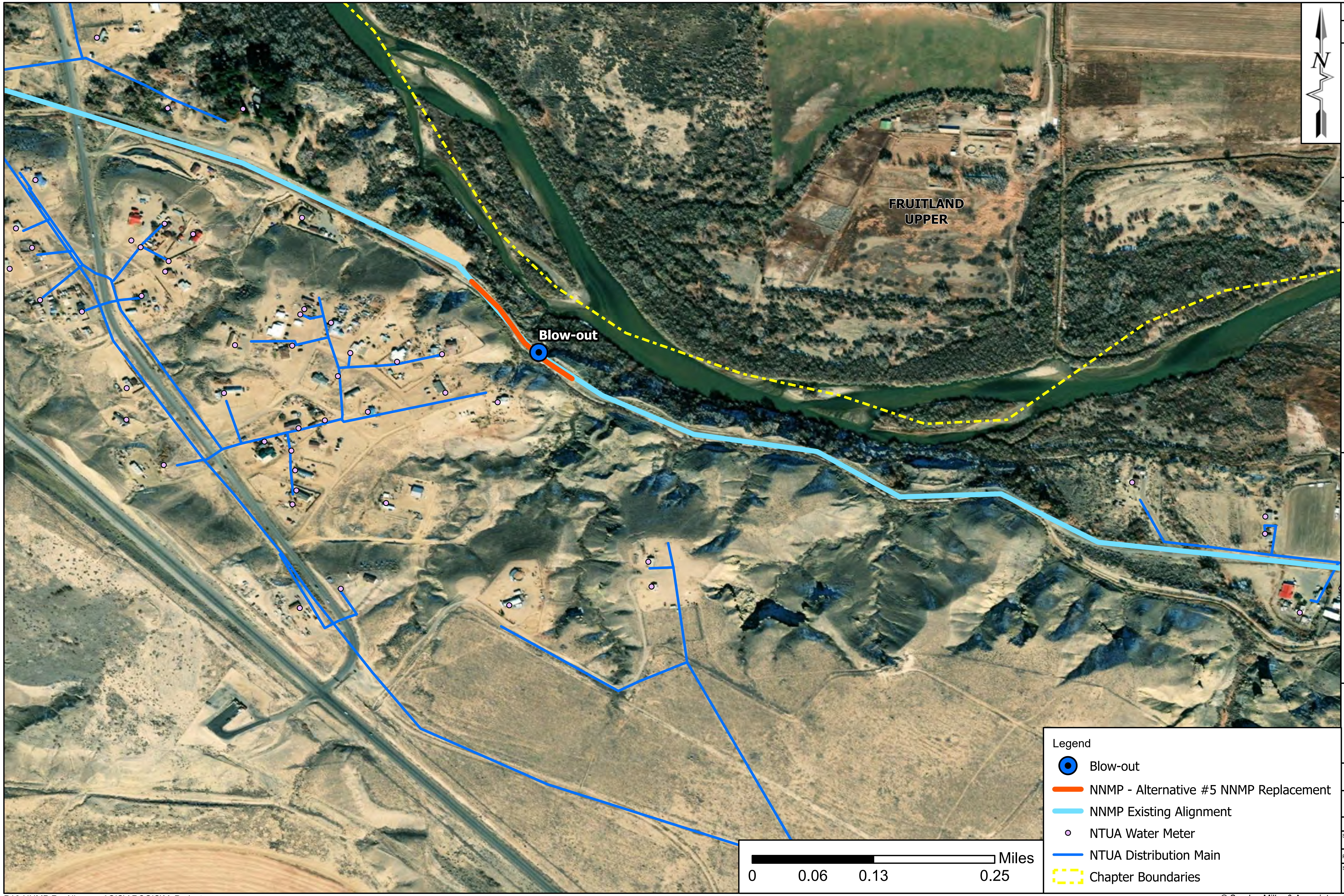


| Rev # | Date | Description | By | Chkd |
|---|---|---|---|---|


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Geomatics
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Albuquerque, NM 87113
Phone: (505) 299-0942


MAP LOCATION

CLIENT NAME

NNMP Feasibility Study
Alternative 5 - Pipeline Repair
and Fruitland Canal Improvements
Project Map

**PRELIMINARY**

NOT
FOR
CONSTRUCTION

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

| Designed | Drawn | Checked |
|---|---|---|
| | BTY | |

Date: 7/8/2021
Scale: Horiz: - 1" = Vert: -
Project No: PRJ #
Sheet: SHEET

Sources: ESRI, Souder, Miller & Associates

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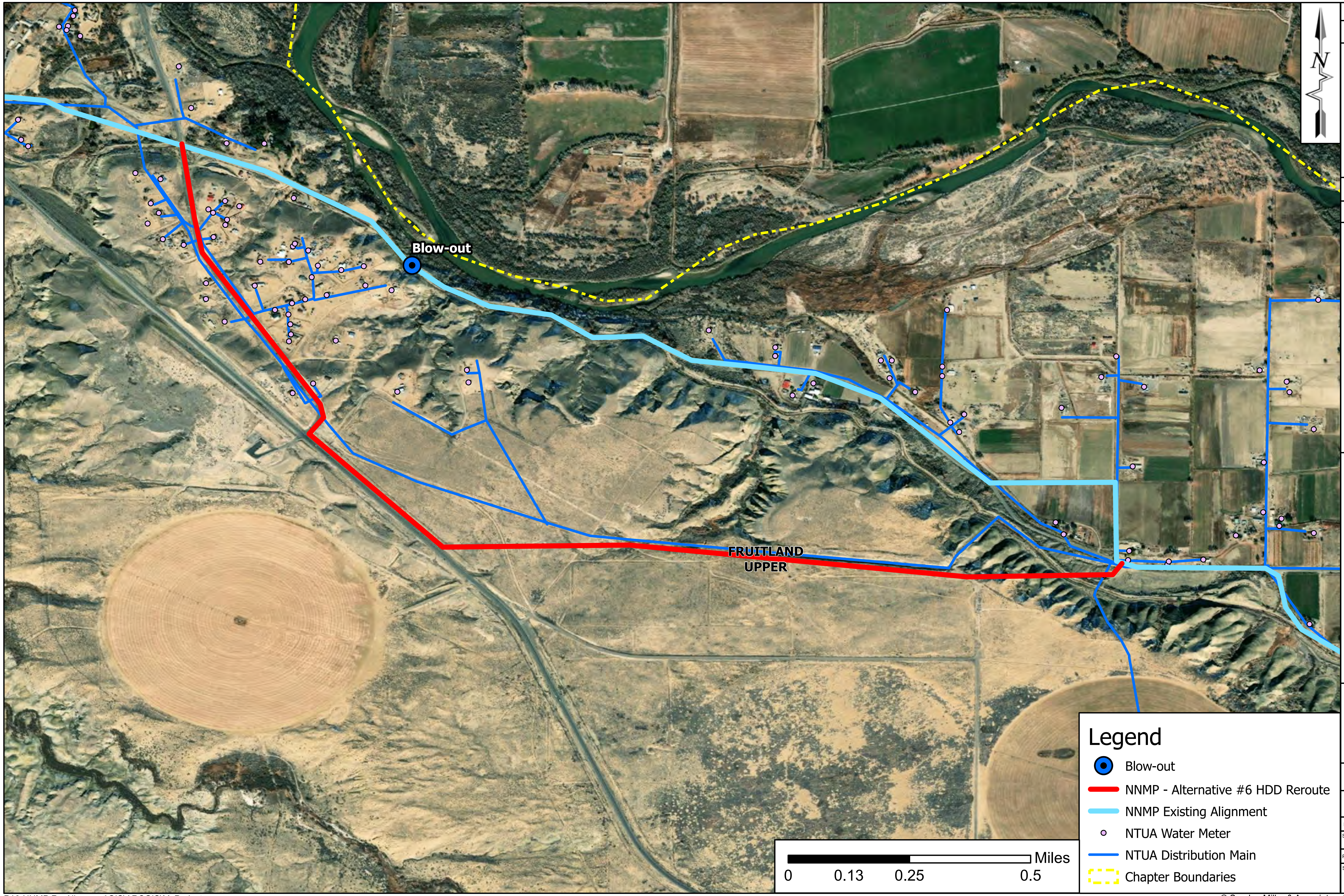


| Rev # | Date | Description | By | Chk'd |
|---|---|---|---|---|
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Albuquerque, NM 87113
Phone: (505) 299-0942

MAP LOCATION

CLIENT NAME

NNMP Feasibility Study
Alternative 6 - HDD Mesa Reroute
Project Map

**PRELIMINARY**

NOT
FOR
CONSTRUCTION

THIS DRAWING IS INCOMPLETE AND NOT TO BE USED FOR CONSTRUCTION UNLESS IT IS STAMPED, SIGNED AND DATED

| Designed | Drawn | Checked |
|---|---|---|
| | BTY | |

Date: 7/9/2021

Scale: Horiz: - 1" = Vert: -

Project No: PRJ #

Sheet: SHEET

Sources: ESRI, Souder, Miller & Associates

P:\6-NNMP Re-Alignment\GIS\ARCGIS\MyProject

# Appendix B
# Environmental Resources

## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction, and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

The **projection** used in the preparation of this map was New Mexico State Plane West Zone (FIPS 3003). The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey, SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit their website at http://www.ngs.noaa.gov/.

**Base map** information shown on this FIRM was derived from multiple sources. This information was compiled from the United States Geological Survey, 1989, the National Geodetic Survey, 2007, the Federal Emergency Management Agency, 1988 and 2002, U.S. Bureau of Land Management, 2006, U.S. Census Bureau, 2000 and 2003 and San Juan County, 2007. Additional information was photogrametrically compiled at a scale of 1:12,000 from New Mexico Resource Geographic Information System aerial photography dated 2006.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and their website at http://www.msc.fema.gov/.

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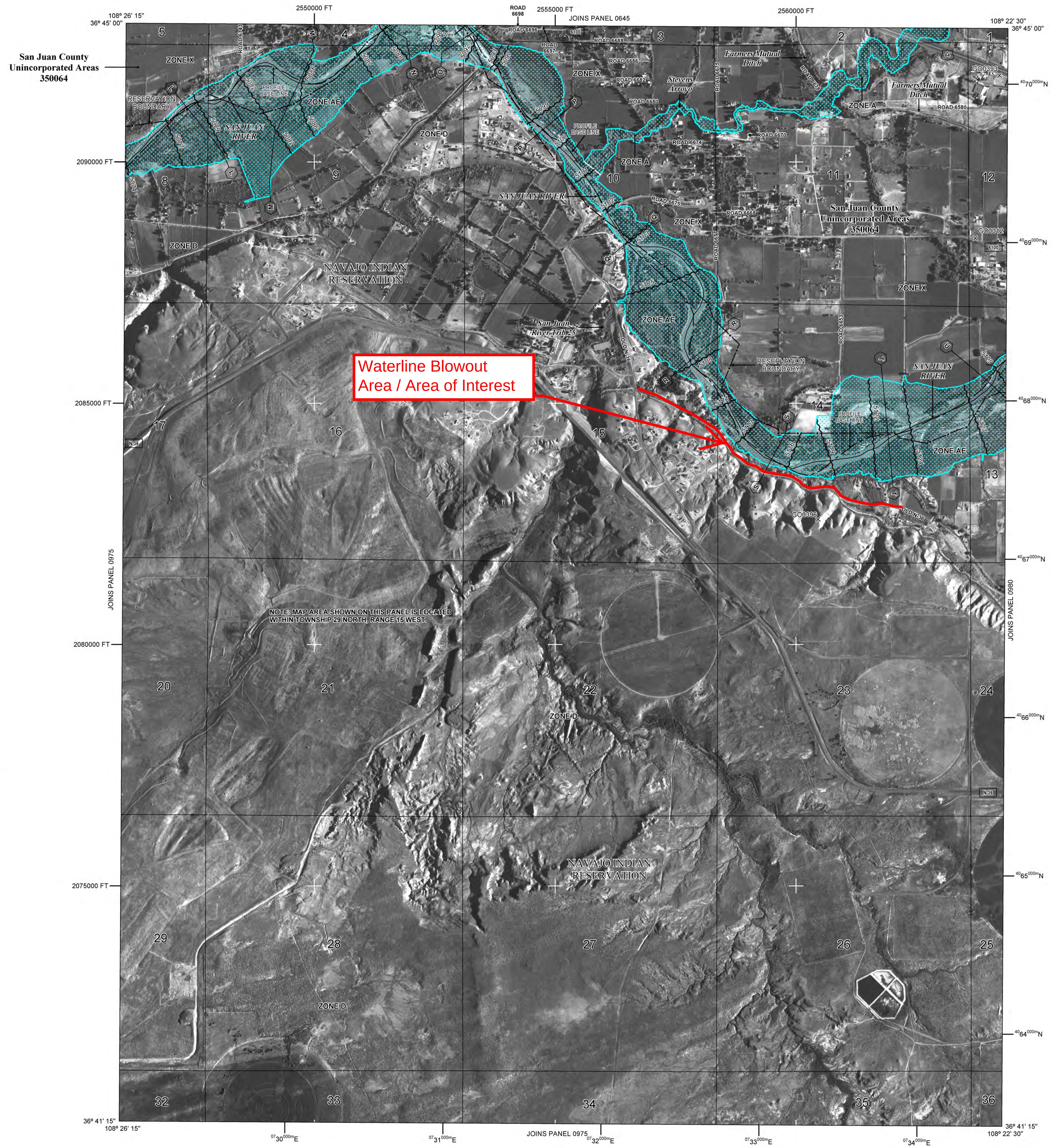


## LEGEND

**SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

| | |
|---|---|
| ZONE A | No Base Flood Elevations determined. |
| ZONE AE | Base Flood Elevations determined. |
| ZONE AH | Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. |
| ZONE AO | Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined. |
| ZONE AR | Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood. |
| ZONE A99 | Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. |
| ZONE V | Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined. |
| ZONE VE | Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined. |

**FLOODWAY AREAS IN ZONE AE**

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER AREAS**

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA Boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*
*Referenced to the North American Vertical Datum of 1988
(A)—(A) Cross section line
(23)- - - -(23) Transect line
97° 07' 30", 32° 22' 30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{42}76^{000m}$E — 1000-meter Universal Transverse Mercator grid values, zones 12 & 13
600000 FT — 5000-foot grid ticks: New Mexico State Plane coordinate system, West Zone (FIPSZONE 3003), Transverse Mercator Projection
DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index.

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP PANEL
AUGUST 5, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0960F

# FIRM
## FLOOD INSURANCE RATE MAP
## SAN JUAN COUNTY, NEW MEXICO AND INCORPORATED AREAS

PANEL 960 OF 2750

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| SAN JUAN COUNTY | 350064 | 0960 | F |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
35045C0960F

EFFECTIVE DATE
AUGUST 5, 2010

Federal Emergency Management Agency

# NOTES TO USERS

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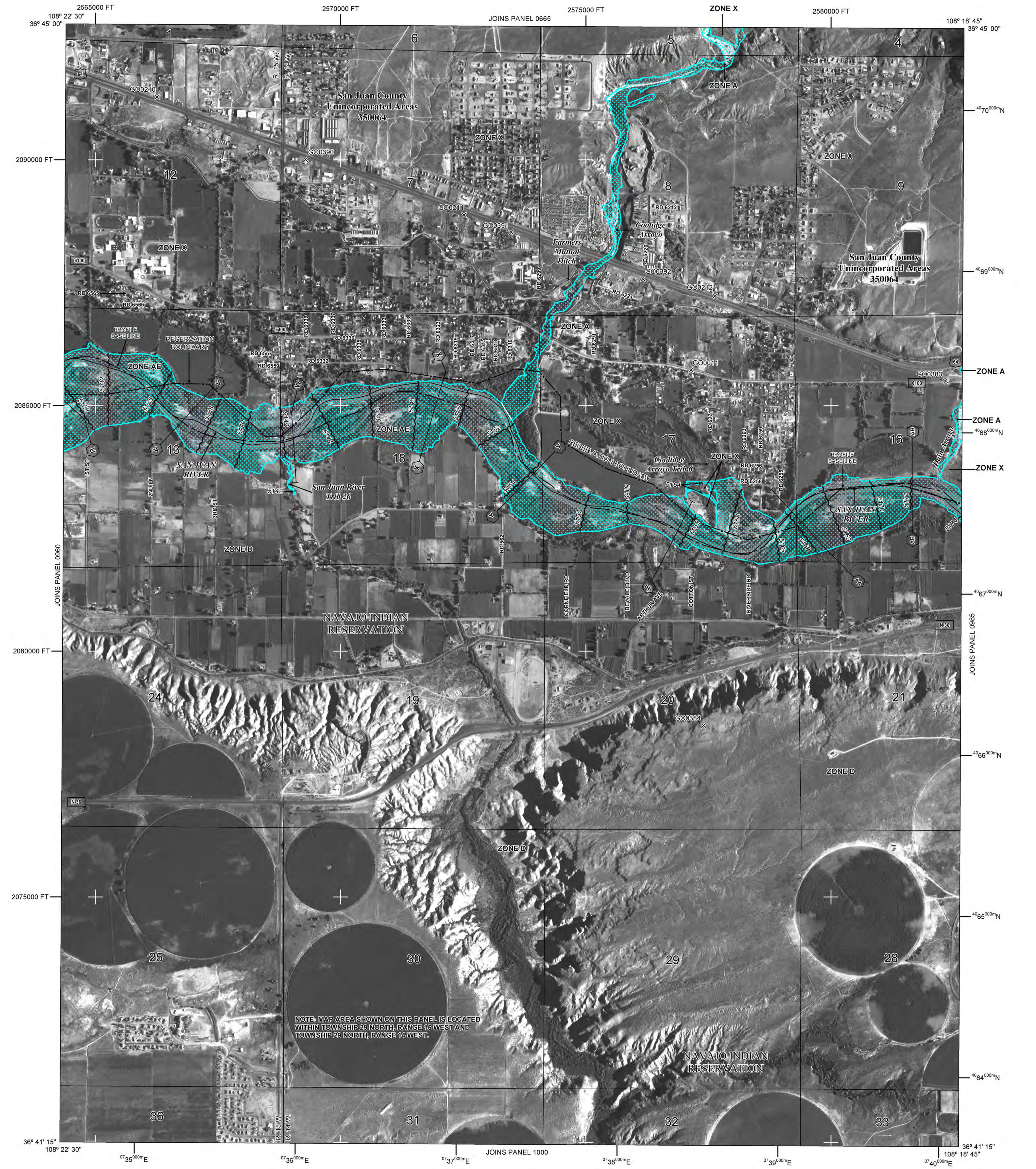


# LEGEND

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**ZONE A** No Base Flood Elevations determined.
**ZONE AE** Base Flood Elevations determined.
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**ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
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**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
**ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA Boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*
*Referenced to the North American Vertical Datum of 1988
(A)——(A) Cross section line
(23)- - - - -(23) Transect line
97° 07' 30", 32° 22' 30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{42}76^{000m}$E — 1000-meter Universal Transverse Mercator grid values, zones 12 & 13
600000 FT — 5000-foot grid ticks: New Mexico State Plane coordinate system, West Zone (FIPSZONE 3003), Transverse Mercator Projection
DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index.

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP PANEL
AUGUST 5, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

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**MAP SCALE 1" = 1000'**

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 0980F**

# FIRM
## FLOOD INSURANCE RATE MAP
## SAN JUAN COUNTY, NEW MEXICO AND INCORPORATED AREAS

**PANEL 980 OF 2750**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
| --- | --- | --- | --- |
| SAN JUAN COUNTY | 350064 | 0980 | F |

Notice to User: The **Map Number** shown below should be used when placing map orders, the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER 35045C0980F**

**EFFECTIVE DATE AUGUST 5, 2010**

Federal Emergency Management Agency

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NGS Information Services
NOAA, N/NGS12
National Geodetic Survey, SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

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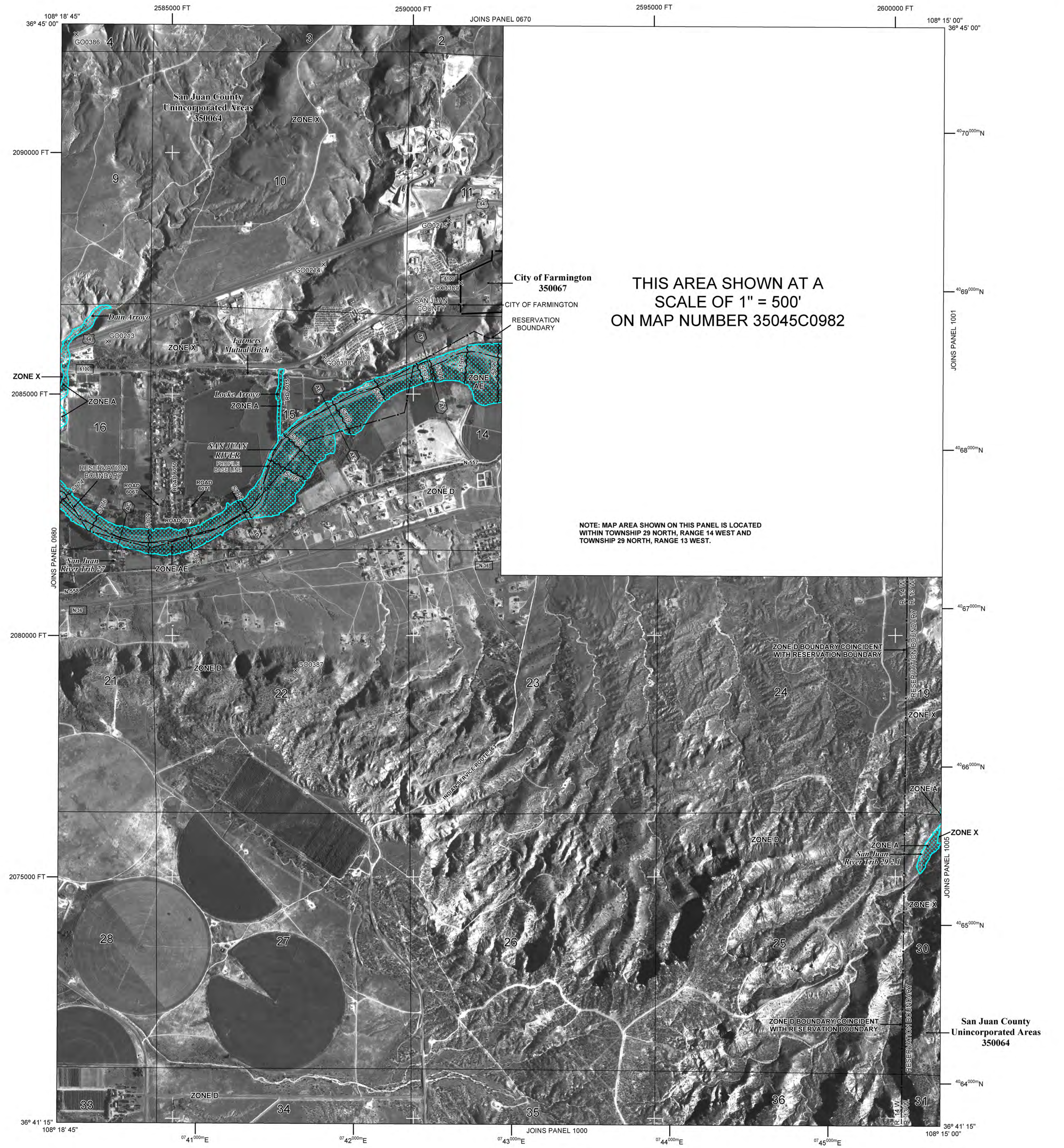


# LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

| | |
|---|---|
| **ZONE A** | No Base Flood Elevations determined. |
| **ZONE AE** | Base Flood Elevations determined. |
| **ZONE AH** | Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. |
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| **ZONE AR** | Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood. |
| **ZONE A99** | Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. |
| **ZONE V** | Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined. |
| **ZONE VE** | Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined. |

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
**ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA Boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

| | |
|---|---|
| 513 | Base Flood Elevation line and value; elevation in feet* |
| (EL 987) | Base Flood Elevation value where uniform within zone; elevation in feet* |

*Referenced to the North American Vertical Datum of 1988

| | |
|---|---|
| A — A | Cross section line |
| 23 - - - - 23 | Transect line |
| 97° 07' 30", 32° 22' 30" | Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere |
| 4276000m E | 1000-meter Universal Transverse Mercator grid values, zones 12 & 13 |
| 600000 FT | 5000-foot grid ticks: New Mexico State Plane coordinate system, West Zone (FIPSZONE 3003), Transverse Mercator Projection |
| DX5510 × | Bench mark (see explanation in Notes to Users section of this FIRM panel) |
| • M1.5 | River Mile |

MAP REPOSITORIES
Refer to Map Repositories list on Map Index.

EFFECTIVE DATE OF COUNTYWIDE FLOOD
INSURANCE RATE MAP PANEL
AUGUST 5, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

**MAP SCALE 1" = 1000'**

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 0985F**

# FIRM

## FLOOD INSURANCE RATE MAP

## SAN JUAN COUNTY, NEW MEXICO AND INCORPORATED AREAS

**PANEL 985 OF 2750**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| FARMINGTON, CITY OF | 350067 | 0985 | F |
| SAN JUAN COUNTY | 350064 | 0985 | F |

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**MAP NUMBER 35045C0985F**

**EFFECTIVE DATE AUGUST 5, 2010**

Federal Emergency Management Agency

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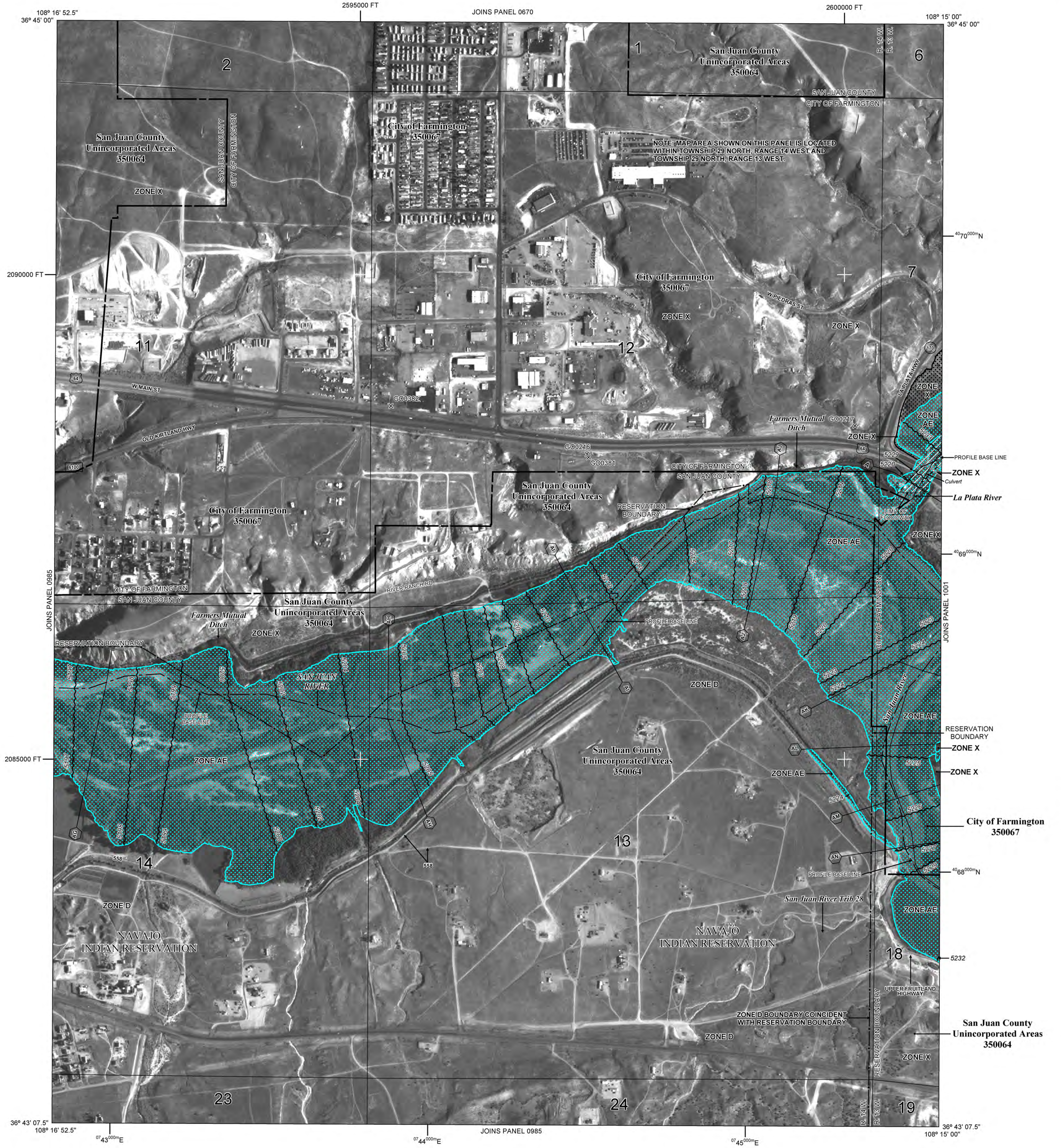


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250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 0982F**

# FIRM

## FLOOD INSURANCE RATE MAP

## SAN JUAN COUNTY, NEW MEXICO
### AND INCORPORATED AREAS

**PANEL 982 OF 2750**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

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**MAP NUMBER**
**35045C0982F**

**EFFECTIVE DATE**
**AUGUST 5, 2010**

Federal Emergency Management Agency

# Appendix D
# Reference Data

Western Technologies Inc.

# GEOTECHNICAL EVALUATION REPORT

**NAVAJO NATION MUNICIPAL PIPELINE**
Bluff Road
Upper Fruitland, New Mexico
WT Reference No. 3121JS009

**PREPARED FOR:**
Souder, Miller & Associates
5454 Venice Avenue NE, Suite D
Albuquerque, New Mexico
Attn: Andrew G. Robertson, P.E.

May 24, 2021

JEFF M. BOYD NEW MEXICO 12412 REGISTERED PROFESSIONAL ENGINEER

Kyel Newberry, E.I.
Project Engineer

Jeff M. Boyd, P.E.
Senior Geotechnical Engineer

## TABLE OF CONTENTS

**GEOTECHNICAL EVALUATION**
**NAVAJO NATION MUNICIPAL PIPELINE**
**BLUFF ROAD**
**UPPER FRUITLAND, NEW MEXICO**
**JOB NO. 3121JS009**

## 1.0 PURPOSE

This report contains the results of our geotechnical evaluation for a proposed pipeline repair/bypass to be located in Upper Fruitland, NM. The purpose of these services is to provide information and recommendations regarding:

- Subsurface conditions
- Lateral earth pressures
- Slabs-on-grade
- Earthwork guidelines
- Seismic conditions
- Geology
- Foundation design parameters
- Drainage
- Excavation conditions
- Geologic hazards
- Trench backfill
- Depth of Shale

Results of the field exploration, field tests, and laboratory testing program are presented in the Appendices.

## 2.0 PROJECT DESCRIPTION

Project information supplied indicates that a slope failure occurred along a section of the Fruitland Canal and Bluff Road (Route N367), upstream of the Bitsui Siphon. The failure impacted the existing roadway and a section of the Navajo Nation Municipal Pipeline. Options of reinstalling pipe along bluff road and Rerouting the pipe were proposed. Final site grading plans were not available at the time of this report. Should this information not be correct we should be notified immediately.

## 3.0 SCOPE OF SERVICES

### 3.1 Field Exploration

Ten borings were drilled to depths ranging from about 10.5 to 51 feet below existing site grade in the proposed pipeline and booster station areas. The borings were at the approximate locations shown on the attached Boring Location Diagram. A field log was prepared for each boring. These logs contain visual classifications of the materials encountered during drilling as well as interpolation of the subsurface conditions between samples. Final logs, included in Appendix A, represent our interpretation of the field logs and may include modifications based on laboratory observations and tests of the field samples. The final logs describe the materials encountered, their thickness, and the locations where samples were obtained.

The Unified Soil Classification System was used to classify soils. The soil classification symbols appear on the boring logs and are briefly described in Appendix A. Local and regional geologic characteristics were used to estimate the seismic design criteria.

### 3.2 Laboratory Analyses

Laboratory analyses were performed on representative soil samples to aid in material classification and to estimate pertinent engineering properties of the on-site soils for preparation of this report. Testing was performed in general accordance with applicable standard test methods. The following tests were performed and the results are presented in Appendix B.

- Water content
- Dry density
- Gradation
- Plasticity

### 3.3 Analyses and Report

This geotechnical engineering report includes a description of the project, a discussion of the field and laboratory testing programs, a discussion of the subsurface conditions, and design recommendations as appropriate to its purpose. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site, discovery of underground storage tanks or other underground structures, or identification of contaminated or hazardous materials or conditions. If there is concern about the potential for such contamination, other studies should be undertaken. We are available to discuss the scope of such studies with you.

## 4.0 SITE CONDITIONS

### 4.1 Surface

**Bluff Slide Area-**

At the time of our exploration, the site was developed as an existing roadway with underground utilities. The ground surface was sloping down towards the San Juan River and contained a moderate growth of brush, and grass on both sides of the asphalt. Site drainage trended to the north as sheet surface flow at a moderate to extreme slope. Photographs of the site at the time of our exploration is provided below.

View of the site near the landslide taken on 4-6-21.

**Alternative No. 4-**

At the time of our exploration, the site was partially developed as an existing roadway with underground utilities the other portion was undeveloped land south of bluff road up on the plateau. The ground surface was sloping down towards the San Juan River and contained a moderate growth of brush, and grass. Site drainage trended to the north as sheet surface flow at a gradual slope. Photographs of the site at the time of our exploration is provided below.

View of the site at Intersection of Bluff road and 36 taken on 4-26-21.

View of the site where the new booster station might be taken on 4-26-21.

View of the undeveloped site the new pipeline might run taken on 4-26-21.

## 4.2 Subsurface

As presented on the Boring Logs, surface soils to depths of 7 to 15 feet consisted of loose to medium dense Silty SAND, Clayey SAND and Poorly Graded SAND with Silt. Near surface soils are of non to low plasticity. Boring 15 has surface soils extending to 17 feet of Sandy Lean Clay with high plasticity. The materials underlying the surface soils and extending to the full depth of exploration consisted of Silty SAND, Clayey SAND and SHALE. The SHALE encountered was very inconsistent in depth, see the table below for Boring Number and depth to shale. Groundwater was not encountered at the time of exploration. A detailed description of the soils encountered can be found on the boring logs in Appendix A.

| Boring Number | Depth to SHALE (FEET) |
|---|---|
| #4 | 25 |
| #5 | 18 |
| #6 | Shale not encountered(Drill depth 31.5') |
| #7 | 10 |
| #8 | 7 |
| #11 | 10 |
| #12 | 40 |
| #13 | Shale not encountered(Refusal depth 10.5') |
| #14 | 13 |
| #15 | Shale not encountered (Drill depth 21.5') |

# 5.0 GEOTECHNICAL PROPERTIES & ANALYSIS

## 5.1 Laboratory Tests

Near-surface soils are of high plasticity. These soils will exhibit medium to high expansion potential when recompacted, confined by loads approximating floor loads and saturated. Slabs-on-grade supported on recompacted on-site soils have a medium to high potential for heaving if the water content of the soil increases.

# 6.0 RECOMMENDATIONS

## 6.1 General

Recommendations contained in this report are based on our understanding of the project criteria described in Section 2.0 and the assumption that the soil and subsurface conditions are those disclosed by the explorations. Others may change the plans, final elevations, number and type of structures, foundation loads, and floor levels during design or construction. Substantially different subsurface conditions from those described herein may be encountered or become known. Any changes in the project criteria or subsurface conditions shall be brought to our attention in writing.

## 6.2 Design Considerations

The borings indicate the presence of clay soils on the site. The clay soils may expand or swell with an increase in moisture content. Slabs-on-grade and related improvements situated on expansive clay soils could be subject to relatively large movements if the foundation soils experience an increase or decrease in moisture content. In addition, densification of the soil by the passage of construction equipment may increase the expansion potential of the on-site clayey soil. As expansive soils are encountered during earthwork operations, selective placement procedures should be implemented. Moderately to highly expansive soils should not be used as fill in the slab-on-grade or structure areas within 36 inches of the final subgrade. It should be understood that if moisture penetrates expansive soils, there could be some heave and resultant cracking/distress of the proposed structures and related improvements. Conversely, as expansive soils dry, shrinkage and resultant cracking/distress of the proposed structures and related improvements may occur.

Cobbles and boulders were encountered in the borings. These oversized materials, greater than 6 inches, could present construction difficulties for foundation, utility trench, and other excavations. In cut areas and excavations, exposed oversized materials should be removed and either disposed offsite or placed within lower portions of fill areas. The upper 3 feet of fill should be reasonably free of oversized materials.

## 6.3 Foundations

Shallow spread-type footings may be used to support the proposed booster station. The booster station may bear on undisturbed native soil. Alternative footing depths and allowable bearing capacities are presented in the following tabulation:

| Footing Depth Below Finished Grade[1] (ft) | Allowable Bearing Capacity[2] (psf) |
|---|---|
| 2.0[3] | 2,000 |
| 3.0 | 3,000 |

We anticipate that differential settlement of the proposed structure, supported as recommended, should be less than ¾ inch. Additional foundation movements could occur if water from any source infiltrates the foundation soils. Therefore, proper drainage should be provided in the final design and during construction.

All footings, stem walls and masonry walls should be reinforced to reduce the potential for distress caused by differential foundation movements. The use of joints at openings or other discontinuities in masonry walls is recommended.

We recommend that the geotechnical engineer or his representative observe the footing excavations before reinforcing steel and concrete are placed. This observation is to evaluate whether the soils exposed are similar to those anticipated for support of the footings. Any soft, loose or unacceptable soils should be undercut to suitable materials and backfilled with approved fill materials or lean concrete. Soil backfill should be properly compacted.

[1] Finished grade is the lowest adjacent grade for perimeter footings and floor level for interior footings.

[2] Allowable bearing capacities assume fulfillment of **EARTHWORK** recommendations. Pounds per square foot (psf).

[3] Minimum depth for frost protection of exterior footings or footings in unheated spaces.

### 6.4 Lateral Design Criteria

Earth retaining structures less than 15 feet in height, above any free water surface, with level backfill and no surcharge loads may be designed using the equivalent fluid pressure method. Recommended active equivalent fluid pressures and coefficients of base friction for unrestrained elements are:

- Active:
  Undisturbed subsoil........................................40 psf/ft
  Compacted granular backfill ........................................30 psf/ft
  Clay site soils........................................not recommended for use

- Passive:
  Shallow wall footings........................................250 psf/ft
  Shallow column footings ........................................400 psf/ft

- Coefficient of base friction (active)........................................0.40

The equivalent fluid pressures presented herein do not include the lateral pressures arising from the presence of:

- hydrostatic conditions, submergence or partial submergence
- sloping backfill, positively or negatively
- surcharge loading, permanent or temporary
- seismic or dynamic conditions

We recommend a free-draining soil layer or manufactured geosynthetic material be constructed adjacent to the back of any retaining walls. A filter may be required between the soil backfill and drainage layer. This drainage zone should help prevent development of hydrostatic pressure on the wall. This vertical drainage zone should be tied into a gravity drainage system at the base of the wall. It is important that all backfill be properly placed and compacted. Backfill should be mechanically compacted in layers. Flooding or jetting should not be permitted. Care should be taken not to damage the walls when placing the backfill. Backfills should be observed and tested during placement.

Fill against footings, stem walls, and any retaining walls should be compacted to densities specified in **EARTHWORK**. Medium to high plasticity clayey soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Over-compaction may cause excessive lateral earth pressures that could result in wall movements.

## 6.5 Conventional Slab-on-Grade Support

A significant geotechnical concern at the site is the expansion potential of the near surface soil. To reduce the potential for booster station floor slab heaving we recommend that the floor slab be supported on a minimum of 36 inches of low- or non-expansive imported material. The slab subgrade should be prepared by the procedures outlined in the **EARTHWORK** section of this report. A four-inch layer of base course is desirable beneath all slabs to help prevent capillary rise and a damp slab. Final determination of the use of base course should be left to the slab designer. The base course may be included as part of the low- or non-expansive material beneath slabs.

All concrete placement and curing operations should follow the American Concrete Institute manual recommendations. Improper curing techniques and/or high slump (high water-cement ratio) could cause excessive shrinkage, cracking or curling. Concrete slabs should be allowed to cure adequately before placing vinyl or other moisture sensitive floor covering.

## 6.6 Drainage

The major cause of soil problems in this vicinity is moisture increase in soils below structures. Therefore, it is extremely important that positive drainage be provided during construction and maintained throughout the life of the facilities. Infiltration of water into pavement subgrades, utility or foundation excavations must be prevented during construction.

Water and sewer utility lines should be properly installed to avoid possible sources for subsurface saturation. It is important that all utility trenches be properly backfilled.

# 7.0 EARTHWORK

## 7.1 General

The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section. Any excavating, trenching, or disturbance that occurs after completion of the earthwork must be backfilled, compacted and tested in accordance with the recommendations contained herein. It is not reasonable to rely upon our conclusions and recommendations if any future unobserved and untested trenching, earthwork activities or backfilling occurs.

If any unobserved and untested earthwork, trenching or backfilling occurs, then the conclusions and recommendations in this report may not be relied on. We recommend that Western Technologies Inc. be retained to provide services during these phases of the project. Observation and testing of all foundation excavations should be performed prior to placement of reinforcing steel and concrete to confirm that foundations are constructed on satisfactory bearing materials.

## 7.2 Site Clearing

Strip and remove any existing fill material, vegetation, debris, and any other deleterious materials from the building and pavement areas. The building area is defined as that area within the building footprint plus 5 feet beyond the perimeter of that footprint. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction.

Sloping areas steeper than 5:1 (horizontal:vertical) should be benched to reduce the potential for slippage between existing slopes and fills. Benches should be level and wide enough to accommodate compaction and earth moving equipment.

## 7.3 Foundation Preparation

Specialized treatment of existing soils within foundation areas is not required. Foundation excavations should be clean and free of any loose soil or debris. Footing excavations should be reviewed by the geotechnical engineer or his qualified representative prior to the placement of reinforcing steel or concrete.

**7.4 Interior Slab Preparation**

Slabs-on-grade should be founded on engineered fill material. Remove existing soils to a minimum depth of 36 inches feet below the bottom of the slab. Following removal, the exposed soils should be moisture conditioned and recompacted as recommended herein. Replace the overexcavated material with properly compacted, low-expansive, fill material.

**7.5 Unstable Subgrade Soils**

If site soils become excessively wet, pumping and instability should be anticipated. If wet, unstable subgrade soils are encountered during construction, there are several alternatives to mitigate them. The alternatives vary in cost and time to implement, so the alternatives should be evaluated and compared in order to decide which one is most beneficial for the project.

On-site clay soils will pump or become unworkable at high water contents. Workability may be improved by scarifying and drying. Overexcavation of wet zones and replacement with granular materials may be necessary. The use of lightweight excavation and compaction equipment may be required to minimize subgrade pumping. It may be necessary to remove the existing subgrade to a depth of 24 inches below subgrade elevation and replace with a granular subbase material, and/or the use of a woven or non-woven separation fabric such as Marifi RS380i, 700X, or 140N, or approved equivalent, potentially in combination with a geogrid such as Tensar Triax or BX1200. With very soft subgrade conditions, it may be necessary for a combination of removal and the use of a separation fabric.

**7.6 Materials**

Clean on-site soils with low expansive potentials and maximum dimension of 6 inches or imported materials may be used as fill material for the following:

- Foundation areas
- Interior slab areas[4]
- Pavement areas
- Backfill

[4] On-site clay or shale materials are not recommended for use within 36 inches of the bottom of slabs-on-grade or as structural backfill behind retaining walls.

Frozen soils should not be used as fill or backfill.

Imported soils should conform to the following:

- Gradation (ASTM C136): percent finer by weight

| | |
|---|---|
| 6" | 100 |
| 4" | 85-100 |
| ¾" | 70-100 |
| No. 4 Sieve | 50-100 |
| No. 200 Sieve | 30 (max) |

- Maximum expansive potential (%)[5] ........ 1.5
- Maximum soluble sulfates (%) ........ 0.10

Oversize material, greater than 6 inches but less than 12 inches, may be used in the lower portions of the building pad, below 3 feet, provided that the particles are distributed throughout the fill and no nesting of oversize material occurs.

Base course should conform to NMDOT or Federal Highway Administration Specifications.

### 7.7 Placement and Compaction

a. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

b. Uncompacted lift thickness should not exceed 10 inches.

[5] Measured on a sample compacted to approximately 95 percent of the ASTM D1557 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

c. Materials should be compacted to the following:

| Material | Minimum Percent Compaction (ASTM D1557) |
|---|---|
| On-site or imported soil, reworked and fill | 95 |
| Base course below slabs-on-grade | 95 |
| Aggregate base below pavement | 96 |
| Nonstructural backfill | 90 |

Fill at depths greater than 5 feet below finished grade should be compacted to at least 100 percent of the ASTM D1557 dry-density value to within 5 feet of finished grade. Fill at depths less than 5 feet below finished grade should be compacted to the minimum values provided above.

On-site clayey soils should be compacted within a water content range of 1 percent below to 3 percent above optimum. Imported and on-site granular soils with low expansion potential should be compacted within a water content range of 3 percent below to 3 percent above optimum.

## 7.8 Permanent Cut and Fill Slopes

The stability of any cut (and fill) slopes at the project site will be dependent upon the properties of the materials comprising the slope face and the susceptibility of slope soils to erosion. For permanent cut slopes in the typical SHALE or Clayey soil matrix encountered and less than 20 feet in vertical height, slopes no steeper than 3H:1V (horizontal:vertical) are recommended. Fill slopes should not be steeper than 2.5H:1V. It is assumed that appropriate slope erosion protection and/or planting will be utilized.

Where exposed slopes are predominantly made up of bare soil, slopes should be covered as quickly as possible with temporary or permanent protection in order to avoid unnecessary soil loss. If during construction, rains are anticipated, flows over graded or disturbed areas should be minimized by diverting upslope surface water through the use of berms, ditches, or other diversion devices.

Where soil slopes are 3H:1V or flatter, revegetate with native vegetation or provide other available ground covers such as netting, spray or hand-applied mulches, or crushed rock. For slopes of 2H:1V to 3H:1V, protection should consist of spray or hand-applied mulches, jute or excelsior vegetation, erosion matting, other equivalent ground covers. For slopes of 1½H:1V to 2H:1V, slope protection should consist of hand placed, grouted or wire-tied rip-rap as appropriate.

Erosional activity, if allowed to form and propagate, will increase soil loss and could result in loss of support to structures, streets and other facilities. Periodic maintenance and prompt repair of erosional features is important to prevent soil loss. The effectiveness of erosion control measures should be evaluated after heavy or prolonged rains.

### 7.9 Compliance

Recommendations for foundations and slabs-on-grade supported on compacted fills or prepared subgrade depend upon compliance with the **EARTHWORK** recommendations. To assess compliance, observation and testing should be performed under the direction of a WT geotechnical engineer. Please contact us to provide these observation and testing services.

## 8.0 PLAN REVIEW

Foundation and grading plans were not available at the time of this report. WT should be retained to review the final plans to determine if they are consistent with the recommendations presented in this report. If the Client does not retain WT to review the plans and specifications, WT shall have no responsibility for the suitability of the plans for project application.

## 9.0 ADDITIONAL SERVICES

The recommendations provided in this report are based on the assumption that a sufficient schedule of tests and observations will be performed during construction to verify compliance. At a minimum, these tests and observations should be comprised of the following:

- Observations and testing during site preparation and earthwork,
- Observation of foundation excavations, and
- Consultation as may be required during construction.

Retaining the geotechnical engineer who developed your report to provide construction observation is the best way to verify compliance and to help you manage the risks associated with unanticipated conditions.

## 10.0 LIMITATIONS

This report has been prepared assuming the project criteria described in **2.0 PROJECT DESCRIPTION**. If changes in the project criteria occur, or if different subsurface conditions are encountered or become known, the conclusions and recommendations presented herein shall become invalid. In any such event, WT should be contacted in order to assess the effect that such variations may have on our conclusions and recommendations. If WT is not retained for the construction observation and testing services to determine compliance with this report, our professional responsibility is accordingly limited.

The recommendations presented are based entirely upon data derived from a limited number of samples obtained from widely spaced explorations. The attached logs are indicators of subsurface conditions only at the specific locations and times noted. This report assumes the uniformity of the geology and soil structure between explorations, however variations can and often do exist. Whenever any deviation, difference, or change is encountered or becomes known, WT should be contacted.

This report is for the exclusive benefit of our client alone. There are no intended third-party beneficiaries of our contract with the client or this report, and nothing contained in the contract or this report shall create any express or implied contractual or any other relationship with, or claim or cause of action for, any third party against WT.

This report is valid for the earlier of one year from the date of issuance, a change in circumstances, or discovered variations. After expiration, no person or entity shall rely on this report without the express written authorization of WT.

## 11.0 CLOSURE

We prepared this report as an aid to the designers of the proposed project. The comments, statements, recommendations and conclusions set forth in this report reflect the opinions of the authors. These opinions are based upon data obtained at the location of the explorations, and from laboratory tests. Work on your project was performed in accordance with generally accepted standards and practices utilized by professionals providing similar services in this locality. No other warranty, express or implied, is made.


Approximate Boring Location

Proposed Pipeline

N

NOT TO SCALE

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| | |
|---|---|
| PROJECT: | **Navajo Nation Municipal Pipeline** |
| JOB NO.: | **3121JS009** |

**BORING LOCATION DIAGRAM**

PLATE

**1**

| | |
|---|---|
| **Allowable Soil Bearing Capacity** | The recommended maximum contact stress developed at the interface of the foundation element and the supporting material. |
| **Backfill** | A specified material placed and compacted in a confined area. |
| **Base Course** | A layer of specified aggregate material placed on a subgrade or subbase. |
| **Base Course Grade** | Top of base course. |
| **Bench** | A horizontal surface in a sloped deposit. |
| **Caisson/Drilled Shaft** | A concrete foundation element cast in a circular excavation which may have an enlarged base (or belled caisson). |
| **Concrete Slabs-On-Grade** | A concrete surface layer cast directly upon base course, subbase or subgrade. |
| **Crushed Rock Base Course** | A base course composed of crushed rock of a specified gradation. |
| **Differential Settlement** | Unequal settlement between or within foundation elements of a structure. |
| **Engineered Fill** | Specified soil or aggregate material placed and compacted to specified density and/or moisture conditions under observations of a representative of a soil engineer. |
| **Existing Fill** | Materials deposited through the action of man prior to exploration of the site. |
| **Existing Grade** | The ground surface at the time of field exploration. |
| **Expansive Potential** | The potential of a soil to expand (increase in volume) due to absorption of moisture. |
| **Fill** | Materials deposited by the actions of man. |
| **Finished Grade** | The final grade created as a part of the project. |
| **Gravel Base Course** | A base course composed of naturally occurring gravel with a specified gradation. |
| **Heave** | Upward movement. |
| **Native Grade** | The naturally occurring ground surface. |
| **Native Soil** | Naturally occurring on-site soil. |
| **Rock** | A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation. |
| **Sand and Gravel Base Course** | A base course of sand and gravel of a specified gradation. |
| **Sand Base Course** | A base course composed primarily of sand of a specified gradation. |
| **Scarify** | To mechanically loosen soil or break down existing soil structure. |
| **Settlement** | Downward movement. |
| **Soil** | Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water. |
| **Strip** | To remove from present location. |
| **Subbase** | A layer of specified material placed to form a layer between the subgrade and base course. |
| **Subbase Grade** | Top of subbase. |
| **Subgrade** | Prepared native soil surface. |

### COARSE-GRAINED SOILS
LESS THAN 50% FINES

| GROUP SYMBOLS | DESCRIPTION | MAJOR DIVISIONS |
|---|---|---|
| **GW** | WELL-GRADED GRAVEL OR WELL-GRADED GRAVEL WITH SAND, LESS THAN 5% FINES | GRAVELS<br>MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE |
| **GP** | POORLY-GRADED GRAVEL OR POORLY-GRADED GRAVEL WITH SAND, LESS THAN 5% FINES | |
| **GM** | SILTY GRAVEL OR SILTY GRAVEL WITH SAND, MORE THAN 12% FINES | |
| **GC** | CLAYEY GRAVEL OR CLAYEY GRAVEL WITH SAND, MORE THAN 12% FINES | |
| **SW** | WELL-GRADED SAND OR WELL-GRADED SAND WITH GRAVEL, LESS THAN 5% FINES | SANDS<br>MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE |
| **SP** | POORLY-GRADED SAND OR POORLY-GRADED SAND WITH GRAVEL, LESS THAN 5% FINES | |
| **SM** | SILTY SAND OR SILTY SAND WITH GRAVEL, MORE THAN 12% FINES | |
| **SC** | CLAYEY SAND OR CLAYEY SAND WITH GRAVEL, MORE THAN 12% FINES | |

**NOTE:** Coarse-grained soils receive dual symbols if they contain 5% to 12% fines (e.g., SW-SM, GP-GC).

### FINE-GRAINED SOILS
MORE THAN 50% FINES

| GROUP SYMBOLS | DESCRIPTION | MAJOR DIVISIONS |
|---|---|---|
| **ML** | SILT, SILT WITH SAND OR GRAVEL, SANDY SILT, OR GRAVELLY SILT | SILTS AND CLAYS<br>LIQUID LIMIT LESS THAN 50 |
| **CL** | LEAN CLAY OF LOW TO MEDIUM PLASTICITY, SANDY CLAY, OR GRAVELLY CLAY | |
| **OL** | ORGANIC SILT OR ORGANIC CLAY OF LOW TO MEDIUM PLASTICITY | |
| **MH** | ELASTIC SILT, SANDY ELASTIC SILT, OR GRAVELLY ELASTIC SILT | SILTS AND CLAYS<br>LIQUID LIMIT MORE THAN 50 |
| **CH** | FAT CLAY OF HIGH PLASTICITY, SANDY FAT CLAY, OR GRAVELLY FAT CLAY | |
| **OH** | ORGANIC SILT OR ORGANIC CLAY OF HIGH PLASTICITY | |
| **PT** | PEAT AND OTHER HIGHLY ORGANIC SOILS | HIGHLY ORGANIC SOILS |

**NOTE:** Fine-grained soils may receive dual classification based upon plasticity characteristics (e.g. CL-ML).

### SOIL SIZES

| COMPONENT | SIZE RANGE |
|---|---|
| BOULDERS | Above 12 in. |
| COBBLES | 3 in. – 12 in. |
| GRAVEL | No. 4 – 3 in. |
| Coarse | ¾ in. – 3 in. |
| Fine | No. 4 – ¾ in. |
| SAND | No. 200 – No. 4 |
| Coarse | No. 10 – No. 4 |
| Medium | No. 40 – No. 10 |
| Fine | No. 200 – No. 40 |
| Fines (Silt or Clay) | Below No. 200 |

**NOTE:** Only sizes smaller than three inches are used to classify soils

### CONSISTENCY

| CLAYS & SILTS | BLOWS PER FOOT |
|---|---|
| VERY SOFT | 0 – 2 |
| SOFT | 3 – 4 |
| FIRM | 5 – 8 |
| STIFF | 9 – 15 |
| VERY STIFF | 16 – 30 |
| HARD | OVER 30 |

### RELATIVE DENSITY

| SANDS & GRAVELS | BLOWS PER FOOT |
|---|---|
| VERY LOOSE | 0 – 4 |
| LOOSE | 5 – 10 |
| MEDIUM DENSE | 11 – 30 |
| DENSE | 31 – 50 |
| VERY DENSE | OVER 50 |

**NOTE:** Number of blows using 140-pound hammer falling 30 inches to drive a 2-inch-OD (1⅜-inch ID) split-barrel sampler (ASTM D1586).

### PLASTICITY OF FINE GRAINED SOILS

| PLASTICITY INDEX | TERM |
|---|---|
| 0 | NON-PLASTIC |
| 1 – 7 | LOW |
| 8 – 20 | MEDIUM |
| Over 20 | HIGH |

### DEFINITION OF WATER CONTENT

| |
|---|
| DRY |
| SLIGHTLY DAMP |
| DAMP |
| MOIST |
| WET |
| SATURATED |

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## METHOD OF CLASSIFICATION

PLATE
**A-2**

The number shown in **"BORING NO."** refers to the approximate location of the same number indicated on the "Boring Location Diagram" as positioned in the field by pacing or measurement from property lines and/or existing features, or through the use of Global Positioning System (GPS) devices. The accuracy of GPS devices is somewhat variable.

**"DRILLING TYPE"** refers to the exploratory equipment used in the boring wherein **HSA = hollow stem auger**, and the dimension presented is the outside diameter of the HSA used.

**"N" in "BLOW COUNTS"** refers to a 2-inch outside diameter split-barrel sampler driven into the ground with a 140 pound drop-hammer dropped 30 inches repeatedly until a penetration of 18 inches is achieved or until refusal. The number of blows, or "blow count", of the hammer is recorded for each of three 6-inch increments totaling 18 inches. The number of blows required for advancing the sampler for the last 12 inches ($2^{nd}$ and $3^{rd}$ increments) is defined as the Standard Penetration Test (SPT) "**N**"-Value. Refusal to penetration is considered more than 50 blows per 6 inches. (Ref. ASTM D1586).

**"R" in "BLOW COUNTS"** refers to a 3-inch outside diameter ring-lined split barrel sampler driven into the ground with a 140 pound drop-hammer dropped 30 inches repeatedly until a penetration of 12 inch is achieved or until refusal. The number of blows required to advance the sampler 12 inches is defined as the "**R**" blow count. The "**R**" blow count requires an engineered conversion to an equivalent SPT N-Value. Refusal to penetration is considered more than 50 blows per foot. (Ref. ASTM D3550).

**"CS" in "BLOWS/FT."** refers to a 2½-in. outside diameter California style split-barrel sampler, lined with brass sleeves, driven into the ground with a 140-pound hammer dropped 30 inches repeatedly until a penetration of 18 inches is achieved or until refusal. The number of blows of the hammer is recorded for each of the three 6-inch increments totaling 18 inches. The number of blows required for advancing the sampler for the last 12 inches ($2^{nd}$ and $3^{rd}$ increments) is defined as the "CS" blow count. The "CS" blow count requires an engineered conversion to an equivalent SPT N-Value. Refusal to penetration is considered more than 50 blows for a 6-inch increment. (Ref. ASTM D 3550)

**"SAMPLE TYPE"** refers to the form of sample recovery, in which **N** = Split-barrel sample, **R** = Ring-lined sample, **"CS"** = California style split-barrel sample, **G** = Grab sample, **B** = Bucket sample, **C** = Core sample (ex. diamond bit rock coring).

**"DRY DENSITY (LBS/CU FT)"** refers to the laboratory-determined dry density in pounds per cubic foot. The symbol **"NR"** indicates that no sample was recovered.

**"WATER (MOISTURE) CONTENT"** (% of Dry Wt.) refers to the laboratory-determined water content in percent using the standard test method ASTM D2216.

**"USCS"** refers to the "Unified Soil Classification System" Group Symbol for the soil type as defined by ASTM D2487 and D2488. The soils were classified visually in the field, and where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the date(s) noted. Variations in subsurface conditions and characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

The stratification lines shown on the boring logs represent our interpretation of the approximate boundary between soil or rock types based upon visual field classification at the boring location. The transition between materials is approximate and may be more or less gradual than indicated.

DATE DRILLED: **4-6-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 4

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7"HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | SAMPLE | BLOW COUNTS | DEPTH (FEET) | USCS | GRAPHIC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| | | G | | | 0 | SM | | 2" Asphalt, No Base Course |
| | | | | | | | | Silty SAND; brown, loose, moist, with some gravel |
| | | N | | 10 | | | | |
| | NR | R | | 21 | 5 | | | medium dense |
| | | N | | 12 | 10 | SC | | Clayey SAND; brown, medium dense, moist |
| | | N | | 18 | 15 | | | |
| | | N | | 16 | 20 | SM | | Silty SAND; brown, medium dense, wet |
| | | N | | 50/33" | 25 | CL | | SHALE; Sandy Lean CLAY, black/green, hard, moist |
| | | N | | 50/5" | 30 | | | |
| | | | | | | | | BORING TERMINATED AT 31 FEET |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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JOB NO.: **3121JS009**

**BORING LOG**

PLATE **A-4**

DATE DRILLED: **4-6-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 5

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7"HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 8.0 | | G | | | SM | Silty SAND; brown, medium dense, moist |
| | | N | 17 | | | |
| 8.0 | 85 | R | 24 | 5 | | light brown |
| | | N | 8 | 10 | | loose |
| | | N | 8 | 15 | SC-SM | Silty Clayey SAND; light to dark brown, loose, moist |
| | | | | | CL | SHALE; Sandy Lean CLAY, black/gray, hard, moist |
| | | N | 50/3" | 20 | | |
| | | N | 50/5" | 25 | | light brown/gray |
| | | | | | | dark brown |
| | | N | 50/3" | 30 | | |
| | | | | | | BORING TERMINATED AT 31 FEET |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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JOB NO.: **3121JS009**

# BORING LOG

PLATE **A-5**

DATE DRILLED: **4-6-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 6

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7"HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 4.5 | | G | | | SP-SM | Poorly Graded SAND with SIlt; brown, medium dense, moist |
| | | N | 11 | | | |
| 4.5 | 96 | R | 11 | 5 | | dark brown, loose |
| | | N | 20 | 10 | | light to dark brown, dense, damp |
| | | | | | SM | Silty SAND; dark brown, medium dense, moist, with gravel |
| | | N | 15 | 15 | | |
| | | | | | | with more gravel/cobble |
| | | N | 24 | 20 | | light brown, no gravel/cobble |
| | | N | 23 | 25 | | |
| | | N | 22 | 30 | | wet |

BORING TERMINATED AT 31.5 FEET

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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JOB NO.: **3121JS009**

PLATE **A-6**

**BORING LOG**

DATE DRILLED: **4-6-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 7

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7"HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | 0 | SM | Silty SAND; dark brown, medium dense, moist, with gravel |
| | | N | 23 | | | |
| | | N | 19 | 5 | | with more gravel/cobble |
| 14.7 | | G N | 15 | 10 | CL | SHALE; Sandy Lean CLAY, brown/gray, stiff, moist |
| | | | | | | black/brown/green, hard, damp |
| | | N | 60 | 15 | | |
| | | N | 87/10" | 20 | | |
| | | | | | | gray/green |
| | | N | 77 | 25 | | |
| | | | | | | BORING TERMINATED AT 26.5 FEET |
| | | | | 30 | | |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

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PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
JOB NO.: **3121JS009**

# BORING LOG

PLATE **A-7**

DATE DRILLED: **4-6-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 8

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7"HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | G | | 0 | SM | Silty SAND; light brown, medium dense, damp |
| | | N | 12 | 2 | | moist |
| | NR | R | 16 | 5 | | |
| | | | | 7 | CL | SHALE; Sandy Lean CLAY, brown/gray, hard, moist |
| | | N | 69 | 10 | | |
| | | N | 94 | 15 | | |
| | | | | 18 | | black/brown/green |
| | | N | 52 | 20 | | |
| | | | | 21.5 | | BORING TERMINATED AT 21.5 FEET |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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JOB NO.: **3121JS009**

# BORING LOG

PLATE
**A-8**

DATE DRILLED: **4-6-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 11

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7"HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 10.1 | | G | | 0 | SC | Clayey SAND; light brown, medium dense, moist, with gravel |
| | | N | 16 | | | |
| 10.1 | 99 | R | 13 | 5 | | |
| 11.2 | | N<br>G | 30 | 10 | CL | SHALE; Sandy Lean CLAY, brown/green, very stiff, moist |
| | | N | 47 | 15 | | hard |
| | | N | 35 | 20 | | black, moist |
| | | N | 50/4" | 25 | | damp |
| | | N | 89/10" | 30 | | |
| | | | | | | BORING TERMINATED AT 31.5 FEET |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
JOB NO.: **3121JS009**

**BORING LOG**

PLATE **A-9**

DATE DRILLED: **4-30-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 12

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7" HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 7.1 | | G | | | SC-SM | Silty Clayey SAND; brown, medium dense, damp |
| 7.8 | 114 | R | 39 | | | moist |
| 4.4 | 108 | R | 39 | 5 | | |
| 3.4 | 101 | R | 20 | 10 | SM | light brown, medium dense, moist |
| | | N | 18 | 15 | | |
| 14.6 | | G N | 20 | 20 | CL | Sandy Lean CLAY; dark brown, very stiff, moist |
| | | N | 18 | 25 | | |
| | | N | 16 | 30 | SC-SM | Silty Clayey SAND; light brown, medium dense, moist |
| | | | | | | with some gravel |
| | NR | R | 50/8" | 35 | | very dense, wet |
| | | N | 50/4" | 40 | CL | SHALE; Sandy Lean CLAY, dark brown/green/orange, hard, damp |
| | | | | | | BORING TERMINATED AT 41 FEET |
| | | | | 45 | | |
| | | | | 50 | | |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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JOB NO.: **3121JS009**

## BORING LOG

PLATE **A-10**

DATE DRILLED: **4-26-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 13

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7" HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | SAMPLE | BLOW COUNTS | DEPTH (FEET) | USCS | GRAPHIC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 5.1 | | G | | | | SM | | Silty SAND; light brown, very dense, damp |
| 3.2 | 99 | R | | 50/6" | | | | light brown/white |
| | NR | R | | 50/6" | 5 | | | with gravel/cobble |
| | NR | R | | 50/2" | 10 | | | |
| | | | | | | | | AUGER REFUSAL AT 10.5 FEET ON COBBLES |
| | | | | | 15 | | | |
| | | | | | 20 | | | |
| | | | | | 25 | | | |
| | | | | | 30 | | | |
| | | | | | 35 | | | |
| | | | | | 40 | | | |
| | | | | | 45 | | | |
| | | | | | 50 | | | |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
JOB NO.: **3121JS009**

PLATE **A-11**

**BORING LOG**

DATE DRILLED: **4-26-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 14

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7" HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 4.3 | | N | | | SC | Clayey SAND; light brown, medium dense, damp |
| 5.3 | 96 | R | 42 | | | light brown/white |
| 4.0 | 90 | R | 24 | 5 | | |
| | | | | | | with gravel |
| 2.2 | 115 | R | 50/5" | 10 | SP | Poorly Graded SAND; light brown/gray, very dense, damp, with gravel/cobble |
| | | N | 50 | | CL | SHALE; Sandy Lean CLAY, dark brown/green, hard, moist |
| 13.5 | | G | 59 | 15 | | |
| | | N | | | | |
| | | N | 35 | 20 | | brown/orange |
| | | N | 92 | 25 | | |
| | | N | 50/5" | 30 | | |
| | | N | 60 | 35 | | |
| | | N | 50/2" | 40 | | |
| | | N | 50/4" | 45 | | |
| | | N | 50/3" | 50 | | |
| | | | | | | BORING TERMINATED AT 51 FEET |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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JOB NO.: **3121JS009**

PLATE **A-12**

**BORING LOG**

DATE DRILLED: **4-30-21**
LOCATION: **See Location Diagram**
ELEVATION: **Not Determined**

# BORING NO. 15

EQUIPMENT TYPE: **CME-75**
DRILLING TYPE: **7" HSA**
FIELD ENGINEER: **J.Liberman**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOW COUNTS | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 7.9 | | G | | | CL | Sandy Lean CLAY; brown, hard, damp, with cobble |
| 7.9 | 97 | R | 49 | | | |
| | | | | | | with gravel |
| 8.2 | 90 | R | 34 | 5 | | |
| | NR | R | 50/9" | 10 | | with gravel/cobble |
| | | N | 14 | 15 | | |
| | | | | | SM | Silty SAND; light brown, medium dense, damp |
| | | N | 11 | 20 | | |
| | | | | | | BORING TERMINATED AT 21.5 FEET |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

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PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
JOB NO.: **3121JS009**

PLATE **A-13**

## BORING LOG

| Boring No. | Depth (ft.) | USCS Class. | Initial Dry Density (pcf) | Initial Water Content (%) | Compression Properties | | | Expansion Properties | | Plasticity | | Percent Passing #200 | Soluble Sulfate (ppm) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Surcharge (ksf) | Total Compression (%) | | Surcharge (ksf) | Expansion (%) | Liquid Limit | Plasticity Index | | | |
| | | | | | | In-Situ | After Saturation | | | | | | | |
| 5 | 0-5 | SM | | 8.0 | | | | | | -- | NP | 31 | | |
| 6 | 0-5 | SP-SM | | 4.5 | | | | | | -- | NP | 9.7 | | |
| 11 | 0-5 | SC | | 10.1 | | | | | | 28 | 9 | 33 | | |

**Note**: Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.
NP = Non-Plastic

**Remarks**

1. Compacted density (approx. 95% of ASTM D1557 max. density at moisture content slightly below optimum.)
2. Submerged to approximate saturation.
3. Slight rebound after saturation.
4. Sample disturbance observed.

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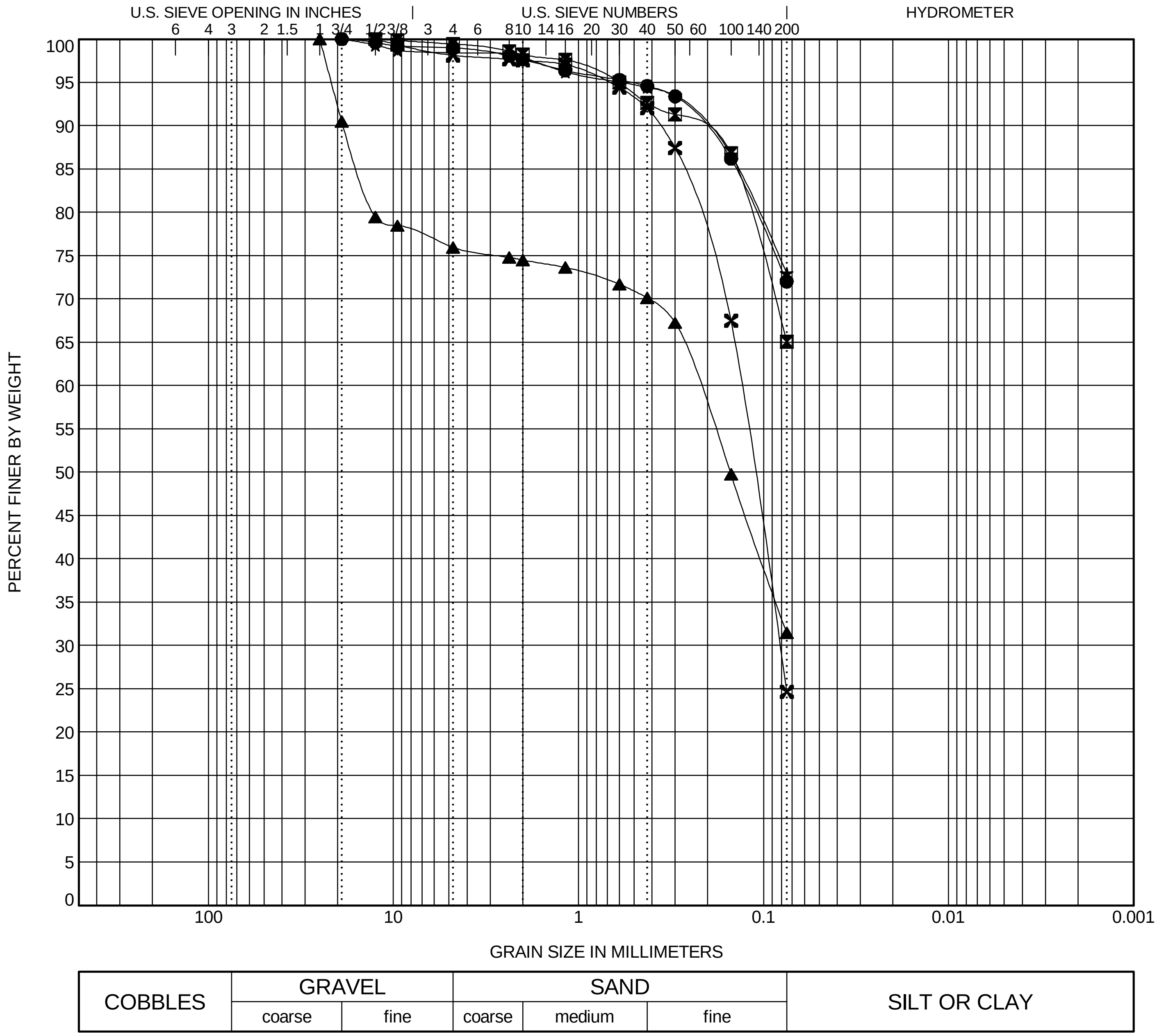
PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
JOB NO.: **3121JS009**

**SOIL PROPERTIES**

PLATE
**B-1**




| Symbol | Sample Identification | | Symbol | Classification | LL | PL | PI | $C_c$ | $C_u$ | $F_m$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 7 | 15.0 ft | CL | Sandy Lean CLAY | 37 | 16 | 21 | | | 3.86 |
| ⧗ | 11 | 15.0 ft | CL | Sandy Lean CLAY | 34 | 18 | 16 | | | 3.84 |
| ▲ | 12 | 5.0 ft | SC-SM | Silty Clayey SAND | 23 | 17 | 6 | | | 2.90 |
| ★ | 12 | 25.0 ft | CL | Sandy Lean CLAY | 34 | 13 | 21 | | | 3.85 |
| ✖ | 13 | 5.0 ft | SM | Silty SAND | NP | NP | NP | | | 3.78 |

| Symbol | Sample Identification | | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | 7 | 15.0 ft | 19 | | | | 1.0 | 27.0 | | |
| ⧗ | 11 | 15.0 ft | 12.5 | | | | 0.6 | 34.3 | | |
| ▲ | 12 | 5.0 ft | 25 | 0.225 | | | 24.1 | 44.5 | | |
| ★ | 12 | 25.0 ft | 19 | | | | 1.6 | 25.4 | | |
| ✖ | 13 | 5.0 ft | 12.5 | 0.133 | 0.082 | | 1.9 | 73.5 | | |

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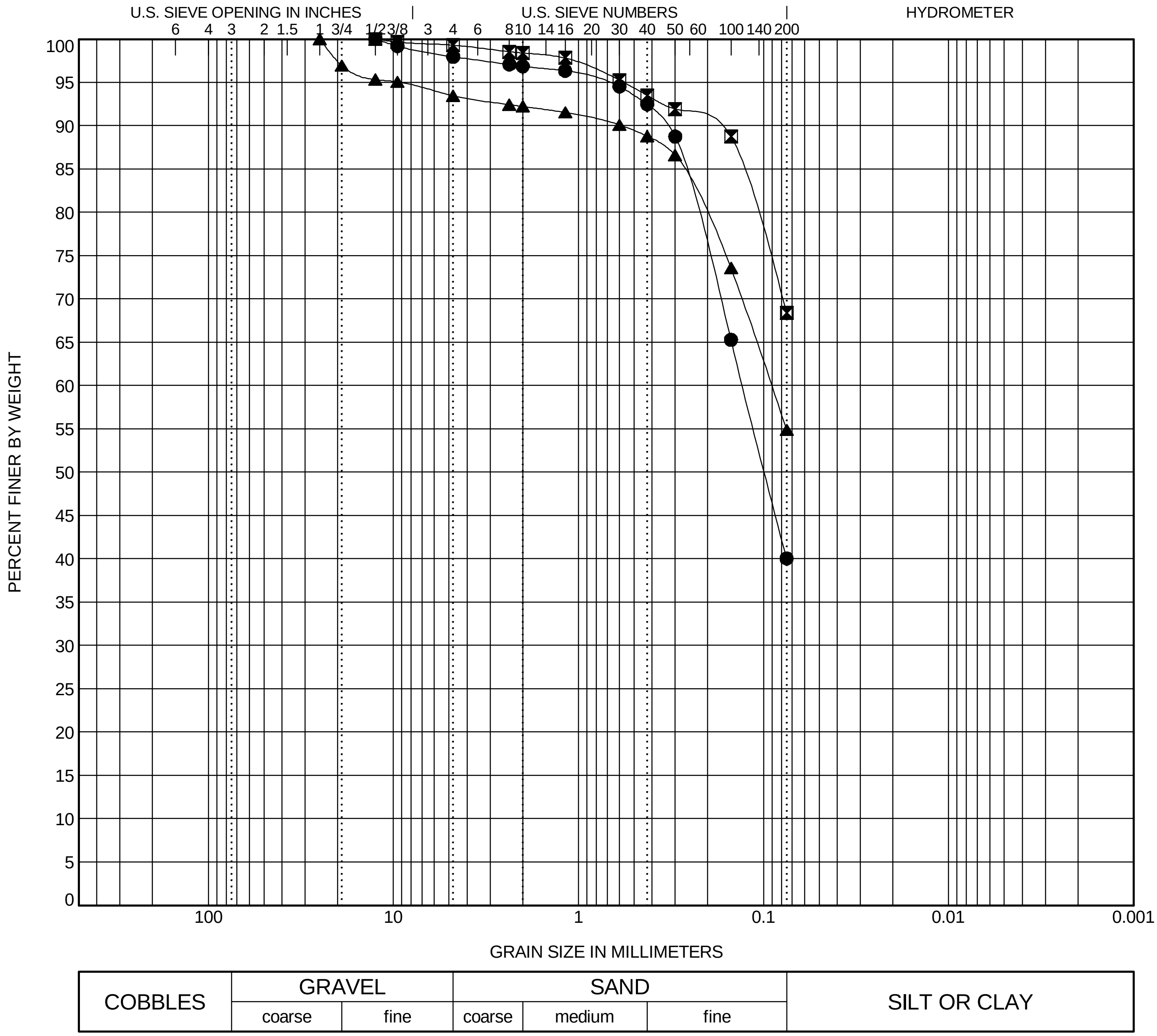
PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
LOCATION:
PROJECT NO.: **312JS009**

PLATE **B-2**

## GRAIN SIZE DISTRIBUTION




| Sample Identification | | Symbol | Classification | LL | PL | PI | $C_c$ | $C_u$ | $F_m$ |
|---|---|---|---|---|---|---|---|---|---|
| ● 14 | 5.0 ft | SC | Clayey SAND | 23 | 15 | 8 | | | 3.78 |
| ⧗ 14 | 20.0 ft | CL | Sandy Lean CLAY | 39 | 17 | 22 | | | 3.85 |
| ▲ 15 | 5.0 ft | CL | Sandy Lean CLAY | 40 | 14 | 26 | | | 3.63 |
| | | | | | | | | | |
| | | | | | | | | | |

| Sample Identification | | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● 14 | 5.0 ft | 12.5 | 0.13 | | | 2.0 | 57.9 | | |
| ⧗ 14 | 20.0 ft | 12.5 | | | | 0.7 | 30.9 | | |
| ▲ 15 | 5.0 ft | 25 | 0.091 | | | 6.5 | 38.6 | | |
| | | | | | | | | | |
| | | | | | | | | | |

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PROJECT: **NAVAJO NATION MUNICIPAL PIPELINE**
LOCATION:
PROJECT NO.: **312JS009**

# GRAIN SIZE DISTRIBUTION

PLATE
**B-3**

# RECLAMATION
*Managing Water in the West*

# HYDRAULIC REPORT

## Navajo Nation Municipal Pipeline
## Animas-La Plata Project, New Mexico
## Upper Colorado Region

**U.S. Department of the Interior**
**Bureau of Reclamation**
**Four Corners Construction Office - Farmington**
**Navajo Nation, New Mexico**

**March 2008**

# 1 Introduction

## 1.1 Introduction

This report summarizes the engineering and hydraulic analyses performed for the new Navajo Nation Municipal Pipeline (NNMP). The NNMP will be located in San Juan County in northwest New Mexico and will convey municipal water to Navajo Nation communities from Farmington to, and including, the community of Shiprock. An existing ductile iron distribution pipeline currently serves the communities between Farmington and Shiprock, see **Figure 1.**

The Navajo Nation through the Navajo Tribal Utility Authority (NTUA) has operated the existing system since 1969. The existing system provides treated municipal water from the City of Farmington to seven Navajo Nation Chapters (Upper Fruitland, Nenahnezad, San Juan, Hogback, Shiprock, Cudei, and Beclaibito). In the late 1990's and early 2000's, the system became incapable of providing the increasing peak summer demands. This prompted a hydraulic analysis which was performed by the Indian Health Service (IHS). In 2005/2006, the IHS designed and constructed a booster pumping plant on the existing system in the Upper Fruitland Chapter to address the capacity issues. The IHS hydraulic analysis performed on the system in 2004 projected that the pumping plant would provide sufficient capacity to meet the demand through the year 2012.

The NNMP is a feature of the Animas – La Plata (A-LP) Project. The A-LP Project was authorized in 2000 and settles the Ute Indian Tribe claims on the Animas and La-Plata river basins. The authorized project consists of a pumping plant, conduit, and dam in southwest Colorado and the NNMP in New Mexico. The NNMP was included in the A-LP project by the Colorado Ute Setttlement Act Amendments of 2000 and authorized the construction of a water line to augment the existing system that conveys municipal water supplies, in an amount not less than 4,680 acre feet per year, (afy) to the Navajo Indian Reservation at or near Shiprock, New Mexico.

The City of Farmington and NTUA currently have a contract for the City of Farmington to provide water to the Navajo Nation at 3MGD (4.64 cfs) average demand and a minimum pressure of 60 psi at the meter located on the south side of the San Juan River near Farmington (approximately Station 14+00 on the existing pipeline).

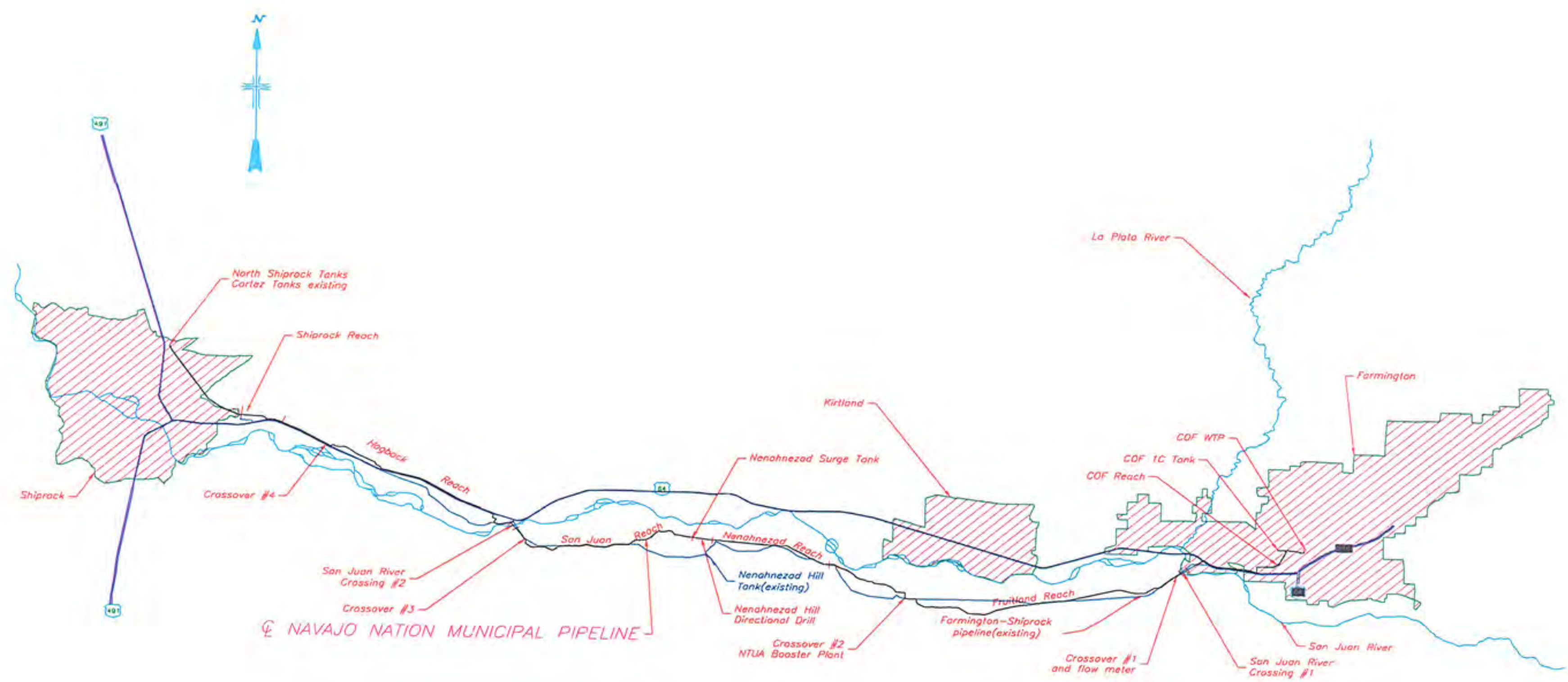


Figure 1. General Map

## 1.2 Background and Previous Studies

The NNMP has been in development and evolution for many years. Reclamation included Navajo Department of Water Resources (NDWR), NTUA, IHS, and other project sponsors and stake holders throughout the process of planning and design of the project.

### 1.2.1 NDWR 1998 Report

The NDWR provided to Reclamation a study performed in 1998 (Navajo Nation Technical Memorandum A-LP Lite) discussing options for obtaining water from the A-LP project. The report included demand flow rates and cost estimates for several options proposed by the NDWR. The NDWR used a total design flow of 12.6 cfs, with a flow to Shiprock of 6.6 cfs. This is a total flow of 4,560 afy and peaking factor of 2.0. Storage tanks and a pumping plant were included as part of the options. This report was provided to Technical Service Center (TSC) for appraisal level review of technical aspects of the project.

### 1.2.2 TSC Technical Review Memorandum, 1999

Reclamation's TSC performed a review of the NDWR 1998 report and provided a memorandum with the discussions on the NDWR options. Reclamation used data in the NDWR 1998 report to perform appraisal level design cost estimates and to check the technical merits of the NDWR report. Reclamation used a total flow of 4,560 afy, with a peaking factor of 2.0. The steady state flow to Shiprock was 6.8 cfs. The two options considered were a pumped system and a gravity system. The pumped system used a pressure of 90 psi and the gravity system used a pressure of 103 psi. Both designs assumed that the new line would parallel or replace the existing waterline. This document was provided to the A-LP project office in Durango, Colorado.

### 1.2.3 IHS Hydraulic Report ,1999

In 1999, the IHS performed an analysis of the existing system and provided a comprehensive report, "Hydraulic Analysis of the Farmington-Shiprock Water Transmission Line" (Steve Dykstra, 1999). The scope of the report was to first determine the capacity of the existing transmission line and, second, to identify improvements necessary to the transmission line to increase the capacity in accordance with NTUA criteria. The report showed that a maximum of 1.125 MGD (1.74 cfs) can be delivered to Shiprock during peak demand periods of the year by the existing transmission line. Secondly, the report showed that the installation of inline booster pumps would be the best way to increase the capacity of the existing transmission line.

As part of the report, field work was performed to determine the pipe friction coefficients in the existing system and other measurements done to calibrate the Haestad's WaterCAD hydraulic model used for the IHS report. The IHS had meter counts along the existing pipeline to determine the actual flow.

### 1.2.4 FSEIS A-LP, 2000

The Final Supplemental Environmental Impact Statement (FSEIS) document provided a cost estimate for delivering the Navajo Nation water supply entitlement of 4,680 afy starting at the west boundary of Farmington and extending 28.9 miles to Shiprock. The preferred alternative described a pipeline that would replace the existing 30 year old pipeline and increase the capacity to deliver water. The water would be treated through the Farmington city system and treatment plant. The pipeline was designed for a peak flow of 8.1 MGD (12.6 cfs). The cost estimate included a total additional storage capacity of 5.5 million gallons that was divided between an elevated 1.5 million tank near Nenahnezad and a ground based tank with a capacity of 4.0 million gallons at Shiprock, on the hill near the existing Cortez Tanks.

### 1.2.5 Value Engineering Study, 2004

A feasibility design based in part on the FSEIS preferred alternative was performed and evaluated in a Value Engineering (VE) study in June/July 2004. The feasibility design differed from the FSEIS preferred alternative in that the design did not replace the existing pipeline but added a new pipeline in accordance with the language in the legislation describing it as an augmentation. The alignment of the pipeline was also changed in some areas to minimize the impact to existing residences and archeological sites. The new pipeline alignment allowed the elevation of the new Nenahnezad storage tank to be lower so that the new pipeline could operate at a higher capacity by gravity. The value engineering study recommended nine possible cost saving measures. Reclamation used the following recommendations from the VE study: reduce depth of minimum cover from 5 feet to 3 feet where conditions allow, and to break the pressure at the high point on Nenahnezad Hill to a maximum of 20 psi. The least costly design option of a pumping plant to further reduce the pipe head class was not incorporated because a gravity system was the preference of the Navajo Nation. In addition, the VE report discussed the need for additional water storage and whether the tanks were actually required.

### 1.2.6 Hydraulic Summary Letter, 2004

The NTUA and the Navajo Nation requested that IHS do a study based on the 1999 model to determine if tanks were necessary at Shiprock for early construction of the NNMP feature. The IHS determined that tanks were not necessary and that with the addition of a pumping plant in 2006, the system could meet the IHS projected demand of 2.5 MGD (3.87 cfs), up to the year 2012, in Shiprock for a total flow of 3.2 MGD (4.95 cfs) from Farmington.

### 1.2.7 Design Criteria Letter, 2004

Based on the results of the VE study, the need to establish design criteria became clear. Reclamation sent a design criteria letter to Navajo Nation for approval on October 6, 2004, outlining the criteria that would be used to finalize the design. The letter also included some of the cost saving recommendations of the NNMP VE report as stated above. The design criterion was approved by the Navajo Nation on October 13, 2004. See **APPENDIX A**.

# 2 Existing System

## 2.1 Introduction

The existing distribution system from Farmington to Shiprock was constructed in 1969 to provide potable water service to the Navajo Nation communities between the cities and to supplement the needs of Shiprock. Shiprock has its own water treatment plant, but the plant has a low capacity and has problems obtaining water from the San Juan River because of silt. Water demand has increased in these communities and the cost to purchase water from the City of Farmington is less than the cost of production at the Shiprock water treatment plant. This has created an increase in demand on the existing distribution pipeline as well as problems meeting the peak demand during the summer. In 2006, the IHS constructed a booster pumping plant in the Upper Fruitland area which increases the total flow of the system to approximately 3.2 MGD (4.95cfs). The projected demand in the year 2012 is 2.5 MGD (3.87 cfs), when the new transmission pipeline is scheduled to be completed.

## 2.2 System Configuration

The existing system is composed of ductile iron pipe ranging in sizes from 18-inch down to 14-inch diameter on the mainline and has smaller diameter distribution piping teeing off along the main line to provide service to the local residents. The 18-inch diameter, cement-lined, ductile iron pipe continues from the Farmington system connection, just south of the San Juan River crossing near Farmington, to the Nenahnezad Tank (500,000 gallons). From the Nenahnezad Tank, the pipe reduces to a 14-inch diameter pipe and continues to the San Juan River crossing near the Hogback. The pipe diameter is then increased back to 16 inches from the river crossing to the Cortez Tanks (3 MG gallons). The original system had a pressure reducing valve downstream of the Nenahnezad Tank, however, the valve is no longer in service since all of the lines tapped into the mainline have their own pressure reducing valves. There are four booster pumping plants off the main line that boost pressure to select distribution zones that were not modeled in this study.

The existing mainline distribution pipeline consists of approximately 69,400 feet of 18-inch, 58,900 feet of 16-inch, and 23,000 feet of 14-inch diameter ductile iron pipe. The cement-lined ductile iron pipe has a working pressure Class of 300 psi.

The existing distribution system was inspected by the Ductile Iron Pipe Research Association (DIPRA) and NTUA in 2000 and found to be in good condition.

## 2.3 System Operations

The existing distribution system is supplied by a 30-inch diameter pipeline from the City of Farmington's water treatment plant to the 1C tank located just east of the Farmington airport. An 18-inch diameter pipe continues as described previously and provides the water supply to customers along the pipeline as well as to NTUA and the Navajo Nation. The 18-inch ductile iron pipeline within the City of Farmington was constructed in 1969 and is approximately 2.8 miles in length from the tee to the termination at the City of Farmington's meter box on the south side of the San Juan River.

The existing mainline system operated by gravity until 2006 when a pumping plant was installed upstream of the Nenahnezad Hill Tank. During the IHS hydraulic study on the existing system in 1999, the average pressure measured at the existing meter ranged from 84 psi to 96 psi. The higher pressure allowed the water to flow into the existing storage tank on Nenahnezad Hill by gravity. As demand increased in Farmington and the pressure decreased due to the capacity of the existing pipeline, a pumping plant was required upstream of the Nenahnezad Hill to meet the current and future needs. The pumping plant provides an increased capacity to the system for the projected demand of 2.5 MGD (3.87 cfs) up to the year 2012 according to the IHS report.

Mainline taps of varying sizes have PRV's from the mainline to the turnouts and deliveries. Most of the distribution system turnouts are interconnected and looped to the existing mainline.

## 2.4 Water Demand

According to IHS and NTUA, there were approximately 4,150 meters supplied by the Farmington to Shiprock pipeline in 2004. There are 1,319 meters from Farmington to Hogback at the river crossing and 2,831 meters from the river crossing at the Hogback to Shiprock. Assuming equal residential use through each meter, approximately 70 percent of the flow is required in the reach between Hogback to Shiprock and approximately 30 percent is required in the reach from Farmington to Hogback. The individual meters were grouped into downstream delivery junctions to simplify the existing system being modeled. **See Figure 2.**

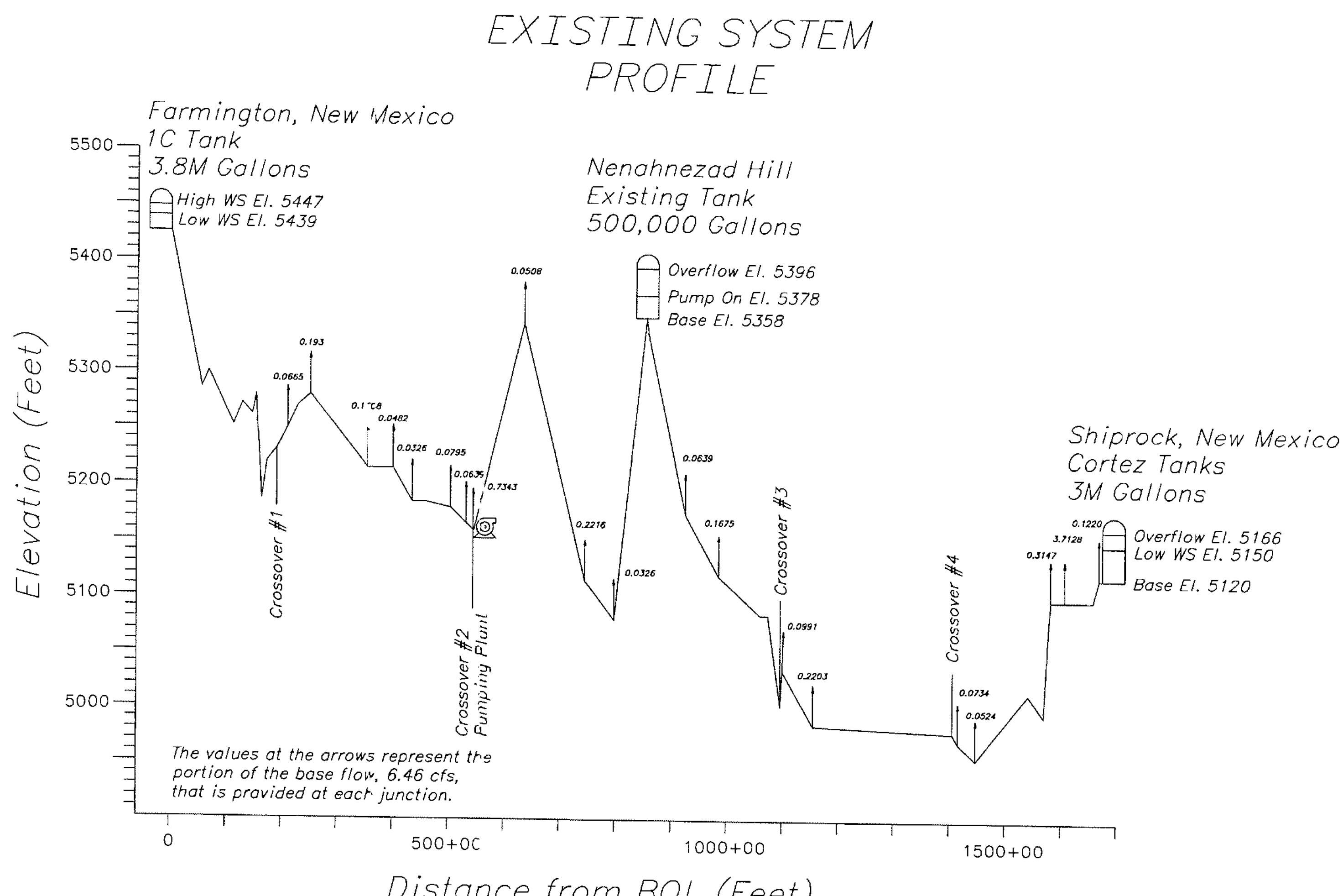


**Figure 2 Existing System Profile**

# 3 New System

## 3.1 Introduction

A Record of Decision (ROD) memorandum dated September 25, 2000, on the FSEIS identifies the NNMP as "*a pipeline to transport M&I water to the Shiprock area for the benefit of the Navajo Nation*". In a later section, the ROD acknowledges the Navajo Nation's request that a "*water conveyance pipeline be included as a structural component of the ALP project, to upgrade the service now being provided for seven Navajo Nation chapters in the Farmington-Shiprock area, and to replace a deteriorating 30-year old pipeline now in place.*" This component was ultimately part of the selected environmentally preferred alternative in the ROD.

In addition, the ROD stated:

> "To avoid potentially significant impacts to residences, school, and cemetery along the recommended route of the Navajo Nation Municipal Pipeline, the pipeline corridor would be routed to minimize, and to the maximum extent possible, prevent disturbance or relocation of residences."

In the 2000 amendments of the A-LP project, the pipeline was included as part of the A-LP Lite proposal. The Colorado Ute Settlement Act Amendments of 2000 states that "*it is the intent of Congress to enact legislation that implements the Record of Decision.*" More specifically, the legislation provides the Secretary the authority "*to construct a water line to augment the existing system that conveys municipal water supplies, in an amount not less than 4,680 acre feet per year, to the Navajo Indian Reservation at or near Shiprock, New Mexico.*" Since the existing system provided water to the Navajo Nation Chapter communities along the route, the design flow is conveyed to Crossover #1, near the boundary of the Navajo Nation land and distributed to the tanks and users along the route. The crossover linking the new system to the old system will augment the flow and pressure into the existing system.

## 3.2 Design Criteria

The Reclamation office in Farmington and the NDWR agreed on the following hydraulic design criteria for the new system. The design criteria meets all of the requirements and intent of the legislation and the supporting documents.

- Legislated volume = 4,680 Acre Feet per Year

- Average daily flow = 6.46 cfs (4.17 MGD)
- Maximum peak demand Factor = 2.0
- Design flow - 2.0 times the average daily flow = 12.92 cfs (8.35 MGD)
- Gravity system to deliver the water to Shiprock
- Minimum system pressure in transmission pipeline = 20 psi
- Minimum Pressure at meter vault point of delivery South of San Juan River (14+00) = 70 psi
- 24-inch nominal diameter PVC pipe from meter vault to Shiprock
- 18-inch nominal diameter PVC pipe at San Juan River crossing near Hogback (the diameter was revised to 24-inch HDPE)
- Directional drill at Nenahnezad Hill and San Juan River crossing near Hogback with 24-inch HDPE pipe
- Additional new storage to be constructed = 5.5 MG (FSEIS) consisting of:
  - 1.5 Million Gallons in South Shiprock, NM
  - 2.0 Million Gallons in North Shiprock, NM
  - 2.0 Million Gallons site to yet to be determined
- Storage recirculation rate = 2.5 days
- Requirement of a re-chlorination plant and location to be evaluated at a later date

The additional tank storage volumes and locations may change with the addition of the one million gallon tank at the Nenahnezad Hill site and the actual future requirements of the community.

## 3.3 Purpose and Alignment of NNMP

The NNMP is designed as a transmission pipeline to provide additional water capacity to the existing distribution system currently operated by the NTUA.

The alignment of the pipeline was located to minimize the impact to existing residences and archeological sites and to lower the elevation of the New Nenahnezad Tank so that the transmission pipeline could operate by gravity.

## 3.4 General Description of System

### 3.4.1 Pipeline

The pipeline is designed as a nominal 24 inch diameter pipe with an outside diameter of 25.8 inches to match ductile iron pipe sizes. The inside diameter of the pipe will vary based on pipe head class. The pipe will consist mainly of PVC material except at road crossings, crossovers, and steep pipe sections (greater than 20 percent slope) where steel pipe with a minimum wall thickness of 0.25 inches will be used. The material at the Horizontal Direction Drill locations will be either HDPE or steel.

### 3.4.2 Water Storage Tanks

Water storage of approximately 5.5 million gallons of potable water was cited in the FSEIS. The storage facilities are to be ground level steel storage tanks. The existing Cortez Tanks site in Shiprock is designated as the location for a two million gallon tank (North Shiprock Tank) and is at the termination of the NNMP. For the purposes of this hydraulic analysis and report, the Cortez Tank, the North Shiprock Tank and the Shiprock Tank are referring to the same tank(s). A proposed 1.5 million gallon tank at a South Shiprock Tank site would not be connected to the NNMP, but would be part of the overall existing Shiprock distribution system. Since a water tank is required on the Nenahnezad Hill for the reduction of head class and isolation of downstream pressure surge, a design decision was made to increase the storage from 500,000 gallons to 1,000,000 gallons to provide additional storage. The actual locations and amounts of storage of the tanks will be determined in the future.

The New Nenahnezad Tank on the Nenahnezad Hill is located at station 703+50. The bottom elevation is 5238 and the overflow elevation is 5283. An altitude valve is opens when the water level drops to below El. 5260 and closes when the water level reaches El. 5282.

### 3.4.3 Flow Measurement

A flow meter will be installed on the City of Farmington Reach on the north side of the San Juan River before the river crossing. At Crossover #1, two flow meters will be installed so that the flow into the NNMP and existing pipeline can be monitored.

### 3.4.4 Crossovers

There are four main crossovers that connect the NNMP to the existing distribution system. The general location of the crossovers was selected by Reclamation with approval from the NTUA.

All of the crossovers have sectionalizing butterfly valves and bypass piping for equalizing pressure during filling. Additionally, Crossover #1 has two turbine flow meters while Crossovers # 3 and # 4 were originally proposed to have pressure reducing valves (PRV) on the connecting pipes. Crossovers #3 and #4 are downstream from the Nenahnezad Tanks. The existing Nenahnezad Tank is higher than the new Nenahnezad Tank. This means that the pressure from the existing system could exceed the design head class of the pipe in the new NNMP system if the PRV was not operating. The PRV on Crossover #4 was modified during the design process to a check valve to allow the crossover to be always open. A check valve will prevent the water flowing from the existing system to the new system, thereby, ensuring that when the valve is open, the pressure is always higher in the new system.

At the crossovers, the size of the pipe is reduced just upstream and downstream of the crossover tees to 18-inches on the main pipeline. The diameter of the pipe linking the existing system and new system for Crossovers #1 and #2 is 18-inches and for Crossovers #3 and #4 it is 12-inches. The inline butterfly valves on the mainline are all 18-inches, while the valves on the crossover lines are the same diameter as the crossover pipe line.

### 3.4.5 Surge Protection

Surge protection is provided at Nenahnezad Hill in the form of the one million gallon storage tank, New Nenahnezad Tank, to protect the downstream pipeline and to isolate the upstream and downstream pipe. The surge or regulating tank will have an altitude valve upstream of the tank to control the level in the tank.

The possible pressure surges would be generated from either a quick closing valve or a power failure at the pumping plant. The transient analysis showed that with controlled slow closing of the valves, the pressure rise was within the PVC pipe head class range and the PVC pipe was designed accordingly. The pressure surges from a power failure at the inline pumping plant into the new NNMP system did not cause a significant pressure increase upstream of the New Nenahnezad Tank due to the tee and the cross between the existing pipe and the new pipeline.

### 3.4.6 Re-chlorination

The impacts of the NNMP on the chlorination levels in the system will need to be evaluated. Locations of re-chlorination stations will need to be analyzed. A chlorination analysis was not performed as part of this hydraulic report.

### 3.4.7 Farmington Reach

The reach of the NNMP located within the City of Farmington is termed the Farmington Reach and will be designed, constructed, owned, operated and maintained by the City of Farmington. This pipeline will provide the conveyance system between the City of Farmington's water treatment plant and NNMP Reach on the Navajo Nation. This hydraulic model and report used a Reclamation appraisal level design of the City of Farmington Reach to perform hydraulics on the system, however the City of Farmington Reach design may vary from that proposed by Reclamation. The WaterCAD hydraulic model included the Farmington Reach pipe, 24-inch PVC, to model the system under extended time periods of more than 4 days (100 hours).

### 3.4.8 Hydraulic Grade Line on Plan and Profiles

The hydraulic grade line on the plan and profile drawings in the specifications assume that a minimum pressure of 70 psi is provided at Station 14+00. At the new Nenahnezad Tank, the hydraulic grade line began at the base of the tank to show, at the lowest pressure, there is enough head to have at least 9.05 cfs flow into the Cortez Tanks. The **Figure 3 New System Profile** shows the vertical alignment of the new transmission line and the hydraulic grade line that is provided on the Plan and Profiles in the specifications.

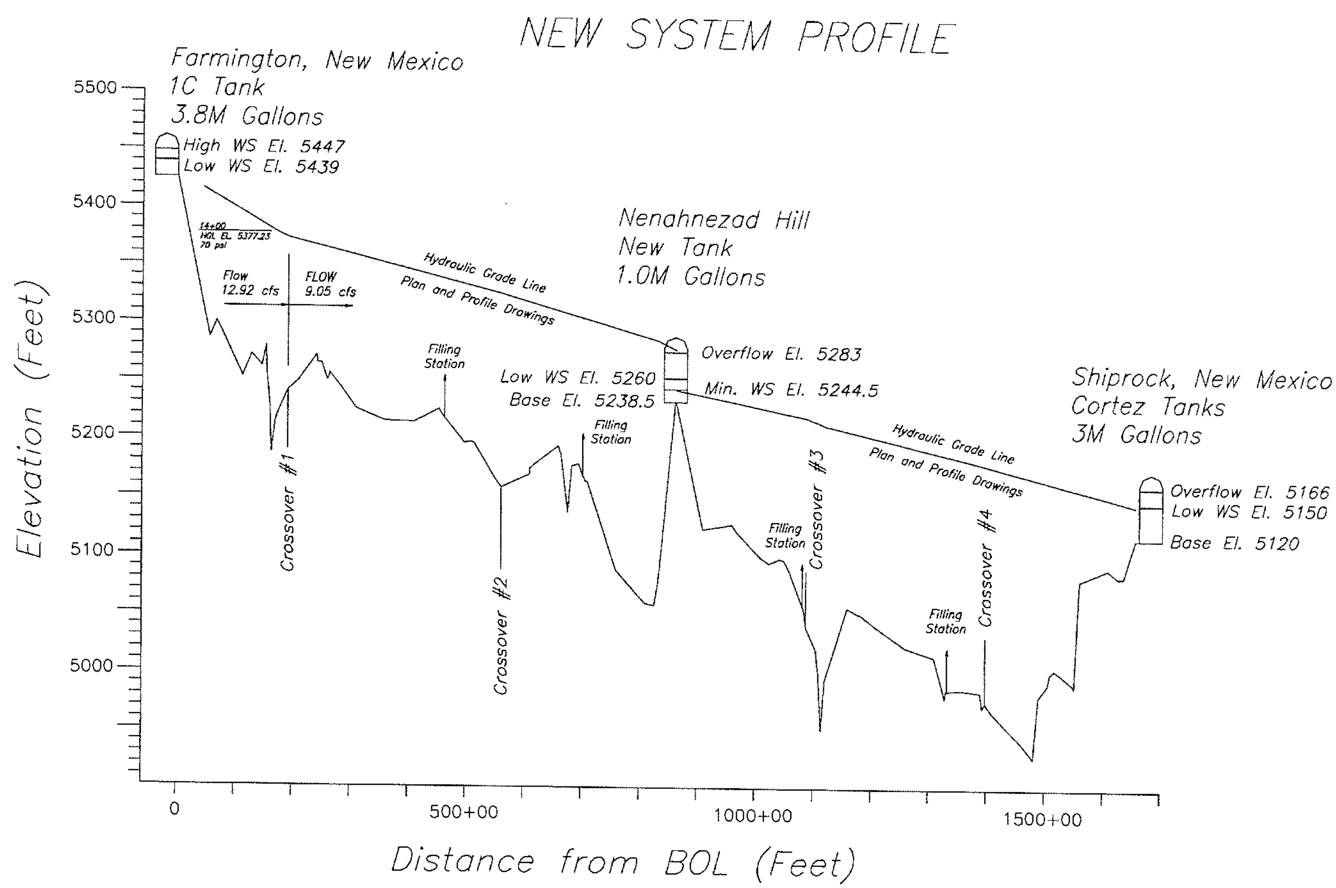


**Figure 3 New System Profile**

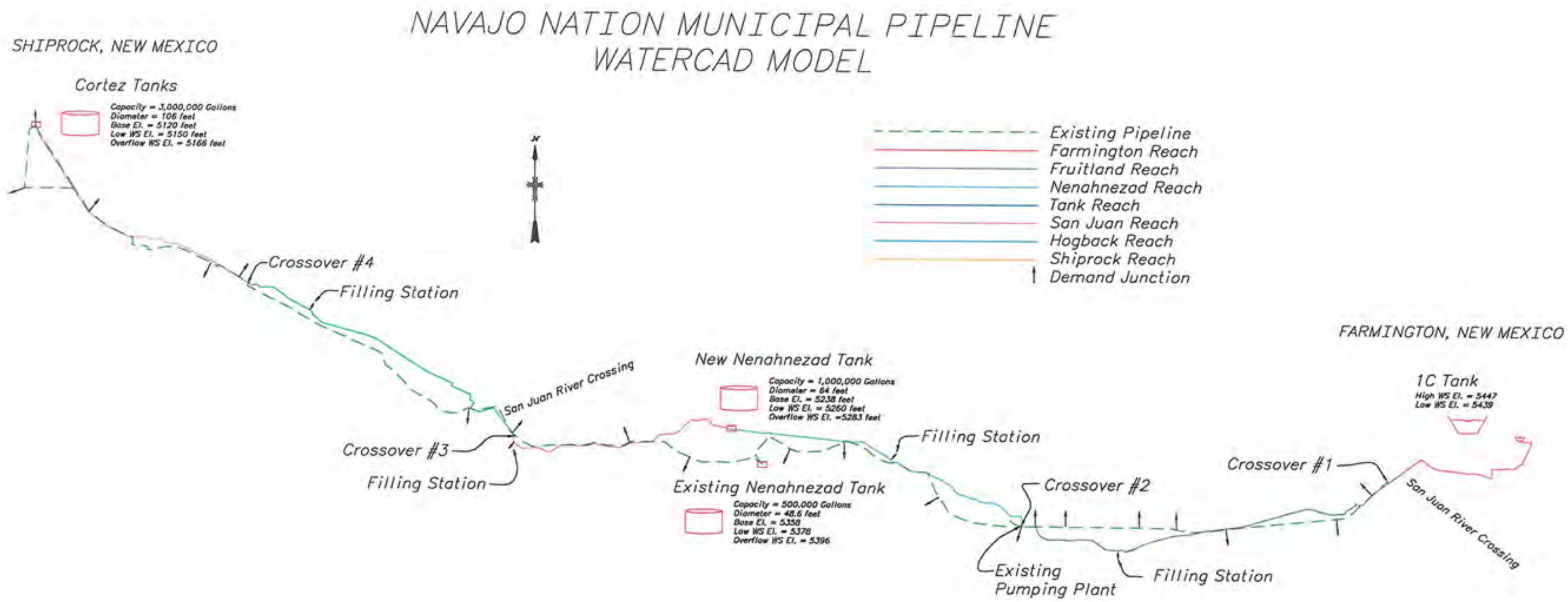


**Figure 6 WaterCAD Site Plan**

# 5 Hydraulic Summary

The signed agreement between Reclamation and the Navajo Nation outlined that the new pipeline and tank system would augment the existing system allowing a gravity powered system with only Crossover #1 open for the design flow 6.46 cfs with a peaking value of 2. This hydraulic analysis shows that with the addition of the new pipeline, tank and crossovers, and fairly high water surface in the City of Farmington Tank, 12.92 cfs can be delivered to the Navajo Nation Municipal water distribution system by gravity on a limited basis depending on the water surface levels in the Shiprock tank.

The analysis showed that if the Design Criteria is amended per the following recommendations, the system would approach a gravity fed system with only an occasional use of the existing inline booster plant. The changes from the signed design criteria letter would be as follows:

First, open Crossover #2 for normal operation. Opening Crossover #2 does not have any additional risk to the pipeline since the pipe and appurtenant structure designs are based on the same water surface in the Farmington 1C Tank. The new pipeline can help supply water to the existing system when the New Nenahnezad Tank's altitude valve is closed.

Second, open Crossover #4 for normal operation. The current design has a check valve to regulate the pressure into the new pipeline. Opening Crossover #4 allows the pressure in the new Nenahnezad Tank to be utilized to help supply the Hogback and Shiprock communities instead of the pressure available in the Shiprock Tanks. A check valve reduces the risk involved in opening up the crossover.

Third, relocate some additional storage to the existing Nenahnezad Tank site. More storage at the existing Nenahnezad Tank site would allow the system to supply the demand for longer periods of time minimizing the amount of pump cycles.

After the NNMP is in-place, the limiting factors preventing the existing system from delivering 4,680 afy by gravity are the existing Nenahnezad Tank height and its storage capacity. When a pump is operating in the system, the next factor limiting the system capacity, especially in the Shiprock area, is the height of the Cortez Tank and the size of the adjacent pipeline system.

The impacts of the NNMP on chlorination levels in the system were not addressed in this report.

United States Department of the Interior
BUREAU OF RECLAMATION
ANIMAS-LA PLATA CONSTRUCTION OFFICE
P.O. BOX 5107
103 Everett Street
Durango, CO 81301

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
ALP-100
PRJ-8.00

OCT -6 2004

Mr. Arvin Trujillo
Executive Director
Navajo Nation Division of Natural Resources
P.O. Drawer 9000
Window Rock, AZ 86515

Subject: Design Criteria – Navajo Nation Municipal Pipeline (NNMP) - Animas-La Plata Project, Colorado and New Mexico (Refer to your June 28 and September 20, 2004 letters)

Dear Mr. Trujillo:

We appreciate the opportunity to work with the Navajo Nation (Nation) and the Navajo Department of Water Resources (NDWR) on the development of this critical water system. At this time we would like to update you on the status and basis for the design criteria and to also address concerns raised by the NDWR staff regarding the subject project. The design criteria is described below and is summarized in **Enclosure 1.** We request your review and concurrence of this information, however, please be aware that we must proceed immediately with the design and specifications finalization. It is necessary to proceed immediately to allow us to be in the best possible position to utilize funds as they become available for the NNMP construction. Also, in accordance with our project Principles of Business, we will be briefing the Project Construction Committee regarding this design criteria and the associated cost estimates.

The development of the design criteria for the NNMP has been an evolutionary process over the past three years. The Bureau of Reclamation (Reclamation) has worked closely with the NDWR staff to formulate a project that best suits the Nation while remaining within the requirements of the Colorado Ute Settlement Act Amendments of 2000 (Act) and the guidelines of the Final Supplemental Environmental Impact Statement (FSEIS), American Water Works Association (AWWA) standards, other supporting documentation, and the budget defined by the 2003 Construction Cost Estimate (CCE).

Our letter dated April 30, 2004, requested the concurrence of the Nation on a draft feasibility level design criteria. This request was made to ensure the Nation's participation in developing a Baseline Conceptual Design to be used for the scheduled summer of 2004 Value Engineering Study (VE). The NDWR staff provided significant input in the form of verbal comments, faxes, and e-mail. In consideration of these comments, Reclamation proceeded with the development of the Baseline Concept for use in the VE. The Navajo Tribal Utility Authority (NTUA) also participated as a member of the VE Team.

Although the resulting cost estimate for the Baseline Concept was higher than the CCE for the NNMP, the VE was held as scheduled to allow the team to creatively address cost saving ideas while maximizing the functionality of the design for the Nation. The VE was completed on July 9, 2004. Since that time, Reclamation has been evaluating the VE's recommendations and refining the NNMP design.

**The Pipeline Alignment**
The new pipeline will parallel the existing pipeline alignment for most of its length from the meter vault on the south side of the San Juan River to the terminus at the Cortez Tank site North of Shiprock, New Mexico. The new pipeline and the existing pipeline will diverge where the existing pipeline ascends Nenahnezad Hill to the existing tank. The new pipeline follows the river until ascending Nenahnezad Hill farther West through a directional drill section.

There has been concern expressed regarding long-term maintenance of the line in the Nenahnezad Hill directional drill section. Directional drilling is a proven construction method used extensively in the oil and gas industry for crossing under existing utilities, rivers, and rough terrain. It has minimal operations and maintenance (O&M) problems associated with it.

The current alignment has the support of the local communities and is the culmination of an extensive coordinated effort between the various chapters, the NTUA, the NDWR, and Reclamation. Although modifications may be necessary as construction commences and field conditions dictate, the present alignment is considered to be firmly established.

**Right-of-Way**
During the construction of the Animas-La Plata Project in the coming years, construction scheduling adjustments may make funding available for other features within the project. In order to take advantage of this flexibility, it will be advantages to have the ROW applications completed and approved as soon as possible.

Reclamation's February 14, 2003, letter to NDWR requested the Nation provide the ROW for the NNMP as a non-federal contribution to the project. Your response of February 24, 2003, informed us that only the Navajo Nation Council Resources Committee had the authority to make that determination.

Reclamation is currently preparing the ROW application package and we appreciate the Nation's continued support.

**Pipe, Pressure, and Flow**
The Act authorized the non-reimbursable construction of "a water line to augment the existing system that conveys the municipal water supplies, in an amount not less than 4,680 acre-feet per year, of the Navajo Nation to the Navajo Indian Reservation at Shiprock, New Mexico." This amount is equivalent to a total average daily flow rate of 6.46 cubic-feet per second (cfs). The hydraulics for the pipeline were based on the 2.0 peaking factor suggested in the NDWR Technical Memorandum (Technical Memo) dated June 19, 1988, and in the FSEIS and yielded a total peak flow rate of 12.92 cfs at the meter vault.

There will be five crossover taps from the new pipeline to the existing system between Farmington and Shiprock. Crossover 1 is at the beginning of the new line just South of the San Juan River crossing near Farmington, downstream of the meter vault, and will utilize the existing pipeline as distribution to serve the Fruitland, Nenahnezad, and San Juan Chapters. Crossover 2 will be located near the proposed Indian Health Service (IHS) booster plant on the existing system. Crossover 3 will be located upstream of the San Juan River crossing at the Hogback. Crossover 4 will be located between the Hogback and Shiprock. These Crossovers will be used for bypassing during pipeline maintenance to alleviate impacts to residents and will not be used for normal operations.

The Hogback, Shiprock, Cudei, and Beclaibito Chapters will receive their water from the Cortez Tanks through the existing distribution system. Crossover 5 will be at the terminus of the new line and will be connected to the existing system at the Cortez Tanks.

The Technical Memo tabulated the projected Shiprock area chapter populations for the year 2040. It also noted that at the 160 gallons per capita per day demand, the flow rate legislated in the Act (then draft) would be sufficient to meet approximately 50 percent of this projected population. Reclamation used the tabulated populations and the per capita demand to prorate the flows to each of the chapters (see **Table 1**).

Although the FSEIS preferred alternative included a booster pumping plant on the line, the present design incorporates the Nation's desire for an all gravity system in order to reduce the life cycle O&M costs. The City of Farmington (COF) is currently contracted to supply water at the meter vault at 60 psi. **Table 1** shows that at this pressure, a portion of the peak daily flow must be supplied from storage, while at 70 psi the peak daily demand is met solely through the pipeline capacity.

**Table 1**

| Chapter | 2040 Population | % of Total Pop. | Peak Flow (cfs) at 60 psi | Peak Flow (cfs) at 70 psi | Supply Source |
|---|---|---|---|---|---|
| Fruitland | 7,720 | 16.78% | 1.89 | 2.17 | Crossover 1 |
| Nenahanezad | 4,234 | 9.21% | 1.04 | 1.19 | |
| San Juan | 1,824 | 3.97% | 0.44 | 0.51 | |
| from storage | | | 0.50 | 0.00 | |
| **Subtotal** | 13,778 | 29.96% | 3.87 | 3.87 | |
| Hogback | 2,502 | 5.44% | 0.61 | 0.70 | Crossover 5 |
| Shiprock | 26,719 | 58.10% | 6.53 | 7.51 | |
| Cudei | 1,678 | 3.65% | 0.41 | 0.47 | |
| Beclabito | 1,310 | 2.85% | 0.32 | 0.37 | |
| from storage | | | 1.18 | 0.00 | |
| **Subtotal** | 32,209 | 70.04% | 9.05 | 9.05 | |
| **Total** | 45,987 | 100% | 12.92 | 12.92 | |

A preliminary pipe head class is based upon a safety factor of 1.3 times the static head pressure. At the Nenahnezad Hill, the static head pressure is reduced to the AWWA minimum requirement of 20 psi to achieve a more economic pipe design in the lower reaches of the system. These estimated pipe flows and head classes may change as a result of the full hydraulic and transient analyses to be performed during the final design process.

**Storage**

The existing system has a 0.5 million gallon tank at Nenahnezad Hill, a 2 million gallon, and a 1 million gallon tank located at the Cortez Tank site in North Shiprock. There are also a 2 million gallon tank located at the Gallup Tank site in south Shiprock and other small tanks in various locations. The FSEIS preferred alternative suggested that 1.5 million gallons of storage be provided at Nenahnezad Hill and an additional 4 million gallons at Shiprock.

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Our letter dated April 14, 2004, transmitted the IHS Update of the Hydraulic Model for Farmington/ Shiprock Transmission Line to the Nation. The updated study was performed to determine if the existing pipeline, augmented by the installation of a new booster plant scheduled to be constructed by IHS and additional storage constructed by Reclamation, would supply the needs of the Shiprock area chapters while the new pipeline is being constructed. The model predicted that the existing system and booster plant would meet the estimated demands through the year 2012 without additional storage, but that the storage would provide redundancy for planned maintenance or emergencies. The Nation and Reclamation were in agreement to proceed with the design and construction of a storage tank to be located at the Cortez Tanks site in North Shiprock, and followed a year later by another storage tank at what is known as the Gallup Tank site.

However, since that time, a proposed Navajo Housing Authority development of 450 homes near the intersection of Highway 491 and Navajo Route 36 has changed the Nation's priority for the storage location from the Cortez Tank site to a site approximately 2 miles South of the Gallup Tank site. Your letter of June 28, 2004, requested that Reclamation consider substituting this new South Shiprock Tank site in place of the previously proposed Gallup Tank site and noted that obtaining the additional right-of-way (ROW) required for Gallup Tank site was going to be delayed by home-site lease issues that could take years to resolve.

Reclamation is open to consideration of this proposal. We are currently awaiting assurance from the Nation that it has obtained sufficient funding to complete the supply and distribution pipelines to the development, that all environmental and archeological clearances have been obtained, that the designs are complete, and that contractors are ready to proceed. When these assurances are obtained, we can proceed with the investigation of the legal and environmental questions pertaining to locating a portion of the storage in this area.

With regards to the construction of the new storage suggested in the FSEIS, Reclamation first proposes construction of the South Shiprock Tank, pending resolution of the issues described above. Construction of the additional storage tanks would be performed near the end of the project completion date. Apart from the tank in South Shiprock, the additional storage will not actually be needed for over 10 years. Placing all of the storage in the system before it is actually required will create additional O&M responsibilities for NTUA and may compromise water quality standards. Various solutions may be explored to resolve this issue. At present, Reclamation suggests that NTUA would not connect these facilities to the system until they are actually needed.

**City of Farmington Reach**

Following our determination that the COF Reach be considered part of the NNMP, your letter dated September 20, 2004, inquired on the status of a previously requested engineering report. The report was to address pipeline design, construction, ownership, joint usage, and O&M for the COF Reach. In reply, we have been exploring the possibility of using an agreement between the Nation, the COF, and Reclamation as a vehicle to address these issues. We will schedule a meeting with NDWR, COF, and Reclamation in the near future to discuss such an agreement.

**Other Considerations**

*Depth of Cover*

The minimum depth of cover over the top of the pipe will be 3-feet. This exceeds the frost depth of 30-inches. The minimum depth of cover under fields, roads, and most washes will be 5-feet. Major washes will be analyzed further to determine if more erosion protection is required.

*Trench Section*
The trench will be designed based on geologic information, side slope stability, bedding material availability, and pipe design.

*Re-chlorination*
Re-chlorination in the system will be evaluated as the project progresses.

**Conclusion**
As mentioned above, the current feasibility design is the culmination of over 3 years of consultation and discussion between NDWR, NTUA, IHS, COF, and Reclamation staff to obtain a project that best meets the needs of the Nation while remaining within the aforementioned constraints. Reclamation has been and will continue to be an advocate for the Nation on this project as demonstrated by our willingness to consider alternate storage options, the determination that the COF Reach should be considered part of the NNMP, our one-on-one work with each of the local chapters for support of the project, and the design of a gravity fed system in lieu of a pumped system.

The criteria described above and summarized in the enclosure have been developed utilizing available data, guidelines, and constraints to apply standard engineering practice for the formulation of the optimum project. It is critical at this time to continue into the final design process as there is no longer any available float in the construction and funding schedules for further investigations of alternate scenarios. To keep this project moving forward, Reclamation would appreciate your concurrence of the stated design criteria no later than November 1, 2004.

If you have any questions, please contact Doug Dockter at 505-325-1794, ext. 151.

Sincerely,

Rick Ehat, Project Construction Engineer
Animas-La Plata Construction Office

Enclosure

cc: Ms. Bernadette Tsosie
Navajo Nation Department of Water Resources
P.O. Drawer 678
Fort Defiance, AZ 86504 (w/encl.)

bc: D-8140 (Linda Bowles), D-8160 (w/encl)

WCG-CDeAngelis, WCD-PSchumacher (w/encl.)

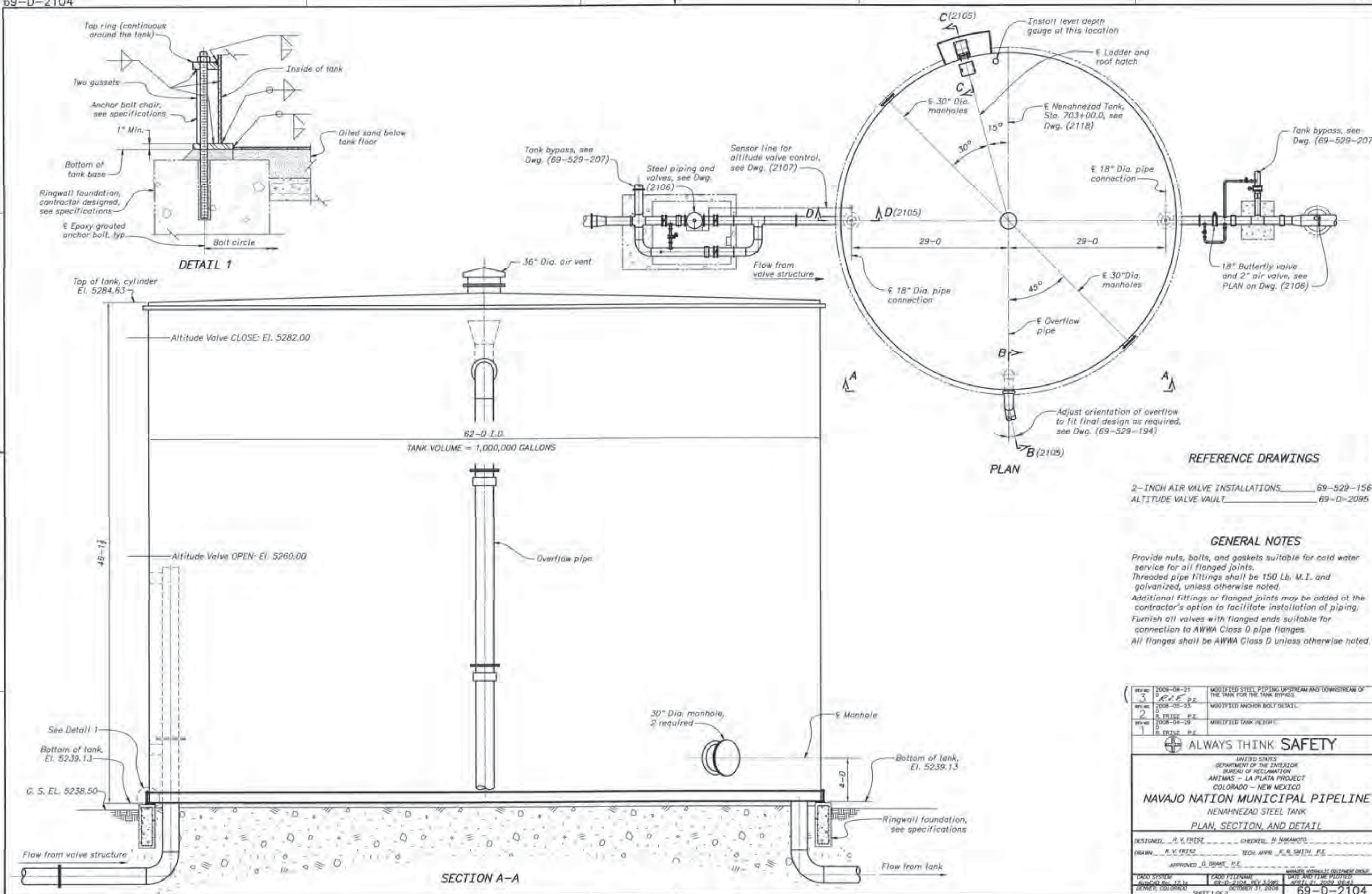
ALP-100, FCO-100, FCO-200, FCO-223 (all w/encl.)

WBR:DDocter:ksmith:10/05/04G:Common/200/DDockter/NNMP/Design Criteria
Control No.: None

**Enclosure 1**

**Navajo Nation Municipal Pipeline Design Criteria Summary (October 1, 2004)**

- Legislated volume = 4,680 Acre Feet per Year
- Average daily flow = 6.46 cfs
- Maximum Peak Demand Factor = 2.0
- Design Peak total demand at 2.0 times the average daily flow = 12.92 cfs
- Gravity fed system
- Minimum system pressure in transmission pipeline = 20 psi
- Minimum Pressure at meter vault point of delivery South of San Juan River = 70 psi
- 24-inch nominal diameter PVC pipe from Meter Vault to Shiprock
- 18-inch nominal diameter PVC pipe at San Juan River crossing near Hogback
- Directional Drill at Nenahnezad Hill and San Juan River crossing near Hogback
- Open Cut at road crossings
- Minimum Pipe Cover:
    - 3-feet to meet 30-inch frost depth requirement
    - 5-feet in agricultural areas and under drainage washes
- Trench Excavation Cross Section:
    - Base Width = 3.0-feet
    - Side Slopes = Vertical to 1.5:1
- Population Growth Rate = 2.48 percent (Technical Memo)
- Per Capita Demand Rate = 160 gallons/day (Technical Memo)
- Additional New Storage to be constructed = 5.5 MG (FSEIS) consisting of:
    - 1.5 Million Gallons in South Shiprock, NM
    - 2.0 Million Gallons in North Shiprock, NM
    - 2.0 Million Gallons site to yet to be determined
- Storage Tank Material: Steel
- Storage Recirculation Rate = 2.5 days (Guidance Manual for Maintaining Distribution System Water Quality, AWWA Research Foundation)
- Requirement of a Re-chlorination plant and location to be evaluated at a later date
- COF Reach Design pending proposed three party agreement


Top ring (continuous around the tank)
Inside of tank
Two gussets
Anchor bolt chair, see specifications
1" Min.
Oiled sand below tank floor
Bottom of tank base
Ringwall foundation, contractor designed, see specifications
℄ Epoxy grouted anchor bolt, typ.
Bolt circle
DETAIL 1
C(2105)
Install level depth gauge at this location
℄ Ladder and roof hatch
℄ 30" Dia. manholes
℄ Nenahnezad Tank, Sta. 703+00.0, see Dwg. (2118)
Tank bypass, see Dwg. (69-529-207)
Sensor line for altitude valve control, see Dwg. (2107)
Steel piping and valves, see Dwg. (2106)
℄ 18" Dia. pipe connection
D(2105)
29-0
Flow from valve structure
℄ 18" Dia. pipe connection
℄ 30"Dia. manholes
18" Butterfly valve and 2" air valve, see PLAN on Dwg. (2106)
℄ Overflow pipe
Adjust orientation of overflow to fit final design as required, see Dwg. (69-529-194)
B(2105)
PLAN
36" Dia. air vent
Top of tank, cylinder El. 5284.63
Altitude Valve CLOSE: El. 5282.00
62-0 I.D.
TANK VOLUME = 1,000,000 GALLONS
45-1½
Altitude Valve OPEN: El. 5260.00
Overflow pipe
30" Dia. manhole, 2 required
℄ Manhole
See Detail 1
Bottom of tank, El. 5239.13
G. S. EL. 5238.50
4-0
Ringwall foundation, see specifications
Flow from valve structure
Flow from tank
SECTION A-A
REFERENCE DRAWINGS
2-INCH AIR VALVE INSTALLATIONS 69-529-156
ALTITUDE VALVE VAULT 69-D-2095
GENERAL NOTES
Provide nuts, bolts, and gaskets suitable for cold water service for all flanged joints.
Threaded pipe fittings shall be 150 Lb. M.I. and galvanized, unless otherwise noted.
Additional fittings or flanged joints may be added at the contractor's option to facilitate installation of piping.
Furnish all valves with flanged ends suitable for connection to AWWA Class D pipe flanges.
All flanges shall be AWWA Class D unless otherwise noted.
3 2009-04-21 MODIFIED STEEL PIPING UPSTREAM AND DOWNSTREAM OF THE TANK FOR THE TANK BYPASS.
2 2008-05-23 R. FRISZ P.E. MODIFIED ANCHOR BOLT DETAIL.
1 2008-04-29 R. FRISZ P.E. MODIFIED TANK HEIGHT.
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ANIMAS - LA PLATA PROJECT
COLORADO - NEW MEXICO
NAVAJO NATION MUNICIPAL PIPELINE
NENAHNEZAD STEEL TANK
PLAN, SECTION, AND DETAIL
DESIGNED R. V. FRISZ CHECKED N. NAKAMOTO
DRAWN R. V. FRISZ TECH. APPR. K. R. SMITH P.E.
APPROVED D. DRAKE P.E.
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DENVER, COLORADO
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SHEET 1 OF 2
69-D-2104

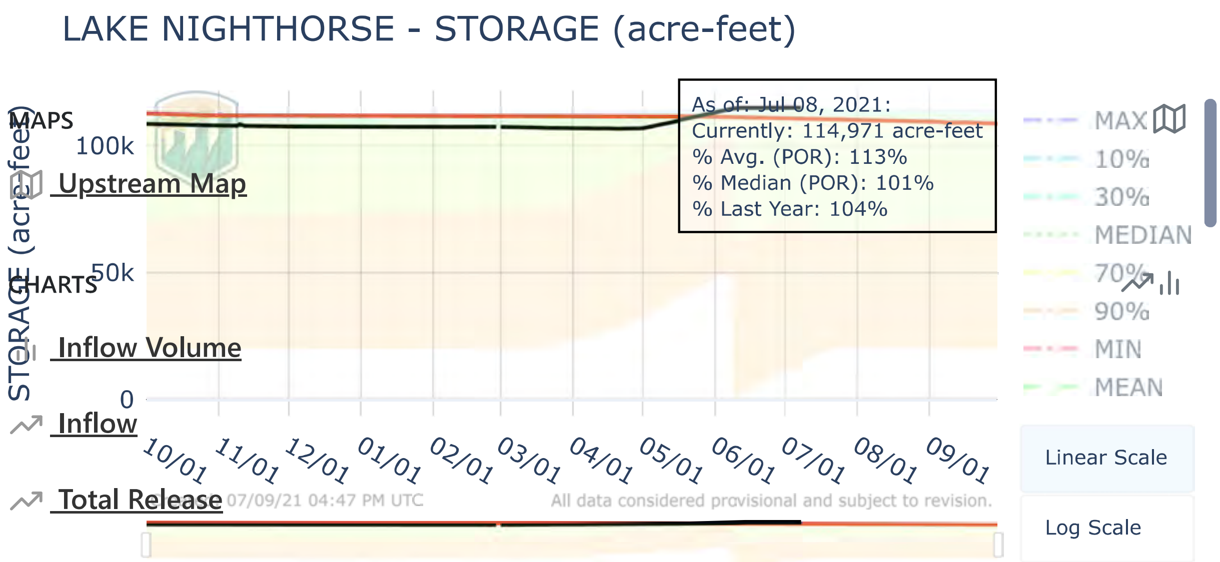
UPPER COLORADO BASIN

# Animas-La Plata Project

*Ridges Basin Dam*

The Animas-La Plata Project located in La Plata and Montezuma Counties in southwestern Colorado and in San Juan County in northwestern New Mexico, was authorized by the Colorado River Basin Project Act of September 30, 1968 (Public Law 84-485). In 1988, it was incorporated into the Colorado Ute Indian Water Rights Settlement Act. The Colorado Ute Settlement Act Amendments of 2000 provide for implementation and completion of the project. Approval to begin construction was granted in October 2001 and initial site work began in April 2002.

Lake Nighthorse began filling on May 4, 2009, and filled for the first time on June 29, 2011. The maximum water surface elevation of 6,882 feet equates to 123,541 acre-feet in storage. The Colorado project features were transferred from construction status to operation and maintenance status in March 2013. Work on completion of the transfer stipulations is continuing. An operation and maintenance contract has been signed with the Animas-La Plata Operations, Maintenance and Replacement Association that allows project sponsors to operate Colorado project features.




MAPS

Upstream Map

CHARTS

Inflow Volume

Inflow

Total Release

Pool Elevation

Delta Storage

Storage

Evaporation

*This is the new HydroData portal for Lake Nighthorse this new web-based data interface tool will update current and historical reservoir operations. To view the HydroData portal full screen click here.*

## Lake Nighthorse Recreation

*Lake Nighthorse*

The Lake Nighthorse Recreation Area is now open. The recreation area is managed by the City of Durango, to learn more about the recreation opportunities available at Lake Nighthorse visit durangogov.org/LakeNighthorse.

To protect cultural resources in the area, recreation is only allowed in developed areas and 25 feet above the high-water level around the reservoir. Land around Lake Nighthorse that is off limits to recreation have been posted with no trespass signs and all visitors receive a brochure with rules for recreating at the lake. Destruction or removal of cultural resources will be prosecuted.

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- Ridges Basin Cultural Resource Management Plan- May 2017
- Final EA for Lake Nighthorse Recreation Plan - December 19, 2016
- Comments on Lake Nighthorse Recreation Plan - December 19, 2016
- News Release - Reclamation Releases the Final Environmental Assessment for Lake Nighthorse Recreation Plan
- News Release - Work Begins on Lake Nighthorse Boat Inspection and Decontamination Station

- News Release - Extended Draft EA Comment Period for Lake Nighthorse Recreation Plan
- News Release - Draft EA for the Lake Nighthorse Recreation Plan
- News Release - Public Meeting on Recreation - June 18, 2014



# Background / History

The Animas-La Plata Project, located in southwestern Colorado and northwestern New Mexico, has been the subject of substantial public interest and environmental review since it was authorized. Following is a short history leading to the initiation of project construction, and current construction progress.

*Aerial view of the Durango Pumping Plant*

**1968** - United States Congress authorized construction of the A-LP Project

**1980** - The Bureau of Reclamation released a Final Environmental Statement on the project.

**1988** - Congress passed the Colorado Ute Indian Water Rights Settlement Act which authorized the implementation of a 1986 water rights settlement agreement.

**1990** - Based on new biological information, the U.S. Fish and Wildlife Service issued a draft biological opinion concluding that the project would jeopardize the continued existence of the Colorado pikeminnow.

**1991** - The Service issued a Final Biological Opinion containing a reasonable and prudent alternative that limited the project depletions to 57,100 acre-feet per year. This opinion allowed construction of the project to begin.

**1992**- A lawsuit filed by environmental organizations halted construction of the project.

**1996** - Reclamation released a Final Supplement to the Final Environmental Statement, that addressed updated environmental information.

**1996-97** - Supporters and opponents of the project addressed unresolved issues associated with the original A-LP Project to gain consensus on an alternative to the project. (Romer/Schoettler Process)

**1998** - The Department of the Interior recommended construction of a substantially scaled-down project that was designed to satisfy the intent of Colorado Ute Tribes' 1986 water rights settlement agreement.

**2000** - Reclamation released a Final Supplemental Environmental Impact Statement and Record of Decision that identified the selected alternative as a down-sized project that focused on providing the Colorado Ute Tribes, as well as others, an assured water supply.

Congress authorized construction of the scaled-down project with the Colorado Ute SettlementActAmendments of 2000.

**2001** - November 9, 2001, Reclamation Commissioner grants approval to initiate project construction.

**2002** - Construction began with installation of the Inlet Conduit Sleeve.

**2003** - Update of Project Construction Cost Estimate reveals increase of project cost from approximately $338 million to $500 million. Ridges Basin Dam Outlet Works excavation was completed. Durango Pumping Plant excavation was initiated.

**2004** - Construction continued on Ridges Basin Dam foundation excavation with over two million cubic yards of material excavated. DPP excavation, Intake Structure, and fish bypass were substantially completed. Preliminary design for the Navajo Nation Municipal Pipeline continued.

**2005** - Construction was initiated on the DPP structure. Erection of an onsite Sky Ute Sand and Gravel concrete batch plant at the DPP site was completed and brought into production. The main pumping plant bay foundation and first floor concrete were completed. The floor of the intake channel/fish screen was completed. The pipes to and from the pumps were installed and were encased in concrete. Ridges Basin Dam Completion Contract was awarded in March. Foundation grouting on the foundation and both abutments was initiated. Placement of the zone materials (including sand and filter drains, impervious clay core, and Zone 4 shell) continued. The materials processing plant was erected and produced Zone 2 (sand), Zone 3 (gravel), Zone 6 (rock), and road base materials. On August 12, 2005, the Ridges Basin Dam Zone One Clay Placement Ceremony was held. During the ceremony, religious leaders of the Colorado Ute Indian Tribes blessed the building of the dam. The outlet works tunnel and gate chamber was excavated and concrete invert tunnel lining was initiated. Construction of Basin Creek Drop Structures was initiated.

**2006** - Construction continued on the DPPApproximately 20,000 cubic yards of concrete were placed through the end of 2006 at the intake fish screen, plant, and air chamber structures. Installation, at the pumping plant site, of a portion of the 72-inch buried steel pipeline (Ridges Basin Inlet Conduit) was initiated and completed. Ridges Basin Dam construction continued. Approximately three million cubic yards of embankment zoned fill material were placed bringing the dam elevation to an average height of 6,783 feet. Grouting operations continued through this season on the dam abutments and in the outlet works tunnel. The materials processing plant continued in full production until winter shutdown. The outlet works tunnel upstream reinforced concrete lining and down stream arch lining were completed. Concrete lining in the gate chamber was initiated in late fall. The intake tower was completed to elevation 6,760 feet. Construction of Basin Creek Drop Structures were completed.

**2007** - Construction on the DPP is 78 percent complete. The DPP structure was completed using a total of 21,300 cubic yards of concrete and the roof was installed. The fish screen was installed in the intake structure and the air chamber for the 72-inch inlet conduit was completed. Ridges Basin Dam was topped out at an elevation of 6,893 feet. At the outlet works the gate chamber was completed and a 4 x 6 foot slide gate was installed. A 66-inch steel outlet pipe was installed in the downstream arch tunnel and the access walkways were completed. Construction of the control house started and a 60-inch jet flow and sleeve valve gate was installed.

**2008** - General construction of Ridges Basin Dam and Inlet Conduit, Durango Pumping Plant, and appurtenant structures of the Animas-La Plata Project were completed. In September 2008, the first two major contracts were awarded for work on the Navajo Nation Municipal Pipeline marking the start of construction on the fourth major component of the project.

**2009** - The first fill of Lake Nighthorse commenced May 4, 2009. Significant progress was made on construction of the Navajo Nation Municipal Pipeline portion of the project by the Navajo Engineering and Construction Authority.

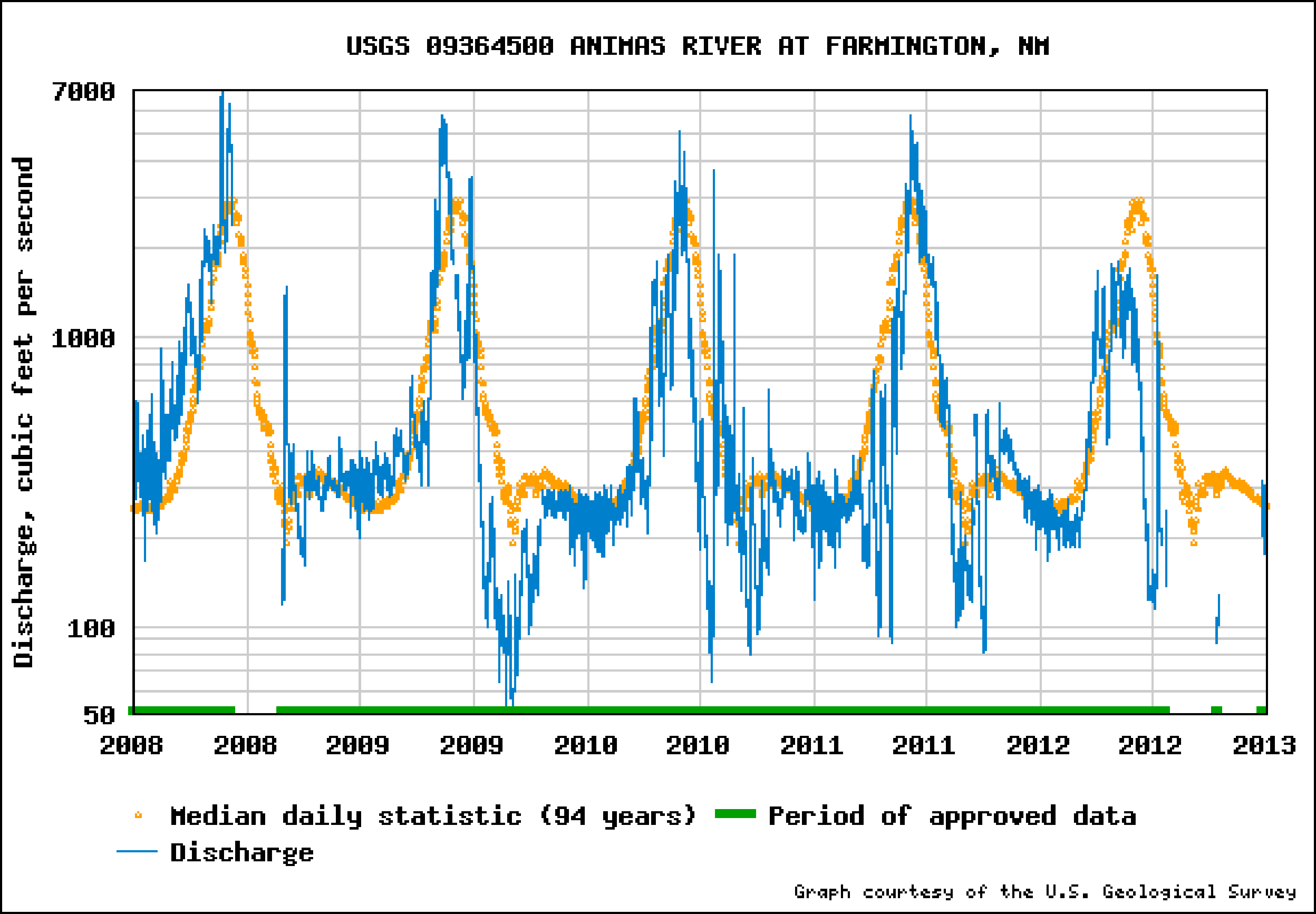
**2010** - Construction continued on the Navajo nation Municipal Pipeline and the permanent operating facility for the project. First fill of the reservoir continued reaching 50 percent of capacity when pumping ended in June. The project sponsors formed the Animas-La Plata Operations, Maintenance and Replacement Association to assume operational responsibility for the Colorado project jeatures.

**2011** - Lake Nighthorse filled the first time on June 29, 2011, with 123,541 acre-feet of water storage. In May, a three-week flow test of the Basin Creek Improvements was conducted to test the series of channel improvements and small check dams, or drop structures to convey water released from Ridges Basin Dam down Basin Creek to the Animas River without increasing, or decreasing, the sediment transport to the river.

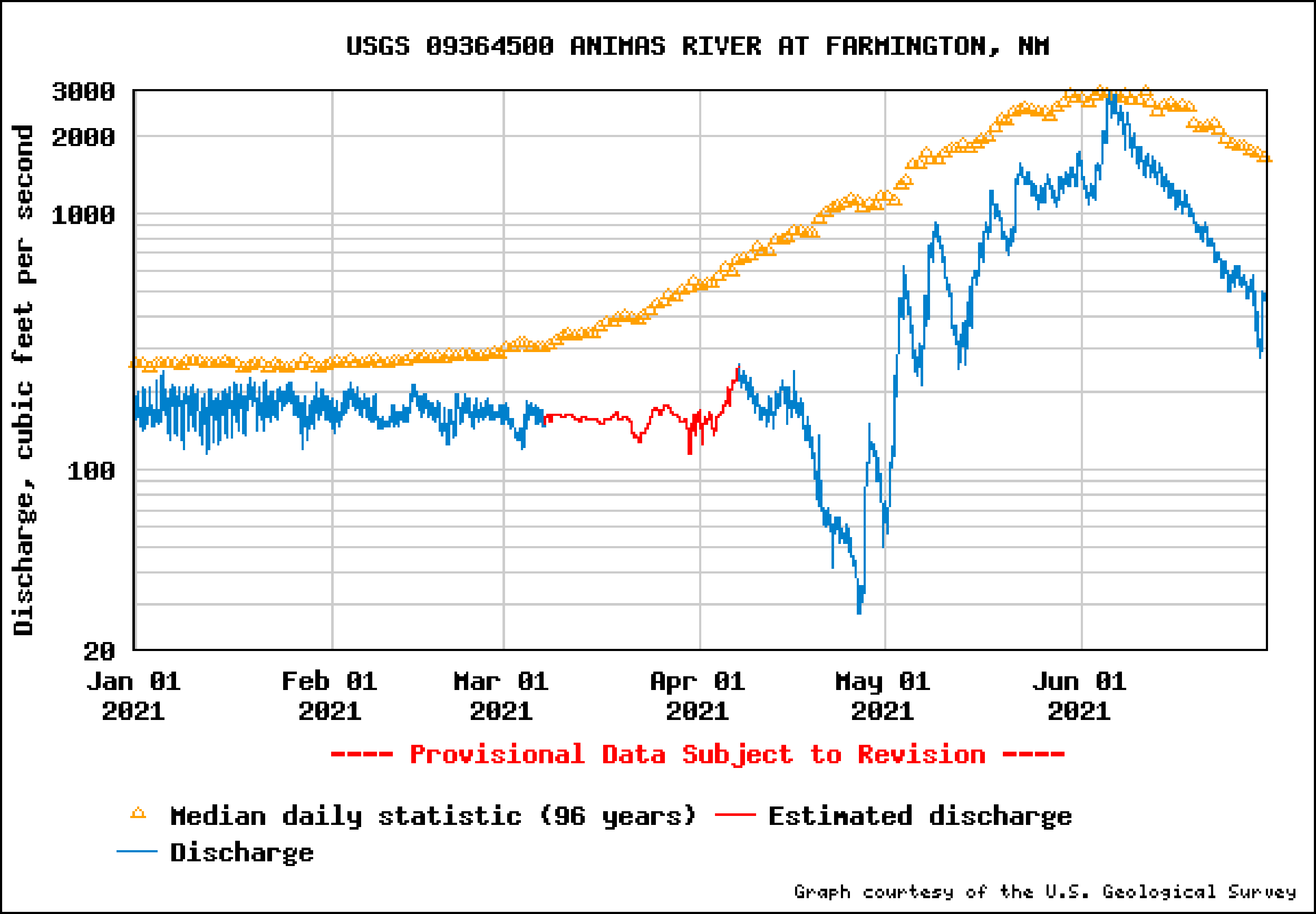
**2012** - The Bureau of Reclamation, Animas-La Plata Water Conservancy District, and community of Durango developed a Recreation Master Plan for Lake Nighthorse and completed the National Environmental Policy Act compliance review. The area in and around Lake Nighthorse would not beopened for public use until a recreation management entity could beidentified and appropriate recreation facilities constructed. Pipe laying operations on the Navajo Nation Municipal Pipeline were completed in July.

**2013** - The Colorado project features were transferred from construction status to operation and maintenance status in March 2013. Work continued on connections to existing distribution systems.

*Last Updated: 2/26/20*



USGS 09364500 ANIMAS RIVER AT FARMINGTON, NM
Discharge, cubic feet per second
7000
1000
100
50
2008
2008
2009
2009
2010
2010
2011
2011
2012
2012
2013
Median daily statistic (94 years)
Period of approved data
Discharge
Graph courtesy of the U.S. Geological Survey



USGS 09364500 ANIMAS RIVER AT FARMINGTON, NM
Discharge, cubic feet per second
3000
2000
1000
100
20
Jan 01 2021
Feb 01 2021
Mar 01 2021
Apr 01 2021
May 01 2021
Jun 01 2021
---- Provisional Data Subject to Revision ----
Median daily statistic (96 years)
Estimated discharge
Discharge
Graph courtesy of the U.S. Geological Survey

# *US EPA ~ APPROVED*

# TOTAL MAXIMUM DAILY LOAD (TMDL)

## FOR THE

# ANIMAS RIVER WATERSHED

## [SAN JUAN RIVER TO SOUTHERN UTE INDIAN TRIBE BND]

**SEPTEMBER 30, 2013**

# EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Load management plans for water bodies determined to be water quality limited. A Total Maximum Daily Load documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. Total Maximum Daily Loads are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations for point sources and Load Allocations for nonpoint source and background conditions. Total Maximum Daily Loads also include a Margin of Safety.

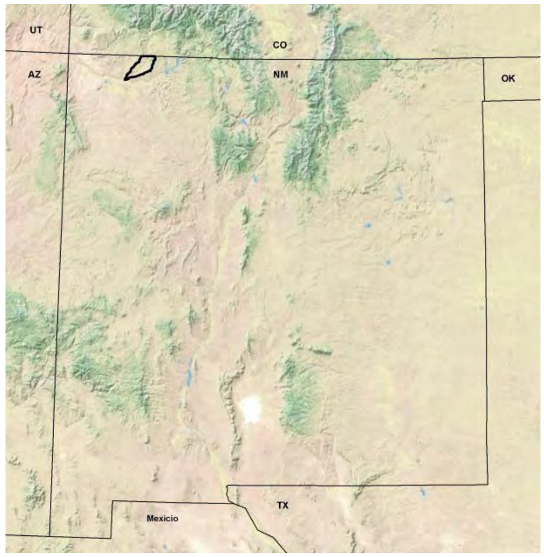
The Surface Water Quality Bureau conducted a water quality survey of the San Juan River basin of northwestern New Mexico in 2010. Water quality monitoring stations were located within the Animas watershed to evaluate the impact of tributary streams and ambient water quality conditions. As a result of assessing data generated during this monitoring effort, impairment determinations of New Mexico water quality standards included *E.coli* and temperature in the downstream stream segment and *E.* coli and total phosphorus in the upstream stream segment.

This Total Maximum Daily Load document addresses the above noted impairments as summarized in the tables below. The Surface Water Quality Bureau has prepared two other Total Maximum Daily Load documents for portions of the Animas River discussed in this document – the 2005 San Juan River Watershed (Part One, 2005) and the San Juan River Watershed (Part Two, 2006). The 2010 study identified other potential water quality impairments which are not addressed in this document due to additional data needs, assessment protocol revisions or re-application, or impending use attainability analyses. If the impairments are verified, subsequent Total Maximum Daily Loads will be prepared in a separate TMDL document.

The Surface Water Quality Bureau's Monitoring and Assessment Section will collect water quality data during the next rotational cycle. The next scheduled monitoring date for the San Juan Watershed is 2018, at which time Total Maximum Daily Load targets will be re-examined and potentially revised as this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate and/or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be moved to the appropriate category in the Integrated Report.

The Surface Water Quality Bureau's Watershed Protection Section will continue to work with watershed groups to develop Watershed-Based Plans to implement strategies that attempt to correct the water quality impairments detailed in this document. Implementation of items detailed in the Watershed-Based Plans will be done with participation of all interested and affected parties.

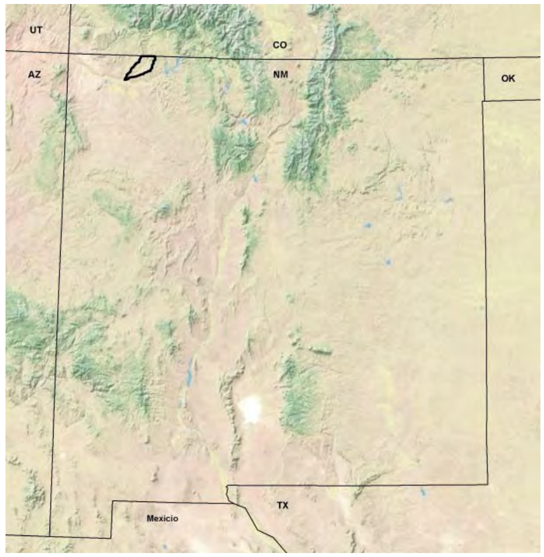
**TOTAL MAXIMUM DAILY LOAD FOR**
**ANIMAS RIVER (SAN JUAN RIVER TO ESTES ARROYO)**




| | |
|---|---|
| New Mexico Standards Segment | 20.6.4.403 |
| Waterbody Identifier | NM-2403.A_00 |
| Segment Length | 16.8 miles |
| Parameters of Concern | *E. coli*, temperature |
| Uses Affected | Marginal Coldwater Aquatic Life, Primary Contact |
| Geographic Location | San Juan River Basin USGS Hydrologic Unit Code 14080104 |
| Scope/size of Watershed | 1356.6 $mi^2$ |
| Land Type | Arizona/New Mexico Plateau (Ecoregion 22i) |
| Land Use/Cover | 56% forest, 8% agriculture, 29% rangeland, 5% developed land, 1% water, and <1% each of wetlands and/or barren lands |
| Probable Sources* | Drought-related impacts, flow alterations from water diversions, municipal (urbanized high density area), municipal point source discharges, streambank modifications/destabilization* |
| Land Management | 34% private, 60% BLM, and 6% State |
| IR Category | 5/5A |
| Priority Ranking | High |
| TMDL for:<br><br>E. coli<br><br>Temperature | **$WLA_{TOTAL}$ + LA + MOS = TMDL**<br><br>$2.1 \times 10^{10}$ + $1.8 \times 10^{11}$ + $2.3 \times 10^{10}$ = $2.3 \times 10^{11}$ cfu/100mL/day<br><br>46.13 + 102.68 + 16.53 = 165.34 $J/m^2/s/day$ |

** Additional Probable Sources noted during the 2010 water quality survey are listed in Tables 4.7 and 5.6.*

## TOTAL MAXIMUM DAILY LOAD FOR
## ANIMAS RIVER (ESTES ARROYO TO SOUTHERN UTE INDIAN TRIBE BND)




| | |
|---|---|
| New Mexico Standards Segment | 20.6.4.404 |
| Waterbody Identifier | NM-2404_00 |
| Segment Length | 18.8 miles |
| Parameters of Concern | *E. coli*, total phosphorus |
| Uses Affected | Coldwater Aquatic Life, Primary Contact |
| Geographic Location | San Juan River Basin USGS Hydrologic Unit Code 14080104 |
| Scope/size of Watershed | 1267.8 $mi^2$ |
| Land Type | Colorado Plateaus (Ecoregion 20c), Arizona/New Mexico Plateau (Ecoregion 22i) |
| Land Use/Cover | 56% forest, 8% agriculture, 29% rangeland, 5% developed land, 1% water, and <1% each of wetlands and/or barren lands |
| Probable Sources* | Channelization, drought-related impacts, irrigated crop production, loss of riparian habitat, municipal (urbanized high density area), rangeland grazing, streambank modifications/destabilization* |
| Land Management | 34% private, 60% BLM, and 6% State |
| IR Category | 5/5B |
| Priority Ranking | High |
| TMDL for: | **$WLA_{TOTAL}$ + LA + MOS = TMDL** |
| *E. coli* | $4.8 \times 10^9$ + $2.4 \times 10^{11}$ + $2.7 \times 10^{10}$ = $2.7 \times 10^{11}$ cfu/100mL/day |
| Total Phosphorus | 0.8 + 41.1 + 4.7 = 46.6 pounds/day |

** Additional Probable Sources noted during the 2010 water quality survey are listed in Tables 4.7 and 6.6.*

# INTRODUCTION

Under Section 303 of the Clean Water Act (CWA), individual states establish water quality standards, which are subject to the approval of the U.S. Environmental Protection Agency (USEPA). Under Section 303(d)(1) of the CWA, states are required to develop a list of waters within a state that are impaired and establish a total maximum daily load (TMDL) for each pollutant. A TMDL is defined as "*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standard including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*" (USEPA 1999). A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources (NPS) at a given flow. TMDLs are defined in 40 Code of Federal Regulations (CFR) Part 130 as the sum of the individual Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for NPS and natural background conditions, and includes a margin of safety (MOS). This document provides TMDLs for assessment units (AUs) within the San Juan River Basin that have been determined to be impaired based on a comparison of measured concentrations and conditions with water quality criteria.

This document is divided into several sections. Section 1.0 provides background information on the location and history of the San Juan River basin, provides applicable water quality standards for the assessment units addressed in this document. Section 2.0 provides information on the water quality survey performed in the watershed in 2010 and the additional confirmation sampling performed in 2012. Section 3.0 provides detailed information on the Animas watershed and its impairments. Section 4.0 presents the TMDLs developed for bacteria in the San Juan River basin. Section 5.0 presents the TMDLs developed for temperature in the Animas watershed. Section 6.0 presents a TMDL developed for Total Phosphorus in the Animas watershed. Pursuant to Section 106(e)(1) of the Federal CWA, Section 7.0 provides a monitoring plan in which methods, systems, and procedures for data collection and analysis are discussed. Section 8.0 discusses implementation of TMDLs and the relationship between TMDLs and Watershed Restoration Action Strategies (WRAS). Section 9.0 discusses assurance; Section 10.0 public participation in the TMDL process; and Section 11.0 provides references for this document. Appendices are referenced throughout and are found at the end of the document.

# 1.0 SAN JUAN RIVER BASIN BACKGROUND

## 1.1 Description and Land Ownership

The San Juan River basin encompasses portions of New Mexico, Colorado, Utah, and Arizona. The New Mexico portion extends into McKinley, San Juan, and Rio Arriba counties in the northwestern portion of the state. The geographic area of the 2010 Surface Water Quality Bureau (SWQB) study was the San Juan River between the Navajo Nation boundary at the Hogback to Navajo Dam, as well as several tributaries that enter the San Juan River in this area and nearby reservoirs. Land ownership and management in the New Mexico portion of the San Juan River basin upstream of the Hogback includes the US Forest Service (USFS), US Bureau of Land Management (BLM), Native American (Navajo Nation, Ute Mountain Ute, Southern Ute, and Jicarilla Apache), State, and Private (Figure 1.1).

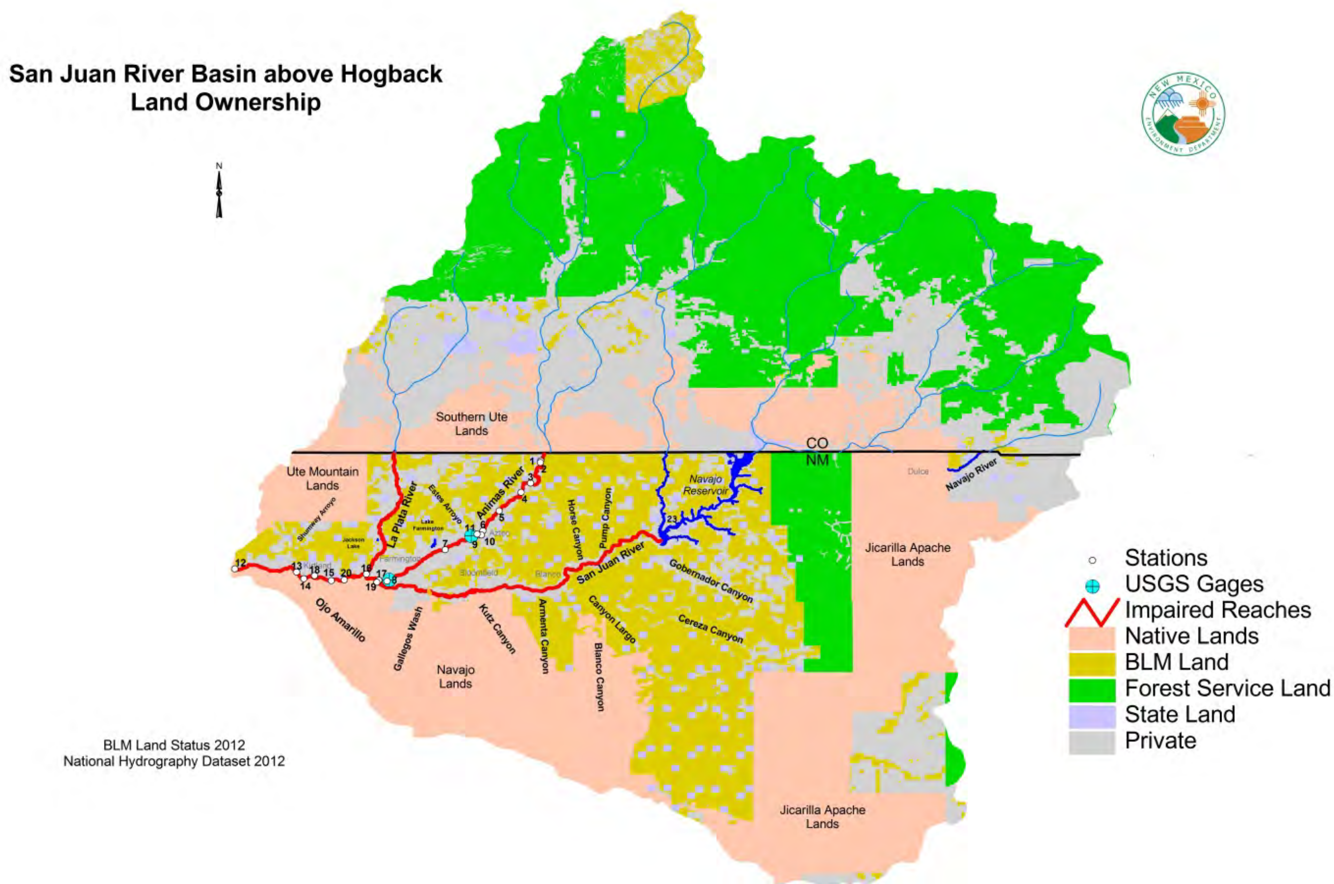



**Figure 1.1 San Juan River Basin above Hogback**

## 1.2 Geology

The San Juan Basin lies on the Colorado Plateau. The consolidated geology in the Animas watershed in the New Mexican portion of the San Juan River basin is composed of several formations of Tertiary and Cretaceous ages. The predominant geologic formation is the Nacimiento Formation of Tertiary age which underlies the area soils and crops out along most of the reach of the San Juan River valley east of Farmington (Blanchard et al. 1993). The Cretaceous Kirtland and Fruitland Formation and the Mancos Shale underlie the soils and are visible in outcrops west of the Hogback. These two formations underlie topsoil and compose the outcrop in most of the upland area south of the San Juan River. The Fruitland Formation is actively mined for sub-bituminous coal and alluvium. Near Farmington, Cretaceous rocks at the surface dip sharply in some areas, forming hogback ridges (Chronic 1987). The Animas River valley is in part composed of Quaternary unconsolidated sand, gravel, silt, clay, and terrace gravel and boulder deposits (Figure 1.2).

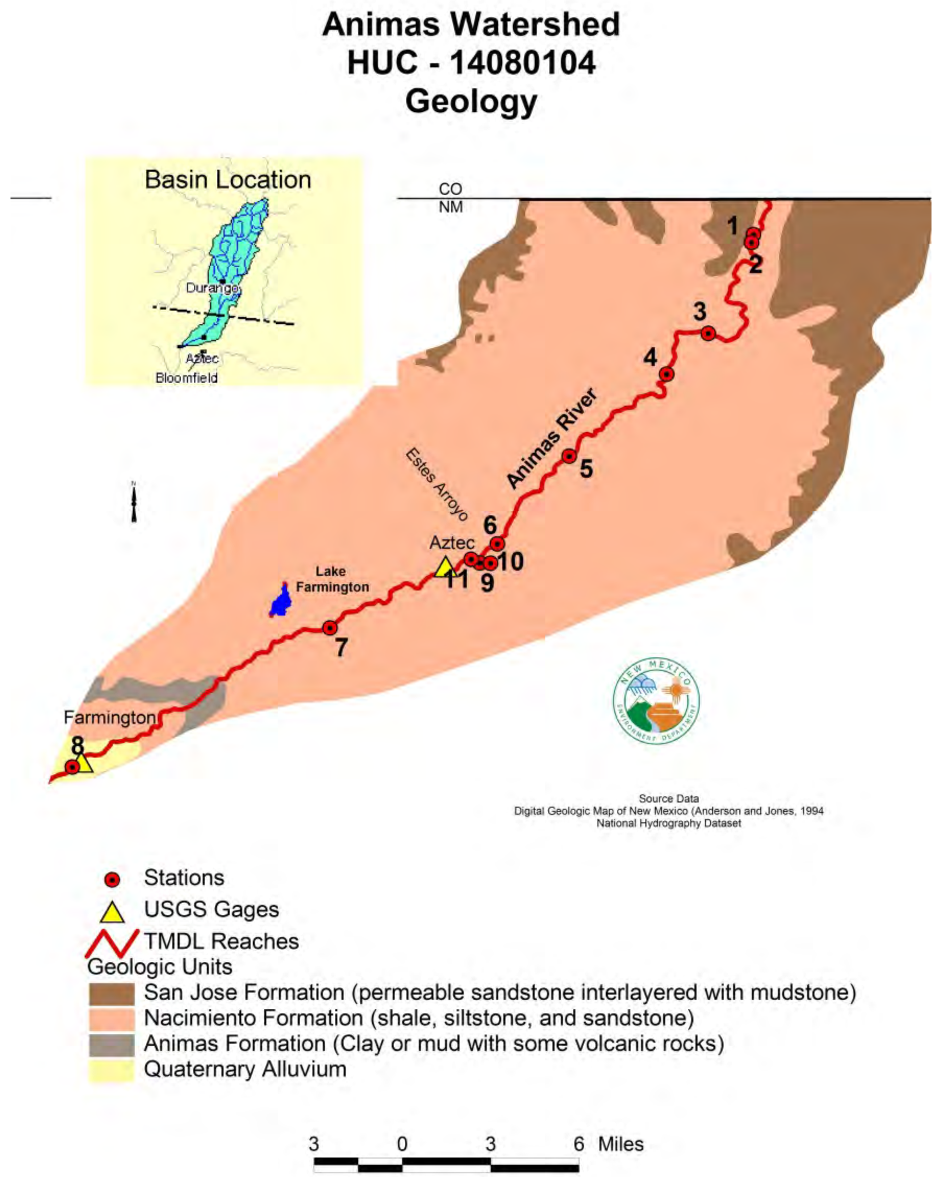



**Figure 1.2 Geology of the Animas Watershed**

Note: The gaging station located near Cedar Hill, NM is located outside of the figure's boundary; it lies approximately 2.5 miles north of the New Mexico stateline.

Soils in the San Juan River watershed are highly complex and variable. Valley soils are typically derived from sandstone, shale, siltstone, and mudstone and range from low to very high permeability and are generally well-drained (Soil Survey Staff 2013).

## 2.2 Hydrologic Conditions

There are several active, real-time U.S. Geological Survey (USGS) gaging stations in the San Juan River basin associated with the reaches presented in this document. The gages on the Animas River include USGS 09363500 (Animas River near Cedar Hill, NM), USGS 09364010 (Animas River below Aztec, NM), and USGS 09364500 (Animas River at Farmington, NM). Gage locations are presented in Figure 1.2. Daily stream flow for these USGS gages are presented graphically in Figures 2.1 through 2.3 for the 2010 calendar year. Flows during the 2010 survey year were below the average annual discharge since the beginning of gage operation, as recorded at relevant USGS gage stations. As stated in the SWQB Assessment Protocol (NMED/SWQB 2011), data collected during all flow conditions, including low flow conditions (i.e., flows below the 4Q3), were used to determine designated use attainment status during the assessment process. In terms of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions.

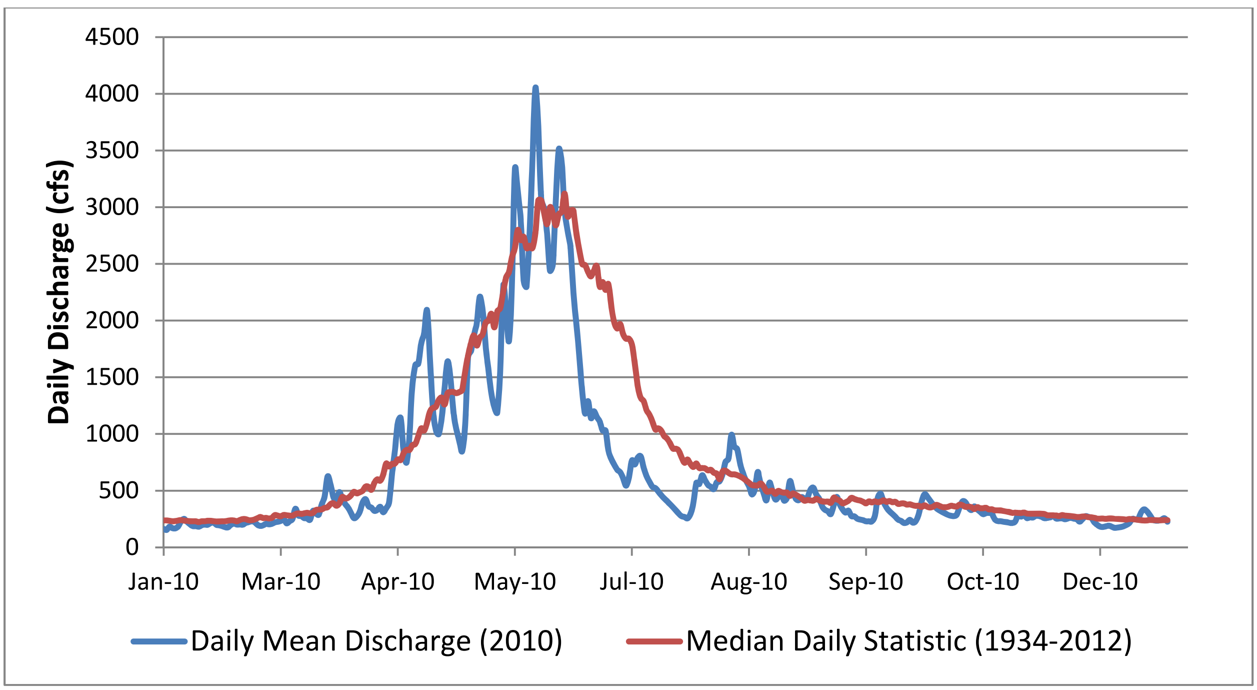



**Figure 2.1 USGS 09363500 Animas River near Cedar Hill, NM**

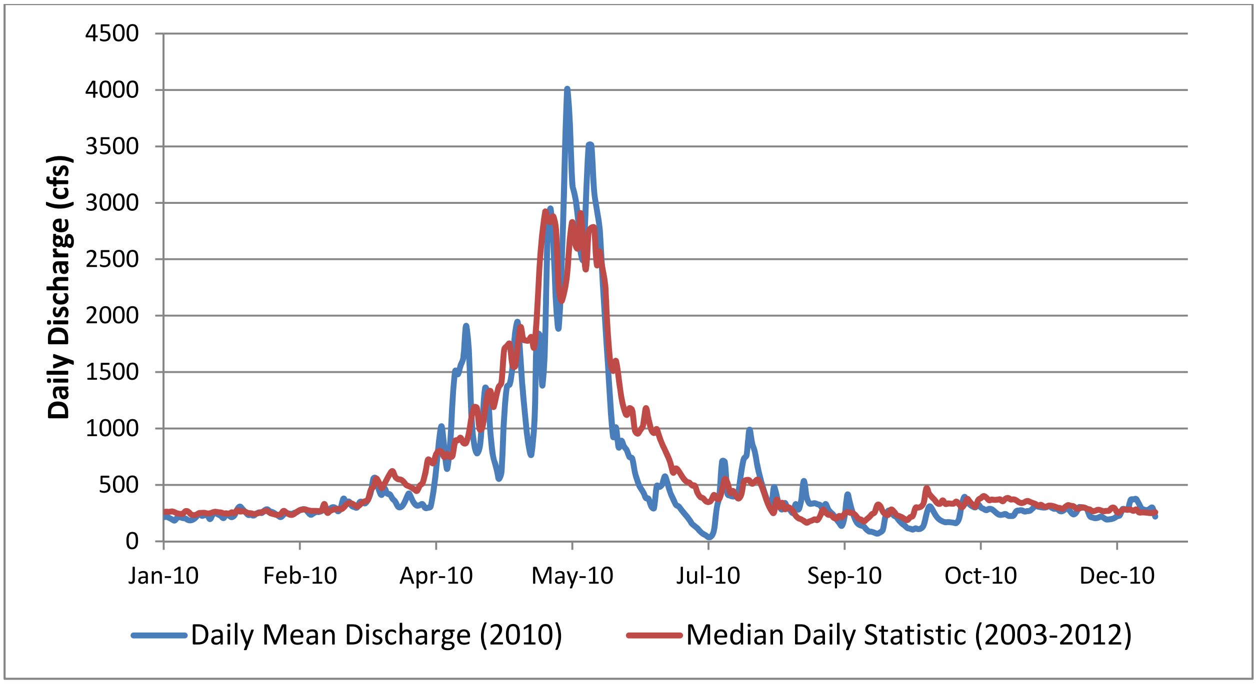



**Figure 2.2** **USGS 09364010 Animas River below Aztec, NM**

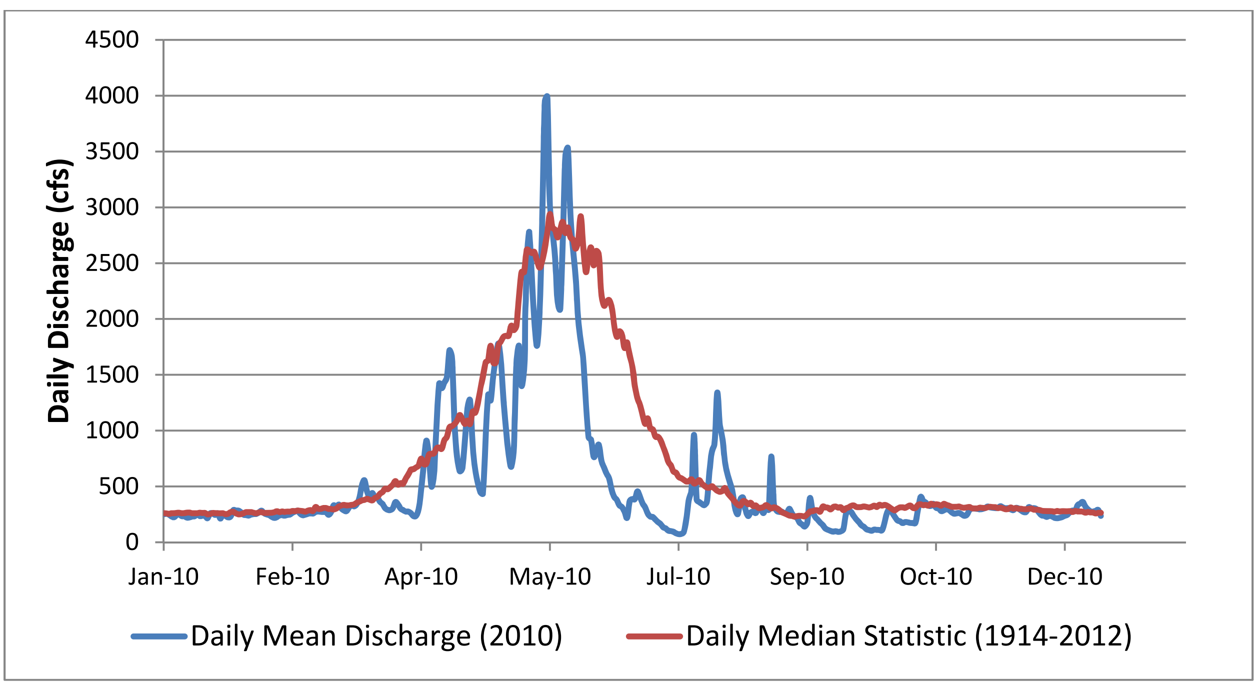



**Figure 2.3** **USGS 09364500 Animas River at Farmington, NM**