Implementation Report with
Integrated Environmental Assessment
for the
Tamaya Drainage Project,
Sandoval County, New Mexico

Prepared by

U.S. Army Corps of Engineers

Albuquerque District

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April 2013

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Finding of No Significant Impact
Tamaya Drainage Project, Sandoval County, New Mexico

The U.S. Army Corps of Engineers (USACE), Albuquerque District, in coordination with and at the request of the Pueblo of Santa Ana, is proposing to fill and drain the pond at Tamaya Village, the ancestral village of the Pueblo of Santa Ana. This action has long been requested by the Pueblo and was agreed to by the USACE in a memorandum of agreement (MOA) dated April, 2001. The pond is caused by seepage of groundwater behind the Santa Ana Pueblo Protection Works levee, which is part of the USACE's Jemez Canyon Dam Project. The purpose of the proposed project is to alleviate health, safety, and aesthetic concerns associated with the presence of standing, stagnant water in close proximity to Tamaya Village. The proposed project is located in Sandoval County, New Mexico. Construction is planned in 2014.

The USACE proposes to fill the pond with sandy soil with relatively high hydraulic conductivity, coupled with a passive drainage system that would divert elevated groundwater to a sump. The surface of the fill would be sloped at 0.8% to the center of the pond, with a corresponding sloped drainage system placed 1.5 feet below the surface of fill. The drainage system would direct subsurface water to a sump equipped with electrical pumps, supplied with power from an existing source routed along the levee. The filled pond area would be revegetated with native riparian plant species. Wetland mitigation would be accomplished using a combination of wetland preservation and creation. Additionally, a pedestrian walkway would be constructed across the levee, providing access from Tamaya Village to the Jemez River.

Five initial alternatives were analyzed for this study and the two most feasible alternatives were subsequently modified to avoid impacting cultural resources. The proposed alternative provides for the best drainage scenario, the least wear on equipment and maintenance, and the best cost effectiveness. The USACE has conducted a groundwater modeling study to justify this design.

Tamaya Village is listed on the National Register of Historic Places. The USACE has worked intensively with the Pueblo of Santa Ana to coordinate planning efforts and project related activities. Consultation has taken place between the USACE and the Pueblo of Santa Ana Tribal Historic Preservation Office. On March 28, 2013, the Pueblo of Santa Ana Tribal Historic Preservation Office concurred with the USACE's determination that there would be no adverse effect to historic properties from construction of the recommended project.

As required by the Endangered Species Act, the USACE has determined that the project would have no effect on any threatened or endangered species or designated or proposed critical habitat receiving protection under the Endangered Species Act.

This action is in compliance with the Endangered Species Act, the Clean Water Act, the Clean Air Act, and the National Historic Preservation Act, as well as pertinent tribal laws and regulations. There would be no significant adverse social or economic effects to the tribal and regional community by the implementation of the selected alternative. The project would have a beneficial effect to aesthetics in the area of Tamaya Village and would fulfill the USACE's agreement with the Pueblo to fill the pond.

Tamaya pond is a jurisdictional wetland and filling the pond would require mitigation. The proposed mitigation plan has two components: preservation of a wet meadow on the opposite bank of the Jemez River across from Tamaya Village, as well as creation of a permanent wetland upstream from the Jemez weir. The created wetland would provide a permanent source of water for wildlife, mitigating for wetland function that would otherwise be lost.

Best Management Practices to protect the environment that would be implemented as part of this project include the following. These measures include those required to comply with the Section 401 Water Quality Certification issued by the U.S. Environmental Protection Agency:

- The contractor would be required to have emission control devices on all equipment.
- To control dust and wind erosion, soils within the construction zone would be kept wet. Stockpiles of debris, soil, or other materials that could produce dust would be watered or covered. Materials transported on- or off-site by truck would be covered. The contractor would be required to comply with local sedimentation and erosion-control regulations.
- All fuels and lubricants would be stored outside of the 100-year floodplain of the Jemez River and construction equipment would be inspected daily and monitored during operation to prevent leaking fuels or lubricants from entering surface water.
- A Storm-Water Pollution Prevention Plan is required. Aquatic and riparian habitat would be protected with silt fencing, geotextiles, or straw bales to prevent runoff of sediments from areas disturbed by construction.
- Random testing of fill material for total petroleum hydrocarbons is required before fill is placed in the pond, if sediments originating from the Santa Ana 1135 project are used.
- All construction equipment would be cleaned with a high-pressure water jet before entering and upon leaving the project area to prevent introduction or spread of invasive species. Equipment that was previously used in a waterway or wetland would be disinfected to prevent spread of aquatic disease organisms such as chytrid fungus. Disinfection water shall be contained in a tank or approved off-site facility and shall not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants.
- Construction would take place outside the migratory bird breeding season.
- Measures to be taken to avoid any aquatic resources or other sensitive resources within the mitigation site would include flagging and fencing to keep equipment out of cottonwood root zones.
- Following construction, the soil at the filled pond site would be stabilized and revegetated with appropriate native plant species including riparian grasses, shrubs and trees. The wetland mitigation site would be planted with wetland species and riparian shrubs. Grasses would be planted in the upland disturbed areas surrounding the mitigation wetland.
- Weeds and salt cedar resprouts would be controlled during the construction period and as a component of maintenance and management of the created wetland mitigation site.

Additional conditions for Section 401 Water Quality Certification (§401 certification) required by the U.S. Environmental Protection Agency are as follows:

- The Wetland Mitigation Plan as presented in Appendix B is incorporated into the §401 certification.
- Prior to commencement of the project, the USACE shall contact the Pueblo of Santa Ana to obtain a list of emergency response personnel. The USACE shall provide this list to all project specific staff, contractors and subcontractors.
- The USACE shall notify the Pueblo emergency response personnel of any accidental discharges, or any significant problems with or changes to the project plans that may affect water quality. This applies to both the pond modification and mitigation portions of the project.
- A copy of the §401 certification must be kept at the project site during all phases of construction. All contractors involved in this project must be provided a copy of this certification and made aware of the conditions prior to starting construction.

The proposed action would not change or affect water rights. The proposed action would result in minor or temporary adverse effects on soils, air quality, noise levels, and wildlife species and habitat during construction. Moderate short-term adverse effects to vegetation and wetlands would be compensated by the proposed mitigation. Beneficial effects would occur to aesthetics, land use and environmental justice by eliminating the problems associated with the pond. Long-term beneficial effects would occur to wildlife habitat as the mitigation area's vegetation matures. The following elements were analyzed and would not be significantly affected by the proposed action: climate, physiography, geology, water quality, floodplains, special status species, and Indian Trust Assets.

The planned action has been fully coordinated with federal and tribal agencies with jurisdiction over the ecological, cultural, and hydrologic resources of the proposed project area. During construction, work operations may be temporarily suspended for tribal ceremonies or special functions as requested by the Pueblo. Temporary work suspensions would be coordinated through all appropriate points-of-contact.

In consideration of the analysis presented in this IR/EA, the proposed action is found to have no significant impacts on the human environment and is recommended for implementation. Therefore, an Environmental Impact Statement will not be prepared for this Federal action.

19 Apr 13
Date

Antoinette R. Gant
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LIST OF ACRONYMS

BIA	Bureau of Indian Affairs
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
cfs	cubic feet per second
DOI	U.S. Department of Interior
DOQQ	Digital Orthophoto Quarter Quad
EA	Environmental Assessment
GMS	Groundwater Modeling System
gpm	gallons per minute
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HTRW	Hazardous, Toxic, or Radioactive Waste
IR	Implementation Report
ITA	Indian Trust Assets
JCDR	Jemez Canyon Dam and Reservoir
LiDAR	Light Detection And Ranging, a remote sensing technology
MRGB	Middle Rio Grande Basin
NAVD 88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NGVD 29	National Geodetic Vertical Datum of 1929
NMED	New Mexico Environment Department
NMISC	New Mexico Interstate Stream Commission
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
PCB	Polychlorinated Biphenyls
PRG	Preliminary Remediation Goals
SHPO	State Historic Preservation Office
SVOC	Semi-Volatile Organic Compound
TAL	Target Analyte List
THPO	Tribal Historic Preservation Office
TPH	Total Petroleum Hydrocarbons
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound

1 - Study Information

1.1 Purpose, Scope, Authority, and Need for Action

The Tamaya Drainage Project is proposed by the U.S. Army Corps of Engineers (USACE), Albuquerque District, to provide a solution to the ponding of water behind a USACE-built levee within the Pueblo of Santa Ana (Pueblo) historic village of Tamaya (Tamaya Village). The purpose of this study is to identify drainage alternatives that are technically feasible, economically practicable, environmentally sound, and publicly acceptable. The Pueblo supports the proposed project to eliminate the nuisance and hazard of standing water adjacent to Tamaya Village.

The Jemez Canyon Dam and Reservoir (JCDR) on the Jemez River was authorized for flood damage reduction and sediment retention and control under the Flood Control Acts of 1948 (P.L. 80-858) and 1950 (P.L. 81-516). Jemez Canyon Dam (dam) is one unit in the comprehensive plan for flood control in the Rio Grande and Tributaries, New Mexico. Construction started in May 1950 and the dam structure and appurtenant works were completed and placed into operation in October 1953. The proposed Tamaya Drainage Project would be conducted under USACE Operations authority for the dam.

All lands associated with the JCDR Project (about 6,711 acres) are located entirely within the boundaries of the Pueblo, a federally recognized Native American Tribe. As such, the operation and maintenance of the facility is directly subject to the Trust responsibilities of the Federal Government. The Department of the Army and the Pueblo signed a Memorandum of Understanding in 1952 (amended in 1978 by P.L. 95-498) which established a perpetual right and privilege for the construction, operation, and maintenance of the JCDR Project, including the Santa Ana Pueblo Protection Works (levee.) The Pueblo reserved the right to use all associated lands for any purposes not inconsistent with those expressly granted to the Federal government for the facility.

During the design of the Jemez Canyon Dam it was determined that Tamaya Village would be vulnerable to inundation during a large flood event or periods of high pool stages in Jemez Canyon Reservoir. The Santa Ana Pueblo Protection Works (levee) was constructed around the village to prevent potential flooding from the river and high reservoir storage (USACE 1994:2-3, 3-1). Construction of the levee began in April 1953 and was completed in May 1954. The levee construction included a diversion channel that directs upland arroyo and surface water flows eastward away from the village and to the outside, east of the levee. Subsequent to the construction of the levee, the abandoned arroyo channel, now within the levee protected area, is actively maintained (graded) as an open area that is utilized for tribal purposes and as a parking area.

Since the levee was completed in 1954, seepage and elevated groundwater levels on the landward side of the levee have created a permanent pond in close proximity to the village. The pond is considered an undesirable feature by the Pueblo. Since the levee acts as a barrier, the pond does not drain naturally. The resulting stagnant water is a concern, causing poor water quality and unpleasant smells associated with anaerobic conditions. The pond also provides breeding habitat for mosquitoes and presents a potential safety hazard. An existing pump system is used to drain the pond to prevent local drainage from encroaching on structures within the village, during flood events, or at the request of the Pueblo. Groundwater seepage into the pond is continuous and therefore standing water could be prevented only by running the noisy pumps continuously. The Pueblo has long desired a permanent and lower-maintenance solution to these issues. Concerns were brought to USACE attention by the Tribal Council shortly after the levee was constructed in the mid-1950s. As Mattingly and Le Cuyer’s (1972:D5) report noted:

> *The design and present operation of this structure [the levee] has resulted in the development of a small mosquito infested swamp at the bottom of the collecting basin. The marsh is there because the intakes of the two levee pumps are two to three feet above the basin surface and water which collects below the pump intakes is allowed to stand and stagnate. The swamp is considered a nuisance to the Santa Ana Indians spending the summer at the old pueblo and to those attending dances held there. The tribal council has requested that something be done to correct the situation.*

In December of 2000, the New Mexico Interstate Stream Commission declined to renew their contract for the storage of a sediment pool at JCDR. As a result, all waters were released and the reservoir emptied by October, 2001. The USACE identified four actions to ameliorate impacts to natural and cultural resources in partnership with the Pueblo. The correction of drainage problems near the Pueblo ancestral village of Tamaya is one of those actions.

The planning effort for the Tamaya Drainage project included extensive involvement by and collaboration with the Pueblo. Pueblo involvement has included participating in the project team, providing data, and participating in and facilitating site visits and field work. Additionally, the USACE has made presentations to the Governor and Tribal Council at critical decision points. Areas of concern include:

- Technical considerations related to effective removal of standing water.
- Cultural resource concerns, including avoidance of cultural sites during project implementation; construction impacts to historical structures from ground vibrations; and the need for the construction schedule to accommodate ceremonial or other events.
- Public health concerns, including elimination of standing water and odors; reduction in the number of pests such as disease-carrying mosquitoes.
- Aesthetic concerns, such as noise and dust impacts during construction.

1.2 Project Area and Location

Tamaya Village is located in Sandoval County, New Mexico, approximately 22 miles north of Albuquerque and eight miles northwest of Bernalillo (Figure 1 and Figure 2). Tamaya is the ancestral village for the Pueblo and has been continuously occupied for more than 700 years. The village is the site of essential community social and religious activities. Tamaya Village is of such historic significance that the entire village is listed on the National Register of Historic Places (NRHP). The village is located adjacent to the Jemez River, which discharges to the Rio Grande about eight miles downstream of the village.

The JCDR Project is located on the Jemez River 2.8 miles upstream from its confluence with the Rio Grande. The dam is situated approximately 4.5 miles downstream of Tamaya Village, about five miles northwest of Bernalillo and about 20 miles north of Albuquerque. The project location is shown in Figure 2. The watershed map is shown in Figure 8.

The levee is a control facility related to the Jemez Canyon Reservoir, and is located at the upper end of the now dry reservoir, approximately 4.5 miles upstream from the Dam, on the north bank of the Jemez River. The pond is situated on the landward side of the levee (Figure 3). The levee is composed of compacted earth fill and is approximately 23.5 feet high and 2,900 feet long. The top of the levee is at elevation 5,245.5 feet referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Removal of seepage and interior drainage is currently accomplished by a pumping station constructed on the land side of the levee.

1.3 Report Organization

For USACE Operations Division projects, the Implementation Report (IR) is a document that serves as the basis for approving a specific project for construction. The IR documents the planning process followed to determine the alternative recommended for construction (the Recommended Plan). This report for the Tamaya Drainage project integrates the IR with an Environmental Assessment (EA) in fulfillment of National Environmental Policy Act (NEPA) requirements. This IR/EA is organized to follow the USACE planning process.

- Chapter 1 includes a description of the proposed project area, problems and opportunities.
- Chapters 2 and 3 contain the inventory of the existing environment and resource conditions and forecast future without-project (No-Action) resource conditions.
- Chapter 4 describes the formulation, evaluation, and comparison of alternative plans and the selection of the Recommended Plan.
- Chapter 5 describes the Recommended Plan in greater detail and summarized its foreseeable effects on the human environment.
- Chapters 6 through 9 include the District Engineer’s recommendations for project implementation; information on document preparation, coordination, and consultation; and references.
- Technical and other detailed information is provided in appendices.

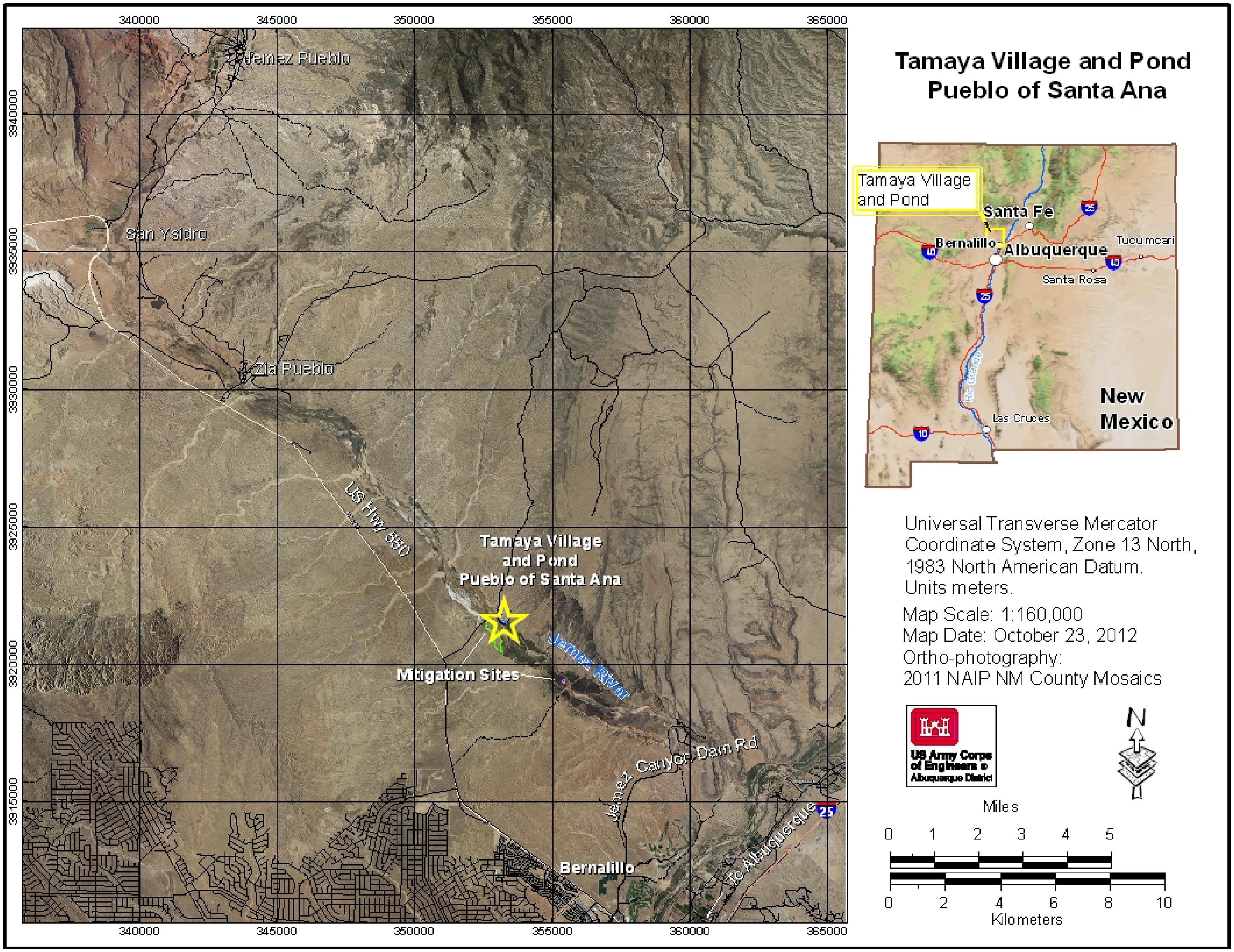

Figure 1: Location map, Tamaya Village and landmarks discussed in report

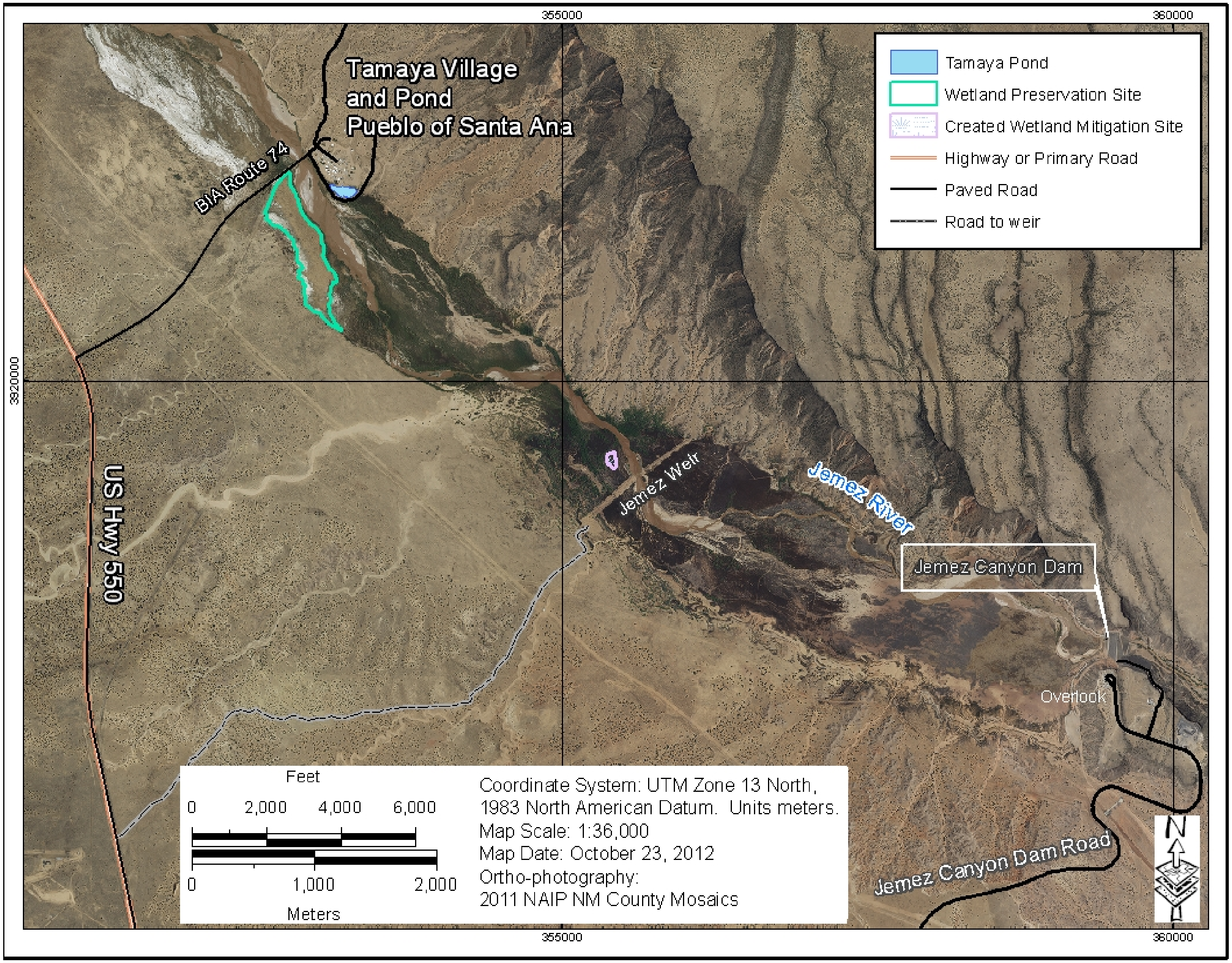

Figure 2: Project Locality Map

Figure 3: Tamaya Village showing levee with water ponding adjacent to Village
Blue line shows approximate existing pond area. Red lines indicate edges and top of levee. Dashed lines indicate berms constructed to divert surface runoff around the Village. (2009 aerial image)

1.4 Regulatory Compliance

This Implementation Report/Environmental Assessment (IR/EA) was prepared by USACE, Albuquerque District, in compliance with all applicable Federal statutes, regulations, and Executive orders, as amended, including the following:

- Archaeological Resources Protection Act (16 U.S.C. 470aa *et seq*.)
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Part 1500 *et seq*.)
- Clean Air Act (42 U.S.C. 7401 *et seq.*)
- Clean Water Act (33 U.S.C 1251 *et seq.*)
- Endangered Species Act (16 U.S.C. 1531 *et seq*.)
- Energy Independence and Security Act of 2007, P.L. 110-140, Section 438, 121 Stat. 1492, 1620

- Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*)
- Federal Noxious Weed Act (7 U.S.C. 2814)
- Fish and Wildlife Coordination Act, 48 Stat. 401; 16 USC 661 *et. seq.*
- Migratory Bird Treaty Act, 16 U.S.C. 703, *et seq.*
- National Environmental Policy Act (42 U.S.C 4321 *et seq.*)
- National Historic Preservation Act (16 U.S.C. 470 *et seq.*)
- Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 *et seq.*)
- U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR Part 230; ER 200-2-2)
- Executive Order 11593, Protection and Enhancement of the Cultural Environment
- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations
- Executive Order 13112, Invasive Species
- Executive Order 13524, Federal Leadership in Environmental, Energy, and Economic Performance

2 - Existing Conditions and Affected Environment

Environmental conditions at the JCDR, along the Jemez River, and in Pueblo lands have been described in numerous documents (Mattingly and LeCuyer 1972; Milford, Muldavin, and Chauvin 2012; Pueblo of Santa Ana Department of Natural Resources 2012; U.S. Army Corps of Engineers 2000, 2003, 2008). This IR/EA provides a brief description of the general area and focuses specifically on conditions at Tamaya Village and the project site, including the pond and mitigation sites.

2.1 Jemez Canyon Dam and Reservoir

The Jemez River (river) originates in the Jemez Mountains of New Mexico and converges with the Rio Grande north of Bernalillo; most of the watershed is situated in Sandoval County. The Jemez River flows in a generally southeasterly direction with a total length of approximately 65 miles. Elevation ranges from over 11,000 feet at the headwaters of the watershed to 5,075 feet at the confluence with the Rio Grande. The river is perennial in the upper reach and ephemeral in the lower reach above the Jemez Canyon Reservoir due to irrigation diversion upstream of the project area. The river in the proposed project area has a sand-bedded, low gradient channel with an elevation of 5,237 feet (NGVD 29) at the upstream, northern end of the levee and 5,233 feet (NGVD 29) at the downstream, southern end of the levee.

Jemez River flows typically pass through the dam with no regulation during low flow periods. However, during large events, Jemez Canyon Dam is operated in combination with operations at the other Rio Grande dams (Cochiti, Abiquiu and Galisteo dams). Current operational authorities on the Rio Grande consist of releases of non-damaging flood flows throughout the Rio Grande valley, typically not exceeding 7,000 cfs at Albuquerque (USACE 1994). When the passage of inflow to the Jemez Canyon Reservoir has exceeded the channel capacity constraints on the Rio Grande downstream, flood control storage has been initiated. Flood waters have been stored only for the duration needed to evacuate the water as rapidly as downstream conditions permit. The maximum water storage in the reservoir to date has been 72,254 acre-feet (elevation 5,220.3 feet NGVD 29) which occurred on 2 June 1987. The average size of Jemez Canyon Reservoir between 1985 and 2000 has been 1,000 to 1,200 surface acres (elevations from 5,190.7 to 5,192 feet NGVD 29) (USACE 2000:15, 18-19, 42; USACE 1994:Appendix D, Plate 7.1, Elevation-Area-Capacity Curves, updated 1994).

The reservoir did not include a permanent pool for its first 26 years of operation. In the spring of 1979, USACE and the New Mexico Interstate Stream Commission (NMISC) established a sediment retention pool of about 2,000 acre-feet at Jemez Canyon Reservoir using water exchanged from the San Juan-Chama Project. The USACE and NMISC storage agreement expired on December 31, 2000. The NMISC decided not to extend the agreement for sediment pool storage. In December 1997, prior to the expiration of the storage agreement, planning efforts began with numerous stakeholders including Federal, state, tribal and local agencies as well as the public, in anticipation of potential effects of water operations and river maintenance activities. Some of this planning was also related to informal consultation pursuant to Section 7 of the Endangered Species Act (USACE 2000). A partial evacuation of the pool began on September 20, 2000 and the pool was finally evacuated in October 2001. Since the pool's evacuation, approximately 190 acre-feet of sand-sized material passes through the dam annually. USACE currently is investigating measures to maintain the passage of sediment through the dam. Subsequent to evacuation of the pool, USACE and the Pueblo formulated a mitigation plan to address the resulting onset of channel incision of the Jemez River. An important part of this plan was a low-head weir, constructed in 2004, that was designed to prevent further incision and loss of riparian vegetation (USACE, 2003) (Figure 2).

2.2 Physical Environment

2.2.1 Geology and Soils

The geology of the Jemez River watershed has a complex history with many structural and volcanic features. Formations within the watershed include Precambrian igneous and metamorphic complexes, Paleozoic and Mesozoic sedimentary deposits, and younger Cenozoic sedimentary and volcanic deposits (Bossert et al. 2004). At the headwaters, a large volcano began building about four million years ago. Approximately 1.2 million years ago, this large volcano collapsed in a cataclysmic eruption and formed the present day Valles Caldera (Dunbar 2005, Bailey and Smith 1978). As the river exits the caldera, it cuts through limestone until approximately Jemez Springs village (Bossert et al. 2004). From Jemez Springs village to just north of Jemez Pueblo, the river cuts through sandstone and shale beds. Downstream of the

Jemez Pueblo, the river cuts through younger alluvial fill deposits consisting of depositional material and reworked sediments of the Santa Fe group (Bossert et al. 2004). The Jemez River continues downstream, incising into these materials until it reaches the Rio Grande confluence.

The Jemez River watershed drains four distinct geologic structural zones and areas of intercontinental volcanism. From west to east, the watershed drains the southeastern San Juan basin (west of the Pajarito fault); the southern extent of the Nacimiento uplift; the Jemez uplift and Valles Caldera; and the western extent of the Rio Grande rift zone within the Middle Rio Grande Basin (MRGB) (Bossert et al. 2004). The Tamaya Drainage Project site is located within the MRGB.

The Tamaya Drainage Project site is located on the U.S. Geologic Survey (USGS) Santa Ana Pueblo Quadrangle geologic map (see Figure 4). In this quadrangle, surficial geology consists of primarily sedimentary formations of the Santa Fe group and post Santa Fe group alluvium (Qal), inset against the older, Tertiary San Felipe Basalt field. The San Felipe Basalt field is the largest exposed basalt field within the Albuquerque basin. Approximately 1.5 miles east and downstream of the proposed project site, the Tamaya fault dissects the river and traverses north of Tamaya Village (Figure 4). The Tamaya fault is uplifted on the south and west, exposing the Cerro Conejo Member of the Zia Formation (Personius 2002). The Cerro Conejo Member (Tzcc in Figure 4) is a weakly indurated, fine to medium grained, parallel to crossbedded, eolian sandstone (Personius 2002). Tamaya Village sits atop this member and more recent Quaternary deposits (almost certainly reworked sediments of the Santa Fe group). The proposed wetland mitigation sites are located within active stream deposits (Qalh in Figure 4).

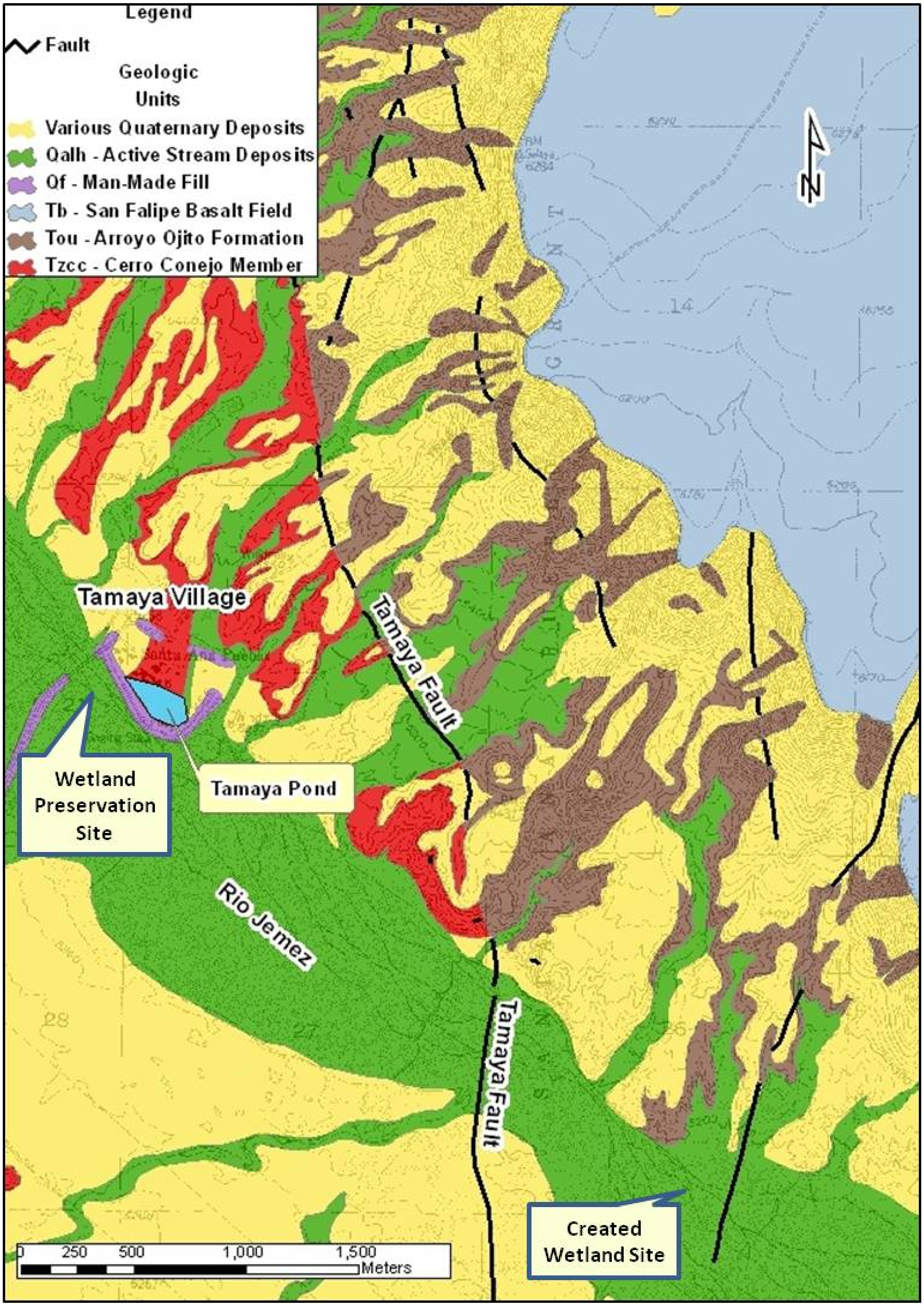

Figure 4: Geologic map - west half of the Santa Ana Pueblo Quadrangle (Personius 2002)

A review of the U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) soil data mart at http://soildatamart.nrcs.usda.gov/ was conducted to provide an overview of soil type, including soil characteristics and chemical and physical properties in the project area (NRCS 2012). Soils found at the site, and adjacent to the site, are predominately sand and fall into six major components or Map Units: Riverwash (Map Unit 31), Dune Land (Map Unit 41), Harvey-Cascajo (Map Unit 54), Sheppard (Map Unit 191) Fragua (Map Unit 322), and Unprotected Trail (Map 831). Only the Riverwash Map Unit is hydric (formed in saturated sediment) and is anaerobic in some cases. The Riverwash Map Unit exists mainly in the channel of the Jemez River.

These soil types easily erode, have low organic content, and are moderately drained. Soil pH ranges from 6.6 to 9.0, with the Unprotected Trail Unit having the highest pH of 8.5 to 9.0. Calcium carbonate percentages range from zero to 20%, with Harvey-Cascajo having the highest calcium carbonate content of 15 to 20 %. For other nearby soils the calcium carbonate content is generally less than 10 % .

The soil classification at the Tamaya Village and the adjacent area of ponding behind the levee is Harvey-Cascajo. The Harvey component is found on slopes ranging from five to 15%. Its parent material consists of eolian deposits and alluvium derived from igneous and sedimentary rock. This soil type drains easily. Water movement in the most restrictive layer is moderately high. Shrink-swell potential is moderate. The calcium carbonate percentage does not typically exceed 18%.

The proposed created wetland mitigation site is located in Riverwash soil. This soil is found in streams and is derived from stream alluvium. Its texture is sandy to sandy loam. It is somewhat poorly drained with slopes of one to three percent. Riverwash is a nonsaline soil with calcium carbonate content below one percent.

The proposed preservation site is located in Unprotected Trail soils. These loamy sands are derived from eolian deposits over stream alluvium. Trail soils are found on alluvial fans, channels, flood plains, and valley floors and have slopes of one to three percent. Calcium carbonate percentage typically does not exceed five percent. These are moderately well drained soils. Although the NRCS describes Trail as nonsaline, the higher edge of the preservation area that is farthest away from the river has a salty crust. This salt crust is likely caused by seepage of groundwater from adjacent higher ground that then evaporates, leaving the salts on the surface.

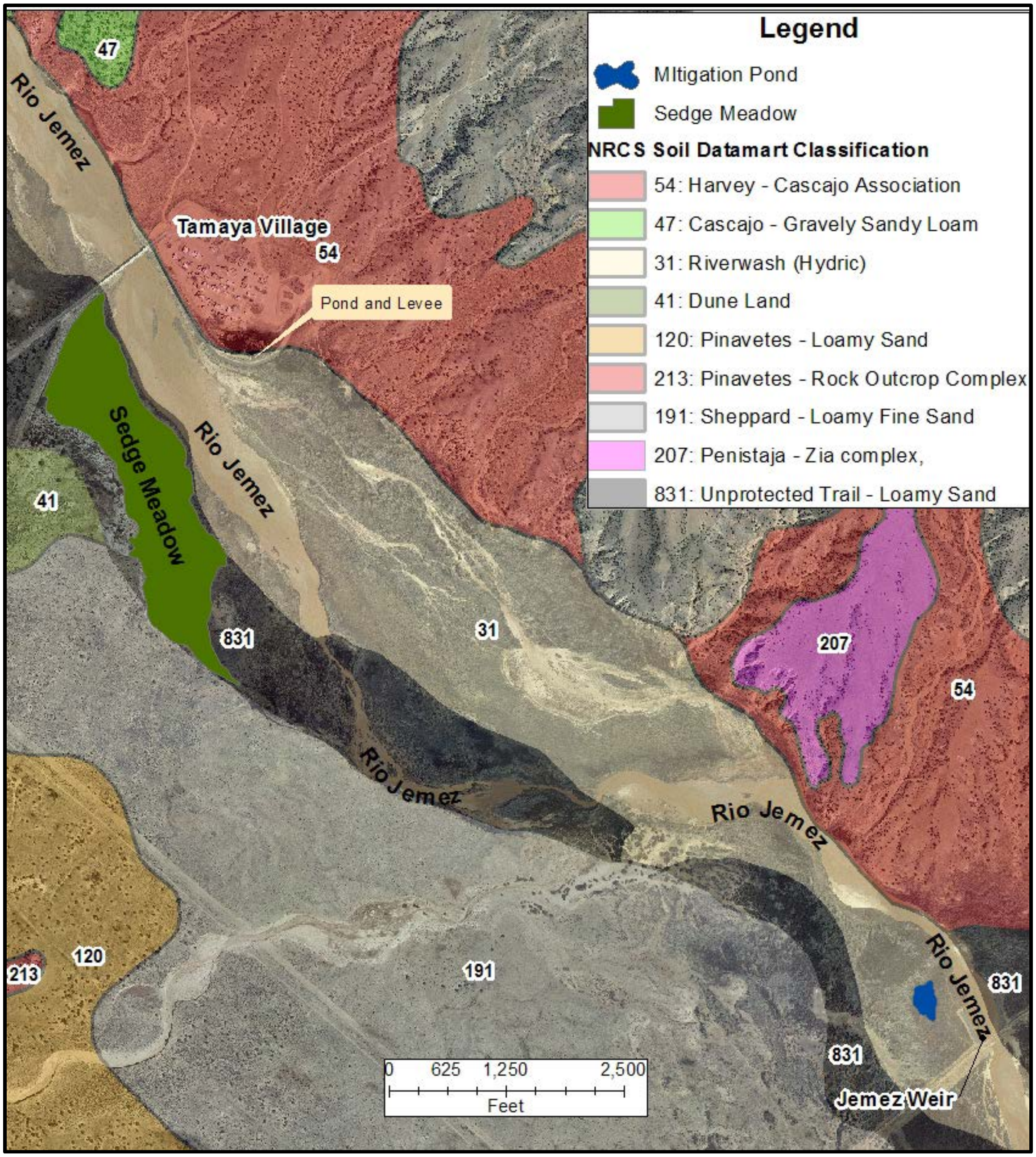

Figure 5: NRCS Soils of New Mexico for the Jemez River area

2.2.2 Groundwater Hydrology

2.2.2.1 General Groundwater

The Pueblo and the Tamaya Village project site are within the Middle Rio Grande basin (MRGB). Groundwater in the MRGB is located in four hydrogeologic units within the Santa Fe group and Post Santa Fe group alluvial deposits. The middle and upper units of the Santa Fe group and the Santa Fe alluvial deposits are the primary aquifers in MRGB (Thorn et al. 1993).

In all probability, shallow groundwater likely exists in Post Santa Fe group sediments, or in the upper section of the Santa Fe group at the project site. USACE, Albuquerque District, estimated hydraulic conductivity (the capacity of a porous medium to transmit water) for this aquifer by performing slug tests on eleven groundwater piezometers in May 2008 (USACE 2008). The mean hydraulic conductivity value was estimated to be 50 feet/day, which is equivalent to an aquifer consisting of medium grained sand (Heath 1995).

The horizontal flow of groundwater near the project site is primarily parallel to the river, northwest to southeast (USACE 2009), with a gradient of about 0.003 feet/foot or 0.3 percent slope (refer to Section 5.1.5). The Jemez River drainage is recharged from surface runoff infiltrating into the shallow portion of the aquifer from the mountains to the northwest, as well as from subsurface flow from the adjacent basin to the northwest (McAda and Barroll 2002). Additionally, the river is hydraulically connected to groundwater over most of its length in the basin and is a major source of recharge (USACE 2009, McAda and Barroll 2002). A small quantity of groundwater is withdrawn from the aquifer by a pumping well east of Tamaya Village (USACE 2009).

2.2.2.2 Groundwater Model

In 2009, the USACE, Seattle District, constructed a groundwater model using the Groundwater Modeling System (GMS) to evaluate several drainage alternatives for the pond. The horizontal extent of the model was approximately 4.9 square miles, and included the pond and Tamaya Village. The depth of the model was approximately 240 feet (USACE 2009). Model parameters such as hydraulic conductivity, groundwater sources and sinks, boundary conditions, and geologic materials were obtained from existing sources such as published USGS reports, Hydrologic Engineering Center River Analysis System (HEC-RAS) surface water models, well logs, and slug tests (USACE 2009). This GMS model was updated in 2011/2012. For additional model details, refer to Appendix D.

The purpose of the model was to assist planners and designers in developing and evaluating appropriate drainage alternatives to eliminate negative impacts associated with the pond. The groundwater model predicts the performance of five predetermined mitigation alternatives (USACE 2009/2012). Each alternative (referred to as scenarios in the model) involves filling the pond with permeable soils, coupled with various levee configurations and pumping approaches.

The 2009 groundwater model used hydrologic conditions defined by January 2006 through June 2006 flow conditions, 100-yr Jemez River stage event, and a worst-case scenario with the river stage rising to within three feet of the top of the existing levee at the location of the BIA Route

74 Tamaya Bridge (bridge; see Figure 2), which crosses the river to Tamaya Village, and remaining constant for eight weeks (USACE 2009). For the 2012 revision, the groundwater model used hydrologic conditions defined by January 1, 2010 through June 25, 2010 estimated river stage and the worst-case scenario with the river stage rising to within three feet of the top of the levee at the location of the bridge. Results from the models are summarized in Sections 4.4.3. and 4.4.4.

Figure 6: Conceptual Groundwater Flow

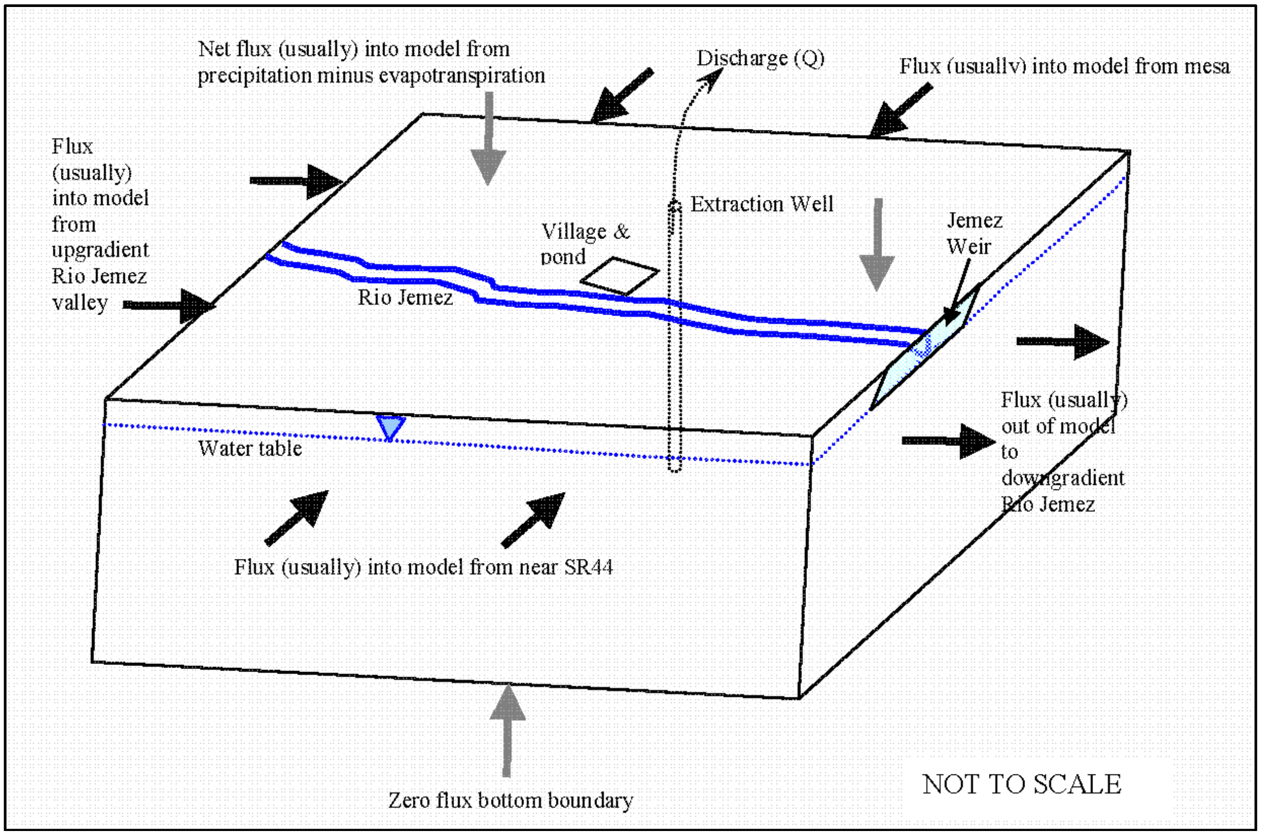

Figure 7: Conceptual Site Block Model (USACE 2008a)

2.2.3 Surface Water Hydrology

Surface water hydrologic information is an important component of the current study. Characterization of the surface water conditions helped to define the environment, and served as boundary conditions in support of the groundwater modeling. The scope of surface water evaluations described in this study consist of topographic, hydrologic, hydraulic and sedimentation conditions and variables within the study area for both the Jemez River, and some of the ephemeral tributary arroyos adjacent to Tamaya Village (detailed in Appendix C, Hydrology, Hydraulics and Sedimentation). The Jemez River watershed map is shown in Figure 8.

Surface water hydrologic information used for this study came from two sources. A watershed hydrologic assessment on the Jemez River above the Dam was completed in 2008 by USACE. This assessment was used to update frequency discharges at specific locations through numerical modeling using the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) (Massong, 2008). HEC-HMS is a computer program used to model surface water hydrologic processes, and is designed to simulate the precipitation-runoff of a wide range of watershed systems including large river basin watersheds, and small urban or natural watershed runoff.

The second source of information was from estimates of localized hydrologic peak discharges over Tamaya Village and estimates were generated for a select number of adjacent tributary arroyos near the levee to assist with alternative formulation and evaluation. The proposed alternatives included realignment of the levee, removal or repositioning of the interior ponded water in the vicinity of Tamaya Village, and alignment and design of flow channels to convey intercepted tributary flows around and away from the village.

2.2.3.1 Topography

The drainage area upstream from the dam is just over 1,000 square miles with a watershed divide of over 10,600 feet in elevation, but dropping to about 5,100 feet at the dam (Massong, 2008). During the winter months, heavy snowfall occurs in the upper mountains of the watershed, with much lighter snow in the lower basin. The average annual snowfall varies from ten inches at the dam to over 100 inches in the mountains. Although snowmelt runoff supplies a large amount of water to the lower Jemez River each spring, the largest floods at Tamaya Village occur from local monsoonal precipitation events (summer thunderstorms).

Runoff response to thunderstorm precipitation events is very rapid due to steep slopes in most of the basin. This results in floods with very high peak flows. Thunderstorm derived flood volumes are usually small due to the limited areal extent of storms.

The Rio Salado channel in the lower watershed (see Figure 8) and the Jemez River channel below the Rio Salado confluence are wide and sandy with a shallow, braided flow pattern that results in rapid attenuation of floods with high peaks and small volumes. The mountains, due to the vegetal cover, have relatively high rates of canopy interception and significant storage in the valleys that greatly reduce runoff. The mesas have flatter slopes, grass and herbaceous cover with large playas that reduce runoff. The landscape generally below 6,000 feet supports semi-desert vegetation and has the highest runoff rates due to the scarcity of vegetation and organic soils (USACE 1994).

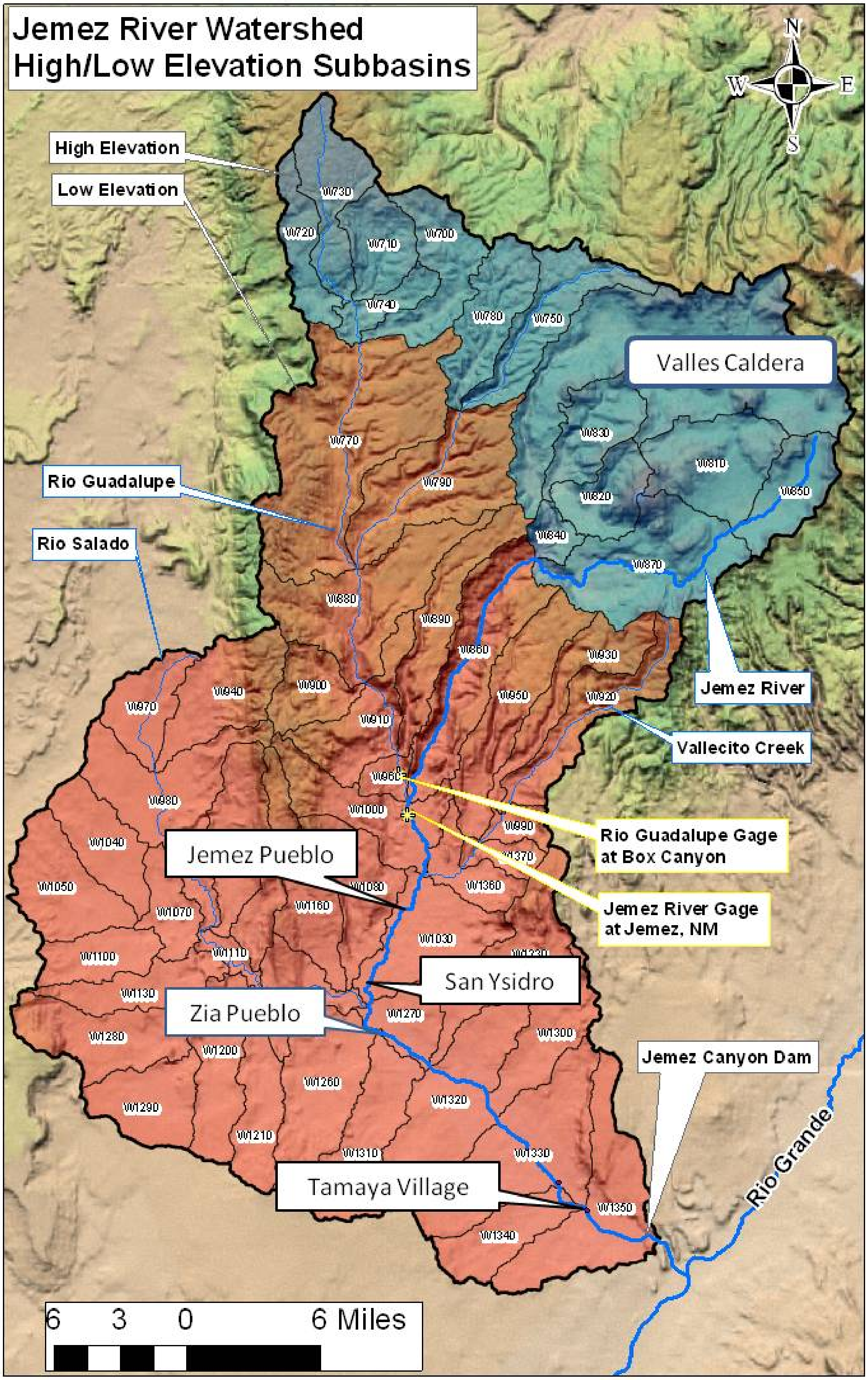

Figure 8: Jemez River Watershed Map

2.2.3.2 Jemez River

Summer thunderstorms, with their intense precipitation and short duration, cause 80 percent or more of the flood events in the project area (Massong 2008). However, spring runoff from snowmelt during March through June produces most of the annual runoff volume within the watershed.

The current study adopted frequency peak discharge values from the *Jemez River Watershed Hydrologic Assessment* (Massong 2008). Those peak values are associated with summer thunderstorm events, as opposed to spring snowmelt runoff, and typically exhibit short-duration, low-volume, high-peak characteristics. Although the largest *volume* of water passing the Jemez River near Jemez, New Mexico gage (08324000) (see Figure 8) originates as snowmelt during the spring, the highest *peak flows* are derived from summer monsoonal precipitation events, and were judged to represent a more critical river boundary condition for the subsequent groundwater modeling. The annual peaks recorded for the Jemez River for water years 1936 through 2005 are shown in Figure 9, below. A review of daily data found that spring flows from snowmelt in the Jemez River watershed usually occurred in April and May, while rain-only flows occurred after May.

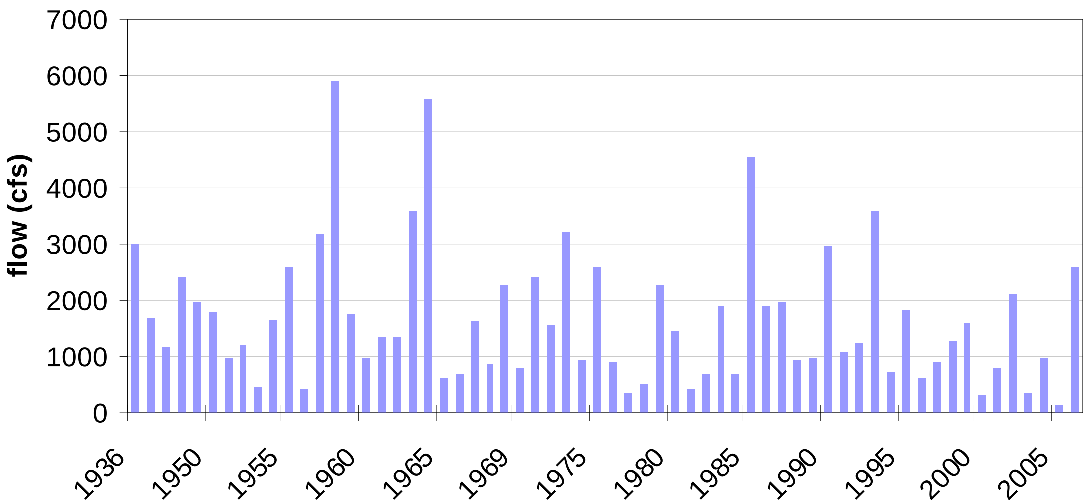

Figure 9: Annual peak flow data, USGS gage for Jemez River near Jemez, New Mexico, 1936 - 2005

In order to estimate representative storms over the basin upstream, a number of hyetographs were created from eight frequency storm events using HEC-HMS to model rainfall. Hyetographs are a graphical means of describing the distribution of rainfall over a time period. Subbasins within the upstream drainage were assigned input hyetographs, and loss rate parameters and other variables were adjusted to produce a calibrated model. The calibrated model was then used to calculate peak flows for the eight frequency events at various points along the Jemez River, including near the village.

2.2.3.3 Interior Drainage

In addition to Jemez River flow, development of project alternatives required estimation of runoff from rainfall over Tamaya Village and the ephemeral arroyos adjacent to the village. The interior hydrology for both pond conditions and adjacent tributary flows were derived using the Tamaya watershed hydrologic models, described in Appendix C, as a basis for alternative formulation. HMS models were created to establish the peak discharge frequency and flood hydrographs of four arroyos that originally drained directly into or near Tamaya Village. These four ephemeral flow paths drain the adjacent bluff of the Jemez Mesa just to the northwest of the village. In addition, the frequency peak flows and volumes of rainfall within the village and levee were computed to support groundwater modeling efforts, and to provide information for drainage feature development (*e.g.*, active pumping).

The four subbasins of interest contributing to the Jemez River near Tamaya Village are not gaged watersheds, so results from the USGS Regional Flood Frequency Equations (Waltemeyer 1996) were selected for use as HMS model calibration targets for the subbasins. Rainfall data used was obtained from NOAA Atlas 14. The excess precipitation (depth) for each frequency event were obtained from the HMS output. This depth was then multiplied by the interior basin area to determine the runoff volume. To account for the impervious areas in the village due to structures, the resulting runoff volumes were increased by ten percent.

2.2.3.4 Hydrologic Conclusions

Jemez River: The frequency-discharge data used for the Hydrologic Engineering Center River Analysis System (HEC-RAS) modeling of the Tamaya Reach on the Jemez River were obtained from the Jemez River Hydrology Report (Massong 2008). The peak discharges used for the Tamaya Reach were those generated for the Jemez Reservoir Weir location, just downstream of the village (Table 1).

Table 1: Jemez River Hydrology Report – Model Output Flows at Points of Interest (Massong 2008)

Return Period	% Chance Event	Jemez Reservoir Weir (cfs)	Flow at Dam (cfs)	Volume at Dam (acre-feet)
500 yr	0.2	28,700	27,700	18,750
200 yr	0.5	21,000	20,700	14,100
100 yr	1	14,730	14,500	10,370
50 yr	2	14,100	13,900	9,690
20 yr	5	8,060	7,900	6,010
10 yr	10	6,400	6,200	4,620
5 yr	20	2,200	2,000	1,400
2 yr	50	1,900	1,700	1,060

Interior Areas: The results for the volume of surface water within Tamaya Village are summarized in Table 2 for each of the frequency events. The resulting frequency peak discharges for the adjacent tributary arroyos are shown in Table 3, below

Table 2: Interior Arroyo Runoff Volumes (V) within Tamaya Village area

$V_{0.50}$ (ac ft)	$V_{0.20}$ (ac ft)	$V_{0.10}$ (ac ft)	$V_{0.05}$ (ac ft)	$V_{0.02}$ (ac ft)	$V_{0.01}$ (ac ft)	$V_{0.002}$ (ac ft)
0.49	1.34	2.36	3.49	4.32	5.23	7.58

Table 3: Frequency peak discharges (Q) for tributary arroyos discharging into Tamaya Village vicinity

Arroyo Basin ID	$Q_{0.50}$ (cfs)	$Q_{0.20}$ (cfs)	$Q_{0.10}$ (cfs)	$Q_{0.04}$ (cfs)	$Q_{0.02}$ (cfs)	$Q_{0.01}$ (cfs)	$Q_{0.002}$ (cfs)
1	38	103	180	263	324	387	534
2	29	76	132	194	238	284	386
3	62	168	289	422	519	618	844
4	10	28	49	71	86	101	135

2.2.4 Hydraulic Conditions

2.2.4.1 Current Hydraulic Conditions

Ground survey data was acquired in 2008 by the Pueblo for the channel and overbanks of the Jemez River near the village (see Appendix C). Field data were also acquired for the measurements of the BIA 74 bridge. This ground survey was combined with the 2002 LiDAR (Light Detection And Ranging) mapping for the areas around the Tamaya Village, and used to construct an HEC-RAS model. HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. A summary of the HEC-RAS modeling is included in this section, with a more thorough description of the numerical modeling provided in Appendix C. The HEC-RAS model extends about 5700 feet downstream of the bridge. Aerial images from the USGS 2005 DOQQ (Digital Orthophoto Quarter Quad), along with the ground cover descriptions from the ground survey, were used to assign the Manning's roughness "n" values along the active channel. The “n” values ranged from 0.035 in the main channel to 0.1 in the dense salt cedar of the overbanks. The model was calibrated to the actual observed water surface elevations (WSE) recorded during the 2008 ground survey. Stream gauge records were retrieved from the USGS website for the dates of the ground survey (February 1-19, 2008) at the Jemez River near Jemez, New Mexico stream gauge (USGS 08324000) (see Figure 8). The Manning’s “n” values were adjusted accordingly in the main channel and several iterations were rerun until the resulting WSE closely matched the observed WSE within an average of 0.10 feet to achieve model calibration. A complete list of calibrated “n” values used in the model appears in Appendix C.

The river hydraulics were modeled using the 8 frequency flows of 50%, 20%, 10%, 4%, 2%, 1%, 0.5% and 0.2% chance events (2-, 5-, 10-, 20-, 50-, 100-, 200- and 500-yr return events) summarized in Table 1. Additional discharges were also analyzed and these included the 35 cubic feet per second (cfs) for calibration, 300 cfs to represent average spring runoff, and 700 cfs to represent the average active channel capacity.

The active channel of the Jemez River downstream of the bridge has aggraded and become a perched reach. Just downstream of the bridge, the right overbank (looking downstream) is characterized by a swale about three to four feet lower than the channel invert. The left overbank is controlled by the levee protecting Tamaya Village. The levee extends about 1700 feet downstream of the bridge. Downstream of the levee, the left overbank is also characterized by a swale about three to four feet lower than the channel invert.

The perched channel and lower overbank swales downstream of the bridge give rise to complex channel and overbank hydraulics. The capacity of the main active channel was determined to be about 700 cfs. All flows above 700 cfs overtop the right bank just downstream of the bridge and enter into the right overbank. For larger events (0.2%, 0.5%, 1%, & 2% chance events), flows combine in the main active channel and right overbank up to River Station (RS) 5600 (see Figure 10). At RS 5600, the flows split, with 700 cfs flowing down the main active channel and the remainder flowing down the right overbank. At about RS 2600 the right overbank flow re-enters the main active channel and then immediately overtops the left channel bank and enters the left overbank. About 5,900 cfs continues downstream along the combined main channel and right overbank. All flows above 5,900 cfs enter the left overbank at this location. At the far downstream (RS 1000), the channel capacity is about 1,000 cfs, with all higher flows overtopping the left bank and entering the left overbank. At this lower end the entire conveyance area, including the main active channel and the floodplain overbanks, turns in an eastward direction.

Locations were selected for the extraction of stage-discharge data to be used as input data for the groundwater model. The data was used to characterize surface water boundary conditions and analyze the interaction between the surface water and the groundwater. Stage-discharge data was determined from the following specified locations and provided to the groundwater modeling team members: RS 7000, RS 6300, RS 5200, RS 3000. The data was tabulated individually for three conveyance areas: the main active channel, right overbank and left overbank.

The downstream boundary of the groundwater model was selected at the Jemez Weir (weir) (see Figure 2 for location and Figure 6 and Figure 7 for the groundwater model). An additional surface water hydraulic model (HEC-RAS) for the Tamaya Reach was configured from an existing HEC-2 (predecessor of HEC-RAS) model assembled by USACE, Albuquerque District in 2000 for earlier studies. This model was imported into HEC-RAS, reviewed, and adjusted to assure consistency with the Tamaya Reach modeling. The Pueblo also obtained ground survey data just upstream and downstream of the weir in the 2008 survey. The stage-discharge results from this model were also provided to the ground water modeling team members for use as boundary conditions.

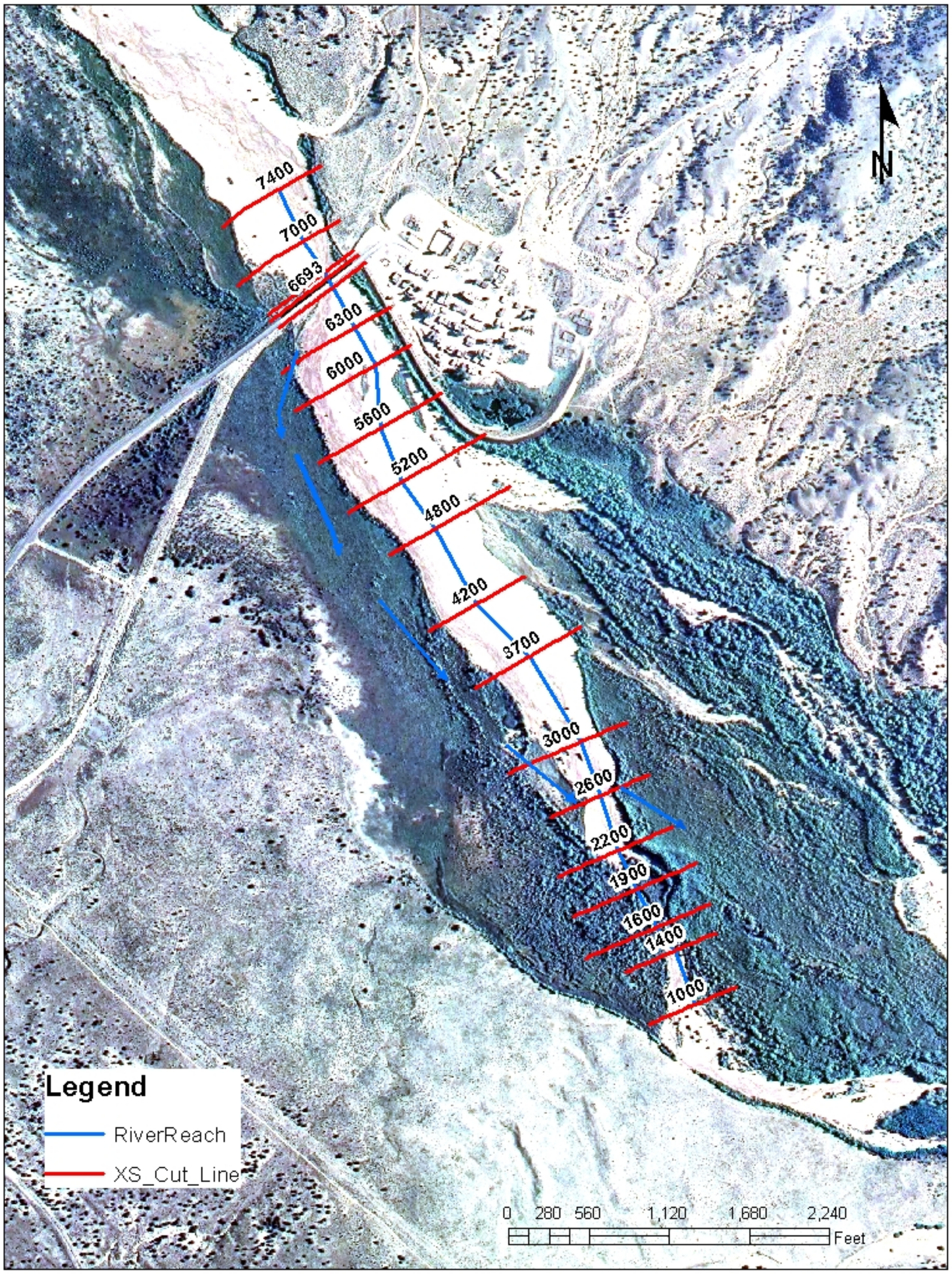

Figure 10. River station and cross section (XS_Cut_Line) locations for the HEC-RAS model

2.2.4.2 Sediment

The Jemez River above its confluence with the Rio Salado at San Ysidro (Figure 8) has a drainage area of about 600 square miles. From sediment sampling records between February 1937 and June 1941, suspended sediment passing San Ysidro was approximately 400 acre-feet per year and the average concentration for all months of record was 0.46 percent sediment by weight. No sediment samples have been collected from this location since 1941.

The Rio Salado, a tributary that enters the Jemez River at San Ysidro, has a drainage area of about 251 square miles with rough, broken and hilly terrain that is easily eroded. For about three miles above San Ysidro, the streambed is wide and sandy. Sediment sampling on this stream between 1937 and 1941 indicated that the sediment carried was about 150 acre-feet per year, including an assumed 15 acre-feet of bed load. Records of sediment sampling from the Jemez River at Zia Pueblo, about five miles downstream of the Jemez-Rio Salado confluence, showed that the average annual suspended sediment load passing Zia Pueblo was about 500 acre-feet per year.

Downstream from San Ysidro, the characteristics of the Jemez River change suddenly. The slope becomes flatter and the streambed becomes wider and is plugged with sand and fine material washed into the river from tributaries and eolian deposition. The 183 square miles of drainage area between the Dam and San Ysidro produces about one-half of the total sediment entering the reservoir area. Most of the sediment comes from the south side of the Jemez River where the Santa Fe group outcrops or is covered with a mantle of wind-blown alluvium. The terrain is rolling hills cut by numerous steep-sided arroyos with sparse vegetation. Near the river the dunes are extensive and have advanced to the edge of the stream in many places. Runoff from this landscape delivers large quantities of sediment into the river. The suspended sediment load entering the reservoir area was estimated from sediment sampling records taken between February 1937 and June 1941 to be about 910 acre-feet per year, with the bed load assumed at about ten percent of the suspended load for a total of about 1,000 acre-feet per year. Approximately 60 percent of the total yearly runoff volume occurs during the spring runoff period, and about 70 percent of the total suspended sediment load is transported during this period (USACE 1994).

Sediment Monitoring: The transport and deposition of sediment, which affects the operation of Jemez Canyon Dam and Reservoir, are monitored by the measurement of suspended sediment concentrations of outflow and by periodic ground and hydrographic surveys of the reservoir area. There are 13 sediment rangelines located within the reservoir area and 14 degradation rangelines located in the channel below the dam. Sediment rangelines 10 through 13 are located above the maximum water surface of the reservoir for the purpose of determining channel changes and aggradation or degradation of the river channel. Rangelines one through nine are used to determine the amount of sediment deposition that has taken place in the reservoir area. Reservoir sedimentation rangelines in the vicinity of Tamaya Village are shown in Figure 11. Both sedimentation and degradation rangelines are shown in Appendix C. Sedimentation resurveys are normally scheduled on a five to seven year basis. The most recent resurvey at Jemez Canyon Reservoir was made in October 2009.

Initial reservoir capacity allocations were 73,000 acre-feet for flood control and 44,000 acre-feet for sediment deposition. The area and capacity for initial reservoir conditions and subsequent surveys through 1991 are provided in Appendix C.

2.2.5 Geomorphology

The Jemez River forms in the Jemez Mountains and flows southeasterly for about 65 miles. It is perennial in the upper reach and ephemeral in the lower reach due to losses to groundwater and irrigation diversions. The total area drained by the river is 1,038 square miles, with 1,034 square miles above the Jemez Canyon Dam. The watershed is about 65 miles long with a maximum width of 30 miles. The terrain rises from elevation 5,120 feet at the dam to over 11,000 feet in the mountainous region of the headwaters. The stream channel in the upper reach is confined within narrow canyons. In the lower reaches and through the reservoir area, the stream is several hundred feet wide without well-defined banks and meanders through a broad sandy valley. Below the Dam the river enters a narrow steep-sided canyon that extends to the confluence with the Rio Grande. Stream slopes vary from 18 feet per mile at the dam to more than 250 feet per mile in the mountains (USACE 1994).

The Rio Guadalupe, a perennial stream, is the principal mountain tributary in the watershed. It originates in the upper Jemez Mountains and enters the Jemez River about 26 miles above the Dam. Coniferous forest of pine, fir and spruce interspersed with groves of aspen covers the watershed above 7,000 feet. Vegetal cover in the lower elevations is piñon, juniper and oak brush with very sparse grasses and forbs. The upper area is characterized by steep river gradients, varying from 250 feet per mile to 130 feet per mile, which results in rapid runoff (USACE 1994).

The principal tributary in the lower basin is the Rio Salado, an ephemeral stream that drains the southwest portion of the Jemez River Basin. It originates in the lower mountain region and flows through the highly erodible, low-lying plateau area of the watershed. Vegetal cover is sparse and consists of short grasses and desert shrubs. The Jemez River gradients in this area vary from about 130 feet per mile near the Rio Salado confluence to 18 feet per mile in the vicinity of the dam. Because of the nature of the soils and plant cover, the lower area is much more conducive to runoff than the upper area. The Rio Salado-Jemez River confluence is about 17 miles above the dam, near San Ysidro (USACE 1994).

The Jemez River above the weir to the confluence with the Rio Salado is a broad sandy channel with a very shallow braided flow pattern. The Rio Salado channel is very similar to the Jemez River channel for the lower one third of its length. The higher stream channels of both the Jemez River and Rio Guadalupe are steep, narrow and well armored (USACE 1994).

Conditions within the river channel upstream and near Tamaya Village indicate a dynamic channel that continues to change. The 2011 Las Conchas fire burned parts of the upper Jemez River watershed, and is expected to deliver higher-than-normal sediment loadings to the reach over the next several years. The Jemez River within the Zia Pueblo, the upstream neighbor of Pueblo of Santa Ana, (see Figure 1 for location) has experienced significant incision and deposition. Upstream of the Rio Salado confluence on the Zia Pueblo, two sheet-pile grade features constructed across the Jemez River, remnants of an abandoned irrigation diversion facility, result in a grade difference of approximately 10 to 12 feet between the upstream and downstream streambed. In 2007, a sand plug reportedly formed in the channel near the Zia Pueblo/Santa Ana Pueblo boundary. In addition, the BIA 74 bridge was constructed around 1999/2000 to replace the previous timber trestle structure adjacent to Tamaya Village. Based on temporal photographic evidence obtained within Google Earth Pro©, the new bridge imposed a significant constraint on the channel width when it was constructed. The south abutment was apparently extended out into the meander width such that it reduced the available conveyance width by one-third to one-half. This constriction has likely led to some significant localized channel adjustments since.

As described under the hydraulic conditions (Section 2.2.4), the Jemez River channel near the village is perched with a limited carrying capacity within the active channel. Flows in excess of this capacity spill into the lower-elevation areas adjacent to the active channel. It is hypothesized that this perched channel condition may be, at least in part, associated with the replacement of the bridge. The wetland area that has formed south of the current active channel (opposite the levee) lies in the ‘flow shadow’ created by the newer bridge abutment/approach. The perched nature of the channel in this area indicates a current local aggradational trend. Nevertheless, there is not a clear indication of long-term aggradation. The perched low-flow channel adjacent to the village will in all likelihood avulse at some point in the future (when there is a sufficient event) into the lower elevation flood plain area and form a new channel.

An analysis of the 1975 through 2009 reservoir sediment rangeline surveys was undertaken to quantify longer term sedimentation/deposition trends. Four of the reservoir rangeline data sets were evaluated by comparing the average elevations within rangelines to represent fluvial responses. The four rangelines selected for evaluation were S-6, S-7, S-8, and S-9, illustrated below in Figure 11. For orientation, S-8 is aligned just downstream of the bridge into the village, with S-9 located upstream and S-7 and S-6 downstream. The following discussion uses the National Geodetic Vertical Datum of 1929 (NGVD 29), rather than the North American Vertical Datum of 1988 (NAVD 88) used throughout this document, because some of the following information predates the NAVD 88. The average elevations for the 1975, 1983, 1991, 1998, and 2009 resurveys were computed in two ways: by arithmetic averaging of the values below a specified elevation judged to capture the active river channel, and by arithmetic averaging of the values between two specified stations judged to capture the majority of typical river flows. Though the resulting values differed somewhat between the two methods, the comparative results were quite similar. Detailed information pertaining to analysis of sediment range data is presented in Appendix C. Results of this evaluation indicate that the channel elevations have fluctuated both up and down throughout the evaluation period, with no clear long-term aggradation or degradation patterns.

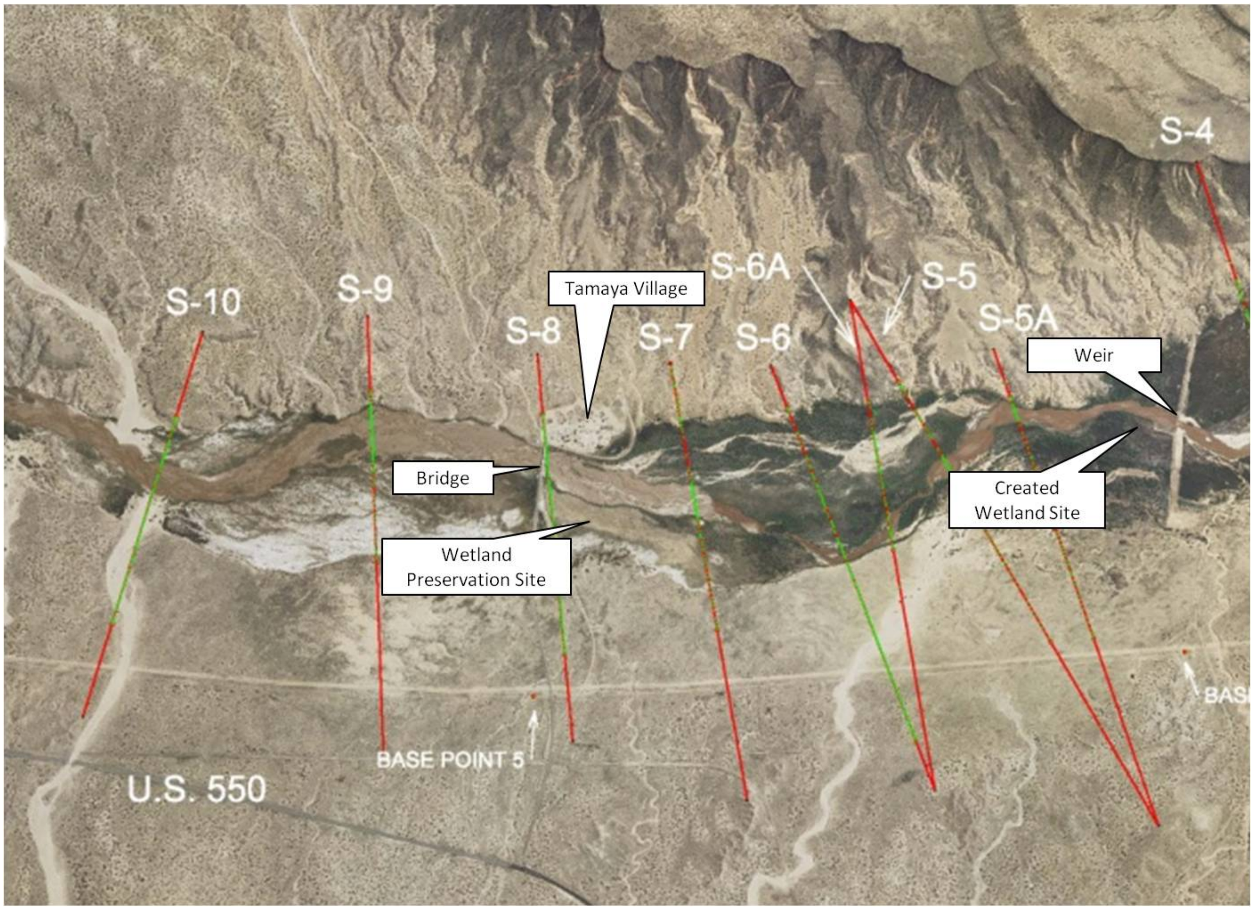

Figure 11: Sediment rangelines in vicinity of Tamaya Village

Sediment Rangeline S-6 shows mean elevation values ranging from 5211.58 feet NGVD 29 to 5220.04 feet The lowest mean elevation comes from the 1983 resurvey, with the highest for the 1998 resurvey. The current (2009) mean value is 5216.54 feet, which is within one standard deviation of the mean periodic average (5216.46 feet). There is no clear evidence of an aggradational trend.

Rangeline S-7 suggests a directional trend of aggradation, with values increasing over time, though the amounts are relatively modest, peaking at around 0.13 ft/yr over the two comparison methods. The lowest mean elevation comes from the 1975 resurvey at 5221.42 feet NGVD 29, and the highest for the 2009 resurvey at 5223.88 feet This is the only sediment rangeline that suggests a temporal trend.

Elevations and rates of change at Rangeline S-8, nearest the village, have fluctuated. The yearly rates of change vary from around 0.2 ft/yr to only 0.04 ft/yr depending on the stations compared. The lowest mean elevation comes from the 1983 resurvey at 5234.86 feet NGVD 29, and the highest for the 1998 resurvey at 5237.24 feet.

The resurvey data available for Rangeline S-9, upstream of the village, covers a shorter evaluation period, from 1991 through 2009. It, too, suggests fluctuating values when screening below elevation 5250 feet. The lowest mean elevation comes from the middle 1998 resurvey at 5243.34 feet NGVD 29, while the highest mean elevation is 5245.01 feet for the 2009 resurvey. However, when screening the active channel between stations, the extremes come from different resurveys, with the lowest value of 5243.79 feet in 1998 and the highest elevation of 5245.99 feet occurring in 1991.

In summary, the up and down fluctuations of the channel elevations throughout the numerous evaluation periods do not indicate a clear vertical trend for the river reach. While there is no clear evidence of a long-term aggradational trend, the shifts in the vertical direction quantified above should be planned for and accommodated as possible in any feature designs. The information above and more fully described within Appendix C, provides insight into the range of variability that can be expected.

2.2.6 Water Quality

The U.S. Army Corps of Engineers reviewed the Pueblo's chemical database for the results of lab analyses of water samples collected from the pond and from nearby monitoring wells (Pueblo of Santa Ana 2011). Analyses were performed on samples to evaluate the presence of pesticides, volatile organic compounds (VOC), semi- volatile organic compounds (SVOC), oil and grease, and radionuclides, metals, polychlorinated biphenyls (PCB), organophosphorus compounds, cyanide, mercury, herbicides, and general water quality shown in Table 4.

Samples collected from monitoring wells, and the pond, contained arsenic and phosphorous above U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSL). Magnesium was detected in groundwater and pond samples above the secondary USEPA Maximum Contaminant Level (MCL). Lithium was detected above the RSL in a sample collected from the pond, and sulfate (as SO_4) was detected above the secondary MCL in a sample collected from the pond. These chemical constituents occur naturally in the environment, and in all likelihood, represent the natural chemical properties of the water in both ground and surface water.

Total dissolved solid (TDS), specific conductance, temperature, pH, hardness, dissolved oxygen (DO), and biological oxygen demand (BOD), were also measured and recorded in the database. The following table lists the highest recorded measurements for these water quality indicators in the pond and the groundwater. These values do not indicate any adverse water quality issue.

Table 4: Water Quality Parameter Measurements

System	DO (mg/L)	BOD (mg/L)	SC (µS/cm)	TDS (mg/L)	TSS (mg/L)	pH	Hardness (mg/L)	Temperature (°F)
GW	0.03[1]	10	690	590	990	7.9	170	68.4[1]
Pond	2.43[1]	29	1800	780	160	9.0	160	69[1]

BOD = Biological oxygen demand

DO = Dissolved oxygen

GW = Groundwater

mg/L = Milligram per liter

SC = Specific conductance

TDS = Total dissolved solids

TSS = Total suspended solids

µS/cm = Microsiemens per centimeter

°F = Fahrenheit

1 = measurements provided by the Santa Ana DNR

2.2.7 Air Quality

Sandoval County, which surrounds the trust lands of the Pueblo, is in attainment status for National Air Quality Standards for priority pollutants (particulate matter, sulfur oxides, nitrogen dioxide, carbon monoxide, ozone, and lead), meaning that ambient air quality meets or exceeds State and Federal standards (USEPA 2012). The nearest air quality monitoring station is in Bernalillo (NMED 2012). Generally, the only air pollutant of concern in the area is particulate matter (blowing dust during periods of high winds). In the State's Prevention of Significant Deterioration program administered by the New Mexico Environment Department, the region is designated Class II, which allows for moderate development and associated air emissions. Class I air quality areas are designated natural area where air quality is subject to maximum limits on degradation. The nearest Mandatory Class I area to the Pueblo is the Bandelier Wilderness Area, approximately 25 miles to the north.

2.2.8 Climate

Climate of the Jemez River Basin is arid continental, characterized by hot summers with a large diurnal range in temperature. Winters vary from moderate in the lower basin to severe in the higher mountainous area. The spring and fall transition seasons are usually very short. Change from summer to winter is characterized by the disappearance of the thunderstorm activity common in the summer to the clear weather which generally dominates between winter frontal passages. During the summer, northern New Mexico has a higher frequency of thunderstorms than most areas in the United States. Monsoon thunderstorms are most active during July and August and usually reach peak activity in late afternoon.

The average annual precipitation over the Jemez River Basin, based on National Weather Service stations in and adjacent to the basin, is approximately 17 inches based on data from 1914 to 2001. Mean annual precipitation in the Jemez River Basin varies from nine inches at the Dam (USACE Operational Records, 1954 to 2010) to more than 30 inches in the high, mountainous portions of the basin. About one-third of the annual precipitation typically occurs during July and August as thunderstorms. Since the installation of the weather station at the dam in 1954, the maximum annual precipitation (calendar year) was 13.56 inches in 1998 and the minimum was 2.57 inches in 1956. Annual rainfall is highly variable: during the period 1954 to 2010 there have been four years with less than five inches of precipitation recorded, and four years with over 13 inches (USACE Operational Records).

During the winter months, heavy snowfall occurs in the high elevation, mountainous portions of the watershed, but snowfall is light over the lower elevation areas of the basin. Snow remains in the mountainous areas above 7,000 feet elevation from December into April. Below 7,000 feet in elevation, snow seldom stays on the ground more than a few days. The average annual snowfall varies from 10 inches at the dam to over 100 inches in the mountains.

2.3 Biological Resources

2.3.1 Vegetation

Jemez Canyon Dam and Reservoir lies within the Plains and Great Basin Grassland biotic community as defined by Brown and Lowe (1980). Vegetation outside the Jemez River riparian corridor is within the Plains-Mesa Sand Scrub biotic community as defined by Dick-Peddie (1993). Common grasses and forbs that occur in sparse stands throughout this community include: blue grama (*Bouteloua gracilis*), galleta (*Pleuraphis jamesii*), sand dropseed (*Sporobolus cryptandrus*), bush muhly (*Muhlenbergia porteri*), and sandhill muhly (*M. pungens*). Shrubs commonly found throughout the area include four-wing saltbush (*Atriplex canescens*), sand sage (*Artemisia filifolia*), broom dalea (*Psorothamnus scoparius*), rabbitbrush (*Ericameria nauseosa*), bush penstemon (*Penstemon ambiguus*), hoary rosemary-mint (*Poliomintha incana*) and, occasionally, one-seed juniper (*Juniperus monosperma*). Unconsolidated sand dunes with sparse pioneer vegetation occur in a portion of this community. At slightly higher elevations, and often interspersed with the sand scrub community, are piñon pine / one-seed juniper woodlands.

Tamaya Pond supports a wetland plant community which is dominated by cattail (*Typha domingensis*) throughout the deeper, frequently-inundated areas. A variety of wetland species grow on the margins of the pond in the transition from wetland to upland, including: saltgrass (*Distichlis spicata*), alkali muhly (*Muhlenbergia asperifolia*), Yerba mansa (*Anemopsis californica*), threesquare bulrush (*Schoenoplectuss pungens*.), spikerush (*Eleocharis rostellata*), knotweed (*Polygonum* sp.), alkali yellowtops (*Flaveria campestris)*, annual rabbitfoot grass (*Polypogon monspeliensis*) and foxtail barley (*Hordeum jubatum*). Woody species along the levee side of the pond included Russian olive (*Elaeagnus angustifolia*) and salt cedar or tamarisk (*Tamarix* sp.), which are exotic, invasive species.

Vegetation associated with the slopes of the levee includes warm season grasses (*Sporobolus* spp. and *Bouteloua* spp.), cactus species (*Opuntia* spp.) and one-seed juniper (*Juniperus monosperma*).

Riparian vegetation located outside of the levee and within the adjacent Jemez River riparian corridor includes a mixture of cottonwood (*Populus deltoides* subsp. *wislizeni*), salt cedar, Russian olive and willow species (primarily coyote willow, *Salix exigua*, but also tree willows *S. gooddingii* and *S. amygdaloides*). Prior to construction of the Dam, in the early 1950s, the Jemez River floodplain between the dam site and Tamaya Village was very sparsely vegetated (USACE 1976). The river occupied a wide, braided channel through the area. Plant community establishment was likely hindered by ephemeral flows, periodic large floods and deposition of sediment, and a shifting channel location. Riparian vegetation likely bordered at least a portion of the channel, but information on its location and extent are lacking.

By the early 1970s, vegetation occupied about 624 acres of the 1,143-acre space below elevation 5,197 feet (USACE 1976). Vegetation development was likely enhanced due to flood control operation which generally increased soil moisture and nutrient availability. The widespread invasion of salt cedar throughout the middle Rio Grande Valley during this period also contributed to plant community development at Jemez Canyon Reservoir. The upper portion of the reservoir became vegetated by sparse salt cedar with a modest understory of salt grass and sedges. A salty crust on the soil surface was common.

Currently, riparian vegetation occurs at the delta that formed where the Jemez River emptied into the reservoir during the years when a pool was present, and along the river below the dam. A narrow band of riparian vegetation occurs along the sediment pool margins. In the delta area, large mixed stands of Rio Grande cottonwood, Gooding’s willow, and coyote willow occur, intermixed with non-native Russian olive and salt cedar. Approximately 230 acres within the two-mile-long delta reach consists of fairly dense tree or shrub-dominated stands, and another 75 acres consists of sparse salt cedar. Along the reservoir shoreline and the river below the dam, woody vegetation is more sparsely, linearly distributed. Alkali sacaton and saltgrass are common grass species in these riparian communities.

The proposed created wetland mitigation site would be located 500 feet upstream of the Jemez River weir in an area currently dominated by a monoculture of decadent saltcedar. This area is described in more detail in the Mitigation Plan (Appendix B).

The proposed wetland preservation site is a wet sedge meadow on the right bank of the Jemez River, across the river from Tamaya Village. The sedge meadow is an emergent wetland community with saturated soils at a shallow depth. In March 2012, USACE biologists delineated a wet meadow of approximately 64 acres in this area. New Mexico Natural Heritage Program botanists mapped five herbaceous wetland community types in this area. Dominant species include threesquare bulrush, inland saltgrass, common spikerush, Baltic rush, and yerba mansa. The wet meadow area is described in more detail in the Mitigation Plan (Appendix B).

2.3.2 Fish and Wildlife

Mammals expected to be located near the wetland include white-footed mice (*Peromyscus leucopus*), western harvest mouse (*Reithrodontomys megalotis*), deer mice (*Peromyscus maniculatus*), coyote (*Canis latrans*), pocket gophers and several bat species. On site visits, mule deer (*Odocoileus hemionus*) sign was plentiful around Tamaya Pond.

Bullfrogs (*Bufo bufo*) were observed in September 2010 and June 2011. Tiger salamander (*Ambystoma tigrinum*), woodhouse's toad (*Bufo woodhousii*), turtles (likely painted turtle, *Chrysemys picta*) and collared lizards (*Crotaphytus collaris*) have been documented in the area.

Bird species observed during wetland surveys (July 3, 2002; September 17, 2010; June 8, 2011) included: red-winged blackbird (*Agelaius phoeniceus*), American crow (*Corvus brachyrhynchos*), common yellowthroat (*Geothlypis trichus*), mourning dove (*Zenaida macroura*), white-winged dove (*Zenaida asiatica*), barn and cliff swallows (*Hirundo rustica* and *Petrochelidon pyrrhonota*), Say's phoebe (*Sayornis saya*), and killdeer (*Charadrius vociferous*). In June 2011, both mallards (*Anas platyrhynchos*) and coots (*Fulica americana*) were observed with young in the pond.

No comprehensive fish surveys have been conducted in the JCDR area or at Tamaya Pond. Fish species known to be present in the reservoir in the past have been listed in other USACE documents (USACE 2003). These species have no means of dispersing into Tamaya Pond. The pond is known to have mosquitofish (*Gambusia affinis*), which are not native to the Jemez watershed and were likely introduced directly into the pond at some point in the past in an attempt to control the mosquito population.

2.3.3 Special Status Species: Federally Threatened and Endangered Species

The Rio Grande silvery minnow (*Hybognathus amarus*), listed as Federally endangered in 1994 (USFWS 1994), is known to occupy the Rio Grande and may potentially occupy sections of the Jemez River downstream from the dam, but not above the dam. The Jemez River is not designated as critical habitat for the species upstream of the dam.

The Southwestern Willow Flycatcher (*Empidonax traillii extimus*), listed as Federally endangered in 1995 (USFWS 1995), may occur in a variety of riparian habitat types along the Jemez River during spring or fall migration periods. However, suitable breeding habitat is not present at Tamaya Pond, the proposed wetland mitigation area near the weir, or the wet meadow preservation area. The Pueblo and USACE conducted surveys to U.S. Fish and Wildlife Service (USFWS) protocol standards throughout the Jemez River delta on Pueblo lands during the spring and summer of 2001 to 2003. The Pueblo continued surveying suitable habitat within the riparian area from 2005 through 2007. From 2008-2012, the Pueblo's surveys have focused on areas where flycatchers were previously detected. From these surveys, Southwestern Willow Flycatchers are known to migrate through the project area in late May and June, but do not establish resident territories. Furthermore, no evidence of breeding Southwestern Willow Flycatcher pairs has been observed in any of the project areas (personal communication, A. Hatch and C. Nishida, Pueblo of Santa Ana, 2012).

The Yellow-billed Cuckoo (*Coccyzus americanus*), a Federal candidate species, is known to occur in Sandoval County. In New Mexico, the species is found in riparian zones with dense understory vegetation (USFWS 2011). After observing cuckoos in the Jemez River delta during flycatcher surveys (2001), the Pueblo conducted surveys for the species from 2005 through 2009. Cuckoos were observed in riparian habitat consisting of mixed native (cottonwood and willows) and exotic (salt cedar and Russian olive) vegetation. One pair was confirmed nesting on the north side of the Jemez River in 2006. Cuckoos were detected in the area during 2007 - 2008, but surveyors did not have reason to suspect pair activity or breeding. During 2009 surveys, no yellow-billed cuckoos were detected anywhere along the Rio Jemez during four surveys or incidentally. After 2009, surveys specifically for the cuckoo were discontinued because the number of cuckoos had declined in the area. This decline is attributed to lack of water in the riparian zone. However, the Pueblo's biologists conducting flycatcher surveys still listen for cuckoos. Mature, dense riparian habitat preferred by the cuckoo does not exist in the proposed project sites at Tamaya Pond or the wet meadow. At the weir, the habitat has changed since 2006 and is no longer suitable (personal communication, C. Nishida, Pueblo of Santa Ana, 2012).

The New Mexico meadow jumping mouse *(Zapus hudsonius luteus)* is known to occur in Sandoval County. This Federal candidate species has a Listing Priority of 3 and its listing is anticipated in 2013. The jumping mouse is a habitat specialist that nests in dry soils, but uses moist riparian and wetland habitats with, dense vegetation for foraging. The jumping mouse utilizes persistent emergent herbaceous wetlands, especially patches of tall dense sedges on moist soil along the edge of permanent water. The jumping mouse is generally nocturnal, and is active only during the growing season of the grasses and forbs on which it depends. It hibernates about nine months out of the year, longer than most other mammals (USFWS 2012). The New Mexico meadow jumping mouse is unlikely to occur at Tamaya Pond because of the proximity to habitation and because the levee isolates the pond from the Jemez River riparian corridor. Nevertheless, surveys would be conducted in 2013 prior to construction to verify absence.

2.3.4 Noxious Weeds and Invasive Species

Invasive species that occur at the project site and mitigation sites include Russian olive (*Elaeagnus angustifolia*), salt cedar (*Tamarix sp.*), Swainsonpea (*Sphaerophysa salsula*) and cocklebur (*Xanthium strumarium*). Salt cedar is prevalent in the Jemez River watershed. In 2011, the salt cedar leaf beetle (*Diorhabda sp.*) arrived in the area. USACE and Pueblo of Santa Ana biologists observed extensive areas of defoliated salt cedar on Pueblo lands. Defoliation continued in 2012 and defoliated salt cedar was observed at the proposed created wetland site. The complete extent of salt cedar defoliation or mortality is unknown at this point.

2.4 Floodplains

Due to the presence of the levee, Tamaya Pond is no longer within the Jemez River 100-year floodplain. The tributary arroyos in the vicinity of Tamaya Village have been diverted so the Village is outside their floodplains. The interior area that collects rainfall over the Village is the only remaining floodplain in the area of the Village and pond. As described in Section 2.2.3.3, interior drainage has been addressed in project planning. The mitigation sites are within the historic floodplain.

2.5 Wetlands

The project site, Tamaya Pond, is an artificially created emergent wetland. Water level in the wetland fluctuates with groundwater and management (pumping) by the Pueblo and USACE. Wetland delineation was performed on July 28, 2011 and confirmed a 3.3-acre wetland at the project site. Mitigation is required for filling the wetland. A mitigation plan, including monitoring and adaptive management, has been developed and appears in Appendix B. Wetland functions of the pond and mitigation areas, as described in the Mitigation Ratio Checklist (Appendix B) include surface water storage, dissipation of energy from runoff, cycling of nutrients, removal of elements and compounds, retention of particulates and maintenance of plant and animal communities. Delineation field forms for the pond and the wet meadow preservation site as well as a Section 404(b)(1) analysis are also included in Appendix B.

2.6 Hazardous, Toxic or Radioactive Wastes

Several site visits were made by USACE, Albuquerque District’s Environmental Engineering staff during 2011 to determine the existence of hazardous, toxic, or radioactive waste (HTRW) conditions near the pond and Tamaya Village. The area is rural with no known industries and/or hazardous waste sites or issues, and only consists of a few, mostly adobe-style, residential homes. There was no surface evidence to indicate hazardous waste disposal practices. Additionally, Environmental Engineering staff reviewed the Pueblo’s chemical database for results of water samples collected from the pond and nearby monitoring wells (Pueblo of Santa Ana 2011). Results of these water samples do not indicate releases of hazardous wastes or substances to the environment. Based on all available information, there appear to be no HTRW issues associated with the village or pond. Appendix E contains field trip notes and other documentation germane to HTRW.

2.7 Cultural Resources

2.7.1 Previous Cultural Resource Studies and Existing Conditions

Historically, because of its out-of-the-way location in the landscape, a short distance west of the primary Rio Grande travel corridor, the Pueblo’s traditional village of Tamaya, and the “Tamayame” as they call themselves have not been the subject of intense historic or cultural documentation (Bayer et al. 1994:xix; Strong 1979:406). The earliest primary reference is that of Leslie White’s 1942 American Anthropological Association’s publication entitled *The Pueblo of Santa Ana, New Mexico*. The most recent significant reference is that prepared by Laura Bayer with Floyd Montoya and the Pueblo entitled *Santa Ana: The People, the Pueblo, and the History of Tamaya* (1994). The ancestral Pueblo village of Tamaya has been documented as New Mexico Laboratory of Anthropology (LA) historic property number LA8975. Tamaya Village was listed on the New Mexico State Register of Cultural Properties, SR No. 165, on March 13, 1970, and was nominated and listed on the National Register of Historic Places, NR No. 74001204, on November 1, 1974 (New Mexico Office of Cultural Affairs 2001; U.S. Department of Interior, National Park Service 2001).

Culture history and archaeological work for the Pueblo and generally for the Middle Rio Grande valley has been documented in numerous references such as White (1942), Cordell (1979, 1984, 1997), Ortiz (1979), Strong (1979), and Bayer (1994). The Pueblo and the local area are within the Northern Rio Grande Region as archaeologically defined by Wendorf and Reed (1955). In recent years, the Pueblo has been actively working to develop and protect its natural and cultural resources, and has sponsored numerous archaeological surveys on Pueblo Reservation lands. Some of these surveys were performed in anticipation of construction and rehabilitation projects, and habitat restoration efforts related to Pueblo Reservation development. Survey results for these and other activities have been provided to the Pueblo and the New Mexico State Historic Preservation Office and include reports such as Penner *et al*. (2001a, b), Larralde (2000, 1999a, 1999b), Acklen *et al*. (1998a, 1998b), Anschuetz (1997), Condie (1993), Frizell and Acklen (1987), Walt and Marshall (1986a, 1986b), Harrill (1984), Koczan (1984), and Enloe (1976). Many of these were linear surveys for utility line rights-of-way such as underground pipelines and above-ground electrical lines, highway roads projects, and block surveys for gravel quarry areas and areas to be developed.

No archaeological surveys were conducted prior to or during construction of the dam and the levee between 1950 and 1954, because at that time, no Federal legislation requiring such surveys had been passed. The National Historic Preservation Act was passed in 1966 (16 USC 470); the Act requires that Federal agencies document and manage cultural resources on properties owned or managed as Federal fee or easement land.

The first USACE-related archaeological survey of the JCDR Project was a survey of the access road leading to the dam, the maintenance area, the overlook and public recreation/picnic area, and the service road leading to the dam that was conducted by the Center for Anthropological Studies and documented in a letter report to USACE dated April 18, 1977 (Ward 1977). During the 1977 survey, Ward documented a total of 10 archaeological sites. Seven sites were located along the 200-foot wide access road right-of-way or within a 25-foot buffer on either side, and three were observed in proximity to the recreation/picnic area. Subsequently, the Center for Anthropological Studies conducted a second intensive cultural resources survey for the USACE, covering approximately 1,200 acres upstream of the dam, an area estimated to approximately cover the proposed 25-year flood pool (Rodgers 1979). The 1979 Rodgers survey documented eighteen (18) archaeological sites that consisted of historic and prehistoric structures including corrals, agricultural terraces, lithic and ceramic artifacts, and petroglyphs.

In fall 2000, per an agreement with NMISC, USACE initiated the drawdown of the 12,000 acre-feet of storage within the sediment retention pool. The drawdown in 2000 and the subsequent complete drainage of the reservoir in 2001 required that several archaeological surveys be conducted to facilitate tribal management and operation of their lands. Through cooperative and contractual agreements between the Pueblo and USACE, these surveys were conducted by Earth Analytic, Inc., a contractor to the Pueblo, for projects such as grazing land fencing and livestock water tanks/wells. Earth Analytic also conducted archaeological surveys for the weir structure (constructed in 2004 across the Jemez River to prevent channel erosion). These surveys, listed chronologically, include: Penner et al. (2001a); Dorshow and Barz (2002); Penner et al. (2003a); Byszewski (2003); and Duncan et al. (2003).

The 2001 drainage of the reservoir also afforded USACE with the opportunity to conduct an archaeological survey of all of USACE easement land in the reservoir area that may be impacted by future storage levels up to the top of the dam (elevation 5,274.6 feet NGVD 29), excluding any culturally sensitive areas at the request of the Pueblo. USACE contracted with Statistical Research, Inc. (SRI) for that archaeological survey and, after consultation with the Pueblo, the field survey was completed in 2010 (Murrell and Leckman 2011). The SRI survey covered USCAE easement lands upstream of the dam from an elevation of approximately 5,180.3 feet, up to an elevation of 5,285.7 feet NGVD 29, and, with the assistance of Tribal monitors, avoided areas of Tribal concern and several marshy areas within the reservoir pool area. Through discussions with the Pueblo it was determined that it was not necessary for reservoir operations and maintenance activities to conduct an archaeological survey of the 4,661 acres of USACE easement land located away from the reservoir area. Therefore, the SRI survey did not include easement land in the upland areas on both the north and south sides of the reservoir pool, the area upstream (west) of the BIA 74 bridge, nor the area downstream (east) of the dam. This 2,050-acre SRI survey is the first major survey of the reservoir area. The SRI survey report provides comprehensive discussions of previous survey work in the immediate area, project setting, as well as culture history.

The culture history of the Southwest and the project area has been chronologically generalized into several classification schemes that utilize noticeable changes in the cultural record, as seen in temporal and spatial similarities and differences, to assist in the explanation and interpretation of the cultural record. The primary Periods and their approximate dates are as follows:

PaleoIndian	ca. 11,500 B.C. - 7,500 B.C..
Archaic	ca. 7,500 B.C. – ca. 1 A.D.
Puebloan	ca. 1 A.D. – 1540 A.D.
Historic	1540 A.D. - Present.

These Periods are further subdivided to describe specific regional and local variations in the archaeological record (Penner *et al*. 2001a:10-14; Bayer 1994:247-264; Cordell 1997: 197-199, 1984: 106-107, 1979: 131-151; Rodgers 1979:16-24; Simmons *et al*. 1989:23-26, 32-35; Stuart and Gauthier 1984: 44-54). More detailed culture history information appears in Appendix A.

The SRI survey resulted in the documentation of 80 new archaeological sites and updated information for 20 previously recorded sites, and provided insight to reservoir storage/inundation impacts to some of those sites. At this time, final eligibility determinations have not been made for any of the historic properties at the JCDR. Many of the archaeological sites are lithic scatters of undetermined age. Other sites within the survey area can be attributed to the following periods and numerous sites include several components: Early Developmental (A.D. 600-900) and Late Developmental (A.D. 900-1200); Coalition Period (A.D. 1150/1200-1300/1325); Classic Period (A.D. 1300/1325-1540/1600); and within the Historic Period, the Contact Period (A.D. 1539-1600), Early Spanish Colonial Period (A.D. 1600-1680), Pueblo Revolt Period (A.D. 1680-1692), Post Pueblo Revolt Period (A.D. 1692-1821), and the Mexican, U.S. Territorial, and Statehood Periods (A.D. 1821-1945). The site types include prehistoric artifact scatters, both lithic and ceramic; rock art; prehistoric and historic short-term habitations and campsites;

agricultural and herding/ranching related sites; prehistoric field houses, as well as the historic alignment of the Santa Fe Northwestern Railroad.

2.7.2 Background Regarding the Proposed Tamaya Drainage Project

Reservoir storage and flooding on the Jemez River have had no direct effects upon the village of Tamaya. However, standing groundwater, ponded on the landward side (north) of the Tamaya Protection Works levee, adjacent to the village, has been a concern to the Pueblo ever since the levee was constructed and the pond formed.

In anticipation of work regarding the proposed Tamaya Drainage project, at the direction of the Pueblo, Earth Analytic conducted a survey and limited testing in an area adjacent to the eastern margin of Tamaya Village, on the landward side of the levee (Penner et al. 2003b). This area, located immediately east of the village, was historically an active arroyo channel. The existing pond is located in an area that was once a part of the active river channel (see Figure 3). In the initial stages of planning for the Tamaya Drainage project, USACE and the Pueblo considered several levee re-alignments that could potentially alleviate the water ponding problem. The Earth Analytic archaeological survey and limited testing was conducted in an effort to determine the nature and extent of the village, e.g., if any intact cultural deposits were present below the old arroyo channel.

The Penner et al. (2003b) cultural resources survey and testing for the Tamaya Drainage project covered a total of 194 hectares (479 acres) that included the eastern portion of the ancestral Tamaya Village, on the landward side of the levee, the old arroyo channel, and a significant area to the east of the Pueblo (Figure 12). The survey area is shown as Area A in Figure 12. Two archaeological sites (LA137629, LA137630) were discovered east of the Pueblo on gravel terraces above the Jemez River floodplain. In consultation with Santa Ana Pueblo, it was agreed that limited archaeological testing would be conducted in a smaller area in the old arroyo channel along the eastern margins of Tamaya Village, defined as Area B (Figure 12). Area B, where limited testing occurred, is approximately 4.5 hectares (11.3 acres). The purpose of this testing was to determine the nature and extent of subsurface cultural deposits and their proximity to the existing levee so that the boundaries of the proposed construction area could be defined. Prior to USACE Section 106 consultation with the New Mexico Historic Preservation Officer (SHPO) regarding the proposed work at the village, Earth Analytic conducted the survey and survey level limited testing between August and October, 2002. The results are presented in Penner et al. 2003b (Earth Analytic Report EA66.02; NMCRIS No. 80680). Portions of Area B, as determined from historic aerial photography, were historically within the Rio Jemez floodplain or within the channel of an unnamed arroyo that, prior to construction of the flood control levee in the early 1950s, flowed immediately east of the Pueblo.

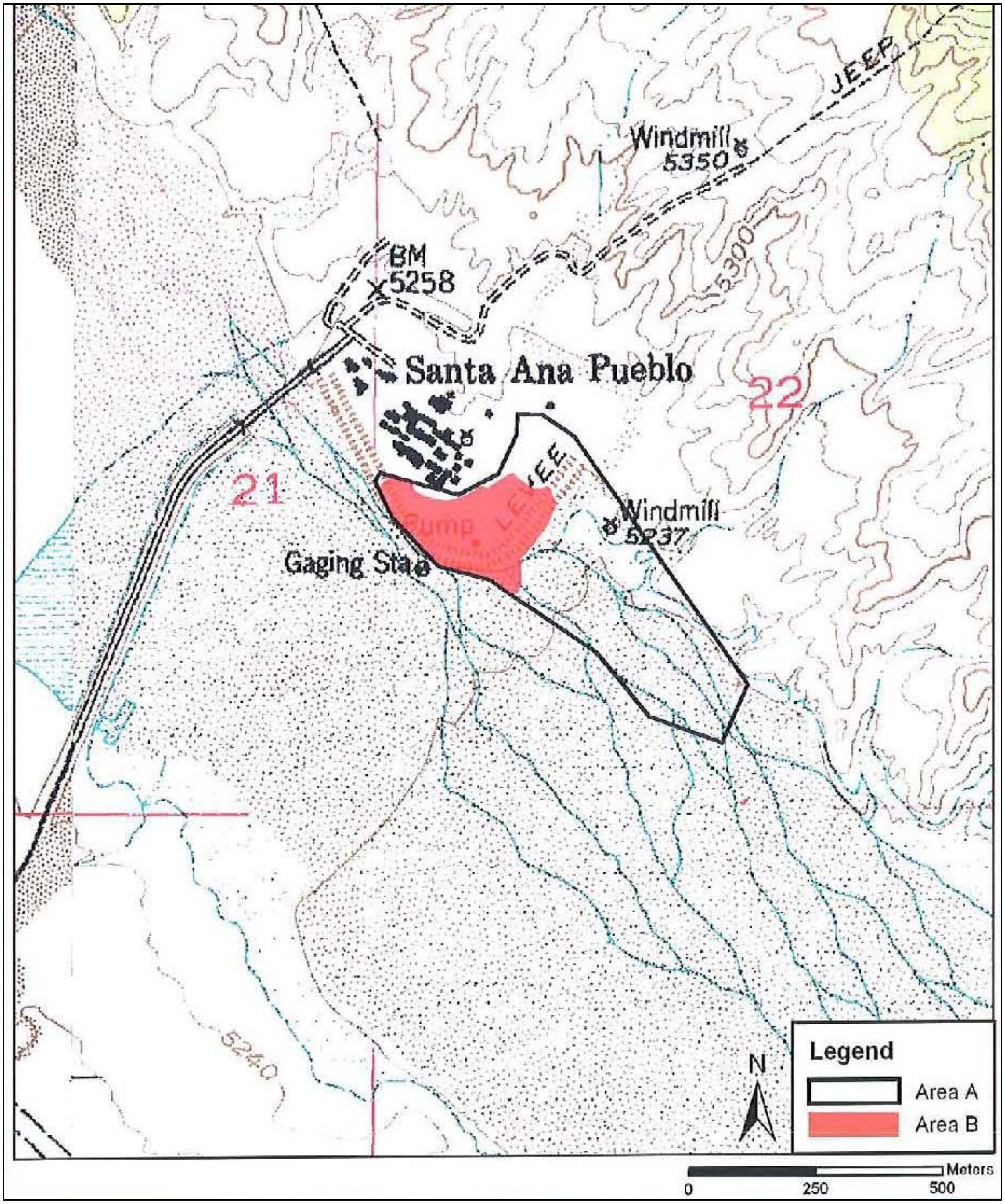

Figure 12: Penner et al. (2003b) cultural resources survey for the Tamaya Drainage project

2.8 Land Ownership

All lands within the Tamaya Drainage project area are Pueblo lands. The Santa Ana Pueblo Protection Works (levee) is associated with the USACE JCDR project and is located on restricted fee lands with respect to which the United States has a trust responsibility to the Pueblo. The Department of the Army and the Pueblo signed a memorandum of understanding in 1952 which established a perpetual right and privilege for the construction, operation, and maintenance of the JCDR project. The Pueblo reserved the right to use all associated lands for any purposes not inconsistent with those expressly granted to the government for the facility.

The JCDR project originally consisted of 2,831 acres owned by the United States (2,383 acres owned by the U.S. Department of the Interior (DOI) and 447.75 acres owned by USACE) and 3,880 acres owned by the Pueblo in restricted fee status over which USACE obtained 3,720 acres in flowage easement and 160 acres in permit. P.L. 95-498, October 21, 1978, declared the 2,383 acres owned by the DOI to be held in trust by the United States for the benefit and use of the Pueblo, subject to P.L. Order 873, which was the Order allowing USACE to use the lands for the JCDR project. P.L. 99-575, October 28, 1986, declared the 447.75 acres of USACE- owned land to be held in trust for the Pueblo, subject, again, to USACE's right to operate and maintain the JCDR project. Thus, USACE has an easement for 6,711 acres for operations and maintenance of the JCDR project (USACE 2000:14; USACE 1994:2-3).

2.9 Indian Trust Assets

Indian Trust Assets (ITAs) are a legal interest in assets held in trust by the United States Government for Indian tribes or individuals. The United States has an Indian Trust Responsibility to protect and maintain rights reserved by or granted to Indian tribes or individuals by treaties, statues, Executive orders, and rights further interpreted by the courts. The Secretary of the DOI, acting as the trustee, holds many assets in trust. Some examples of ITAs are lands, minerals, water rights, hunting and fishing rights, titles and money. ITAs cannot be sold, leased, or alienated without the express approval of the United States Government. The Indian Trust Responsibility requires that all Federal agencies take all actions reasonably necessary to protect such trust assets. The Department of Defense's American Indian and Alaska Native Policy, signed by Secretary of Defense William S. Cohen on October 20, 1998, and DOI's Secretarial Order 3175 and the Bureau of Indian Affairs (BIA) ITA Policy require that USACE, as the project's Lead Federal Agency, and BIA, as the Federal Land Managing Agency, consult with tribes and assess the impacts of its projects on ITAs. If any ITAs are identified and are to be impacted, further consultation on measures to avoid or minimize potential adverse effects will take place. If the project results in adverse impacts, consultation regarding mitigation and/or compensation will take place.

Since the proposed Tamaya Drainage project is within Pueblo Reservation lands and is located immediately adjacent to their ancestral village of Tamaya, the Pueblo has cultural resources and ITA concerns. USACE has worked intensively with the Pueblo to coordinate planning efforts and project related studies. Several areas of tribal concern will be avoided during construction. No other tribal entities have been consulted regarding the proposed project.

2.10 Socioeconomic Considerations and Environmental Justice

2.10.1 Demographics

The Pueblo Reservation covers approximately 79,000 acres spanning the Rio Grande and lower Jemez River. The majority of the population of approximately 850 resides in three communities along the east side of the Rio Grande: Rebahene, Ranchitos and Chicale. Only a few residents live full-time at Tamaya Village, the historic pueblo. Many tribal members are bilingual and proudly speak the Keresan language, the native language of the Tamayame. The southern border of the reservation is the town of Bernalillo. Interstate 25 runs through the east of the Pueblo (Pueblo of Santa Ana 2012).

Since the early 1980s the Pueblo has actively pursued a strategy of developing tribal enterprises, seeing economic independence as crucial to maintaining and safeguarding traditional concepts and values. Principal employment sectors include agriculture, government, and service industries. Over the past 25 years, the Pueblo has developed a successful agricultural enterprise centered on the production and processing of organic blue corn products. Other natural resource enterprises include sand and gravel mining and a native plant nursery. Extensive recreational and entertainment attractions include the Santa Ana Star Casino, the Prairie Star Restaurant, two golf courses, a 22-field soccer complex, and the Tamaya Hyatt resort.

2.10.2 Land Use

Land use in the Tamaya Drainage project area includes tribal ceremonial and living space. No livestock are now allowed to graze in the JCDR project area. Nevertheless, an occasional breach of fencing occurs with resultant short-term utilization of the area by cattle. Tribal members utilize the area near the proposed project and mitigation sites for hunting, hiking, fishing, horseback riding, and ceremonial activities.

2.10.3 Environmental Justice

Executive Order 12898 states that to the extent practicable and permitted by law, “each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” The Pueblo, as a recognized Native American Tribe, is a minority community, and analysis of the proposed project and the no-action alternative must address any disproportionate health or environmental effects to the Pueblo. See Section 3.9 and 5.9 for these assessments.

2.11 Noise and Vibrations

Existing noise levels in the Jemez Canyon Reservoir area and in Tamaya Village are very low, as is typical of rural locations. The major source of ambient noise is air traffic to and from local airports and occasional vehicle traffic to and from the village. There are no major roads near the village and therefore, no background traffic noise. Pumping water from the pond is also a source of noise. This data suggests that the soil conditions at Tamaya Village provide significant isolation and make the buildings insensitive to external vibrations.

Due to the Pueblo's concern about potential impacts from vibrations during implementation of the Tamaya Drainage project, background vibrations were recorded at Tamaya Village on March 8, 2011 (Machine Dynamics, 2011). The pond was being drained and the pump was operating during the time that data was collected, but the pump vibrations were not detected at any of the sites tested. Vibrations from a backup diesel generator were .00116 mm/s at 30 Hz. The background vibration levels at Tamaya Village were around .001 mm/s, below the level of human perception of 0.4 mm/s, even with a generator operating and a passenger vehicle moving nearby.

2.12 Aesthetics

Tamaya Village is situated at the base of bluffs on the bank of the Jemez River in a pleasant, quiet natural setting. Views of the surrounding landscape and sky are mostly unobstructed, except for the visual obstruction of the levee. The pond detracts from this natural aesthetic with the nuisance of seasonal pests such as mosquitoes and other insects, the odors that result from water level fluctuations in the pond area, and the noise from the existing pumping system when drawing down the water is necessary.

3 - Future Without Project Conditions and Effects of the No-Action Alternative

This section describes the future conditions that are expected to exist at Tamaya Village and the pond if no action is taken (the No-Action Alternative). If the Tamaya Drainage Project were not implemented, some resources and conditions would experience changes whereas others would not, as described below.

3.1 Physical Environment

3.1.1 Geology and Soils

Geological and soil conditions would not be affected by a no-action alternative.

3.1.2 Groundwater Hydrology

Current conditions at the project site indicate that hazards created by the pond will continue to exist if no action is taken. Groundwater model results suggest the pond formed due to localized river sediment aggradation outside the levee**,** followed by a rise in the water table. While the groundwater model developed by USACE, Seattle District did not specifically address a scenario in which the pond was left in place, as is, the five predictive scenarios (alternatives) evaluated with GMS confirms that adjacent groundwater infiltrates the pond (USACE 2009, 2012). Due to the relatively high hydraulic conductivity of subsurface soils of this shallow aquifer (refer to Sections 2.1.2.1 and 5.1.5) and shallow water table, the pond area readily fills with groundwater. Additionally, the pond is adjacent to the Jemez River, which contributes to groundwater recharge (USACE 2009; McAda and Barroll 2002). When the river stage increases, the water table rises in response. Consequently, the height of the pond surface will increase and decrease relative to the stage of the river. The surface elevation of the pond is an expression of the adjacent water table; therefore, groundwater will continue to infiltrate the sides and floor of the pond as long as the water table remains at its current elevation. Due to the pond's close proximity to the Jemez River, it is unlikely that the water table will decline to an elevation lower than the floor of the pond. Therefore, hazards associated with the pond will continue to exist with a no action alternative.

3.1.3 Surface Water Hydrology

With the exception of temporary changes associated with the previously noted Las Conchas fire of 2011, the hydrologic parameters that control runoff within the study area are not expected to change significantly in the future.

3.1.4 Hydraulic Conditions

As with the future hydrology, the channel hydraulics are not anticipated to change significantly in the future, with a few caveats described below. Because the channel near the village has exhibited a tendency to vary its geometry, as described under the Geomorphology section (2.2.5), there will be variations in the water surface elevation and related hydraulic variables associated with these channel adjustments. Though there is not sufficient evidence to predict definite vertical trends, it is reasonable to anticipate some moderate vertical increase in the river's stage. Also, given the perched nature of the active channel near the village, it is likely that the river stage will both rise and drop over time periodically, as the channel avulses to lower adjacent areas.

3.1.5 Geomorphology and Sedimentation

As described previously, it is difficult to predict with certainty the future state of the Jemez River as it responds to sedimentation. However, because the Jemez River channel is confined within the Tamaya Village vicinity, both by the available width between the bridge abutments as well as on the north side by the levee protecting the village, there is some limitation to the channel's ability to adjust laterally. There is, therefore, a higher likelihood of an increase in the channel bed's elevation and river stage near the village. There is quantitative evidence of changes in the channel bed's mean elevation which translates to the corresponding surface water elevations, and these have certainly exhibited aggradational behavior on numerous occasions. Thus, this long-term state cannot be ruled out. Since this is also the evolution most typically provided anecdotally by Tribal members, Santa Ana Pueblo Department of Natural Resources staff, and USACE operations personnel, it lends further confidence in continuation of a modest aggradational trend over the long term.

3.1.6 Water Quality

The quality of water below the surface (groundwater) and water quality in the pond would not likely change, nor be improved, if there is no action taken to drain the pond.

3.1.7 Air Quality

Air quality in the future without the proposed drainage project would not change.

3.1.8 Climate

Climate change refers to any significant change in measures of climate such as temperature or precipitation patterns lasting for an extended period, such as decades or longer. Climate change may result from natural processes within the climate system and from human activities that change the atmosphere's composition through burning fossil fuels or changes in the land surface such as deforestation, urbanization and desertification (USEPA 2010).

Global climate change related to emissions of greenhouse gases (*e.g.* carbon dioxide, methane, nitrous oxide, chlorofluorocarbons) is predicted to result in a drier Southwest with greater variation in precipitation (Backlund, Janetos, and Schimel 2008). As a result of climate change, summer air temperatures in the Southwestern United States are predicted to rise considerably from 2011 through 2039, average annual precipitation is expected to decrease, and mountain snowpacks are predicted to decrease significantly (USEPA 2010). These future changes are anticipated regardless of whether the Tamaya Drainage project takes place. The No-Action alternative would have no effect on climate.

3.2 Biological Resources

3.2.1 Vegetation

In the future without any action, wetland vegetation would persist at the site. As stated in Section 3.1.2 - Groundwater Hydrology, the pond would continue to exist if no action is taken. Depending on the frequency of pumping and the water level that is maintained, the area of cattails may increase or decrease. Similarly, the wetland fringe vegetation of bulrushes, spikerushes, alkali muhly and similar species would continue to exist but could expand or contract depending on future water level management.

3.2.2 Fish and Wildlife

No change in wildlife populations would occur in the future without the proposed project. Wildlife would continue to use the Tamaya Pond.

3.2.3 Special Status Species

As discussed in Section 2.3.3, migrant Southwestern Willow Flycatchers may use riparian vegetation along the Jemez River during migration, but do not breed in the project area. Yellow-billed cuckoos use the Jemez River for migration and may in the future use suitable mature riparian habitat in the area to breed opportunistically, particularly if a series of wet years provide the insect resources needed to successfully raise young. However, suitable breeding habitat is not currently present in any of the project work areas or expected to develop in the foreseeable future. No other special status species currently occur in the project area and none are expected to move into the area in the future. There would be no effect to special status species under the No-Action Alternative.

3.2.4 Noxious Weeds and Invasive Species

Without any action in the future, invasive species that are present in the project area would continue to exist. Due to the recent arrival of the salt cedar leaf beetle, there would likely be a reduction in the number and vigor of salt cedar trees in the project area.

3.3 Floodplains

Executive Order 11988, Floodplain Management, directs Federal agencies to evaluate the potential effects of any actions it may take in a floodplain to restore and preserve the natural and beneficial values served by floodplains. There would be no effect to the Jemez River floodplain under the No-Action Alternative.

3.4 Wetlands

In the future, without the project, the Tamaya Pond wetland would continue to exist. However, depending on water level management and future groundwater changes, the size of the wetland could increase or decrease.

3.5 Hazardous, Toxic or Radioactive Wastes

The project area is rural with no known industries and/or hazardous waste sites or issues and consists of a few, mostly adobe style, residential homes. There is no evidence to indicate hazardous wastes/substances have ever been dumped or disposed of at, or near, the project site. Taking no action at the pond would not create HTRW issues.

3.6 Cultural Resources

As described in Sections 1.1 and 2.7.2, the purpose of the Tamaya Drainage project is to reduce or eliminate the ponding problem adjacent to Tamaya Village and the resulting nuisance impacts on the Pueblo people. Were the proposed Tamaya Drainage project not implemented, there would be no physical effect to the structural components of the State and National Register listed Tamaya Village and related traditional cultural properties known to occur in the immediate vicinity of the proposed Tamaya construction area; however, the nuisance of pests, odors, and noise would continue to negatively affect the Tamayame and the traditional use of their historic village. Were the proposed project not constructed there would be no need for construction of a wetland mitigation site and there would be no historic properties affected by that portion of the proposed project. There would be no effect to other historic properties known to occur on Pueblo lands.

Were the proposed Tamaya Drainage project not constructed, there would be no change to the potential for flood related effects to the Pueblo's ancestral village of Tamaya. The levee was constructed to an elevation of 5,245.5 feet NGVD 29, effectively protecting the village from flooding under normal operating conditions. The top of the dam is at an elevation of 5,274.6 feet NGVD 29. Flood storage above elevation 5,222 feet NGVD 29 will result in water on the levee and flood storage above 5245.5 feet NGVD 29 would overtop the levee.

3.7 Land Ownership

There would be no change in land ownership with or without the proposed project.

3.8 Indian Trust Assets

With the No Action alternative, Pueblo concerns would not be addressed and there would continue to be negative impacts to Indian Trust Assets such as health and safety.

3.9 Socioeconomic Considerations and Environmental Justice

Future socioeconomic conditions including demographics and land use would not change in the absence of a project to drain the pond. Tamaya Village would continue to be used for residential, ceremonial, and recreational uses as previously described. The pond would continue to be a nuisance and hazard. The failure to resolve the nuisance issues at the historic Santa Ana Pueblo village could be construed as an environmental justice issue since it disproportionally affects a Native American community.

3.10 Noise and Vibrations

No change in the level of noise or background vibration is expected in the future without the proposed project.

3.11 Aesthetics

Aesthetic conditions in vicinity of Tamaya Village would not change in the future without the proposed project. The natural setting of the village and the nuisance factors associated with the pond would continue to exist. The No-Action alternative would continue to create aesthetically unpleasant conditions at the Village.

4 - Plan Formulation and Evaluation

4.1 USACE Planning Process

This section presents the rationale used in the development of this plan. The USACE six-step planning process specified in ER 1105-2-100 (Planning Guidance Notebook) is used to provide a rational framework for problem solving and sound decision making. The plan formulation process includes the following steps to develop, evaluate, and compare the array of candidate plans that are considered:

- **Identifying Problems and Opportunities:** The specific problems and opportunities to be addressed in the study are identified and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified. This information is provided in Sections 1.1 and 4.2.

- **Inventorying and Forecasting Resources:** Existing and future without-project conditions are identified, analyzed, and forecasted (Section 3 - Future Without Project Conditions). The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

- **Formulating Alternative Plans:** Plan formulation is the process of building plans, consisting of structural or non-structural measures singly or in combination, which meet planning objectives and avoid planning constraints. For this study, alternatives consisted of structural measures to fill and drain the pond, as described in Section 4.4.

- **Evaluating Alternative Plans:** Evaluation allows the PDT to determine whether each individual alternative plan meets the study's specified goals and objectives and whether it will therefore be compared against other plans. Specific criteria are used to evaluate qualified plans. The significant contributions or effects of an individual plan are assessed and appraised. Screening criteria include completeness, effectiveness, efficiency, and acceptability. The evaluation of alternatives is described in Sections 4.4.3 and 4.4.4.

- **Comparing Alternative Plans:** Alternative plans are compared to each other. A benefit-cost or cost effectiveness analysis is conducted to prioritize and rank possible alternatives based on the cost of alternatives and the nonmonetary metrics of benefits produced by each alternative. A public involvement program obtains public participation in the alternative identification and evaluation process. For this study, costs of the drainage alternatives were evaluated qualitatively. Costs of the mitigation alternatives were calculated (Appendix B). In both cases, the most cost-effective alternative was selected.

- **Selecting the Recommended Plan:** The study team selects plans that maximize benefits and minimize costs (consistent with the Federal objective). The least expensive plan that meets the planning objective is generally identified as the Tentatively Selected Plan. This plan is described in Sections 4.4.5 and 6.1.

4.2 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, meet challenges, and seize opportunities. A problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected future without-project conditions.

Problems identified by the Pueblo of Santa Ana include:

- Stagnant water adjacent to village is aesthetically unpleasant and provides breeding a area for mosquitoes
- Ponded water adjacent to village constitutes a drowning hazard, especially to small children
- Levee presents a barrier to Pueblo members who wish to access the river

Opportunities include:

- Eliminate breeding area for disease-carrying mosquitoes
- Eliminate drowning hazard adjacent to village
- Preserve cultural and historical resources
- Improve aesthetics by replacing stagnant, anaerobic water with native riparian vegetation and grasses
- Provide a water source for wildlife in a location removed from human use
- Provide wetland habitat in an arid region
- Reduce populations of invasive plants, such as saltcedar
- Provide pedestrian access from Tamaya Village to the river

4.3 Planning Objectives and Constraints

4.3.1 Federal Planning Objectives

The Federal Principles and Guidelines for Water and Land Related Resources Implementation Studies (U.S. Water Resources Council 1983) state that the Federal objective of water and related land resources project planning is to contribute to the National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to environmental statutes, applicable executive orders, and other Federal planning requirements. Water and related land resources project plans should be formulated to alleviate problems and take advantage of opportunities in ways to contribute to this objective. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

Ecosystem restoration is also one of the primary missions of the Corps of Engineers Civil Works Program. The USACE' objective is to contribute to National Ecosystem Restoration (NER) through increasing the net quality and/or quantity of desired ecosystem resources. NER measurements are based upon improvement in habitat quality or quantity and expressed quantitatively in physical units or indices (not monetary units).

Alleviating drainage issues at Tamaya Village is consistent with these Federal objectives, as stated in USACE project management plans and other planning documents dating back to 2006. The unique nature of the intergovernmental relationship between the Federal Government and American Indian Tribes requires the Federal Government to take proactive steps to protect and preserve Tribal cultural and natural resources, to support to the greatest extent possible the development of Tribal assets in the conduct of the activity, and to support Tribal self-determination in processes and procedures that implement the activity.

4.3.2 Specific Planning Objectives

Clear statements of specific planning objectives and constraints act as basic building blocks for developing alternative plans to alleviate problems and achieve opportunities. Through coordination with the Pueblo, site assessments and site-specific studies, specific planning objectives were identified. The planning objectives listed below reflect the problems and opportunities and represent desired positive changes at the Pueblo's historic Tamaya Village:

- Eliminate stagnant water ponded within the Santa Ana Pueblo levee and associated odors.
- Reduce or eliminate populations of mosquitoes and other noxious insects.
- Avoid impacts to historic and cultural resources.
- Mitigate for lost wetland habitat and provide a water source for wildlife in the project area.
- Reduce infestation of invasive saltcedar in the project area.

4.3.3 Planning Constraints

Planning constraints represent restrictions that should not be violated. The planning constraints identified in this study are as follows:

- Avoid impacts to endangered species – Coordination with the Pueblo's Department of Natural Resources and the USFWS will ensure any recommended plans will meet this constraint.
- Avoid impacts to cultural resources – Coordination with the Pueblo's Tribal Historic Preservation Office will ensure any recommended plans will meet this constraint.
- Infrastructure – The project must not impact the safety of existing transportation, utilities, or any other public infrastructure such as levees.
- Health and Human Safety – The existing level of any current flood risk management structures (the levee) must be maintained.

4.4 Development of Alternative Plans

Formal planning for the Tamaya Drainage project was initiated in about 2001. In 2000, Pueblo Governor Montoya requested that USACE initiate studies into seepage onto Tamaya lands from reservoir operations. The Governor's letter to Colonel Fallin stated that Tamaya Pond is a "safety hazard, a breeding ground for mosquitoes and has a disagreeable odor." Colonel Fallin's reply to Governor Montoya stated that no funds were available for studies at that time, and that USACE recognized "the need to determine a long term solution to the problem."

The correction of drainage problems at Tamaya Village was identified as one of the actions to be taken by USACE to ameliorate impacts to natural and cultural resources following the draining of the reservoir in 2001. In a 2001 MOA among USACE, the NMISC and the Pueblo, it was agreed that "the Corps will continue to pursue a long-term solution to the ponding and drainage problem behind the levee that protects Tamaya Pueblo and that actions taken will be satisfactory to Santa Ana."

From 2001 to 2009, USACE and the Pueblo continued meeting and discussing possible solutions. It was recognized that groundwater and surface water data were needed for planning and evaluation of alternatives. The USACE Seattle District was contracted to produce a groundwater model. This model was completed in 2009.

4.4.1 Alternative Development and Evaluation Process

Five initial alternatives were developed by 2009 to encompass a broad range of potential solutions to eliminate the standing water in the pond. All alternatives analyzed for the 2009 Groundwater Report involved filling the existing pond to an even elevation of 5235 feet NAVD 88. The initial evaluation of alternatives focused on technical effectiveness related to groundwater hydrology. Alternatives 1 and 3 were carried forward for subsequent analysis in 2011-12 and were adjusted in fill elevation, slope and other details as described in Section 4.4.4. At this stage, other essential components of the project were added including revegetation of the filled pond site and wetland mitigation, described in detail in Appendix B.

Alternatives considered in 2009 and analyzed for the Groundwater Report included the following. All elevations refer to a mean fill elevation and the North American Vertical Datum of 1988 (NAVD 88).

1. Existing levee alignment with pond filled to 5235 feet.
2. Existing levee alignment, pond filled to 5235 feet and pumping.
3. Existing levee alignment, pond filled to 5235 feet, plus passive drain and pumping.
4. Levee extension with arroyo interceptor channel, pond filled to 5,235 feet.
5. Levee extension with arroyo interceptor channel, pond filled to 5,235 feet, and pumping.

An aerial view of the existing conditions at Tamaya Village is shown in Figure 13, below. The levee that protects the southern portion of the village from the adjacent Jemez River is approximately 2,600 feet from the bridge to its abutment at the east edge of the village. Atop the levee a service road, approximately 20 feet wide, connects to BIA Route 1 that bisects the village. The existing elevation at the top of the levee (as of the LiDAR survey dated 2002) is 5247 feet. The 2002 LiDAR survey also indicates that the lowest point of the pond is at elevation 5227 feet. Based on the hydraulic modeling, the 50% chance event (2-year return event) for the Jemez River at Tamaya Village location has an approximate river stage of 5235 feet NGVD; therefore, this elevation was selected as the mean fill level within the pond.

Figure 13: Existing Site

4.4.2 Description of Alternative Plans

The five initial alternatives are described here. Section 4.4.3 provides the groundwater modeling evaluations completed for these alternatives in 2009 and Section 4.4.4provides evaluations for Alternatives 1 and 3 as revised in 2011-12.

4.4.2.1 Alternative 1 – Existing levee alignment with pond filled to 5235 feet.

Alternative 1 (Figure 14) would involve leaving the existing levee as is and filling the existing pond to an elevation of 5235feet. The fill material would consist of random fill loosely compacted to a density equivalent to several passes of heavy construction equipment. Fill material for all alternatives would be imported from an approved borrow site. The limits of the fill material are also shown in Figure 14. Total fill material required to fill the pond to elevation 5235 feet would be approximately 38,600 cubic yards. It is anticipated that construction traffic would enter the pond site via the main access road at BIA Route 74 (BIA 74) and the service road atop the levee. A turnaround would need to be constructed at the intersection of BIA 74 and the levee access road due to the tight turning radius that exists now. Large construction equipment vehicles would not be able to make the tight turn. Because the top of the levee is only wide enough for one-way traffic, more economical alternative access routes for construction traffic that would include a loop were explored. However, the initially proposed route around the north end of the village was later rejected.

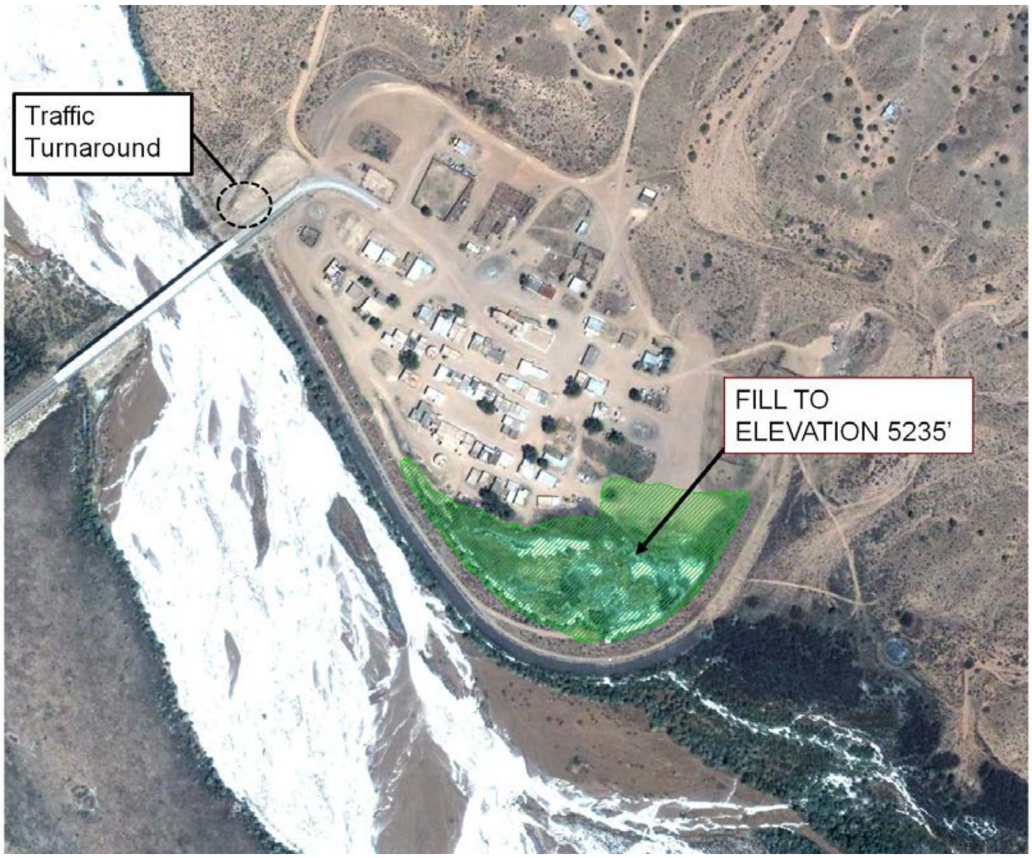

Figure 14: Alternative 1

4.4.2.2 Alternative 2 – Existing levee alignment, pond filled to 5235 feet, and pumping

Alternative 2 (Figure 15) would be the same as Alternative 1 with the addition of an active pumping component. It is anticipated that the active pumping would be in the form of a single, or possibly dual, sump pump located approximately in the same location of the existing pump house. The existing pump house would be replaced with a new pump house and system to actively pump groundwater when it reaches a certain elevation. Pumped groundwater would be directed downstream to the adjacent Jemez River, similar to the existing conditions. Total fill material required to fill the pond would be the same as alternative 1.

Figure 15: Alternative 2

4.4.2.3 Alternative 3 – Existing levee alignment, pond filled to 5235 feet, plus passive drain and pumping

Alternative 3 (Figure 16) is similar to Alternative 2 with the addition of a passive drain system to collect groundwater and direct it to the active pumping system. The passive drain system may consist of a number of perforated drain pipes installed underneath the random fill in either a radial or staggered formation that would collect groundwater from the entire fill footprint. This system of perforated drain pipes would be connected to collector pipes that would gravity feed the collected groundwater to the single or dual sump pump system described above in Alternative 2. The groundwater would then be pumped to the adjacent Jemez River when it reached a certain elevation, similar to Alternative 2. The main difference between this Alternative and Alternative 2 is the system of drain pipes anticipated for this Alternative would collect groundwater from more points under the entire pond footprint rather than a single point within the pond.

Figure 16: Alternative 3

4.4.2.4 Alternative 4 – Levee extension with arroyo interceptor channel, pond filled to 5235 feet.

Alternative 4 (Figure 17) consists of removing a portion of the existing eastern levee, constructing an extension of the remaining levee south and east along the edge of the Jemez River, and constructing an interceptor channel at the northeast end of the village. Removal of the eastern portion of the existing levee would allow the existing pond to drain downstream, effectively moving the pond approximately 1,200 feet south and east from its current location. Construction of a new levee would tie into the remaining levee and continue approximately 1,950 feet south and east along the edge of the Jemez River and then tie back to high ground. An interceptor channel would be constructed to capture flows north of the village and convey them to the Jemez River. This proposed interceptor channel would be approximately 3,560 feet in length and would prevent future ponding from surface runoff by diverting it around the new levee and out into the river. The area behind the levee would be filled to an elevation of 5235 feet, and the area where the existing pond is situated would also be filled and sloped to drain toward the new levee. Excavation quantity for removal of a portion of the existing levee would be approximately 58,000 cubic yards. The total channel excavation quantity would be approximately 91,500 cubic yards and the total fill quantity would be approximately 38,900 cubic yards, for a net cut of 52,600 cubic yards. The quantity of fill material needed for the proposed new levee is approximately 77,900 cubic yards. Filling the area behind the levee would require approximately 136,200 cubic yards. Since more fill material is required than what would be excavated, borrow material would be imported from an approved borrow site.

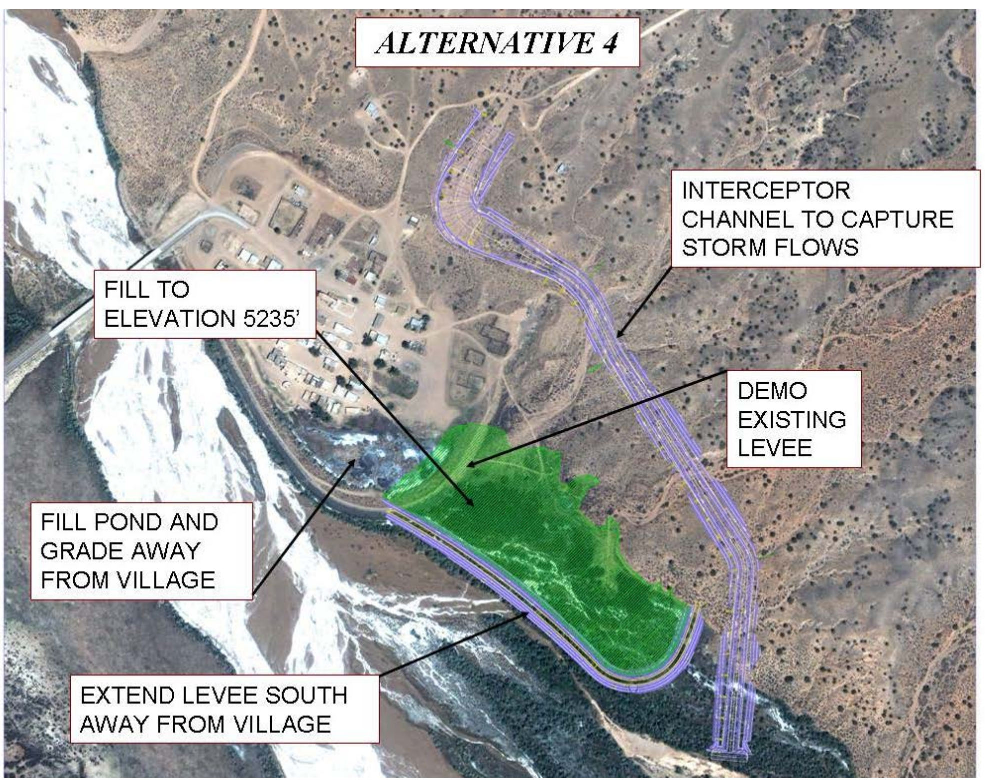

Figure 17: Alternative 4

4.4.2.5 Alternative 5 - Levee extension with arroyo interceptor channel, pond filled to 5235 feet, and pumping

Alternative 5 (Figure 18) is the same as Alternative 4 with the addition of an active pumping component. It is anticipated that the active pumping would be in the form of a single, or possibly dual, sump pump (similar to what is existing and similar to what was described for Alternatives 2 and 3). The proposed location of the sump and pump house is at the southeastern most portion of the new levee. Again, the pumped groundwater would be directed to the adjacent Jemez River.

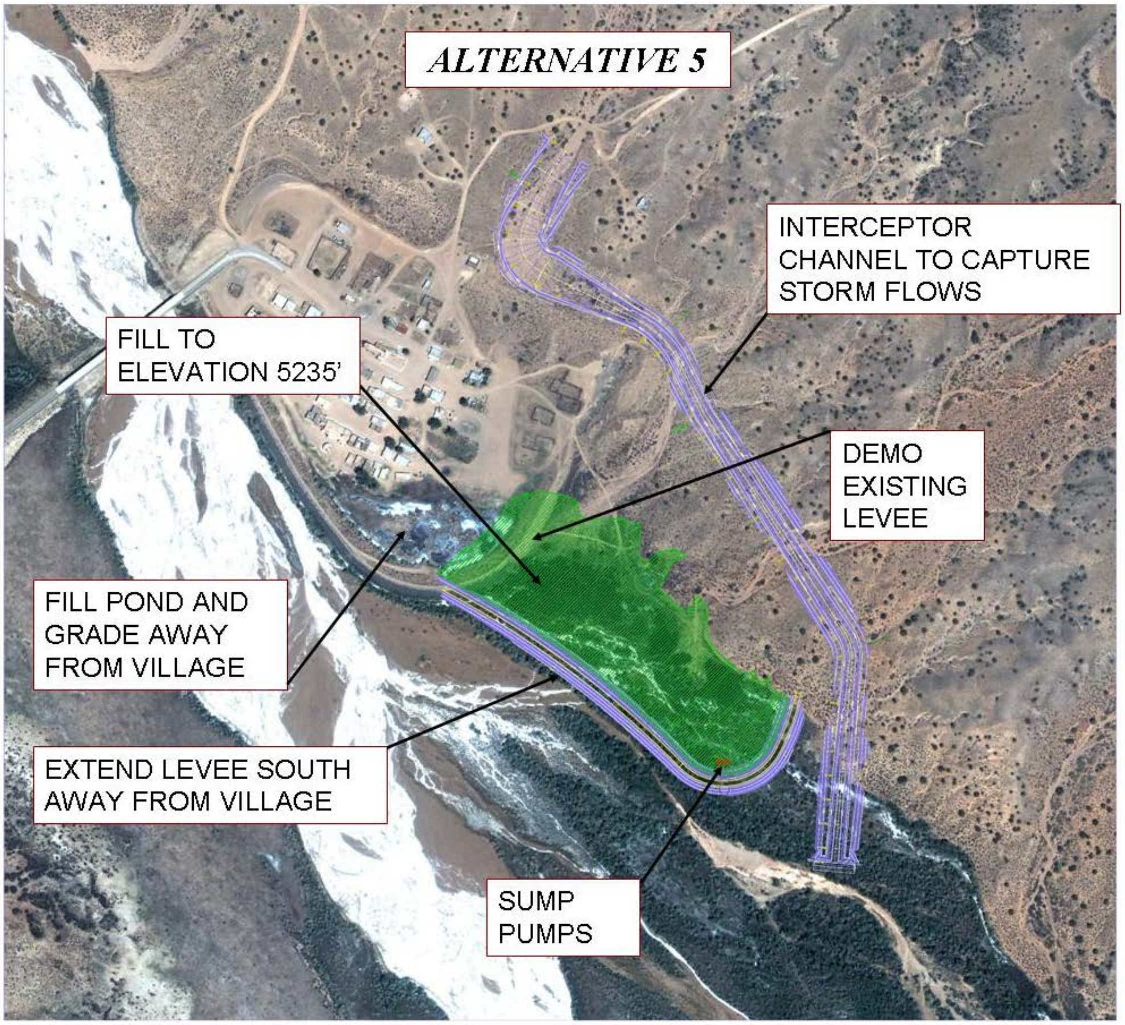

Figure 18: Alternative 5

4.4.3 Evaluation of Alternatives, 2009 Groundwater Model

Five alternatives (referred to as scenarios in the groundwater model) were evaluated in 2009 using GMS. For Alternatives 1 through 4, three hydrologic conditions were simulated to predict the effectiveness of each alternative: January through June 2006 flow conditions; the 100-yr Jemez River stage event; and a worst-case scenario where the Jemez River stage is elevated to within three feet of the top of the levee for a period of eight weeks. For Alternative 5, only the 100-yr Jemez River stage event and the worst case scenario were evaluated. The following is a summary of each predictive scenario simulated under the three hydrologic conditions used in the 2009 groundwater model (USACE 2009). All elevations in this section refer to NAVD 88.

4.4.3.1 Alternative 1: Existing levee alignment with pond filled to 5235 feet.

a. January Through June 2006 Flow Conditions: The highest simulated water table elevation for this condition was 5233.2 feet, at the northwestern edge of the filled pond. In the center of the filled pond, the highest simulated water table elevation was 5,231.4 feet. During the last time step of this simulation, groundwater in the center of the filled pond reached an elevation of 5228.5 feet.

b. 100 Year Flood Stage: The highest simulated water table elevation for this condition was 5,229.6 feet.

c. Stage Three Feet below the Top of the Levee: From when the model simulated a river stage three feet below the top of the levee, it took 14 days for the groundwater to rise above 5,235 feet in the area of filled pond. The model also predicted approximately 4 acres would flood. Eleven days after the river stage started receding, surface water in the area of the filled pond receded below ground surface.

4.4.3.2 Alternative 2: Existing levee alignment, pond filled to 5235 feet and pumping

a. January Through June 2006 Flow Conditions: The results for this simulation were similar to Alternative 1, under January through 2006 flow conditions. However, extraction wells were included to simulate hydraulic conditions with groundwater extraction, in conjunction with the filled pond. Three extraction wells were simulated with a flow rate of 25 to 35 gallons per minute (gpm). Modest drawdown was observed in two wells, and one the extraction wells went dry. On the last time step, groundwater in the center of the filled pond reached an elevation of 5,228.5 feet.

b. 100 Year Flood Stage: The extraction wells were not required. The highest groundwater elevation reached in the filled pond for this simulation was 5,229.4 feet, similar to results of Alternative 1.

c. Stage Three Feet below the Top of the Levee: The three extraction wells were turned on when the Jemez River reached peak stage. An extraction rate of 25 to 45 gpm was required to prevent flooding. The highest groundwater elevation of 5,233 ft in the center of the filled pond occurred on the last day of the elevated river stage.

4.4.3.3 Alternative 3: Existing levee alignment, pond filled to 5235 feet, plus passive drain and pumping.

a. January Through June 2006 Flow Conditions: A passive drain system was placed below the surface, in the fill material, at an elevation of 5,230 feet. The highest simulated groundwater elevation for this simulation was 5,230.5 feet. At the start of the simulation, the passive drain system received a maximum flow rate of 57 gpm. During the last time step, groundwater reached an elevation of 5,228.6 feet in the center of the filled pond.

b. 100 Year Flood Stage: The passive drain did not receive water during this simulation because groundwater had a lower initial starting elevation. Refer to the 2009 groundwater model report for a detailed description of this simulation.

c. Stage Three Feet below the Top of the Levee: The highest simulated groundwater elevation for this simulation was 5,230.7 feet. Passive drains began receiving water two days after peak river stage and continued to receive water until 43 days after the last day of elevated river stage. Maximum flow into the passive drain was 153 gpm on the last day of elevated river stage, which also corresponded to the highest groundwater elevation.

4.4.3.4 Alternative 4: Levee extension with arroyo interceptor channel, pond filled to 5,235 feet.

a. January Through June 2006 Flow Conditions: Groundwater was observed at its highest in the center of the filled pond at elevation 5,231.5 feet.

b. 100 Year Flood Stage: Groundwater was observed at its highest in the center of the filled pond at elevation 5,230.6 feet.

c. Stage Three Feet below the Top of the Levee: In this simulation, flooding occurred 11 days after the Jemez River peaked. Flooding first occurred along the northwestern perimeter of the filled pond and beyond, closest to where the river bottom elevation is highest within the boundaries of the model. On the last day of peak river stage, groundwater reached its highest elevation in the center of the filled pond at elevation 5,234.9 feet (0.1 foot below the surface). Water in flooded areas did not recede to a depth below the ground surface until seven days after the river stage receded. The model predicted approximately 2.1 acres would flood.

4.4.3.5 Alternative 5: Levee extension with arroyo interceptor channel, pond filled to 5,235 feet, and pumping

a. 100 Year Flood Stage: Three extraction wells evenly distributed within the filled pond area were pumped at 25 to 45 gpm. Groundwater dropped on an average 4 feet in the filled pond compared to Alternative 4, without active pumping.

b. Stage Three Feet below the Top of the Levee: Three extraction wells evenly distributed within the pond area were pumped at 25 to 45 gpm. No flooding occurred in the filled pond, but flooding occurred where ground elevations ranged from 5,226 to 5,230 feet.

4.4.4 Evaluation of Alternatives, 2011/2012 Revised Model

In 2011 and 2012, the USACE Seattle and Albuquerque Districts revised the 2009 GMS model to further refine the alternative design to account for site constraints. The original alternative evaluations used a uniform fill to surface elevation of 5,235 feet NAVD 88. To accommodate site constraints, a refined design was developed with the surface graded with a slope of 0.8% from 5,240 feet at the northwest end of the pond to 5,232.5 feet at the center of the pond (USACE 2012). The fill elevation at the northeast side of the pond would be approximately 5,233 feet, thereby avoiding site constraints. Only Alternatives 1 and 3 were simulated with the refined graded design. Alternatives 2, 4 and 5 were eliminated from further consideration due to lower estimated performance relative to cost. Two scenarios for Alternative 3 were simulated in GMS with the new design concept: Alternative 3 would have subsurface drains set at a uniform elevation of 5,231 feet, whereas Alternative 3a would have drains configured at 1.5 feet below the graded surface of the fill material at a slope of 0.8% (i.e., paralleling the surface grade). The 2012 groundwater model evaluated two hydrologic conditions: an approximation of the river stage over the period from January 1, 2010 through July 25, 2010; and the *worst-case* condition with the Jemez River stage elevated to within three feet of the top of the levee for a period of eight weeks. The 100-year stage was not simulated because it is bracketed by the other two conditions. A total of six simulations were evaluated in the revised model: (Alternative 1) filled with no drains, (Alternative 3) filled with drains set uniformly at 5,231 feet with pumping, and (Alternative 3a) filled with drains set 1.5 feet parallel below the surface and pumping. The following are the results of each simulation.

4.4.4.1 Alternative 1-Revised: Existing levee alignment, pond filled and graded at a slope of 0.8% (from 5,340 to 5,232.5 feet), no drainage.

a. January 1 – June 25, 2010 Estimated River Stage: Groundwater never became visible at the surface (“day-lighted”). The highest water table elevation simulated for this condition was approximately 1 foot below the surface of the fill material.

b. Stage Three Feet below the Top of the Levee: Because there are no drains, the entire filled area was completely inundated for approximately 65 days.

4.4.4.2 Alternative 3-Revised: Existing levee alignment, pond filled and graded at a slope of 0.8% and drains set uniformly at 5,231 feet, and pumping.

a. January 1 – June 25, 2010 Estimated River Stage: Groundwater never day-lighted. Groundwater elevation peaked on April 23rd at 5232.4 feet, six days after river peak stage. Groundwater flowed into the drainage system for most of the simulation. Maximum drain flow occurred on April 24th at 19.9 gpm. Total volume of water that flowed through the drain over the entire period was 2.7 million gallons.

b. Stage Three Feet below the Top of the Levee: Groundwater never day-lighted. The highest water table elevation occurred on August 30th at 5234.2 feet. The drain received groundwater during most of the simulation. The maximum flow rate into the drain was 99.0 gpm. The total volume of water that flowed through the system was 7.78 million gallons.

4.4.4.3 Alternative 3a: Existing levee alignment, pond filled graded at a slope of 0.8% and drains set 1.5 feet below the surface with a slope of 0.8%, and pumping.

a. January 1 – June 25, 2010 Estimated River Stage: Groundwater never day-lighted. The highest water table elevation within the footprint of the current pond was 1.6 feet below the fill (5231.3 feet) at the terminus of the lowest drain. The ground elevation at this location is 5132.9 feet. Groundwater flowed into the drainage system from April 11 to May 23. Maximum flow rate into the drain was only 1.8 gpm. Total volume of water that flowed into the drainage system during the simulation was 71,595 gallons. Thus, by raising the drain to correspond to 1.5 feet below graded ground surface (as opposed to setting at a uniform 5231 feet elevation), total volume of water moved was reduced by 97%.

b. Stage Three Feet below the Top of the Levee: Groundwater never day-lighted. Highest groundwater occurred on August 3rd at 5235.1 feet. The drain received groundwater from July 8th to September 19th with maximum flow of 73.1 gpm on the last day of peak river stage. Total volume of water to flow into the drainage system during this simulation was 4.9 million gallons. Total volume was reduced by 36% in this scenario compared to the drain set to uniform 5231 feet.

The 2009 groundwater model and 2012 revised groundwater model reports are included in Appendix D. For more details on parameter inputs, results, and revisions to the model itself, refer to these groundwater model reports.

4.4.5 Alternative Proposed for Implementation

The original 2009 GMS groundwater model and the revised 2011/2012 GMS model simulated drainage results for several Alternatives (USACE 2009 and 2012). The simulations for Alternative 3a provided the best results of all Alternatives evaluated.

Alternative 3a combines filling the pond with sandy soil with relatively high hydraulic conductivity, coupled with a passive drainage system that diverts elevated groundwater to a sump equipped with pumps. The surface of the fill would be sloped at 0.8% from the northwest end of the pond (elevation 5,240 feet) to the center of the pond (elevation 5,232.5 feet). A corresponding sloped drainage system would be placed 1.5 feet below and parallel to the surface of fill, reducing the predicted volume of water to be pumped from the sump. Simulation of Alternative 1 (no drainage system) indicates that under normal conditions, groundwater would never day-light. Therefore, under normal conditions with Alternative 3a, flooding would not be expected to occur if the pumping system malfunctioned. Under extreme conditions, such as the event with the river stage 3 feet below the top of the levee, flooding may occur, but only if the drainage systems or pump fails. So long as the drainage system, sump, and pumps, are properly maintained and functional, flooding would not be expected to occur. Under normal conditions, pump(s) would operate only about 1.5 months out of the year. During this period, pump(s) would cycle less often, and the total volume of water diverted would be less than any of the other Alternatives evaluated. Alternative 3a provides for the best drainage scenario, the least wear on equipment, and the greatest cost benefit.

Concurrently with the development and evaluation of Alternative 3a, the USACE and the Pueblo developed additional project components and details to complete the proposed alternative. These components would have been similar with any of the drainage alternatives that were considered:

- A utility plan for supplying power to the pumps, pictured in Figure 22. Electrical power recently has been provided at the Village. Power would be routed from the bridge along the levee to the sump pumps. A backup generator would be provided in case of electrical outage.

- Surface and sub-surface drainage plans, pictured in Figure 23 and Figure 24. The beehive grate inlets for surface drainage will be detailed to minimize entrance of soil and debris. The USACE Operations Branch will be responsible for maintenance (i.e. removal of sediment and debris).

- A pedestrian walkway would be constructed across the levee to provide access to the Jemez River. The walkway would be 6 to 8 feet wide with a slope of 10%. This would address Pueblo concerns that the levee has blocked people's access to the river.

- Revegetating the filled pond area with native riparian plant species such as cottonwood, willow, golden currant, New Mexico olive and other fruiting shrubs, and grasses.

- Wetland mitigation, as described in detail in the Wetland Mitigation Plan (Appendix B), would consist of two components: wetland creation and preservation. A new 1.65-acre wetland would be created near the Jemez weir, 1.75 miles downstream from Tamaya Village, in an area currently dominated by a monoculture of saltcedar. The mitigation wetland would be created by excavating to reach groundwater and would be planted with species that occur at the pond to create a similar plant community. The preservation component of the proposed mitigation would preserve 13.2 acres of wet sedge meadow on the right bank of the Jemez River, across the river from Tamaya Village.

Table 5: Comparison of Preliminary Alternatives

Alternative / Item Assessed	No Action	(1) Existing Levee and Fill to 5,235 ft (No Pumping)	(2) Existing Levee and Fill to 5,235 ft with Pumping	(3) Existing Levee and Fill to 5,235 ft with Pumping and Drainage	(4) Extended Levee and Fill to 5,235 ft (No Pumping)	(5) Extended Levee and Fill to 5,235 ft with Pumping
Eliminate ponding of water	No	Partially; ponding during maximum flood events	Yes	Yes; Passive drain ensures groundwater never surfaces	Partially; ponding during maximum flood events	Yes
Potential impacts to cultural resources	High impacts to ceremonies at the Village due to ponded water.	Moderate construction impacts	Moderate construction impacts	Moderate construction impacts	High construction impacts	High construction impacts
Estimated length of construction period	No construction	4 months	4 months	4 months	9 months	9 months
Duration of trucking to import fill (approximate)	No trucking	50 days	50 days	50 days	150 days	150 days
Impacts to wildlife	None	Moderate, short-term during construction.	Moderate, short-term during construction.	Moderate, short-term during construction. Long-term benefit from mitigation.	Moderate, longer duration than Alt. 3 due to longer construction period.	Moderate, longer duration than Alt. 3 due to longer construction period.
Impacts to aesthetics	High and long-term due to ponding problem not being addressed.	Moderate, short-term during construction. Long-term benefit.	Moderate, short-term during construction. Long-term benefit.	Moderate, short-term during construction. Long-term benefit.	Moderate, longer duration than Alt. 3 due to longer construction period.	Moderate, longer duration than Alt. 3 due to longer construction period.
Cost including maintenance	Low construction costs but highest maintenance costs due to high frequency of pumping.	Moderately low cost for construction. Low maintenance in the long term.	Moderate cost for construction. Moderate maintenance due to pumping.	Moderate construction cost. Low maintenance; passive drain reduces pumping costs.	High construction cost due to extended levee, but low maintenance.	High construction cost due to extended levee. Moderate maintenance due to pumping.

Alternatives carried forward and revised for further analysis are highlighted green

Table 6: Comparison of Alternatives Carried Forward for 2011-12 Revised Groundwater Analysis

Alternative / Item Assessed	No Action	(1-Revised) Existing Levee, Graded Fill (from 5,340 to 5,232.5 ft.) with a slope of 0.8%, No Drainage or Pumping	(3- Revised) Existing Levee, Graded Fill (from 5,340 to 5,232.5 ft.) with slope of 0.8%, Drains set at 5,231 feet and Pumping	(3a) - Recommended Existing Levee, Graded Fill (from 5,340 to 5,232.5 ft.) with slope of 0.8%, Drains set 1.5 feet below surface with slope of 0.8%, and Pumping
Eliminate ponding of water	**No**	**Partially;** ponding during maximum flood events	**Yes** - Passive drain ensures groundwater never surfaces	**Yes** - Passive drain ensures groundwater never surfaces
Impacts to cultural resources and aesthetics	**High long-term impacts; ponding not addressed**.	**Moderate short-term** construction impacts Long-term benefit	**Moderate short-term** construction impacts Long-term benefit	**Moderate short-term** construction impacts Long-term benefit
Impacts to wildlife and Vegetation	**None**	**Moderate short-term** impact during construction. **Long-term benefit** from mitigation	**Moderate short-term** impact during construction. **Long-term benefit** from mitigation	**Moderate short-term** impact during construction. **Long-term benefit** from mitigation
Impact to Wetlands	**None**	**Moderate short-term** impact during construction. **Long-term benefit** from mitigation	**Moderate short-term** impact during construction. **Long-term benefit** from mitigation	**Moderate short-term** impact during construction. **Long-term benefit** from mitigation
Impact to Soils	**None**	**Moderate short-term** impact due to pond fill. **Mitigated over long term** by created wetland.	**Moderate short-term** impact due to pond fill. **Mitigated over long term** by created wetland.	**Moderate short-term** impact due to pond fill. **Mitigated over long term** by created wetland.
Impact to Hydrology	None, but ponded water continues to be problem	**Minor short-term** impact to surface water hydrology, **mitigated** by created wetland	**Minor short-term** impact to surface water hydrology, **mitigated** by created wetland	**Minor short-term** impact to surface water hydrology, **mitigated** by created wetland
Cost including maintenance	**Low** construction cost; **Highest maintenance costs** due to high frequency of pumping.	**Moderately low** cost for construction. **Low maintenance** in the long term.	**Moderate** construction cost. **Moderate maintenance** due to pumping	**Moderate** construction cost. **Low maintenance; passive drain reduces pumping costs.**

Recommended alternative highlighted green

5 - Expected Future With Project

5.1 Physical Environment

5.1.1 Geology and Soils

Geological conditions would not be affected by the selected alternative. There would be a moderate short-term and long-term adverse effect to soils as wetland soils in the existing pond would be buried or removed to the mitigation site. Wetland soils would develop over time at the mitigation site, mitigating the effect in the long term.

5.1.2 Groundwater Hydrology

The pond is believed to be the result of gradual, localized river aggradation and a subsequent rise of the water table (UASCE 2009). As the water table elevated, groundwater seeped into a depressed area between the levee and the village, creating a pond. To eliminate the nuisance factors associated with the pond, a proposal to fill the pond and install a passive drainage system with a sump equipped with a pump(s), was selected as a feasible solution. This solution is discussed in Sections 4.4.4.3 and 4.4.5 as Alternative 3a. For Alternative 3a, with the pond filled and equipped with a below ground passive drain system that diverts elevated groundwater to a sump, the revised 2011/2012 groundwater model predicted the water table would not rise above 5,231.3 feet. Groundwater in the sump is evacuated with an active pumping system. With a fill material consistent with native soil adjacent to the pond, that has a hydraulic conductivity value of a well to poorly sorted sand (26 and 62 feet/day respectively), groundwater would flow through the fill in a southeasterly direction, roughly parallel to the Jemez River (see Figure 6).

The implementation of Alternative 3a should have no adverse effects on the local shallow aquifer or the water supply well used by the village. Local hydrogeologic characteristics should not be altered. Groundwater would continue to flow in a southeast direction, roughly parallel to the Jemez River. No “day-lighting” of groundwater is anticipated in the filled pond area or other areas in close proximity to the pond. Only during the worst-case scenario would the gradient and flow of groundwater be altered. A localized flow and steep gradient would most likely develop near the passive drainage system as the sump diverts elevated groundwater. Once this event is over, groundwater gradient and flow would return to a characteristic similar to the surrounding area. Under normal conditions, groundwater near the filled pond would maintain a natural potentiometric surface, groundwater should flow unimpeded through the filled pond, there should be no change in groundwater chemistry, and no additional gains or losses should occur. Therefore, there would be no adverse effect to groundwater of the area.

5.1.3 Surface Water Hydrology

The alternatives being considered for alleviation of the ponding condition at the village overwhelmingly are intended to affect groundwater. They do involve collection of some amount of groundwater and return as surface water into the Jemez River. However, the volumes involved, within the context of normal Jemez River surface flows, are insignificant. Therefore, future conditions following implementation of any of the proposed alternatives would not be expected to materially affect the conditions anticipated for the future under existing conditions.

As described above, changes in the surface water hydrology would be inconsequential under with-project conditions, due to the relative magnitude of the water affected by an alternative. Surface runoff from within the interior of the village, for example, would primarily be returned to the Jemez River through pumping, as it currently is. Likewise, small amounts of groundwater would be pumped to the river, as they no doubt are currently, to some degree, but the overall volume is insignificant in comparison to the base flow estimated upstream of the project area of some 30 to 60 cfs. For comparison, the estimated high rate for temporary pumping to lower groundwater under adverse conditions for Alternative 1, a less efficient alternative than the one being recommended, was 57 gpm, or about 0.12 cfs.

Construction of the proposed Tamaya Drainage Project would cause no change to the potential for flood related effects to Tamaya Village. The Santa Ana Pueblo Protection Works (levee) was constructed to an elevation of 5,245.5 feet NGVD 29. The top of the Jemez Canyon Dam parapet wall reaches an elevation of 5,274.6 feet NGVD 29, though the design flood pool elevation extends only to elevation 5232.0 NGVD 29 and, therefore, the potential for flood storage to encroach on the levee is limited. Flood storage above elevation 5,222 feet NGVD 29 will result in water on the levee but would not overtop the levee at the maximum flood control pool. (Only an extreme event that far exceeded the Jemez Canyon Dam design flood could result in a pool stage in excess of the 5,245.5 feet NGVD 29 levee crest. While such an event is theoretically possible, the probability of occurrence is extremely low.)

There would be a minor short-term adverse effect to surface water hydrology caused by filling the existing pond. This loss of surface water storage would be mitigated by wetland creation so that there would be no long-term adverse effect on hydrology.

5.1.4 Hydraulic Conditions

As with the surface water hydrology, changes in river hydraulics associated with the groundwater discharges contemplated for the proposed alternatives would not be expected. Indeed, it would be difficult to attribute any changes in the river stage response in the future to the relatively low range of flows associated with operation of the recommended alternative. No adverse short- or long-term effect to hydraulics is expected from the proposed project.

5.1.4.1 Geomorphology

With the expectation of continued morphological channel adjustments for the Jemez River, including within the vicinity of the village, the performance of the proposed alternative could be affected. The current groundwater modeling indicates an efficient engineering formulation that minimizes conditions when pumping would be required. Changes in river stage, as well as lateral proximity of the river channel to the levee, could affect the volume and duration of pumping. The height and proximity of surface flows serve as one, of many, boundary conditions that can influence groundwater response. The current surface flow conditions were modeled and used to estimate surface water boundary conditions. These conditions are expected to change in the future. As described previously, the changes are expected to be moderate on the basis of historical response. Given that these changes could occur in either direction (*i.e.,* higher or lower river stage, closer or farther active river channel), the current conditions are assumed to be representative. Some measure of performance robustness for the proposed pond alternatives were built into the groundwater modeling to account for this through boundary sensitivity study. In addition, continued monitoring of the sediment ranges (see Figure 11) would facilitate future management of any implemented alternative. The proposed project would have no adverse short- or long-term effects on geomorphology.

5.1.4.2 Sediment

As described in the previous Future Without Project Conditions discussion (Section 3.1.4), there remains some uncertainty in the future state of the Jemez River as it responds to sedimentation. However, the future state of the river, for the reasons cited about, would not be anticipated to be influenced by the operation of the recommended alternative. Therefore, the proposed project would have no adverse short- or long-term effects on sediment in the Jemez River.

5.1.5 Water Quality

The pond is believed to be the result of gradual, localized aggradation of the river with a subsequent rise of the water table (USACE 2009). As the water table elevated, groundwater seeped into a depression located between the levee and the village, creating a pond. Alternative 3a requires the pond to be filled. Fill soil for the pond would not have any negative impact on the quality of groundwater. Groundwater chemistry is related to the geochemical properties of the surrounding geology/soil. The degree of which the groundwater is affected by the surrounding geologic material is mostly a function of residence time, the length of time groundwater is in contact with minerals (Driscoll 1986). Other chemical and physical properties of groundwater, such as pH and temperature, would also affect how groundwater dissolves minerals of the surrounding geological environment (Driscoll 1986).

The soil proposed as fill material for this project is sediment dredged from the Rio Grande and/or similar sediment excavated from the proposed mitigation site located near the weir. The Rio Grande sediment was removed from the Rio Grande as part of the Santa Ana Section 1135 Ecosystem Restoration project. Dredging occurred in 2008, and the spoils were transported to a location on the Santa Ana Pueblo approximately one half mile south of the Dam and stockpiled (see Figure 20). This sediment was tested for conventional geotechnical properties and classified as a sand (97.3% sand, 2.5% clay) (Ayres and Associates 2008). Hydraulic conductivity (K) values should be in the range of the groundwater model recommendation of 26 to 62 feet/day, so groundwater should flow through this material at a moderate rate. Knowing the hydraulic conductivity of soil or an aquifer, one can calculate the velocity of groundwater moving through the aquifer. The proposed fill material has an approximate K value of 44 feet/day.

This is a rough estimate only, and assumes that the system has a consistent gradient and the fill material will have a homogenous K value, which it most likely will not. High river stages will affect the groundwater gradient due to rapid recharge, and the K value will vary throughout the fill. In general, however, groundwater in shallow environments such as this has relatively little time to dissolve minerals due active water movement (Driscoll 1986). Additionally, the volume of the material that would be used to fill the pond is relatively small.

Anthropogenic activities can also have an effect on the quality of ground and surface waters. Therefore, any fill material proposed for the site must be evaluated to determine if there have been any impacts attributable to anthropogenic activities. To ensure that proposed materials have not been adversely affected, a review of available documents and records was conducted to evaluate potential degradation of groundwater quality.

During the execution of the Santa Ana Section 1135 Ecosystem Restoration project, *in situ* samples were collected from nine locations (Ayres and Associates 2008). These samples are analyzed for the target analyte list (TAL) for metals, total petroleum hydrocarbons (TPH), pesticides, SVOCs, VOCs, PCBs, and radionuclides. Sample results were then compared to the USEPA, Region 6, Preliminary Remediation Goals (PRG). The majority of results were below instrument method of detection and represent “non-detects”. One sample, collected from overbank deposits, contained a small amount of TPH (oil and grease) at 110 mg/L. The PRG for oil and grease is 100 mg/L (Ayres and Associates 2008). No other constituents were detected above a PRG. Given the concentration of the TPH detected, and that only one sample contained TPH, the fill material does not likely contain any hazardous wastes. These sediments should have no negative impact to the quality of groundwater. As a precaution, however, USACE recommends some random testing for TPHs in this material before being placed in the pond. For additional details of these chemical results, refer to Appendix E.

5.1.6 Air Quality

The proposed action would result in a temporary but negligible, localized increase in suspended dust (fine particles) from construction activities. BMPs to be followed during construction to minimize dust include the following:

- Access roads and disturbed soil will be wetted.
- All vehicles involved in transporting fill material, rubble and spoil to or from the project site will be covered and would have required emission control equipment.
- Stockpiles of debris, soil, sand, or other materials that could produce dust will be watered or covered.
- Following construction, the soil would be stabilized and revegetated with appropriate native plant species.

These practices would minimize dust and emissions-related air quality impacts during construction. Once construction is complete, the filled pond area and the maintenance for the wetland mitigation area would have no further long-term effects on air quality. Therefore, air quality at Tamaya Village and in Sandoval County would not be affected by the proposed project or by the No-Action Alternative.

5.1.7 Climate and Climate Change

The contribution of the proposed project to greenhouse gas emissions that cause climate change would be negligible. The construction phase of the proposed project would produce carbon emissions. However, it is likely that the reduced need for pumping of the pond would result in lower carbon emissions in the long term because the pumps would run less and fewer vehicle trips would be made to the site. These effects would be negligible. Therefore, the proposed action would have no detectable effect on climate in the short or long term.

Climate change is not expected to adversely affect the filled pond area because a warmer, drier climate would generally result in less need to pump water from the area. The effect of climate change on groundwater hydrology and possible change in water table at the created wetland is unknown. If there is an adverse change, it would be addressed through adaptive management, a component of the Wetland Mitigation Plan (Appendix B).

5.2 Biological Resources

5.2.1 Vegetation

The proposed project would have the following effects on vegetation:

- At the existing Tamaya Pond, a wetland would be replaced by native riparian vegetation.
- At the mitigation site, invasive salt cedar would be replaced by a wetland. Wetland vegetation would be transplanted from the existing pond to the mitigation site. Species would include bulrushes, spikerushes, yerba mansa, Baltic rush, saltgrass and scratchgrass. Other wetland species would be planted from nursery-grown plants to increase diversity (complete list in Appendix B).
- Native riparian shrubs and upland grasses would be planted on the higher slopes surrounding the wetland as depth to water table increases away from the wetland. Species would include golden currant, baccharis, sumac, New Mexico olive, alkali sacaton, dropseeds, galleta, and Indian ricegrass.

There would be a short-term adverse effect to wetland vegetation, which would be mitigated by transplanting vegetation to the created wetland. The long-term result of the proposed project would be an increase in the amount of native vegetation. This would be a beneficial effect to native plants and wildlife, aesthetics, and land use.

5.2.2 Fish and Wildlife

Filling Tamaya Pond would result in moderate adverse short-term impacts to wildlife. During construction, waterfowl and riparian birds would be displaced. Non-native aquatic animals inhabiting the pond (mosquito fish and bullfrogs) would perish. Native tiger salamanders, if present, would be salvaged if possible, held in tanks and relocated to the created wetland. Native turtles would be trapped and relocated by hand carrying to the adjacent Jemez River.

Over the longer term, the created wetland would provide habitat for the animals displaced from the existing pond. Waterfowl would be attracted to the mitigation site and would bring eggs of aquatic animals such as salamanders attached to their feet. Aquatic microorganisms would be brought to the mitigation site when wetland plants are transplanted from the existing pond. Terrestrial wildlife would be attracted to the mitigation site as a source of water. With mitigation in place, effects to fish and wildlife would be minimal. Therefore, there would be no long-term effect to wildlife populations.

5.2.3 Special Status Species

As a result of past and ongoing activities at JCDR, USACE and Pueblo personnel are extremely knowledgeable about the potential for occurrence of listed species. From past surveys conducted by USACE and the Pueblo, Southwestern Willow Flycatchers (*Empidonax traillii extimus*) are known to migrate through the project area in late May and June, but do not establish breeding territories. Yellow-billed cuckoos may use suitable mature riparian habitat in the general vicinity, but suitable habitat does not occur at any of the project areas (Tamaya Pond or the wetland mitigation and preservation areas). Riparian habitat suitable for migration or nesting would not be impacted by the proposed project. Project construction would occur outside the migratory bird nesting season to avoid indirect effects to any birds that may migrate through or forage in the general vicinity of the project. The project site is not within designated critical habitat for any listed or proposed species. Pursuant to the Endangered Species Act of 1973, the USACE has determined that the proposed action would have no effect on listed species.

5.2.4 Noxious Weeds and Invasive Species

The excavation of the wetland mitigation area would result in the removal of approximately six acres of salt cedar. This invasive shrub would be replaced by a wetland containing native species. There would be a beneficial effect to invasive species control due to removal of saltcedar in the mitigation area.

To prevent introduction of invasive species and noxious weeds into the filled pond and the mitigation site, the following BMPs would be implemented:

- All construction equipment will be cleaned with a high-pressure water jet before entering and upon leaving the project area to prevent introduction or spread of invasive plant species. Equipment that was previously used in a waterway or wetland will be disinfected to prevent spread of aquatic disease organisms such as chytrid fungus. Disinfection water will be contained in a tank or approved off-site facility and will not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants. Waste water will be tested and disposed of in accordance with all federal, state, and local regulations.
- Following construction, the soil at the filled pond site will be stabilized and revegetated with appropriate native plant species including riparian grasses, shrubs and trees. The wetland mitigation site will be planted to wetland species and riparian shrubs. Grasses will be planted in the upland disturbed areas surrounding the mitigation wetland. These native plantings will reduce the bare ground available for invasive species to establish.

- Weeds and salt cedar resprouts would be controlled during the construction period and as a component of maintenance and management of the created wetland mitigation site.

5.3 Floodplains

Executive Order 11988, Floodplain Management, directs Federal agencies to evaluate the potential effects of any actions it may take in a floodplain to restore and preserve the natural and beneficial values served by floodplains. There would be no effect to floodplains from the proposed project since the area is not in a floodplain.

5.4 Wetlands

The project would result in filling a 3.3-acre wetland at Tamaya Village and replacing it with a 1.67-acre mitigation wetland pond and protection of 13 acres of wet meadow, shown below. A detailed wetland mitigation plan is presented in Appendix B. With mitigation in place, effects to wetlands would be minimal.

To protect mitigated wetlands, groundwater will be monitored during and for three to five years following construction. After assessing any changes during the year following construction, a longer term plan will be developed, including additional monitoring and mitigation if there has been a significant impact to wetlands.

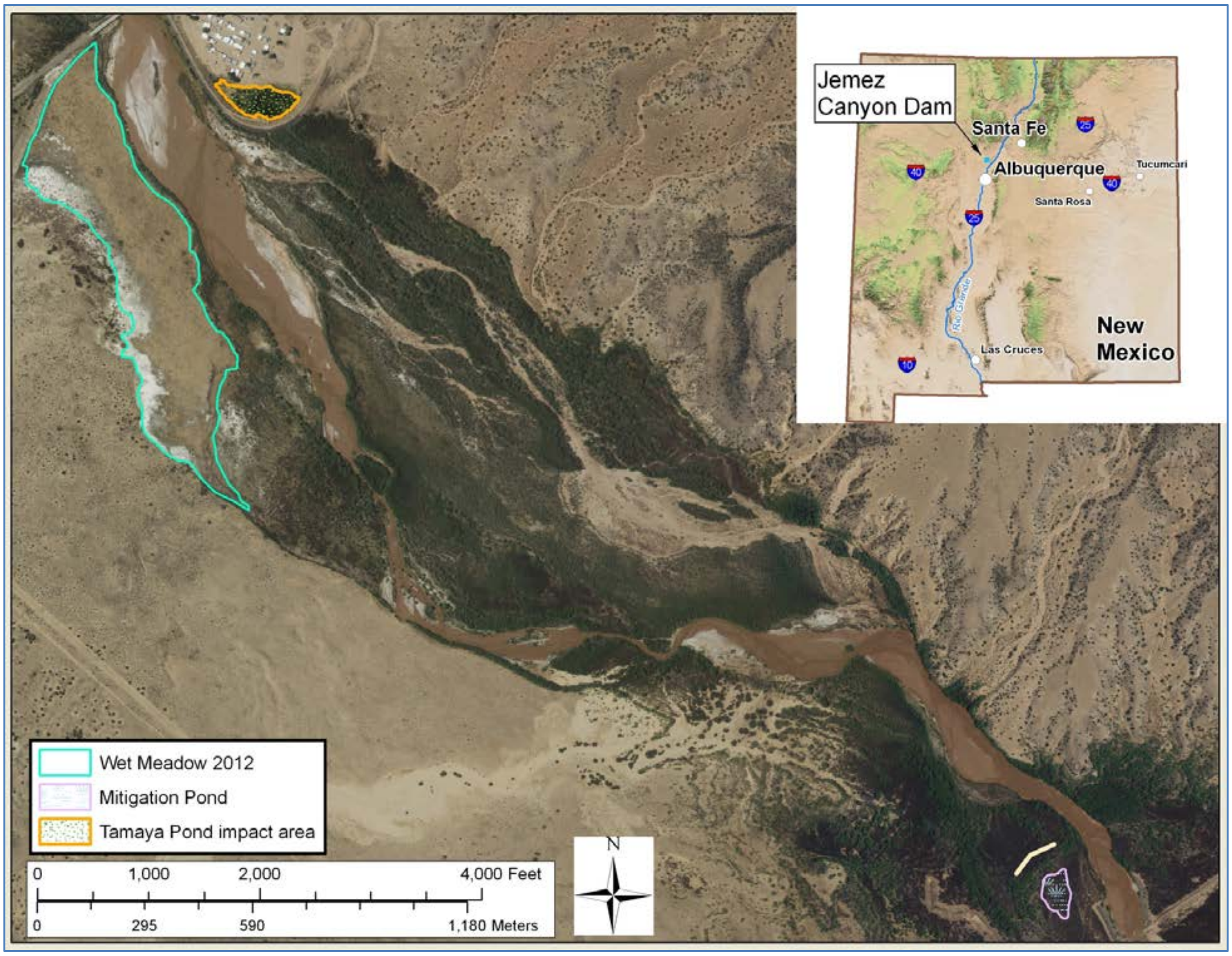

Figure 19: location of wetland mitigation areas

5.5 Hazardous, Toxic or Radioactive Wastes

Several site visits made by Environmental Engineering staff during 2011 verified that no hazardous waste conditions exist on site. The area is rural with no known industries and/or hazardous waste sites or issues. The village consists of a few, mostly adobe style, residential homes. There was no evidence found to indicate hazardous or toxic substances were disposed of at the project site. No visible HTRW conditions exist at the site. For additional information, refer to Appendix E. To the best of our knowledge, the project site is free of any HTRW issues.

Alternative 3a requires the pond to be filled. USACE proposes using stockpiled sediment that ws previously dredged from the Rio Grande as fill material. Material excavated from the mitigation site may also be used as part of the fill. However, any material used to fill the pond must be free of any hazardous wastes and/or substances. To ensure that the proposed materials do not contain HTRW issues, a review of available records was conducted.

The stockpiled sediment was removed from the Rio Grande as part of the Santa Ana Section 1135 Ecosystem Restoration project. Dredging of the sediment occurred in 2008, and the spoils were transported to a location on the Santa Ana Pueblo approximately one half mile south of the Jemez Dam and stockpiled (Figure 20). Before these sediments were removed, samples were collected from nine in-situ locations. Five samples were collected from sandbars and four samples were collected from over bank deposits (Ayres and Associates 2008). Samples were submitted to laboratories and analyzed for the TAL metals, TPH, pesticides, SVOCs, VOCs, PCBs, and radionuclides (Ayres and Associates 2008).

Sample results were compared to the Environmental Protection Agency, Region 6, Preliminary Remediation Goals (PRG). The majority of the results were below instrument method of detection and represent “non-detects”. One sample, collected from over bank deposits, contained a small amount of TPH (oil and grease) at 110 mg/L (Ayres and Associates2008). The PRG for oil and grease is 100 mg/L (Ayres 2008). No other chemical constituents were detected above a PRG. Given the concentration of the TPH detected, and that only one sample contained TPH, the fill material is not consider hazardous or detrimental to human health and/or the environment. This fill is believed to be free of any hazardous, toxic, and radioactive wastes or substances. As a precaution, however, USACE recommends some random testing for TPHs in this material before being placed in the pond. This will alleviate any lingering doubt as to the quality of this material. For additional details of these chemical results, refer to Appendix E.

Figure 20: Fill Material Location

5.6 Cultural Resources

USACE has worked intensively with the Pueblo to coordinate planning efforts and project related studies. If the proposed project is constructed, the nuisance pests and odors as well as the noise that results from the existing pumping system could be significantly reduced. The historic village of Tamaya was nominated and listed on the State and National Registers in 1970 and 1974 respectively, subsequent to the construction of the levee in 1953. Construction of the proposed project, in the immediate vicinity of the National Register of Historic Places listed village of Tamaya, would result in no adverse effect to the historic village. Several areas of tribal concern including traditional cultural properties are known to occur in the immediate vicinity of the proposed Tamaya Drainage construction area; these would be avoided during construction. Construction vehicles would be confined to the planned travel route that primarily uses the existing levee top, thereby reducing ground vibration during construction. Construction activities and related noise would be of short duration. Hauling of excavated earthen materials from the Tamaya ponding area for placement at the habitat mitigation site or for stockpiling, or hauling existing earthen fill materials for placement at the Tamaya ponding area would result in no historic properties affected. Construction of the project would result in a positive benefit to the Pueblo's traditional use of the village.

There are no historic properties in the vicinity of the proposed mitigation site; however, there are four archaeological sites located along the access roadway (Penner et al. 2003a). Use of the access road to the proposed wetland mitigation site would result in no adverse effect to historic properties. There would be no effect to other historic properties or traditional cultural properties known to occur on Pueblo lands.

The USACE is of the opinion that construction of the project would have no adverse effect to historic properties, e.g., to the historic village of Tamaya. Early on, the Pueblo had raised concerns regarding the unwanted public safety and nuisance side-effects of the ponded area that resulted from the construction of the flood protection levee in the 1950s. The proposed project will alleviate those problems and construction of an earthen, ramped walkway over the levee to the river will provide the Pueblo with easier access to the river. The Pueblo is in favor of constructing the preferred alternative and agrees that the proposed project would have no adverse effect to historic properties. During construction, work operations may be temporarily suspended for Tribal ceremonies or special functions. Temporary work suspensions would be coordinated through all appropriate points-of-contact.

For the Tamaya Drainage Project, Section 106 consultation (of the National Historical Preservation Act of 1966, as amended) began with submittal of several archaeological survey reports, prepared by a Pueblo of Santa Ana contractor, to the New Mexico State Historic Preservation Officer (SHPO) in 2003. The USACE is the lead agency for the Section 106 consultation process. The SHPO requested additional documentation regarding the surveys as well as survey level, limited testing. Several of the related Pueblo of Santa Ana projects were on-hold for several years and the additional documentation has since been received. In the interim, the Pueblo of Santa Ana established their own Tribal Historic Preservation Office (THPO). Section 106 consultation has been reinitiated with the Pueblo and the Corps is recommending that copies of Section 106 consultation with the THPO and related documentation be submitted to the SHPO for their records. Copies of Section 106 consultation were also submitted to the

U.S. Bureau of Indian Affairs, Southwest Region. The USACE has been intensively coordinating planning for the project with the Pueblo. On March 28, 2013, the Pueblo's THPO concurred with the USACE determination of no adverse effect to historic properties (Appendix A) and that construction of the recommended project is in the best interests of the Pueblo.

5.7 Land Ownership

Implementation of the Tamaya Drainage project would not require or result in any change in land ownership. The proposed project would have no effect to existing land ownership.

5.8 Indian Trust Assets

Construction of the proposed project would have a direct and immediate beneficial effect by alleviating the nuisance problems with insect pests and standing water odor, and long-term benefits to Indian Trust Assets such as health and safety. Construction of the project will address USACE concerns for trust responsibility to the Pueblo.

5.9 Socioeconomic Considerations and Environmental Justice

Construction of the proposed project would have no effect on socioeconomic conditions or demographics of the Pueblo. There may be a minor, temporary beneficial effect to socioecomonics if the Pueblo is contracted to perform some of the work. There would be a beneficial effect to land use because the aesthetics of the Tamaya Village area would improve due to elimination of odors and mosquitoes. This would improve conditions at the village during cultural and ceremonial events. Environmental justice would be served by eliminating the hazards associated with the pond.

5.10 Noise and Vibrations

Construction of the project would produce unavoidable temporary noise impacts to Tamaya Village from trucks hauling fill, grading, and other construction activities. To minimize impacts, construction would be halted during ceremonial or other occasions as requested by the Pueblo.

The level of background vibrations at the village would temporarily increase during construction. This increase would be minor and would not pose a threat to the integrity of historical structures. A USACE study measured vibrations from two 5 to 7 ton loaded trucks driving on a levee. The vibration was mostly broadband energy between 5 and 50 Hz. Vibrations were measured at speeds of 3, 5 and 7 mph and ranged from .024 to .075 mm/sec. These levels of vibration are below the level of human perception of 0.4 mm/sec, and are about two orders of magnitude below the level that can be expected to impact sensitive structures (2.0 to 3.0 mm/sec).

Once construction is complete, noise and vibration levels would be similar to, or less than pre-project conditions. The new electrical pumps would be quieter than the existing pumps. Also, fewer maintenance visits would be needed because the pumps would operate less often and for shorter periods of time. Once the pond has been filled, pump(s) would operate only about 1.5 months out of the year and would cycle less often. Therefore, there would be less noise in the future if the project is constructed.

5.11 Aesthetics

Aesthetic conditions at the villages would improve if the project were constructed. There would be short-term, minor impacts to aesthetics during construction due to the presence of construction vehicles and bare dirt in the filled pond area. Once construction is complete, the stagnant pond would be replaced by plantings of native grasses, shrubs and trees. Odors from the stagnant water would be eliminated and nuisance insects would likely decrease.

6 - Recommendations for Implementation

6.1 The Recommended Alternative: Alternative 3a

Alternative 3a (Figure 21) combines filling the pond with sandy soil with relatively high hydraulic conductivity, coupled with a passive drainage system that diverts elevated groundwater to a sump equipped with pumps. The surface of the fill would be sloped at 0.8% to the center of the pond, with a corresponding sloped drainage system placed 1.5 feet below the surface of fill, reducing the predicted volume of water to be pumped from the sump. Simulation of Alternative 1 (no drainage system) indicates that under normal conditions, groundwater would not reach the ground surface. Therefore, under normal conditions with Alternative 3a, flooding would not be expected to occur even if the pumping system malfunctioned. Under extreme conditions, such as the event with the river stage 3 feet below the top of the levee, flooding could occur, but only if the drainage systems and/or pump fails. So long as the drainage system, sump, and pumps, are properly maintained and functional, flooding would not be expected to occur. Under normal conditions, pump(s) would operate only about 1.5 months out of the year. During this period, pump(s) would cycle less often, and the total volume of water diverted would be less than any of the other Alternatives. Additional components of the proposed alternative include: electrical power routed from the bridge along the levee to the sump pumps; a pedestrian walkway to cross the levee; revegetating the filled pond area with native riparian plant species; and wetland mitigation, as described in the Wetland Mitigation Plan (Appendix B). Alternative 3a provides for the best drainage scenario, the least wear on equipment, and the greatest cost benefit.

Key design points for the Recommended Alternative are:

A. Retention of the existing levee alignment.

B. Filling the pond, with fill sloped at 0.8% from elevation 5,240 feet NAVD 88 at the northwest end of the pond to 5,232.5 feet at the center of the pond (32,000 cubic yards fill required) (*Fill elevation and haul route to be adjusted as needed to avoid cultural resources).*

C. Installation of a passive groundwater collecting network to direct subsurface flow to a central vault.

D. Active pumping with sump pump for management of excess surface water or groundwater.

E. Use of electrical pumps, with power routed along the levee from an existing power source near the end of the bridge.

F. Pedestrian access ramps across the levee.

G. Revegetating the filled pond site with native riparian plant species.

H. Wetland mitigation consisting of a combination of preservation and creation. See Figure 19 for location and Appendix B for details.

Details for the Recommended Alternative are illustrated in Figure 22: Proposed Site Plan, Figure 23: Proposed Grading and Surface Drainage Plan, and Figure 24: Proposed Sub-surface Drainage Plan.

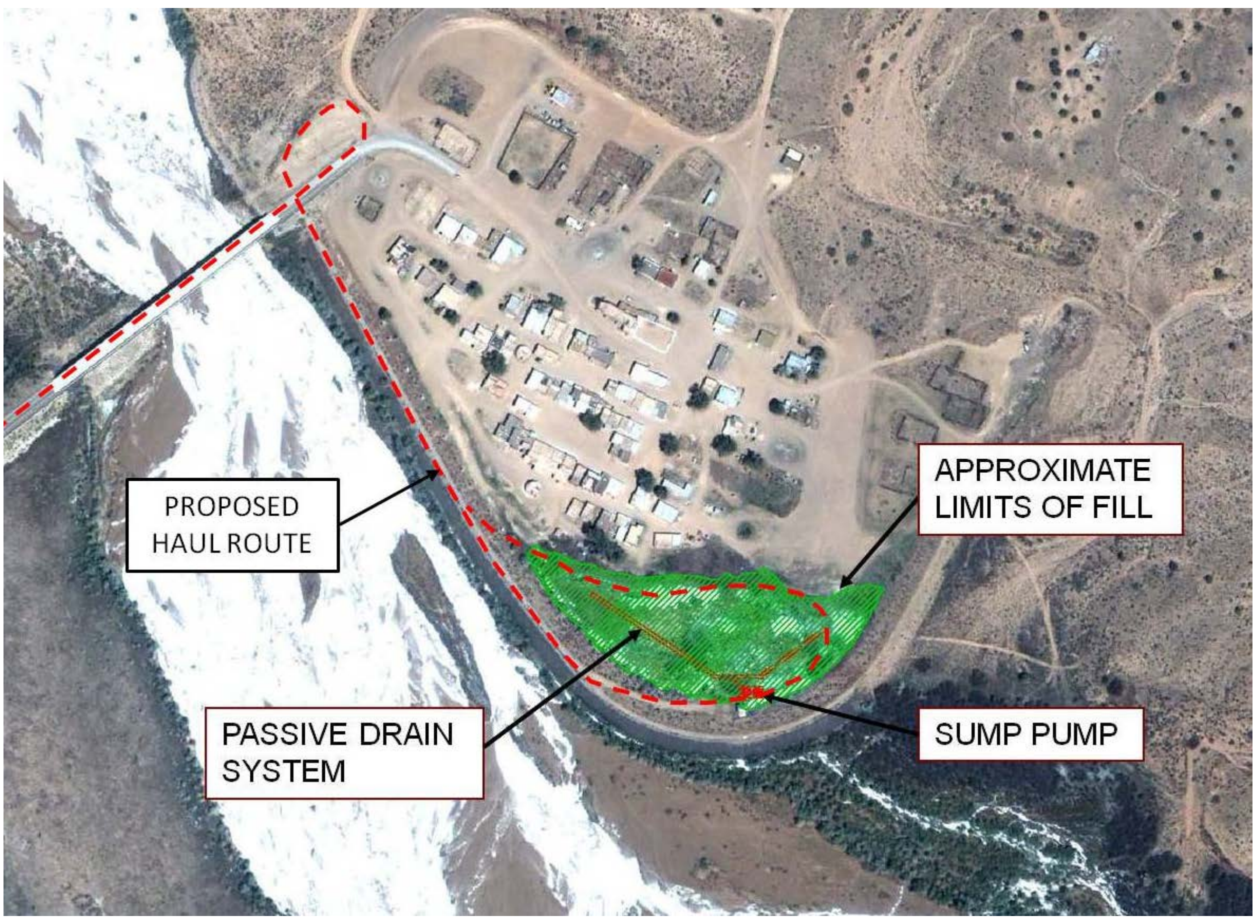

Figure 21: Recommended Alternative (Alternative 3a)

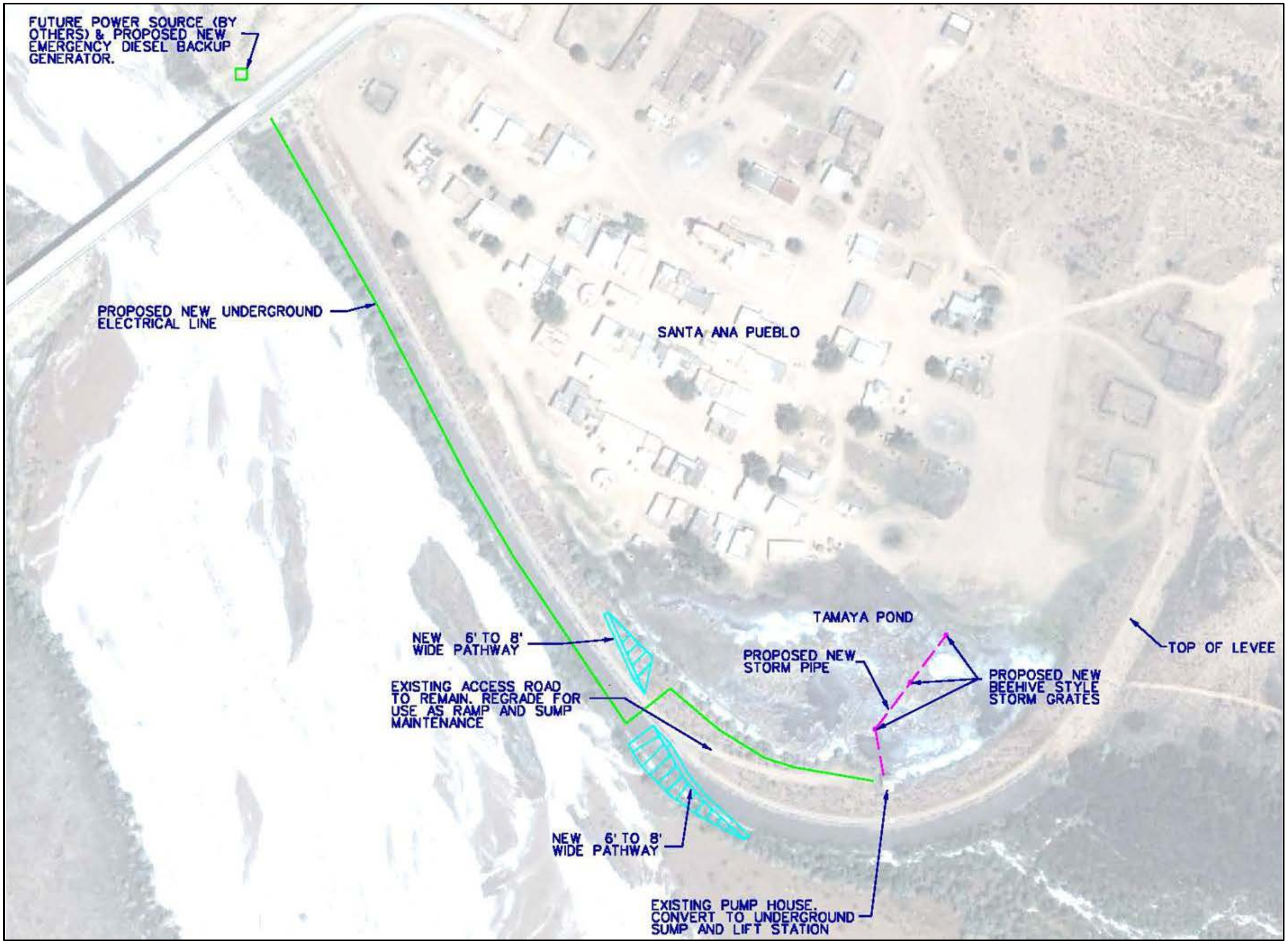

Figure 22: Proposed Site Plan showing Electrical Line, Surface Drainage, and Walkway over Levee

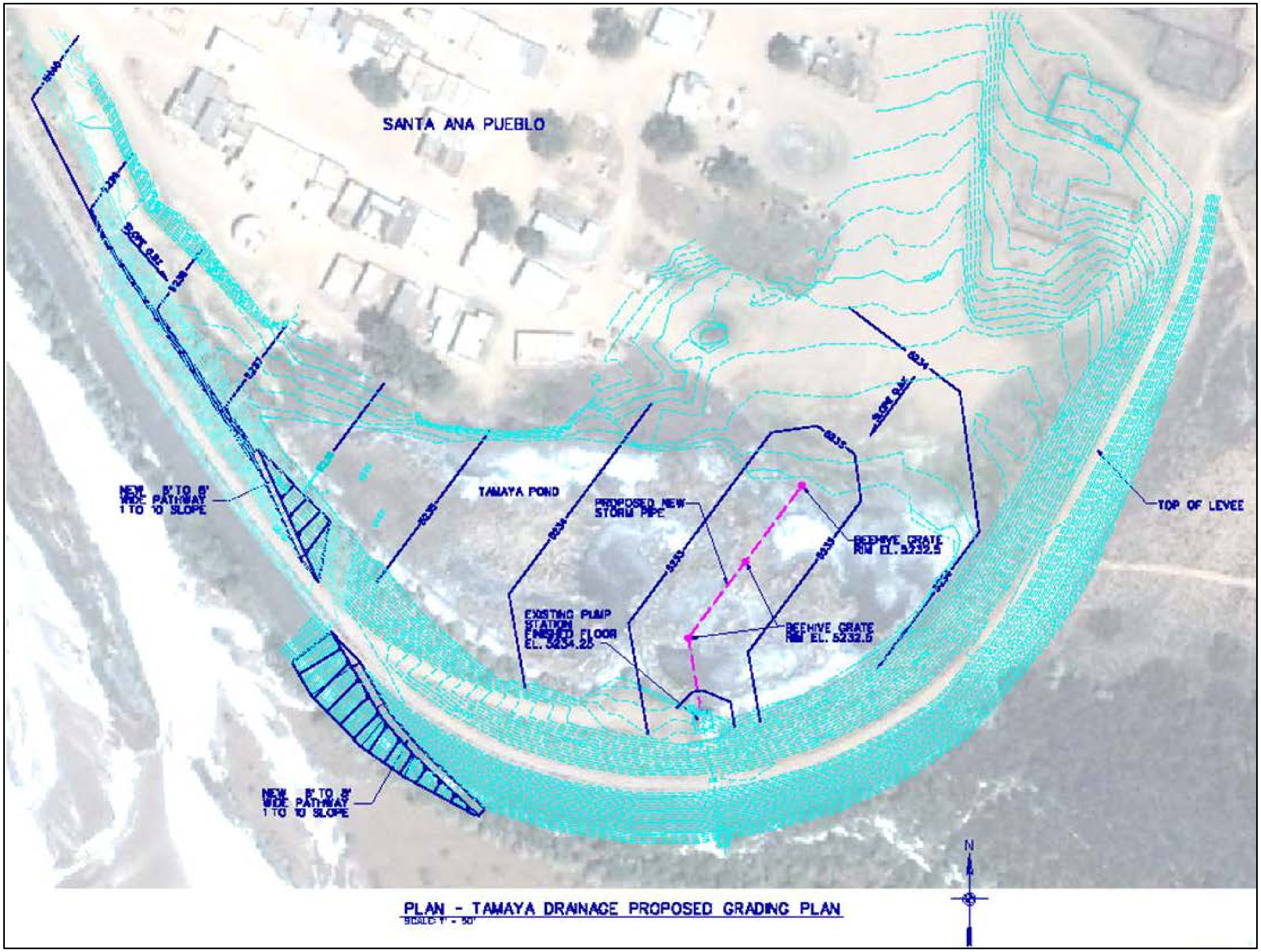

Figure 23: Proposed Grading and Surface Drainage Plan

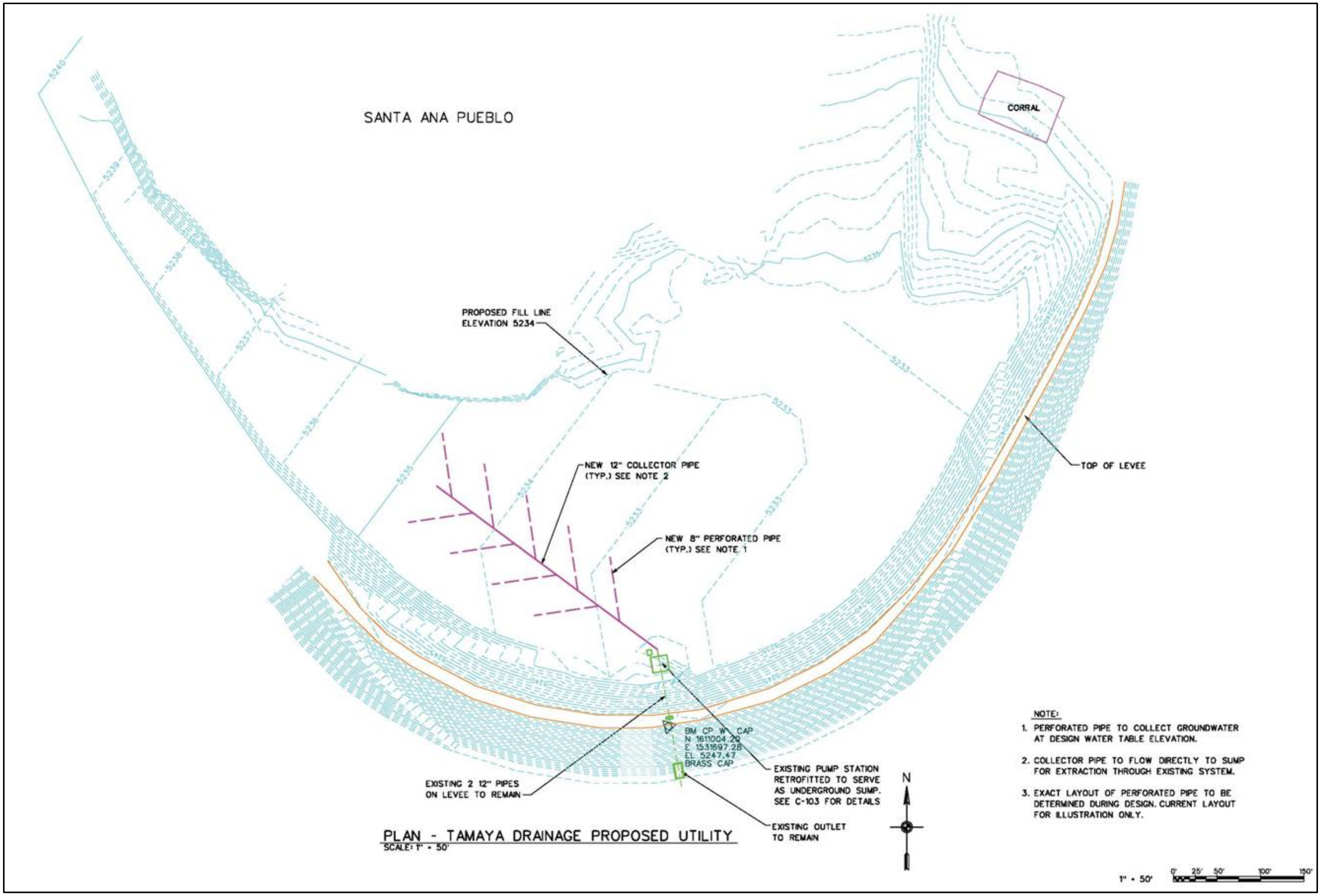

Figure 24: Proposed Sub-surface Drainage Plan showing groundwater collector pipes

7 - Preparers

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8 - Coordination and Public Review

8.1 Agency Consultation & Coordination

Agencies and entities that were consulted in preparation of this Environmental Assessment include:

- Mr. Wally Murphy, Field Supervisor, US Fish and Wildlife Service
- Ms. Rhonda Smith, Office of Planning and Coordination, and Mr. Tom Nystrom, Section 401 Water Quality Certification, US Environmental Protection Agency
- Mr. William Walker, Director of Southwestern Region, Bureau of Indian Affairs
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Libraries and public locations where Draft IR/EA was made available:

Santa Fe Public Library
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8.3 Summary of public review comments and Corps' responses

The Draft Implementation Report with integrated Environmental Assessment (IR/EA) for the Tamaya Drainage Project was available for public review and comment form February 15 to March 18, 2013. A Notice of Availability was published in the Albuquerque Journal, a newspaper published in the City of Albuquerque, Bernalillo County, New Mexico on February 15, 2013. The Draft IR/EA was available on the Corps' website and at the following libraries: Santa Fe Public Library, Santa Fe, NM; Albuquerque Main Library, Albuquerque, NM; and Bernalillo Roosevelt Public Library, Bernalillo, NM.

A summary of the public and agency comments received is provided below. Copies of the NOA, affidavit of publication, agency review letters, and public review comment letters received are included in Appendix F. Comments were received from the USDA Natural Resources Conservation Service (NRCS). The NRCS commenter remarked that "Our concern in these cases always is that negative impacts of altering any wetland area are mitigated. It appears that these concerns are adequately addressed in your mitigation plan. Therefore, I have no objection to the project moving forward as planned." No other comments were received.

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