Environmental Assessment

Environmental Assessment for Hopi Arsenic Mitigation Project, Hopi Reservation, Navajo County, Arizona

Phoenix Area Indian Health Service

August 2014

Hopi Arsenic Mitigation Project – HAMP
Hopi Reservation
Navajo County, Arizona

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1.0 Purpose and Need

1.1 Proposed Project

The Indian Health Service (IHS) and Hopi Tribe propose to develop the Hopi Arsenic Mitigation Project (HAMP) that would improve the quality of the water supplied to the Hopi villages at First Mesa and Second Mesa by providing water that is naturally low in arsenic and meets other U.S. Environmental Protection Agency (USEPA) water quality standards as a replacement for the current water sources, which substantially exceed USEPA water quality standards for arsenic. The source of water would be shifted from the vicinity of the villages to the Turquoise Trail well site, located approximately 15 miles north of Second Mesa. The IHS prepared a Preliminary Engineering Report (PER) that described the HAMP in accordance with the U.S. Department of Agriculture – Rural Development (USDA-RD) format and the USDA Rural Utilities Service (RUS) Bulletin 1780-2 as a condition of USDA-RD funding application requirements (IHS, 2012 and 2014). The PER described the current water situation, analyzed alternatives, and recommended a preferred alternative. Information from the 2012 PER and an updated 2014 PER were incorporated into this Environmental Assessment (EA). This EA describes HAMP alternatives, affected environment, and anticipated environmental impacts. The EA follows the guidelines in Department of Health and Human Service General Administrative Manual Part 30, the IHS Environmental Review Manual, and Council on Environmental Quality (CEQ) guidance for the National Environmental Policy Act (NEPA) at 40 Code of Federal Regulations (CFR) 1500-1508. See Appendix A for agency coordination.

HAMP cooperating agencies include the Hopi Tribe, Bureau of Indian Affairs (BIA), Bureau of Reclamation (BOR), U.S. Department of Housing and Urban Development (HUD), U.S. Department of Agriculture – Rural Development (USDA-RD), and USEPA. This EA incorporates relevant NEPA requirements and guidelines from these cooperating agencies.

The project would construct a remote well field, regional water storage tanks, in-line booster pump station, and transmission pipelines to convey water from the remote well field to the villages of First and Second Mesa (see Figure 1.1). The proposed Turquoise Trail well field would be developed at a location approximately 15 miles north of the Hopi Cultural Center in the vicinity of Indian Route 4 (Turquoise Trail). Test Wells have been drilled at the well field to evaluate water production and water quality. A new independent utility enterprise authority would be established to manage and operate the proposed facilities. The USEPA and IHS have actively funded the planning and design phases of the HAMP with the goal of assisting the Hopi Tribe in implementing a long-term, sustainable arsenic solution. In effect, the HAMP is designed as a wholesale water system, which would be operated by an independent Tribal enterprise to pump, convey, and deliver water to the village water systems.

The purpose of the HAMP is to provide drinking water to the First and Second Mesa regions that meets the USEPA's 10 parts per billion (ppb) arsenic standard. In January 2001, the USEPA reduced the arsenic maximum contaminant level (MCL) from 50 ppb to 10 ppb. Effective 2006, all public water systems were required to meet this revised standard under the Safe Drinking Water Act. Water systems in the Hopi Reservation's First and Second Mesa regions do not meet the USEPA's 10 ppb arsenic standard. Arsenic concentrations in this area range from 15 ppb to 40 ppb.

While the primary purpose of the HAMP is to provide arsenic compliant drinking water, additional benefits of the regional system include an increase in the quantity of water available and improved

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water system reliability. Tribal leaders have reported that water quantity has been historically limited. In addition, improvements are needed to reduce the risk and occurrence of water outages.

With support from the Hopi Tribe, IHS, USEPA, and the Hopi Water Resources Program conducted public outreach, planning, and preliminary engineering activities. IHS would provide the Hopi Tribe with engineering and technical support.

Figure 1.1 Proposed pipeline alignment headed into Wepo Valley.

1.2 Population Basis for Capacity Determination

Based on U.S. Census Bureau data, the HAMP planning area experienced strong population growth during the 2000-2010 decade (see Table 1.1). Growth rates ranged from 1.68% on Second Mesa to 3.30 percent on First Mesa. The weighted average population growth rate was 2.61%.

Table 1.1 Hopi Community Population Trends Based on U.S. Census

Community	Year 2000	Year 2010	Growth Rate 2000-2010
First Mesa	1,124	1,555	3.30%
Second Mesa	814	962	1.68%
Shungopavi	632	831	2.78%
Keams Canyon	260	304	2.82%
Weighted Average Growth Rate	--	--	**2.61%**

Source: IHS (2014)

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The PER examined a variety of growth rates (IHS, 2014). The growth rates vary between different organizations as follows:

- U.S. Census Bureau, population growth rate for years 2000-2010: 2.61%
- U.S. Census Bureau, growth in occupied housing units for years 2000-2010: 3.33%
- Arizona Department of Economic Security, growth rate through year 2035: 0.93%
- Tetra Tech (2006), growth rate through year 2035: 2.0%
- HDR (2003 report), growth rate through year 2035: 2.5%
- IHS (2012) draft PER, growth rate through year 2035: 2.0%
- U.S. Department of Agriculture in 2012 draft PER comment: 1.0-1.25%

It is recognized that there is a range of possible growth rates through 2035. It is also recognized that population projections are forward looking and are best estimates of future unknown conditions. A moderate growth rate estimate was used near the midpoint of the probable range of growth rates. The recommend population growth rate of 1.8% was used in the PER. This rate was used to project the corresponding growth in water demand through the year 2035.

1.3 Design Capacity and Increase Over Present Capacity

Facilities proposed as part of the HAMP would be separate but connected to the existing village water systems. The HAMP regional transmission mains would connect to the village water storage tanks, and the villages would maintain ownership and operate their respective water systems.

The existing water facilities are serviceable, and when major facilities become unserviceable, they qualify for upgrading through the IHS Sanitation Facilities Construction Program. Electro-mechanical system components (such as well pumps, booster pumps, and chlorination pumps) tend to wear out faster and are more maintenance intensive than other water system components (such as water mains and storage reservoirs). The HAMP would relieve the existing utilities of some of their operations and maintenance tasks by eliminating operations and maintenance requirements of several existing booster pumps, well pumps, and chlorination pumps and extensive well water sampling mandated by USEPA and the Safe Drinking Water Act.

By connecting the villages to a new well field, the villages would have improved water availability for their systems over most of the current systems. The proposed Turquoise Trail well field would be developed at a location approximately 15 miles north of the Hopi Cultural Center in the vicinity of the Turquoise Trail.

The demand for water is expected to increase during the 20-year planning period for the HAMP (see Table 1.2). IHS assumed a geometric growth rate of 1.8% per year and assumed that average per capita water consumption will increase by up to 50% by the end of the planning period. The 2013 reported annual production of water systems in Shungopavi, Sipaulovi-Mishongnovi (lower), Sipaulovi-Mishongnovi (upper), and First Mesa Consolidated Villages was 69,601,400 gallons. The 2013 reported average annual production for this area was 132.4 gallons per minute (gpm). The Year 2035 peak design demand is 392 gallons per minute. The Turquoise Trail Hydrogeologic Study determined that water was available in the Turquoise Trail well field to provide water for the HAMP (IHS, 2012; Kennedy/Jenks Consultants, 2011). Subsequent investigations of Turquoise Trail Wells #2 and #3 by John Shomaker and

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Associates, Inc. (2014) found that each well produced 300-350 gpm. Regional water aquifer drawdown rates from the Navajo Aquifer are estimated at approximately 3 feet annually, which will allow the Turquoise Trail Wells to produce water for more than 40 years. The Turquoise Trail Wells #2 and #3 do not require primary treatment and have the capacity to provide water to the Villages of First and Second Mesa for an expected useful life of more than 40 years (IHS, 2014).

Table 1.2 Water Demand Projections – Hopi Arsenic Mitigation Project

Water System	Number of Residential Services	Number of "Other" Services	Total Number of Services	2013 Reported Annual Production Volume	2013 Reported Annual Production	Year 2015 Peak Design Demand	Year 2035 Peak Design Demand
	Number	Number	Number	Gallons	GPM*	GPM	GPM
Shungopavi	146	3	149	10,402,600	19.8	30.8	58.6
Sipaulovi/Mishongnovi (Lower)	100	8	108	7,142,300	13.6	21.1	40.3
Sipaulovi/Mishongnovi (Upper)	25	1	26	2,102,600	4.0	6.2	11.8
First Mesa Consolidated Villages	580	40	620	49,953,900	95.0	147.7	281.3
TOTALS				**69,601,400**	**132.4**	**205.8**	**392.0**

** GPM – gallons per minute*
Source: IHS (2014)

1.4 Relationship with Other Community Planning

The Hopi Tribe is a sovereign nation located in northeastern Arizona. The reservation occupies portions of Coconino and Navajo Counties although the HAMP is located just within Navajo County. The Hopi Reservation covers more than 1.5 million acres and consists of 12 villages. Villages are generally located on three mesas, with the exception of Moenkopi to the west and Keams Canyon to the east.

According to the Tribe's constitution, the Hopi Tribal Council has the power and authority to represent and speak for the Hopi Tribe in all matters for the welfare of the Tribe. The Tribal Council is authorized to negotiate with federal, state, and local governments, and with councils or governments of other tribes. The Hopi Constitution recognizes village authority in specific areas such as the authority to assign village land. The villages value their autonomy and their ability to make village decisions independently of the Tribal Government.

Much community planning occurs at the village level. Villages establish their own priorities for use of land and natural resources within the District 6 range units. Initiatives for economic development are often formulated at the village level. Villages operate their own public drinking water systems pursuant to USEPA regulations. The HAMP would require cooperation and coordination between the villages to operate the regional water system as part of a regional water utility. Nevertheless, the villages would retain control of their individual water systems within the overall framework of the HAMP regional system.

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2.0 Analysis of Alternatives

The HAMP project team determined that arsenic treatment systems employed in this region would be burdensome and that arsenic compliance issues would likely persist. Based on the findings of the draft 2012 PER and final 2014 PER (IHS, 2012 and 2014), arsenic treatment systems within the Hopi villages should be avoided. The option of using arsenic treatment systems is discussed below in Section 2.1. The recommended solution is to import higher quality water from the Turquoise Trail region. Water quality and yield potential are superior to the production wells currently used by First and Second Mesa communities. Alternatives A, Revised A, B, and C propose alternative alignments to convey water from wells in the Turquoise Trail region to water systems in the First and Second Mesa villages.

2.1 Alternatives Considered But Eliminated

Modification or Rehabilitation of Existing Hopi Wells

One comment received on the 2012 Draft PER (IHS, 2012) recommended an evaluation of existing water wells that serve First and Second Mesa to determine if the wells could be rehabilitated or modified to prevent the production of arsenic non-compliant water. This alternative is summarized in this section and further described in the 2014 PER (IHS, 2014).

The most important aquifer in this part of Arizona is the Navajo aquifer, consisting primarily of the Navajo and Kayenta formations. These formations vary in thickness from 950 feet north of the Hopi Reservation, to 500 feet in the Turquoise Trail region at the northern Hopi Reservation border, to 0 feet at the southern and eastern edges of the Hopi Reservation. The Coconino and Dakota aquifers, which overlie the Navajo aquifer, have poorer water quality than the Navajo aquifer. The Carmel Formation acts as a confining layer and separates the Navajo and Dakota aquifers in the northern half of the Hopi Reservation. In contrast, the Carmel Formation allows leakage between the Navajo and Dakota aquifers in the southern half of the Hopi Reservation. This leakage causes the two aquifers to have similar water chemistry. The Navajo aquifer in the vicinity of the Hopi Mesas has arsenic concentration above 10 ppb and concentrations as high as 79 ppb have been measured (Kennedy/Jenks Consultants, 2011). The precise mechanism by which the leakage occurs is not fully understood. Arsenic may be present in the Carmel Formation confining layer and contribute to the high arsenic levels in the Navajo aquifer (Tetra Tech, 2006).

The majority of First and Second Mesa municipal water wells obtain water from the Navajo aquifer. There is no apparent means to take water from specific screened levels from the existing water wells to reduce the production of arsenic non-compliant water due to the homogeneity of the Navajo aquifer, thinness of the Navajo aquifer, thinness of the overlying confining layer, leakage between the Navajo and Dakota aquifers, and generalized arsenic concentrations in the Navajo aquifer. The modification or rehabilitation of existing Hopi wells was eliminated from consideration as a viable alternative because of the following reason. Based on the understanding of the area's hydrogeology and known arsenic concentrations of the Navajo aquifer, it was assumed that all First and Second Mesa area wells will be of similar quality, with arsenic concentrations greater than 10 ppb.

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Treatment Alternative

The 2014 PER provided additional consideration of a Treatment Alternative for arsenic mitigation for the First and Second Mesa water systems. This alternative is summarized in this section and further described in the 2014 PER (IHS, 2014).

Under the Treatment Alternative, existing water sources would be treated to remove arsenic and comply with Safe Drinking Water Act requirements, primarily treating drinking water to meet the 10 ppb standard. More than one water source would be required per village, to provide redundancy and allow for down-time maintenance operations. Each village would have or would have to develop sufficient water sources for the 20-year project life. Where electric grid power is available, diesel generators would provide backup power in the event of an extended, multi-day power outage. Water storage capacity would meet IHS standards. Each village would own and operate their distribution system, disinfect the distribution system, and collect utility fees from customers. Additional water storage facilities would be constructed. A hydrogeological study would need to confirm that the Navajo aquifer underlying the villages has the capacity to provide 206 gpm initially and 392 gpm in 20 years.

The following three arsenic treatment systems were evaluated: (1) reverse osmosis membrane system, (2) ion exchange and alumina or iron based granular media sorption system, and (3) a precipitative system using chemical addition to oxidize and precipitate arsenic compounds. An ion exchange sorption system was selected as the preferred arsenic removal process, based on cost and other factors. The Siemens PV 2000 package system, with a capacity of 100 gpm, was selected as the package for evaluation. The PV 2000 uses granular ferric hydroxide media with low pressure steel vessels to adsorb the arsenic into the media as it passes through the vessel.

The Treatment Alternative was not considered the most sustainable alternative. A high degree of operator skill is required to adequately maintain and operate the system. The lack of skilled and trained operators in the villages would present a substantial challenge to implementing this alternative. The complexity of operations is high due to the type and number of tasks required to adequately operate and maintain the treatment system. Hourly adjustments to the treatment process are often needed.

A live cycle present worth cost analysis was used to compare the Treatment Alternative with the non-treatment alternatives (described in the following sections) using net present value (IHS, 2014). A life cycle present worth cost analysis is an engineering economics technique used to evaluate present worth and future costs for comparison of two or more alternatives. In accordance with USDA-RUS Bulletin 1780-2, the federal discount rate from Appendix C of Office of Management and Budget (OMB) Circular A-94 was used to determine the present worth of the uniform series of operations and maintenance values over the life of the planning period in current dollars, and the salvage value, or remaining useful facilities life, at the end of the planning period. Net present value was calculated with the following equation: (Net Present Value) = (Capital Costs) + (Present Value of the Uniform Series of Operations and Maintenance Costs) + (Present Value of the Uniform Series of Replacement and Rehabilitation Costs) – (Single Payment of the Present Value of the Salvage Value). The HAMP has a lower present value of $17,811,000 compared with $24,556,000 for Arsenic Treatment. The HAMP has a higher capital costs than Arsenic Treatment, but Arsenic Treatment has higher replacement, rehabilitation, and annual operations and maintenance costs. The Treatment Alternative replacement costs are three times that of the HAMP due to the need to replace the arsenic treatment alternative periodically over the planning period.

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Table 2.1 Life Cycle Present Worth Cost Analysis Summary

Cost or Value	HAMP with Electric Power Grid (Non-Treatment)	Arsenic Treatment
Capital Costs	$16,914,000	$13,155,000
Annual Operations and Maintenance Costs	$430,000	$765,000
Operations and Maintenance Present Value	$7,032,000	$12,502,000
Renewal and Replacement Costs	$1,097,000	$2,425,000
Total Present Value	$25,043,000	$28,076,000
Remaining Useful Life	$7,232,000	$3,520,000
Net Present Value	**$17,811,000**	**$24,556,000**

Assumes 1.8 percent annual growth in water use. Planning period is 20 years. Discount rate is 3.6 percent based on OMB Circular A-94.

The estimated average user costs for Arsenic Treatment plants would be in the range of $80 - $95 per month per connection. This cost would be in addition to ongoing user costs in the villages for operation of the water distribution systems and wastewater collection and treatment.

In addition to life cycle costs, the Treatment Alternative was eliminated from further consideration for the following reasons. There is a high probability of mechanical or operator failure, leading to arsenic non-compliance with the Safe Drinking Water Act. The Treatment Alternative has a high probability of failure due to the lack of certified local operators, not storing pre-treatment chemicals in sufficient quantities, and not periodically repairing or replacing mechanical treatment systems. Additionally, the requirement for utility operators to handle hydrochloric acid and sodium hypochlorite in the pre-treatment process creates safety concerns. Because of the higher life cycle costs and the above technical issues, Arsenic Treatment was eliminated from further consideration as a viable alternative.

2.2 Common Elements of Non-Treatment Alternatives

Four non-treatment Alternatives (A, Revised A, B, and C) are discussed and evaluated. These alternatives share the following design criteria and assumptions. The project area for each non-treatment alternative includes 100-foot wide pipeline corridors and areas surrounding wells, tanks, booster stations, and other HAMP facilities.

A strategic plan was developed to address asset maintenance and sustainability, operation maintenance plans and costs, recommended staffing, organization and business requirements and plans, system costs and financial plans, and an implementation plan. The strategic plan was based on asset management principles to provide a sustainable utility organization of the water supply and distribution system, and to identify long term costs and requirements to maintain and sustain the system and level of service (GHD, 2014).

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Based on the recommendations of the strategic plan (see Appendix E), the Hopi Public Utility Authority (HPUA) was established to manage and operate the proposed HAMP facilities. Each village would maintain ownership of, and continue to operate and maintain, their respective water distribution systems. The HPUA would act as water 'wholesaler' to the villages. The villages would purchase bulk water from the HPUA through a master water meter. Villages may be given the option of turning over operation their respective facilities to HPUA under some future arrangement.

Based on the strategic plan, the initial operating strategy includes local automatic operation of most HAMP facilities. This means equipment would be started and stopped based on different measurements in the system. Well pumps would start and stop based on the level in a designated tank. Booster pumps would also operate automatically based on water tank levels. Hypocholorite pumps at village chlorination stations would be automated to operate based on the flow through village flowmeters. Surge tank air compressors would operate automatically to maintain pressure in surge tanks.

Chlorination would be used for water treatment. Chlorination would occur using solid calcium hypochlorite tablets. A stream or water from the transmission main would be diverted to a calcium hypochlorite chlorinator, where the un-chlorinated water dissolves the solid calcium hypochlorite tablets. A weak solution of chlorinated water is generated from the dissolution of tablets and is injected into the transmission main. Calcium hypochlorite tablets are safe to handle, safe to store, and do not emit chlorine vapor while in the solid state. The use of calcium hypochlorite tablets eliminates the need for bulk liquid chlorine storage, liquid chlorine transfer facilities, and liquid chlorine spill containment, which would be needed with liquid sodium hypochlorite.

Electric power would be provided by one of three options. Under the first option, Navajo Tribal Utility Authority (NTUA) would construct a three-phase power extension to provide electric power to the HAMP. An electric service agreement would be negotiated between the Hopi Tribe, NTUA, and Navajo Nation. Under the second option, Arizona Public Service (APS) would construct approximately 14 miles of transmission line to provide three-phase power to the HAMP. Both options would require the construction of electric transmission line along portions of the pipeline routes. Transformers would be installed to step-down power voltage. Under the third option, well generators would supply power, which could be a temporary or permanent measure. If temporary, the use of the generators would be a supplement to the other two options. In any case, generators would be installed at each of the wells as back up to any transmission line in case of power outages.

Booster stations would include twin alternating 15 horsepower (hp) pumps, backup 40 kilowatt (kW) diesel generator, and tank level/pump controls. APS or NTUA provided electric power would be supplied to booster stations. Specific items common to non-treatment alternatives are described below:

- A 20 year planning period was used for facility sizing.
- A geometric population growth rate of 1.8 percent is assumed (see Section 1.2 and 1.3 for further discussion).
- Average per capital water consumption is assumed to increase by up to 50 percent by the end of the planning period.
- Reported village water production is assumed to be equivalent to total per capita water consumption.
- Water sources and water delivery facilities would be sized to handle expected peak flows.

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- The Turquoise Trail Well Field meets all primary drinking water standards under the Safe Drinking Water Act, including arsenic, which would need no treatment other than possible disinfection.
- More than one well would be developed to provide redundancy and allow for down-time for maintenance operations.
- Diesel generators would provide back-up power. Double-walled fuel storage tanks of 500-2,000 gallon capacity with leak prevention and spill containment measures will be installed at the wells and booster stations.
- Villages would purchase water from the HPUA and would continue to own and operate their own respective distribution systems.
- Villages would be responsible for maintaining disinfection throughout their distribution systems.
- Villages would be responsible for payment to the HPUA for the bulk water delivered.
- Villages would collect utility fees from individual village customers.
- HPUA would meter the water quantity delivered to each village and distribute the costs on a pro-rata basis (IHS, 2014).

Total annual HPUA operating costs would range from $559,000 in 2015 to $680,000 in 2025. Revenues would range from $559,000 in 2015 to $691,000 in 2025. Recommended fees include the following: (1) Base fee of $33.42 is recommended per connection or equivalent residential unit; and (2) usage fee of $2.55 per 1,000 gallons of water used (GHD, 2014).

Project designs will include suitable design specifications for the slope sensitive areas located along the sides of First and Second Mesa. The specifications will include measures to minimize the potential for erosion and land subsidence. A Storm Water Pollution Prevention Plan (SWPPP) would be developed and specify best management practices (BMPs) to minimize soil erosion and sediment transport during construction. At the completion of construction, exposed soils will be reseeded with weed-free native vegetation and additional invasive species control measures will be implemented in accordance with recommendations from the Hopi Tribe Pesticide Officer.

Trees and shrubs will be cleared outside of the migratory bird nesting season (March 1 through August 30), and construction will not take place near active migratory bird nests. If this is not possible, a preconstruction survey will be conducted prior to construction and clearing any trees or shrubs during the nesting season. In accordance with the Hopi WEMP recommendations, no construction activity will be allowed during the golden eagle and red-tailed hawk nesting seasons (February 1 through July 31) in the vicinity of occupied eagle and hawk nests.

HAMP facilities would avoid traditional cultural properties (TCPs) or other cultural sites. Per the policy of the Hopi Cultural Preservation Office (HCPO), the following mitigation measure will be implemented: In the event of an unanticipated discovery including the encounter of any previously unidentified or incorrectly identified cultural resource including, but not limited to, archaeological deposits, human remains, or places reported to be associated with Native American religion beliefs and practices not considered in the cultural assessment, all operations in the area of the discovery will cease and the HCPO will be contacted. An assessment of the discovery will be made by the HCPO. If the discovery is deemed significant, the SHPO will be notified by IHS and HCPO and appropriate recordation will be prepared prior to any resumption of work in the discovery area.

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The project engineers and Hopi Water Resources Program will work closely with villages to define appropriate time periods for construction work. Construction equipment will be maintained to minimize extraneous noise.

Chlorine used for water treatment will be handled and stored according to state and federal standards. Any solid waste produced during construction will be disposed of at a licensed landfill. Fuels, lubricants, and hazardous materials used in construction and operations of the HAMP will be managed according to federal and state standards to ensure that no releases (above the *de minimis* level) into soil, surface water, or groundwater occur.

The visual impact of HAMP facilities would be reduced where feasible. Lands disturbed for pipelines would be recontoured to their original form and revegetated. Tanks and pump stations will be painted a tan or earth-tone color to help them blend into the landscape. Most transmission and distribution lines will be locate along roadway corridors where the landscape has been modified.

2.3 Alternative A – Turquoise Trail Well Field with Split Pipeline to First and Second Mesa

Alternative A consists of developing a new well field in the Turquoise Trail region and utilizing a remote elevated water storage tank to convey water to First and Second Mesa by means of gravity (see Figures 2.1 and 2.2). Proposed wells would be drilled along the well transmission route. Wells in the well field would be spaced a minimum of 1 mile apart with maximum individual well pumping rates of about 400 gpm. The system would initially consist of two 400 gpm wells, each capable of exceeding the average daily demand. Test wells have been developed drilled at Wells #2 and #3. The wells are currently not permanent operational wells, and permanent well facilities would be constructed, including well house, communications, electrical power, and connecting piping to the HAMP. As demand increases or additional connections are made to the system, additional wells would be developed.

Figure 2.1 Proposed well location at Orabi Wash.

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A combination of radio-telemetry and buried signal wires would be used for well field communications. A solar powered radio transmitter at the Turquoise Tank would transmit a signal to the nearest well. All wells will be hard wired together via buried signal wire. Wells would cycle on and off, and alternate, to maintain a predetermined water level in the proposed elevated storage tank.

The pipeline routes along Alternative A split at the Main Junction ("Y") with one pipeline branch providing water to First Mesa and the other pipeline branch providing water to Second Mesa. The proposed 500,000 gallon Turquoise Tank would be constructed approximately 4.5 miles north of the Main Junction (see alternative summary in Table 2.2).

The pipeline alignment to First Mesa would be routed to the southeast of the Main Junction along Wepo Wash Road (Indian Route 8) and would end at the existing 500,000 gallon Polacca East Tank. A small branch connection to the fill line for the 10,000 gallon First Mesa Top Tank would also be constructed. Both tanks would be filled by gravity flow, and no booster pumping would be needed on First Mesa.

The pipeline alignment to Second Mesa would be routed to the southwest from the Main Junction onto the highlands of Second Mesa. An in-line booster station housing two parallel booster pump stations would be constructed approximately 1.5 miles north of where the pipeline alignment divides again with a southwest alignment extending to Shungopavi and a southeast alignment extending to Sipaulovi and Mishongnovi. The southwest alignment would end at the existing 250,000 gallon Shungopavi Tank. On the southeast alignment, a 200,000 gallon Upper Sipaulovi/Mishongnovi storage tank would be constructed to provide water pressure and storage for the upper villages and provide a constant water supply to fill the existing Lower Sipaulovi/Mishongnovi Tank. As an alternative option, a booster station may be used to provide the needed pressure and flow. Numerous un-served homes are located along the proposed alignments between the booster pump station and terminal water storage tanks. Alternative A could serve these homes if service is requested by the respective village and if soils are suitable for onsite wastewater treatment and disposal.

Alternative A would traverse Hopi Partitioned Lands, District Six, Village lands, BIA Right-of-Way, and Arizona Department of Transportation (ADOT) right-of-way. The alignment minimizes potential land issues and disputes by allowing for separate pipeline branches to serve each mesa.

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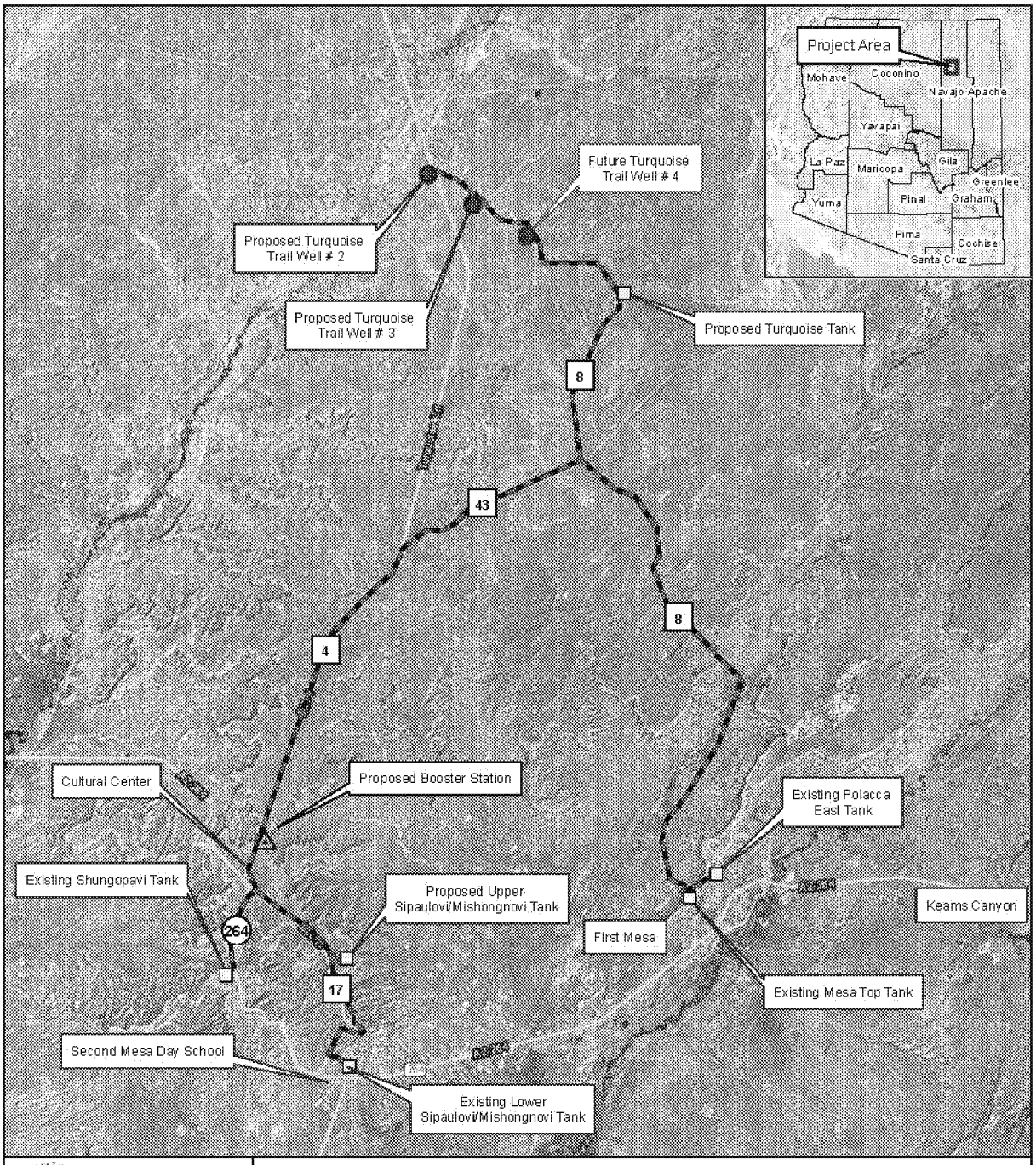

Figure 2.2
Alternative A

Legend

- Route A Waterline
- Booster Station
- Tank
- Well

0 1 2 4 Miles

0 2 4 8 Kilometers

N

1:150,000

Hopi Arsenic Mitigation Project, Hopi Indian Reservation, Navajo County, Arizona

Table 2.2 Alternative A Summary

Feature	Alternative A
Pipeline Route	Pipeline from the Turquoise Trail well field divides at the "Y" with southwest alignment to Second Mesa and southeast alignment to First Mesa.
Proposed Tanks	Two tanks: 500,000 gallon Turquoise Tank, and 200,000 gallon Upper Sipaulovi/Mishongnovi Tank or booster station.
Proposed Booster Stations	One booster station on Second Mesa
Length	33.7 miles of pipelines
Area	425 acres
Cost	$18.7 million
Technical Considerations	Can provide service to unserved homes between the Second Mesa Booster Pump Station and Upper Sipaulovi/Mishongnovi and Shungopavi Tanks.

Under Alternative A, the regional water system would deliver water to each of the villages, and connections to the village systems would include a master water meter and flow and level control valves as needed. Interconnections would be provided to Shungopavi, Upper Sipaulovi/Mishongnovi, Lower Sipaulovi/Mishongnovi, First Mesa Top Tank, and Polacca East Tank. The Shungopavi and Upper Sipaulovi/Mishongnovi interconnections would be provided at the Second Mesa Booster Station. The Lower Sipaulovi/Mishongnovi interconnection would include a delayed opening altitude valve and flow control valve for maintaining the water tank level. The interconnection to the First Mesa Top Tank and First Mesa would include a delayed opening altitude valve and flow control valve mechanism, and the Polacca East Tank interconnection would include a delayed opening valve and flow control valve.

Alternative A would be constructed in various phases depending on construction funding availability and if there are logical segments that can be constructed to immediately serve villages upon completion of each segment. However, it is expected that total costs would be lower and the project completed more rapidly if the HAMP were constructed under a fully-funded single contract. Rapid completion of the HAMP would best achieve the elimination of high arsenic levels from village water supplies and meet Safe Drinking Water Act standards at the earliest possible time.

2.4 Revised Alternative A (Preferred Alternative) – Adjusted Route, Turquoise Trail Well Field with Split Pipeline to First and Second Mesa

Based on additional investigation, Alternative A was revised (IHS, 2014). The pipeline route between the well field and "Y" was adjusted to take a direct route (see Table 2.3 and Figure 2.3). The Turquoise Tank was eliminated, and a 260,771 gallon Radio Tower Tank was added. The Second Mesa Booster Station was eliminated, and a Radio Tower Booster Station was added. A dedicated fill line would be provided to the Polacca West Tank. There would be no connection to the First Mesa Top Tank. Other information presented in Section 2.2 applies to the Revised Alternative A.

The Radio Tower Tank would be located downslope of the existing Radio Tower, north of the Hopi Cultural Center. The Radio Tower Tank would be sited at an elevation to provide gravity flow to the East Polacca Water Storage Tank and would be located along the proposed main to Second Mesa. The tank would be sited at ground level.

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Table 2.3 Revised Alternative A (Preferred Alternative) Summary

Feature	Revised Alternative A
Pipeline Route	Pipeline from the Turquoise Trail well field divides at the "Y" with southwest alignment to Second Mesa and southeast alignment to First Mesa. The route was adjusted to take a direct route between the well field and "Y".
Proposed Tanks	Two tanks: 260,717 gallon Radio Tower Tank, and 110,547 gallon Upper Sipaulovi/Mishongnovi Tank. Alternate tank site located between "Y" and Radio Tower site.
Proposed Booster Stations	One booster station at Radio Tower site
Length	32.8 miles of pipelines
Area	420 acres
Cost	$16.9 million
Technical Considerations	Can provide service to unserved homes between the Second Mesa Booster Pump Station and Upper Sipaulovi/Mishongnovi and Shungopavi Tanks.

The Upper Sipaulovi/Mishongnovi Tank would be located above Upper Sipaulovi. The tank would be located at a high point to provide sufficient water pressure for the upper villages of Sipaulovi and Mishongnovi. During high flows, the existing hydropneumatic system currently serving Upper Sipaulovi may be needed to maintain 20 pounds per square inch (psi) maximum pressure.

A small booster pump at the base of the Radio Tower Tank would be required to boost water to the Shungopavi elevated water storage tank and to the proposed Upper Sipaulovi/Mishongnovi Tank. The booster station would be composed of twin alternating 15 hp pumps, a backup 40 kW diesel generator, and tank level/pump controls. Electric power would be required at the booster station and is expected to be available upon completion of the proposed APS power line extension.

Prior to the tank connection, two service vaults would be required. HPUA would use the first vaults, which would include a gate valve, master meter, and an in-line throttling ball valve, to slow the flow into the East Polacca Tank, to prevent formation of negative pressures at the point where the transmission main crosses over First Mesa. First Mesa Consolidated villages would use the second vault, which will contain an altitude valve to control the water level of the East Polacca Tank, a sampling port for water sample collection, and chlorination injection taps.

The West Polacca Tank is connected to the distribution system in pressure zone 3. Revised Alternative A would install a dedicated inlet and outlet as well as an altitude valve to ensure water turnover and to eliminate the pressure reducing valve, which is currently controlling tank water levels.

Revised Alternative A would connect to the existing East Polacca Tank, operated by the First Mesa Consolidated Villages, which is the highest gravity point in the First Mesa Consolidated Villages system. Revised Alternative A would connect to the existing Shungopavi elevated water storage tank at its base, where existing inlet and outlet piping exists. Prior to the Shungopavi tank connection, two service vaults would be installed, similar to the East Polacca Tank. The HPUA would use the first vault, which would contain a gate valve and master meter. Shungopavi would use the second vault, which would contain a double check valve, sampling ports, and chlorination injection taps.

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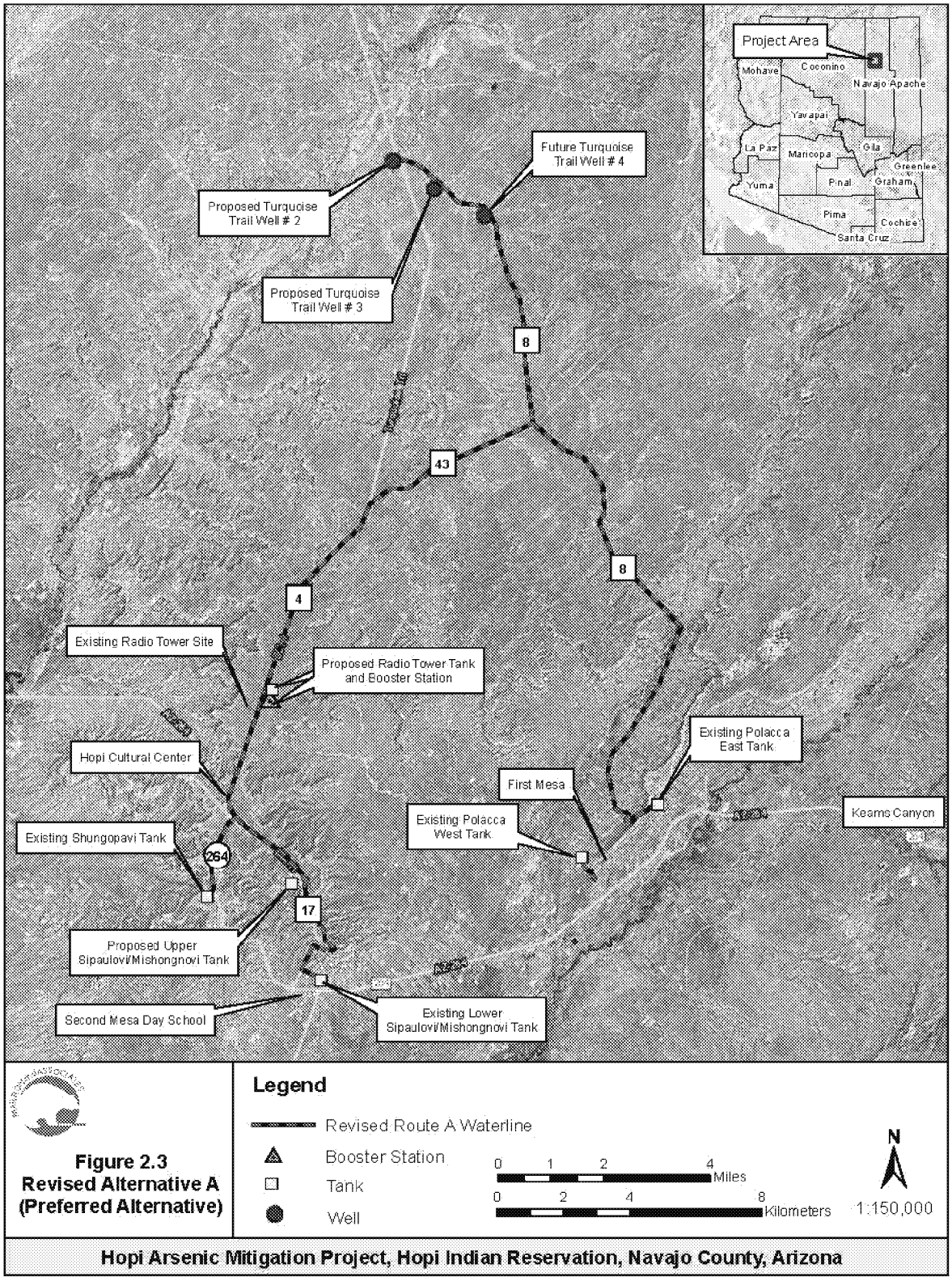

Figure 2.3
Revised Alternative A
(Preferred Alternative)

The Upper Sipaulovi/Mishongnovi system connection would be located at the existing Upper System well between the two villages. One small vault would be placed at the connection point for a master

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meter. The Lower Sipaulovi/Mishongnovi connection would be located at the base of the existing Lower Sipaulovi Tank. One vault would be installed for a master meter and in-line throttling valve. A second valve would be installed for an altitude valve and sampling port.

2.5 Alternative B – Turquoise Trail with Pipeline to First Mesa Then To Second Mesa

Alternative B consists of developing a new well field in the Turquoise Trail region and utilizing a remote 500,000 gallon elevated storage tank (Turquoise Tank) to convey water to First Mesa by means of gravity (see Figure 2.4). The well field would be developed in the same manner as Alternative A including well field communications and electric power. Test wells have been developed drilled at Wells #2 and #3. The wells are currently not permanent operational wells, and permanent well facilities would be constructed, including well house, communications, electric power, and connecting piping to the HAMP. The alignment would follow a south to southeast orientation towards First Mesa. The alignment is routed around the south side of the mesa and connects to the existing 500,000 gallon Polacca East Tank and existing 10,000 gallon First Mesa Top Tank. The Alternative B alignment branches with one alignment looping to the northeast to First Mesa and the second alignment extending west along Arizona State Highway 264 (AZ 264) and then turning north to Second Mesa. The pipeline alignment on Second Mesa would connect with the existing 75,000 gallon Lower Sipaulovi/Mishongnovi Tank, proposed 200,000-gallon Upper Sipaulovi/Mishongnovi Tank or booster station, proposed Shungopavi Booster, proposed 500,000 gallon Second Mesa Tank, and existing 250,000 gallon Shungopavi Tank (see alternative summary in Table 2.4).

Relatively high operating pressures would occur in the lower elevations along AZ 264. Head loss is more substantial with this alternative than Alternative A due to the pipeline alignment, resulting in the need for increased pipe diameter. On Second Mesa, the existing Shungopavi Tank and proposed Second Mesa Tank are located in close proximity to one another. The proposed tank is required to maintain separation between the regional water system and the Shungopavi water system.

The existing elevated Shungopavi tank belongs to the village of Shungopavi and cannot be used for regional water system storage. The tank has not been repaired and is awaiting transfer from the Hopi Tribe to the Village pending completion of this repair.

Alternative B would traverse Hopi Partition Lands, District 6, village land, BIA right-of-way, and ADOT right-of-way. The elevated storage tank at Second Mesa is located in an area claimed by multiple villages, and this tank site may be controversial. In addition, the Second Mesa booster station would be located in a narrow section of the road to Sipaulovi/Mishongnovi. This area is culturally sensitive.

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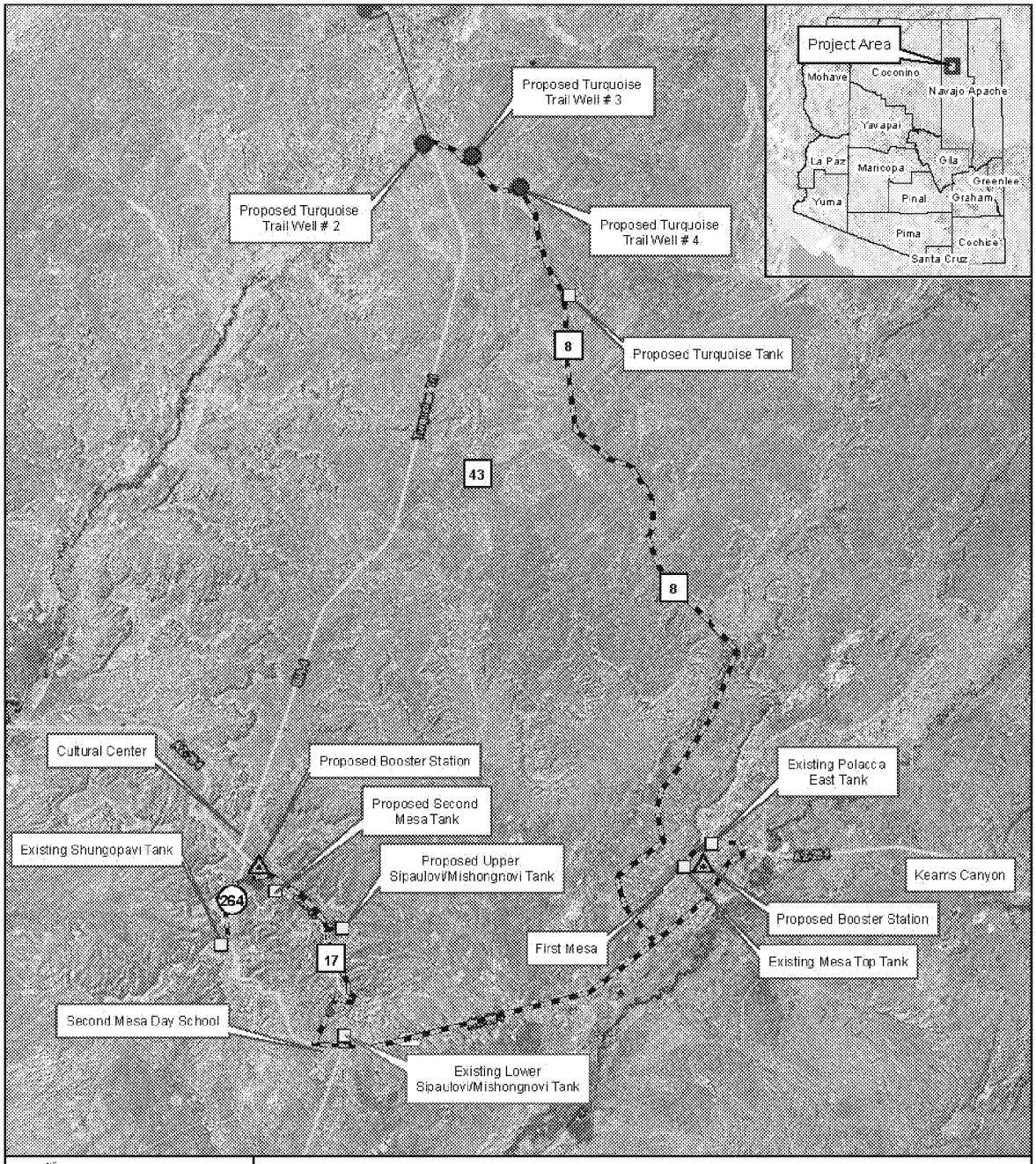

Figure 2.4
Alternative B

Legend

- Route B Waterline
- Booster Station
- Tank
- Well

0 1 2 4 Miles

0 2 4 8 Kilometers

N

1:150,000

Hopi Arsenic Mitigation Project, Hopi Indian Reservation, Navajo County, Arizona

Table 2.4 Alternative B Summary

Feature	Alternative B
Pipeline Route	Pipeline from the Turquoise Trail well field extends first to Turquoise Tank, continues to First Mesa, and then extends to Second Mesa.
Proposed Tanks	Three tanks: 500,000 gallon Turquoise Tank, 200,000 gallon Upper Sipaulovi/Mishongnovi Tank or booster station, and 500,000 gallon Second Mesa Tank.
Proposed Booster Stations	Three booster stations: First Mesa, Second Mesa, and Shungopavi on Second Mesa.
Length	32.2 miles of pipelines
Area	408 acres
Cost	$20.9 million
Technical Considerations	Lower operating pressures in well field. Large diameter pipe required to minimize head loss. High operating pressures at lower elevations along AZ 264.

2.6 Alternative C - Turquoise Trail with Pipeline to Second Mesa Then To First Mesa

Alternative C would develop the Turquoise Trail well field and convey water directly to a proposed water tank at Second Mesa. The well field would be developed in the same manner as Alternative A including well field communications and electric power. Test wells have been developed drilled at Wells #2 and #3. The wells are currently not permanent operational wells, and permanent well facilities would be constructed, including well house, communications, electric power, and connecting piping to the HAMP. The alignment would follow a south to southwest orientation towards Second Mesa (see Figure 2.5). At the southern end of Second Mesa, the pipeline alignment would divide with one alignment extending southwest to the proposed Shungopavi Booster Station and existing 250,000 gallon Shungopavi Tank. The second alignment would extend southeast to the proposed 200,000 gallon Upper Sipaulovi/Mishongnovi tank or booster station and extend south down the mesa edge to the existing 75,000 gallon Lower Sipaulovi/Mishongnovi tank.

The second alignment would continue in an east/northeast direction along AZ 264. At First Mesa, the alignment would loop north and then west to connect with the existing 500,000-gallon Polacca East Tank, proposed First Mesa Booster, and existing 10,000 gallon First Mesa Top Tank (Pollaca West Tank) (see alternative summary in Table 2.5).

Conveying water directly from the well field through a single linear pipeline to Second Mesa would result in increased head losses, and the highest well field operating pressures. Alternative C would pump the entire system demand to the higher elevation needed to serve Second Mesa and then would reduce the pressure to serve First Mesa. This operational approach is energy inefficient because all water is pumped to an elevated tank at Second Mesa. Subsequently, water conveyed to First Mesa would be run through a pressure-reducing valve, effectively wasting the pressure/energy stored in the system. With the majority of the system demand at First Mesa, pumping the entire system demand to the higher elevation at Second Mesa is not an optimal use of energy. As with Alternative B, the Second Mesa Tank would be constructed since the nearby existing elevated Shungopavi tank belongs to the village of Shungopavi and cannot be used for regional water system storage.

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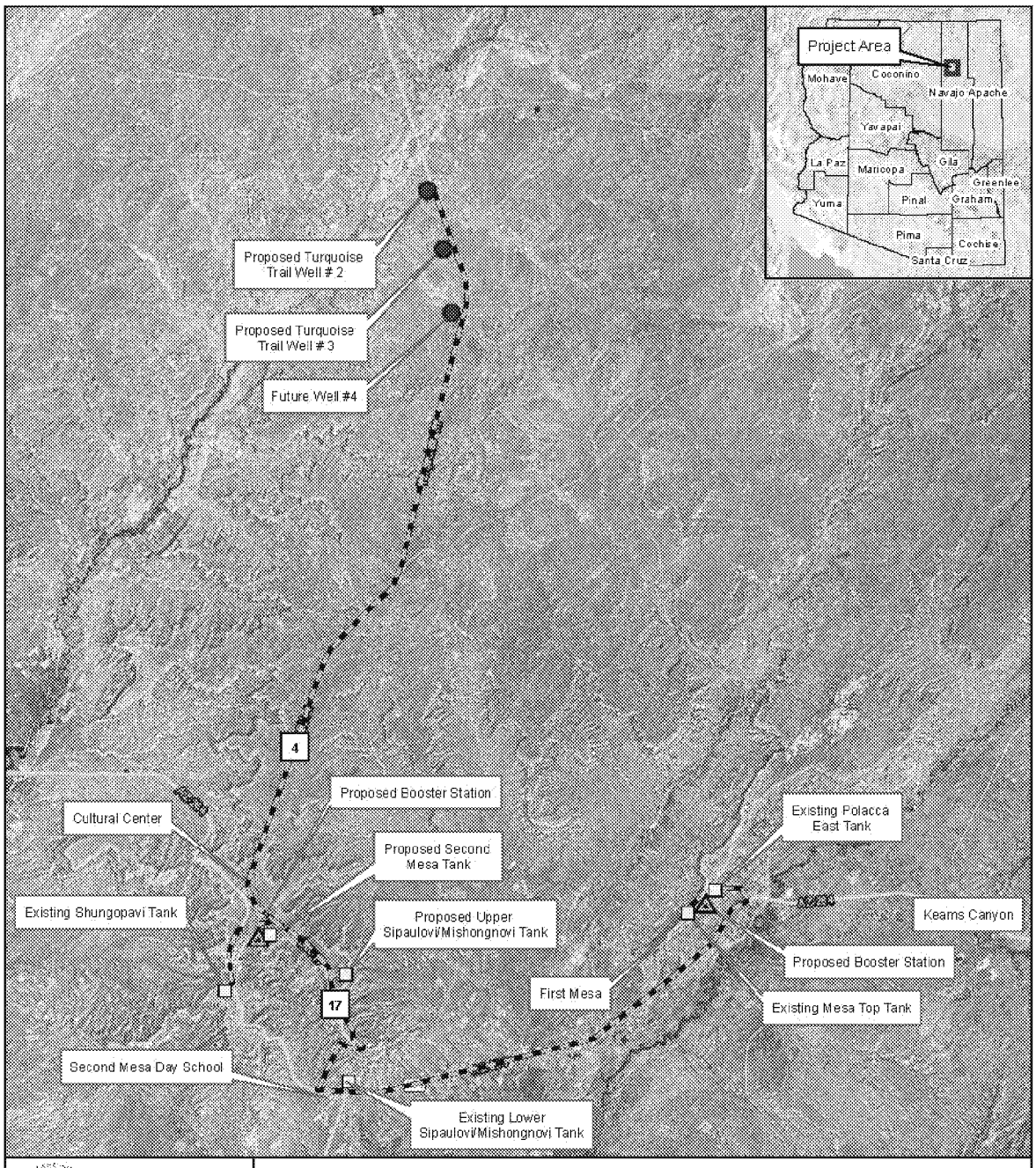

Figure 2.5
Alternative C

Legend

- Route C Waterline
- Booster Station
- Tank
- Well

0 1 2 4 Miles

0 2 4 8 Kilometers

N

1:150,000

Hopi Arsenic Mitigation Project, Hopi Indian Reservation, Navajo County, Arizona

Table 2.5 Alternative C Summary

Feature	Alternative C
Pipeline Route	Pipeline from the Turquoise Trail well field extends directly to Second Mesa and then extends to First Mesa.
Proposed Tanks	Two tanks: 200,000 gallon Upper Sipaulovi/Mishongnovi Tank or booster station and Second Mesa Tank.
Proposed Booster Stations	Two booster stations: First Mesa, and Shungopavi on Second Mesa.
Length	29.0 miles of pipelines
Area	350 acres
Cost	$17.7 million
Technical Considerations	High operating pressures in the vicinity of the Turquoise Trail well field. The operational scheme is least energy efficient by pumping water to Second Mesa and then using pressure reducing valves while conveying water to First Mesa with higher operating costs.

Alternative C would traverse Hopi Partition Lands, District 6, village land, BIA right-of-way, and ADOT right-of-way. The elevated storage tank at Second Mesa is located in an area claimed by multiple villages, and this tank site may be controversial. Much of alignment follows established roadways mostly within BIA and ADOT rights-of-way.

2.7 No Action Alternative

Under the No Action Alternative, the HAMP would not be developed. Proposed tanks, pipelines between the well field and First and Second Mesas, booster stations, and other tanks would not be constructed. Two wells in the Turquoise Trail well field have been drilled, but additional wells would not be drilled. Nevertheless, Hopi villages would need to take some actions to meet the USEPA 10 ppb arsenic standard. The established compliance deadline is January 23, 2015. It is expected that each village would have to move forward with a treatment option for the individual village water systems.

In June 2006, the Hopi Tribe received a USEPA Drinking Water Tribal Set-Aside (DWTSA) grant to conduct a feasibility study on arsenic mitigation compliance strategies (IHS Project # PH06-D33). After initial compilation of water quality data and available arsenic treatment technologies, it was determined that arsenic treatment would be difficult because of region-specific conditions. The following conditions would create challenges for the Hopi Tribe and especially to the managers of individual village water systems: complex water chemistry, high operations and maintenance costs, compliance monitoring and required operator certification levels, and technical requirements for an arsenic treatment system. Three specific treatment challenges are summarized below: pH level, arsenic speciation, and competing ions.

In terms of pH, Hopi water wells have high ambient pH levels and moderate alkalinity. Arsenic treatment technologies operate most efficiently with pH levels close to neutral, therefore substantial pretreatment adjustment would be required for effective arsenic removal. Introduction of more corrosive lower pH water into distribution systems that have historically conveyed high pH, scale forming water, could lead to operational and water quality issues. Careful management would be needed to prevent corrosion or dissolution of existing scale deposits.

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In terms of arsenic speciation, arsenic measured in the First Mesa and Shungopavi wells consisted of arsenite, a trivalent arsenic form. For treatment, arsenic needs to be in a pentavalent form such as arsenate. Arsenic removal technologies would require that arsenite be transformed into arsenate through oxidation by using a strong oxidizer such as potassium permanganate or chlorine. This would add another chemical addition and step to arsenic treatment.

And finally, regarding competing ions, groundwater in the First and Second Mesa regions contain several of the primary constituents that make up the anions that compete with arsenic for removal. Of primary concern is the excessively high level of vanadium found in the Second Mesa water. Vanadium found in the Sipaulovi wells is approximately 100 times greater than levels typically measured in groundwater. At these levels, the vanadium content will affect the arsenic removal efficiency and media service life of adsorption technologies.

If a village was unable to implement an arsenic treatment option, the village would need to make other modifications to their water system since the system would not meet the 10 ppb standard under the Safe Drinking Water Act. Bottled water would need to be provided to village residents for drinking, cooking, washing, and other purposes. Providing bottled water would be very expensive with costs for purchasing water, transporting water to the village, and disposing of used bottles. There would be increased energy expenditures used to fuel vehicles to transport water to the villages and transport used bottles away from the villages.

2.8 Future Alternatives

It is anticipated that NTUA or APS electric transmission and distribution lines would provide power to the HAMP. The transmission and distribution line routes and substation locations have not been established. A supplemental EA would be prepared to evaluate the environmental effects of the electric facilities. Biological and cultural resource field surveys would study the project area covered by this future alternative.

During the HAMP project development process, the opportunity to incorporate BIA and Bureau of Indian Education (BIE) water systems was considered (IHS, 2014). BIA/BIE owns and operates three water systems at Keams Canyon, Hopi Junior/Senior High School, and Second Mesa Day School. The three systems have water sources that exceed the 10 ppm USEPA standard: approximately 40 ppb at Keams Canyon, approximately 18 ppb at Hopi Junior/Senior High School, and approximately 17 ppb at Second Mesa Day School. The Keams Canyon system consists of two supply wells, a booster pump station, two water storage tanks, an 8 inch asbestos cement transmission main, distribution system, and a new arsenic treatment system. The Hopi Junior/Senior High school system consists of two supply wells, a reverse osmosis treatment facility, PVC distribution system, 250,000 gallon elevated water storage tank, and brine storage/evaporation ponds. The BIA Second Mesa Day School system consists of one supply well, an adsorption arsenic treatment facility, 50,000 gallon water storage tank, booster pump, and distribution system. The 2013 reported annual average production volumes for the systems were 3.4 gpm for Second Mesa Day School, 40.9 gpm for Keams Canyon, and 12.4 gpm for Hopi Junior/Senior High School (IHS, 2014).

In the future, the three BIA/BIE water systems may be connected to the HAMP as part of a future project. The HAMP pipelines discussed in this EA would be sized during final design to allow for future connections to the BIA/BIE water systems. Additional storage capacity and a future well would be developed to ensure adequate water supplies. A partnership would be developed to address

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construction/capital cost sharing, service agreement details, fee structure and rates, right-of-way acquisition, and cost effectiveness. A supplemental EA would be prepared to evaluate the environmental effects of connecting the HAMP to the BIA/BIE water systems. Biological and cultural resource field surveys would study the project area covered by this future alternative.

2.9 Evaluation of Alternatives

The 2012 draft PER evaluated the alternatives (IHS, 2012). The No Action alternative was eliminated. If no modifications were made to existing water systems, the USEPA arsenic standard of 10 ppb would not be met. The Hopi Tribe would be subject to USEPA action, and most important, Hopi residents would continue to be exposed to high arsenic levels in their drinking water. If the No Action Alternative resulted in the implementation of the treatment option for individual water systems, the villages would have to implement expensive and sophisticated arsenic treatment technologies on each water system. The PER determined that the arsenic treatment systems would prove burdensome and that arsenic compliance issues would likely persist.

The 2012 draft PER evaluated the action alternatives using a decision scoring system. The scoring system used the following evaluation criteria: public health impact, village concurrence, Tribal Council concurrence, ease of operation, construction cost, operating costs (pumping), schedule, right-of-way and realty issues, funding acquisition, biological resources, cultural resources, drainage/floodplain, visual impacts, Safe Drinking Water Act compliance, socio-economic considerations, planning progress to-date, and water rights (see Table 2.6). Using this decision matrix, the action alternatives were scored. Alternative A received the highest score of 348. Alternative C received a score of 296.25, and Alternative B received a score of 289. Revised Alternative A was selected because it is the lowest cost alternative and its pipeline alignments are acceptable to the Hopi Tribal Council and Hopi Villages. Additionally, key reasons for selecting Alternative A as revised included:

- The public and stakeholders are supportive of Alternative A. Proposing a different alternative would require substantial additional public outreach.
- Alternative A would minimize potential village land issues and disputes by constructing separate pipelines to the First and Second Mesas.
- Alternative A makes extensive use of gravity water flow, and thus, minimizes the number of booster stations. Only one booster station is required. In addition, one of the proposed booster stations proposed under Alternative B would be located in a culturally sensitive area, which is not desirable.
- Alternative A avoids the need to construct along much of AZ 264, a key roadway link between First and Second Mesas. Construction would only occur along AZ 264 between the Hopi Cultural Center and the existing Shungopavi tank. Alternative A limits traffic disruptions during construction.
- The Hopi Tribal Council passed a Resolution supporting construction of the initial Alternative A.

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Table 2.6 Alternative Decision Matrix

Evaluation Criteria		Alternative A		Alternative B		Alternative C	
	Weighting Factor	Average	Average x Weight	Average	Average X Weight	Average	Average X Weight
Public Health	3	10	30	7.75	23.25	6.75	20.25
Village Concurrence	3	9.75	29.25	5.75	17.25	6.5	19.5
Tribal Council Concurrence	3	7.5	22.5	8.5	25.5	9.5	28.5
Ease of Operation	2	9.75	19.5	7.5	15	7.25	14.5
Construction Cost	2	8.75	17.5	7.5	15	9.25	18.5
Operating Costs (Pumping)	2	8.5	17	10	20	7.25	14.5
Schedule	3	10	30	6.5	19.5	7	21
Right-of-way/Realty Issues	1	9	9	7	7	9.25	9.25
Funding Acquisition	3	10	30	7.75	23.25	7.75	23.25
Biological Resources	1	7.75	7.75	7.75	7.75	8.25	8.25
Cultural Resources	1	8.25	8.25	7.5	7.5	9.25	9.25
Drainage/Floodplain	1	8.25	8.25	7.25	7.25	8	8
Visual Impacts	2	9	18	8	16	6.75	13.5
Safe Drinking Water Act	3	10	30	7.5	22.5	7.25	21.75
Socioeconomics	2	9.25	18.5	8.25	16.5	8.75	17.5
Planning Progress to Date	3	10	30	7	21	7	21
Water Rights	3	7.5	22.5	8.25	24.75	9.25	27.75
Total			348		289		296.25

Source: IHS (2012)

After Alternative A was selected, additional information was gathered and the design was further refined into Revised Alternative A. A more direct pipeline route was proposed. Tank and booster stations were adjusted to improve the performance of the water delivery system. A revised PER was prepared (IHS, 2014). Revised Alternative A was selected as the Preferred Alternative.

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3.0 Present Environment

Community Location

The villages of the First and Second Mesa of the Hopi Indian Reservation are included in the HAMP project planning area. First Mesa villages include Walpi, Tewa, Sichomovi, and a residential area known as Polacca. These three villages are referred to as the First Mesa Consolidated Villages (FMCV). Walpi, Tewa, and Sichomovi are located on the mesa top. Second Mesa villages include Sipaulovi, Mishongnovi, and Shungopavi. Sipaulovi and Mishongnovi have upper and lower village areas with the village areas located on the top of the mesa and the lower residential housing complexes and individual housing located on the southern base of the mesa.

Service Area

The HAMP project planning area is defined by the existing water systems on the Hopi Indian Reservation that do not meet Safe Drinking Water Act compliance standards for arsenic. None of the First and Second Mesa villages meet the Safe Drinking Water Act standard for arsenic and are included in the project planning area. All FMCV villages receive water from a common water utility using the same water sources and wells. Second Mesa, Sipaulovi and Mishongnovi receive water from a shared water system with one water system serving the upper portion of the villages and a separate system serving the lower residential and business areas.

The BIA operates three water systems in the HAMP planning area. A BIA water system in Keams Canyon services tribal residences, United States (U.S.) Government staff housing, the Hopi Police Station, and the BIA maintenance and administrative complex. Another BIA system services the Second Mesa Day School water system, and the third serves the Hopi Junior/Senior High School. The BIA operates water treatment systems to reduce arsenic at Hopi Junior/Senior High School and Second Mesa Day School. Another arsenic treatment system was recently installed for Keams Canyon and is now in operation. These BIA systems are not included in the HAMP at this time, and the HAMP has not been designed with adequate capacity to serve the three BIA systems. To serve the BIA systems, additional well and pipeline capacity would be required. The BIA, IHS, and the Tribe have drafted a planning agreement to further evaluate the possibility of the Tribe serving the BIA water systems through the HAMP. The planning project work would be accomplished by the IHS and would include publishing addendums to the PER and EA to include the BIA.

The following topics were eliminated from evaluation in this EA:

- Coastal zones and coastal barriers were eliminated from evaluation because the Hopi Reservation does not include any coastal areas.

3.1 Population

As is typical of rural Arizona, the Hopi Reservation has low population densities. People reside in a few dispersed communities. Data from the 2010 Census were obtained from the U.S. Census Bureau for Arizona, Navajo County, First Mesa, Second Mesa, Shungopavi, and Keams Canyon (see Table 3.1). At the time of the census, Arizona's population was 6,392,017, and Navajo County's population was 107,449. The local Hopi communities populations were 1,555 in First Mesa, 962 in Second Mesa, 831 in Shungopavi, and 304 in Keams Canyon. The Navajo County median age was 34.7 years, and the Arizona

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median age was 35.9 years. The communities had median ages ranging from 24.6 years in Shungopavi to 35.5 years in Keams Canyon.

Table 3.1 2010 Population Data

Characteristic	Arizona	Navajo County	First Mesa	Second Mesa	Shungopavi	Keams Canyon
2010 Population						
- Total Population	6,392,017	107,449	1,555	962	831	304
- Median Age	35.9 years	34.7 years	32.8 years	28.9 years	24.6 years	35.5 years
- Percent Under 18 Years of Age	25.5%	29.8%	30.9%	34.8%	38.4%	30.9%
- Percent Over 64 Years of Age	13.8%	13.3%	9.8%	7.5%	10.1%	10.5%
Percent Racial Composition						
- Native American	4.6%	43.4%	97.7%	95.7%	99.2%	88.8%
- White	73.0%	49.3%	1.4%	2.2%	0.1%	7.9%
- Black or African American	4.1%	0.9%	0.0%	0.2%	0.0%	0.3%
- Asian	2.8%	0.5%	0.3%	1.0%	0.1%	0.3%
- Native Hawaiian/Pacific Islander	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%
- Some Other Race	11.9%	3.4%	0.1%	0.0%	0.1%	0.0%
- Two or More Races	3.4%	2.5%	0.5%	0.8%	0.5%	2.6%
Other Group – Any Race						
- Percent Hispanic/Latino	29.6%	10.8%	1.0%	2.5%	1.4%	3.6%

Source: U.S. Census Bureau (2014)

In terms of racial composition, the communities had a larger Native American proportion than in Navajo County (43.4%) or Arizona (4.6%). The Native American proportions in the Hopi communities were 97.7% in First Mesa, 95.7% in Second Mesa, 99.2% in Shungopavi, and 88.8% in Keams Canyon. In the communities, all other racial groups and Hispanic/Latino were less than 8.0% and typically less than 1.0% as would be expected on the Hopi Reservation.

3.2 Topography

The project area consists of rolling to uneven terrain. Somewhat level to slightly sloping terrain occurs on mesa tops and in valley bottoms. Steep slopes occur on the edges of the mesas. In general elevations range from 5,800 to 6,300 feet. The proposed Turquoise well field at the northern end of the project area is approximately 5,900-6,000 feet in elevation.

3.3 Geology

The project area is located on the Black Mesa portion of the Colorado Plateau Physiographic province. This province extends across northeastern Arizona, southeastern Utah, southwestern Colorado, and northwestern New Mexico. The plateau is made up of layers of sedimentary rock formed by sediment deposits from the presence, retreat, and return of seas (Chronic, 1987; Kennedy/Jenks, 2011). Erosion has resulted in mesas, buttes, and other rock outcrops separated by open plains and rolling terrain. Approximately 4,000 feet of limestone, mudstone, siltstone, and sandstone were deposited during the Paleozoic, Mesozoic, and Cenozoic eras. On the Hopi Reservation, the principal geographic formations and groups starting at the ground surface by geologic area include:

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- Quaternary and Tertiary - volcanic rock;
- Tertiary – Bidahochi Formation;
- Cretaceous – Mesa Verde Group and Mancos Shale;
- Jurassic – Dakota Sandstone, Morrison Formation, Entrada Formation, Carmel Formation, Navajo Sandstone, Keyenta Formation, and Wingate Sandstone;
- Triassic – Chinle Formation, Moenkopi Formation, and Kaibab Limestone; and
- Permian – Coconino Sandstone and Supai Formation or Group (Kennedy/Jenks, 2011).

Mineral resources on the Hopi Reservation include coal, sand, gravel, and clay. Coal is confined to the Dakota Sandstone, Toreva Formation, and Wepo Formation. Undiscovered oil and gas, metallic, and uranium resources may be present (Thompson and Dupree, 1987).

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3.4 Soils

Soils in the project area tend to have sandy textures such as sands and sandy loams. Clay loams are present in a few areas, and rock outcrops are also found in the project area (see Table 3.2). The most common soil mapping unit is the Penistaja-Begay complex followed by the Jeddito loamy sand. The soil mapping units most vulnerable to wind erosion are the Mido fine sand and Sheppard sand. The soil mapping units most vulnerable to water erosion are the Hano fine sandy loam, Mido-Begay complex, and Tewa very fine sandy loam.

Table 3.2 Soil Mapping Units

	Slopes	Major Soil Type >10% of Project Area	Common Soil Type 2-10% of Project Area	Minor Soil Type <2% of Project Area	Wind Erosion Risk (tons of soil/acre/year)	Water Erosion Risk (K factor)*
Cannonville clay loam	15-50%			X	86	.28
Hano fine sandy loam	2-10%			X	86	.37
Ives fine sandy loam	0-2%		X		86	.24
Jeddito loamy sand	0-5%	X			134	.15
Jocity fine sandy loam	0-3%		X		86	.28
Kydestea-Zyme-Tonalea complex	5-50%		X		0	.15
Mido fine sand	1-15%		X		220	.17
Mido-Begay complex	1-8%		X		134	.37
Naha loamy sand	0-3%			X	134	.15
Penistaja-Begay complex	1-8%	X			86	.28
Polacca clay loam	0-3%		X		86	.28
Querencia clay loam	0-3%			X	48	.32
Rock outcrop-Torrieorthents complex	5-60%		X		0	0
Sheppard loamy sand	1-15%			X	134	.15
Sheppard sand	1-12%		X		220	.10
Tewa very fine sandy loam	1-5%		X		86	.37
Torrifluents	0-2%			X	0	0
Travessilla-Rock outcrop complex	1-8%		X		86	.32
Ustic Torriorthents	10-35%		X		0	0

**K factor indicates the susceptibility of a soil to sheet and rill erosion by water. K values range from 0.02 to 0.69. The higher the K value, the more susceptible the soil is to sheet and rill erosion. Source: Natural Resources Conservation Service (2012).*

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3.5 Climate and Air Quality

Climate near the project area is arid. Summers are dry and hot with precipitation occurring mostly in July and August, months that typically receive more than one inch of precipitation. Temperature data was obtained for Polacca, Arizona, and rainfall for Winslow, which is the nearest station with precipitation data. Polacca's average monthly minimal temperatures range from 18°F in January to 56°F in July. Average monthly maximum temperatures range from 45°F in January to 89°F in July. Winslow receives an average of 9.73 inches of precipitation annually. The most precipitation occurs in August (1.59 inches) and the least in June (0.21 inches) (Weather.com, 2012). Snowfall occurs occasionally during the winter months. Extensive periods of sunshine, low humidity, and winds result in high evaporation rates.

Global climate change has been identified as an environmental issue of increasing concern. Increased atmospheric concentration of greenhouse gases, such as carbon dioxide, are correlated with increasing global surface temperatures documented since the mid-1800s. If these trends continue, land surface, hydrologic, and other environmental conditions are expected to change (International Panel on Climate Change, 2007; USEPA, 2010).

The USEPA regulates six air pollutants for which standards for safe levels of exposure have been set under the Clean Air Act of 1990 (CAA): ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb). These pollutants are called "criteria pollutants." Hazardous and other toxic air pollutants, including mercury, are regulated under the CAA Amendments of 1990. For each criteria pollutant, the maximum concentration above which adverse effects on human health may occur are called National Ambient Air Quality Standards (NAAQS). Areas of the country where air pollution levels persistently exceed the NAAQS may be designated "nonattainment."

The CAA further classifies ozone, carbon monoxide, and some particulate matter nonattainment areas based on the magnitude of an area's problem. Nonattainment classifications may be used to specify what air pollution reduction measures an area must adopt, and when the area must reach attainment (40 CFR 81).

Ozone is a highly reactive and unstable gas and is found as an ingredient in smog. It poses a health concern because it is capable of damaging the lining of the respiratory tract. Exposure to levels above the current ambient air quality standard can cause long-term inflammation and tissue damage causing impaired lung functioning. Symptoms of ozone exposure are coughing, chest tightness, shortness of breath, and increased asthma symptoms. The greatest risk is to people who spend large amounts of time outdoors during periods of heavy smog. Elevated ozone can also damage rubber, plastics and fabrics, and reduce crop yields. Ozone forms in the atmosphere from chemicals, such as hydrocarbons and nitrogen oxides, emitted from vehicles, industrial plants, and other sources.

Particulate matter includes both solid particles and liquid droplets found in the air. Particles less than 10 micrometers in diameter (PM_{10}) pose a health concern because they can be inhaled into and accumulate in the respiratory system. Sources of coarse particles include crushing and grinding operations, and dust from paved or unpaved roads and construction activities. Dust is a sensitive issue in the area, as winds speeds are generally high with much dust generated.

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The USEPA is responsible for ensuring that air quality on Indian Reservations protects public health and welfare. The project area located in Navajo County, AZ is in attainment for USEPA regulated pollutants. Under the USEPA's General Conformity Rule, Federal agencies are required to prepare a written conformity analysis and determination for proposed activities where the total of direct and indirect emissions of a non-attainment or maintenance criteria pollutant caused by the activity will exceed the threshold emission levels specified under the CAA.

3.6 Wetlands

Wetlands are locations with characteristic hydrologic soils, wetland vegetation, and wetland indicators. Wetlands provide important wildlife habitat, store surface water, and can help improve water quality by trapping sediment and contaminants. Wetlands are identified by indicators as defined in the *1987 Corps of Engineers Wetland Delineation Manual* (U.S. Army Corps of Engineers, 1987). Because of limited water sources, few wetlands are present within the Hopi Reservation, and wetlands are not present within the project area.

3.7 Groundwater Resources, Including Sole Source Aquifers

Three aquifers have been identified at the Hopi Reservation. The Dakota Aquifer includes Dakota Sandstone, Morrison Formation, Entrada Sandstone, and Carmel Formation. It is a shallow aquifer that has limited use as a groundwater source. Groundwater in the Dakota Aquifer is elevated in fluoride, sulfur, and total dissolved solids (TDS) especially in the southeastern part of the Hopi Reservation. The Carmel Formation separates the Dakota Aquifer from the Navajo Aquifer, which is situated below the Carmel Formation. The Navajo Aquifer includes Navajo Sandstone, Kayenta Formation, Moenave Formation, and Wingate Sandstone. It is an important water source and would be the source of water for the HAMP. The Coconino Aquifer includes the Chinle Formation, Coconino Sandstone, and Kaibab Limestone, and Supai Formation. It is the deepest aquifer, but it is not used because of poor quality (Kennedy/Jenks, 2011).

Vanadium and other minerals are present in the groundwater and can interfere with arsenic treatment. Vanadium found in the Sipaulovi wells is approximately 100 times greater than levels typically measured in groundwater. At these levels, the vanadium content will affect the arsenic removal efficiency and media service life of adsorption technologies if arsenic treatment is used.

Water systems in the Hopi Reservation's First and Second Mesa regions do not meet the USEPA's 10 ppb arsenic standard. Arsenic concentrations in this area range from 15 ppb to 40 ppb. In January 2001, the USEPA reduced the arsenic maximum contaminant level (MCL) from 50 ppb to 10 ppb. Effective 2006, all public water systems were required to meet this revised standard under the Safe Drinking Water Act.

In the Turquoise Trail well area, groundwater quality from the Navajo Aquifer is considered quite good. There were no detected exceedances of the primary MCLs under the Safe Drinking Water Act, and the only exceedances detected for the secondary MCLs were for pH (Kennedy/Jenks, 2011). Testing of Turquoise Trail Wells #2 and #3 found that arsenic levels were well below the MCLs. Well #2 had an arsenic level of 4.7 ppb, and Well #3 had an arsenic level of 4.2 ppb (John Shomaker and Associates, Inc., 2014).

Sole Source Aquifers are designated by the USEPA under the Safe Drinking Water Act. Federally assisted projects are subject to USEPA environmental review to determine if the project has the potential to

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contaminate a sole source aquifer. No sole source aquifers have been designated on the Hopi Reservation. The nearest sole source aquifer is the Upper Santa Cruz and Aura Basin Aquifer located over 250 miles south of the Hopi Reservation in southern Arizona.

3.8 Floodplains

The alternative pipeline routes cross several drainages where seasonal flooding occurs. Since the Hopi Reservation has not been floodplain mapped by the Federal Emergency Management Agency (FEMA), the potential for a 100-year flood (1% probability) was analyzed by IHS consultants for the Oraibi Wash, Wepo Wash, and Wepo Wash Tributary (Bohannan-Huston, 2012). The 100-year discharge for three washes was calculated as 24,100 cubic feet per second (cfs) for Oraibi Wash, 16,700 cfs for Wepo Wash, and 4,150 cfs for Wepo Tributary Wash (see Appendix C for floodplain documentation).

3.9 Wild and Scenic Rivers

Wild and Scenic Rivers are designated under the Wild and Scenic Rivers Act of 1968. The designation is intended to protect a river's outstanding remarkable values and free-flowing character. No designated Wild and Scenic Rivers are located on the Hopi Reservation (American Rivers, 2012). According to the National Park Service website, the nearest designated Wild and Scenic River is the Verde River in central Arizona, located over 100 miles south of the project area. The Verde River flows southeasterly for 180 miles from the Chino Valley in Yavapai County to the confluence with the Salt River near Phoenix.

3.10 Wilderness Areas

Wilderness areas are protected under the Wilderness Act of 1964, and specific wilderness areas are designated by Congressional acts. In general, the wilderness designation prohibits motorized and mechanized vehicles, timber harvesting, new grazing and mining activity, or any kind of development. No wilderness areas are located on the Hopi Indian Reservation including the project area.

3.11 Vegetation

Vegetation on the Hopi Reservation is predominantly grassland and shrubland in most areas. Scattered coniferous trees grow in higher elevation areas. According to the Gap Vegetation map for Arizona, four vegetation types occur in the project area: (1) Nearctic Upland, Cold Temperate Grassland, (Shrub-Grass) Disclimax Series consists of short-bunch grasses and half shrubs in open irregularly spaced stands. (2) Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Mixed Scrub Series consists of mixed evergreen scrub and deciduous shrubs with succulents (yucca). (3) Neactic Upland, Cold Temperate Desertland Great Basin Desertscub, Shadscale Series consists of open stands of evergreen gray-green scrub with scattered perennial grasses; and (4) Nearctic Upland, Cold Temperate Forest and Woodland, Great Basin Conifer Woodland, Pinyon–Juniper Series consists of evergreen trees, half shrubs, and a reduced perennial grass cover (Bennett et al., 2012). The Cold Temperate Grassland is the most common vegetation type (see Table 3.3). A small area of agricultural land is also present along AZ 264.

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Table 3.3 Vegetation Types

Vegetation Type	Alternative A Percent of Project Area	Revised Alternative A Percent of Project Area	Alternative B Percent of Project Area	Alternative C Percent of Project Area
Map Figures (see Appendix B)	B.1, B.2, B.3	B.4, B.5, B.6	B.7, B.8, B.9	B.10, B.11
Nearctic Upland, Cold Temperate Grassland, Plains, (Shrub-Grass) Disclimax Series	82.5%	81.5%	81.2%	88.5%
Neactic Upland, Cold Temperate Desertland, Great Basin Desert Scrub, Mixed Scrub Series	5.0%	4.8%	3.3%	2.3%
Nearctic Upland, Cold Temperate Desertland, Great Basin Desertscrub, Shadscale Series	8.5%	8.7%	10.2%	2.8%
Nearctic Upland, Cold Temperate Forest and Woodland, Great Basin Conifer Woodland, Pinyon-Juniper Series	4.0%	5.0%	4.7%	5.7%
Agricultural Land	0%	0%	0.6%	0.7%

Source: Bennett et al. (2012) and calculations by Marron and Associates

Based on a field survey, vegetation in the project area consists of desert grassland, shrubland, and juniper woodland. Common grasses include blue grama, alkali sakaton, sand dropseed, and galleta. A wide variety of forbs are present such as globemallow, tansy mustard, spiny phlox, and kochia. Several shrubs are also present such as sand sagebrush, big sagebrush, and rabbitbrush. At higher elevations, woodland vegetation occurs dominated by Utah juniper and pinyon. A botanical survey of the project area was conducted, and the species list from the survey is included in Appendix B (Sahmea, 2012).

Based on the EA prepared for the Management of Noxious/Invasive Weeds on the Hopi Reservation, there are three classifications used for noxious and invasive weeds on the Hopi Reservation: high priority – new invaders, medium priority – established new invaders, and low priority widespread invaders (Balenquah, 2010). The botanical survey identified 10 noxious/invasive weed species growing in the project area: camelthorn, Russian knapweed, field bindweed, Russian olive, saltcedar (tamarisk), cheatgrass, kochia, Russian thistle, death camas, and locoweed. Camelthorn and Russian knapweed are classified as high priority – new invaders. This classification includes noxious/invasive weeds that have not been detected on the Hopi Reservation or may be found in small, scattered, and localized infestations. Management criteria include public awareness and education, prevention of introduction into non-infested areas, early detection, and immediate action to eradicate infestations. Field bindweed, Russian olive, and saltcedar are classified as medium priority – established new invaders. This category includes noxious/invasive weeds that have recently been introduced onto the Hopi Reservation and are rapidly spreading from current infestation sites. Management criteria include awareness and education, prevention of movement into non-infested areas, monitoring, and containment of known infestations, and eradication where possible. Cheatgrass, kochia, and Russian thistle are classified as low priority – widespread invaders. This category includes generally widespread noxious/invasive weeds. Management criteria include public awareness and education, containment and suppression of existing infestations, and prevention of new infestations. Death camas and locoweed are not classified.

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3.12 Fish and Wildlife

Wildlife populations in the project area are limited due to the arid climate and absence of water sources. No permanent or regularly flowing water is present within the project area; thus, fish are not found in the project area. Mammals are limited to those adapted to an arid environment such as black-tailed jackrabbit, desert cottontail, Ord's kangaroo rat, and coyote. A variety of birds may occur such as turkey vulture, Swainson's hawk, western kingbird, and common raven. Reptiles include several rattlesnakes such as the western rattlesnake and lizards such as the lesser earless lizard (Arizona Field Ornithologists, 2005; Behler and King, 1979; Carothers, 1988; and Whitaker, 1980). The Hopi Wildlife and Ecosystems Management Program (Hopi WEMP) identified golden eagle (*Aquila chrysaetos*) and red-tailed hawk (*Buteo jamaicensis*) habitat in the Alternative A and Alternative B project areas as well as along the waterline reroute on Indian Route 8 for Revised Alternative A. These species are considered sacred to the Hopi and protected under the Hopi Constitution. Their feathers are used for ceremonial and cultural purposes. No breeding areas for these species are located in the Alternative C project area (Talayumptewa, 2012 and 2014; see Appendix B). Golden eagles and red-tailed hawks commonly forage on small mammals, snakes and lizards.

3.13 Endangered or Threatened Species

The U.S. Fish and Wildlife Service (USFWS) lists 15 endangered, threatened, and candidate species, but the American peregrine falcon has been delisted (see Table 3.4). Plant and animal surveys of the project area were conducted, but no endangered or threatened species were observed. The California condor could potentially fly over the project area and occurs regularly in the Vermillion Cliffs area, approximately 80 miles northwest of the project area.

Table 3.4 Federal Endangered and Threatened Species Listed in Navajo County

Species	USFWS Status	Habitat
Mammals		
Black-footed ferret *(Mustela nigripes)*	Threatened	Grassland plains with prairie dog towns at less than 5,000 feet elevation. No wild populations exist in Arizona including the Hopi Reservation.
Mexican gray wolf *(Canis lupis baileyi)*	Endangered	Chaparral, woodland, and forested area at 4,000 to 12,000 feet. May cross deserts. Experimental non-essential population in Arizona, but no wolfs known to occur on Hopi Reservation.
Birds		
American peregrine falcon *(Falco peregrinus anatum)*	Delisted	Areas with rocky, steep cliffs primarily near water. Nests on ledges of cliffs, tall buildings, and bridge abutments. Could occur near project area, but species has recovered.
California condor *(Gymnogyps californianus)*	Endangered	High desert canyons and plateaus. Experimental non-essential area designated for southern Utah and northern Arizona including the Hopi Reservation.
Mexican spotted owl *(Strix occidentalis lucida)*	Threatened	Nests in canyons and dense forests with multi-layered foliage from 4,100 to 9,000 feet. No suitable habitat in project area.
Southwestern willow flycatcher *(Empidonax traillii extimus)*	Endangered	Cottonwood/willow and tamarisk vegetation along rivers and stream at less than 8,500 feet. No suitable habitat in project area.
Yellow-billed cuckoo *(Coccyzus americanus)*	Candidate	Large areas of cottonwood, willow, and tamarisk riparian vegetation. Can migrate outside of riparian area. No suitable habitat in project area.

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Species	USFWS Status	Habitat
Reptiles		
Northern Mexican gartersnake *(Thamnophis eques matalops)*	Candidate	Wetlands, stock tanks, and larger river riparian forests from 130 to 8,500 feet. No suitable habitat in project area.
Amphibians		
Chiracahua leopard frog *(Lithobates chiricahuensis)*	Threatened	Springs, livestock tanks, and streams in upper watersheds from 3,280 to 8,890 feet. No suitable habitat in project area.
Fish		
Apache trout *(Onchorhynchus gilae apache)*	Threatened	Streams and rivers generally above 6,000 feet with adequate stream flow and shading. No suitable habitat in project area.
Little Colorado spinedace *(Lepidomeda vittata)*	Threatened	Moderate to small streams from 4,000 to 8,000 feet. No suitable habitat in project area.
Loach minnow *(Tiaroga cobitis)*	Endangered	Small to large perennial streams below 8,000 feet. No suitable habitat in project area.
Roundtail chub *(Gila robusta)*	Candidate	Cool to warm waters of rivers and streams from 1,000 to 7,500 feet. No suitable habitat in project area.
Plants		
Navajo sedge *(Carex specuicola)*	Threatened	Silty soils at shady seeps and springs from 5,700 to 6,000 feet. No suitable habitat in project area, and no populations located during botanical survey.
Peebles Navajo cactus *(Pediocactus peeblesianus var. peeblesianus)*	Endangered	Gravely soils of the Shinarump conglomerate of the Chinle formation from 5,400 to 5,600 feet. No suitable habitat in project area, and no populations located during botanical survey.

Source: USFWS (2012)

3.14 Environmentally Sensitive Areas

Environmentally sensitive areas require attention in the design, construction, or operations. Three main types of environmentally sensitive areas are present in the project: slope sensitive areas, culturally sensitive areas, and noise sensitive areas. Slope sensitive areas are located along the sides of First and Second Mesa. Routing of water pipelines across some steeply sloped areas has the potential for erosion and land subsidence. Culturally sensitive areas are identified by the Hopi Tribe and villages. Project facilities should avoid such areas where possible.

Noise is often defined as unwanted sound. The human ear can detect a wide range of sounds, but typically has reduced sensitivity to those of very low or very high pitch. Sound intensity is measured in decibels. Because the decibel (dB) scale does not accurately reflect the sound exposure levels heard by a human listener, a weighted scale (dBA) is used. Normal speech has a sound level of approximately 60 dBA. Sound levels above 120 dBA begin to be felt inside the human ear as discomfort, and eventually pain at higher levels. Noise sensitive areas are primarily residences and schools located near proposed construction areas. Noise abatement measures may be needed where construction is proposed near residences or schools. Existing ambient noise levels are below 65 decibels (dBA) since: (1) nearby roadways do not have continuous traffic; (2) the project area is not within 15 miles of an airfield with more than 9,000 carrier operations annually; and (3) the project area is not within 3,000 feet of a railroad.

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3.15 National Natural Landmarks

The National Natural Land Program was established by the Secretary of Interior in order to identify and encourage the preservation of geological and biological features that represent nationally important examples of the Nation's natural heritage. One National Natural Landmark is located in Navajo County, Comb Ridge, but no National Natural Landmarks are located on the Hopi Reservation (National Park Service, 2009 and 2012).

3.16 Historic, Prehistoric, Architectural, Archaeological, and Cultural Sites

The Hopi people have a long history of occupation of a large region of northeastern Arizona known as Hopi Tutskwa, or Hopi indigenous land base. The project area was surveyed for cultural resources in order to comply with Section 106 of the National Historic Preservation Act. A total of 38 cultural resource sites were identified, of which 24 were located outside of the project area (Yeatts, 2013). No additional sites were located during the surveys for new areas included in Revised Alternative A (Yeatts, 2014a and 2014b). During project planning, the project area limits were adjusted to avoid known archaeological sites. Consultation was also conducted with the Hopi Tribe and Hopi villages to identify TCPs. The project area limits were adjusted to avoid recognized TCPs.

3.17 Aesthetic and Visual Resources

The Hopi Reservation is characterized by open landscapes. The visual environment consists of open land, broad valleys, low hills, and mesas. Most of the landscapes have varying colors of tan and light brown. Some rock outcrops have reddish and dark brown hues. Dark green juniper and pinyon trees add some contrasting color. First and Second Mesas are distinctive Hopi landscapes that have cultural and spiritual importance to the Hopi Tribe (see Figure 3.1). The mesa edges provide good viewpoints to see surrounding lands. The location of villages on the mesas incorporates views of and from the mesas into the daily lives of Hopi residents. Most developed areas are located at the southern ends of First and Second Mesa and near AZ 264. The landscapes in these areas are slightly disturbed. Areas in the middle and northern part of the project area have little disturbance.

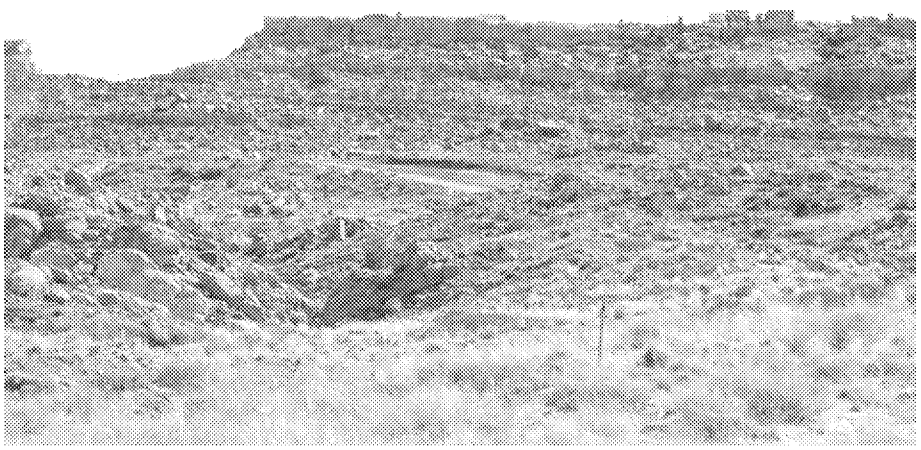

Figure 3.1 Mesa slopes and rock formations are a distinctive part of the Hopi landscape.

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3.18 Hazardous Materials, Toxic, Radioactive, and Solid Waste Materials

Hazardous materials, toxic, radioactive, and solid waste materials are regulated under various federal laws such as the Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). No current or proposed Superfund sites under CERCLA are located on the Hopi Reservation (USEPA, 2012c), although the Tuba City Open Dump (located approximately 45 miles northwest of the project area) is being remediated through a CERCLA process. No RCRA Corrective Action sites are located on the Hopi Reservation (USEPA, 2012d), and no hazardous waste generators are listed by USEPA (2012e). The Hopi Solid Waste Landfill is located more than one mile north of the project area near the Orabi Wash. Solid waste transfer stations are provided on the Hopi Reservation. The Agency for Toxic Substance and Disease Registry (2006) identified sheep dip vats as a health risk on the Hopi Reservation. Individuals could be exposed to toxaphene if they regularly visited a concrete sheep dip vat location. No sheep dip vats have been found in the project area, but they likely occur in areas near the project area. Undocumented accidental fuels spills may have occurred along AZ 264 and other roadways, but no records of fuel spills were obtainable.

The project area is not known to have any environmental contaminant concern. There is no distressed vegetation (except due to dry conditions); vent or fill pipes; oil storage tanks or questionable containers; pits, ponds, or lagoons; stained soil or pavement (other than water stains); pungent, foul, or noxious odors; dumped material or soil; or mounds of dirt, rubble, or fill. Based on available information, no part of the project area has ever been used for a gas station, vehicle repair shop, car dealership, auto garage, depot, commercial printing facility, industrial or commercial warehouse, dry cleaning establishment, photo developing laboratory, hospital, junkyard, landfill, agricultural or farming operations, tannery, or confined animal feeding operation.

Chlorine is used for water treatment in some villages, but usually does not pose a risk if stored in appropriate facilities. No use or storage of radioactive materials is known to occur in the project area. Naturally occurring uranium deposits and radon sources may be present in geologic formations underlying the project area. Uranium mining occurred in dispersed locations in the Colorado Plateau during the 1950s and 1960s, but no former uranium mines or mills are known to occur in the project area. It is possible that undiscovered areas of illegal dumping are present.

3.19 Present Land Use, Status and Related Facilities

Historically, the Hopi Reservation lands were best suited to dry-farming agriculture and livestock grazing. Hopi have a long history of dry farming of corn, beans, squash, and other crops. Since the arrival of the Spanish the 1540s, the Hopi have kept livestock including sheep, cattle, horses, and burros (Balenquah, 2010).

Most lands in the project area are undeveloped and used for livestock grazing. A few lands near AZ 264 have been used for crop cultivation. Villages on First and Second Mesa have a long history of being inhabited. The predominant land use is residential. The Hopi Cultural Center on Second Mesa is a commercial development with a hotel, restaurant, store, and museum. Schools in the area include the Hopi First Mesa Elementary School in Polacca, Second Mesa Day School, and Hopi Junior/Senior High School in Keams Canyon. The Hopi Health Care Center is located in Polacca. A gasoline station and convenience store are located in Keams Canyon.

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3.20 Surface Water Resources, Water Quality Problems

No permanent surface water features occur within the project area. Several ephemeral streams (washes) cross the project pipeline routes. Since the ground surface typically has less than a 25 percent vegetation cover, many soils are exposed to rainfall. Intense storms often result in erosion and sediment transport, which can affect water quality.

The project area is located within the Little Colorado River watershed, which is part of the Colorado River Basin. Major drainages within the project area include Oraibi Wash, Wepo Wash, and Wepo Tributary Wash (see Figures 3.2, 3.3, and 3.4). The square miles of the drainage areas for these three washes are: 341.1 square miles for Oraibi Wash, 183.1 square miles for Wepo Wash, and 16.5 square miles for Wepo Tributary Wash (Bohannan-Huston, 2012). Many smaller drainages also cross the alternative pipeline routes.

Figure 3.2 Oraibi Wash at the Indian Route 4 ("Turquoise Trail") Crossing.

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Figure 3.3 Wepo Wash Tributary at the Indian Route 8 crossing.

Figure 3.4 Wepo Wash at the Indian Route 8 crossing.

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3.21 Transportation

Vehicles are the primary transportation mode in the vicinity of the project area. AZ 264 is the principal roadway near the project area. It is a paved two-lane highway that extends in an east-west alignment from the New Mexico border west to US 160 at Moenkopi and Tuba City. AZ 87 intersects AZ 264 at Second Mesa and extends south to I-40 at Winslow. A few paved and unpaved roads are located on First and Second Mesa. Indian Route 4 (Turquoise Trail) is a north-south route that begins at Second Mesa and continues north to the Turquoise Trail well site (see Figures 3.5 and 3.6). Indian Route 8 is a north-south route that begins at First Mesa and continues north and intersects Indian Route 4 southeast of the Turquoise Trail well site. Indian Route 43 connects Indian Route 4 in a northeast direction towards Indian Route 8.

Use of other transportation modes is limited. Pedestrians walk within villages and occasionally between villages. Horses are used to access pastures and remote parts of the Hopi Reservation. Bicycle use is extremely limited, but AZ 264 and AZ 87 provide viable bike routes across the reservation. An airstrip for small aircraft is located at Polacca. No regular air service is provided to the Hopi Reservation. No railroads are located on the Hopi Reservation.

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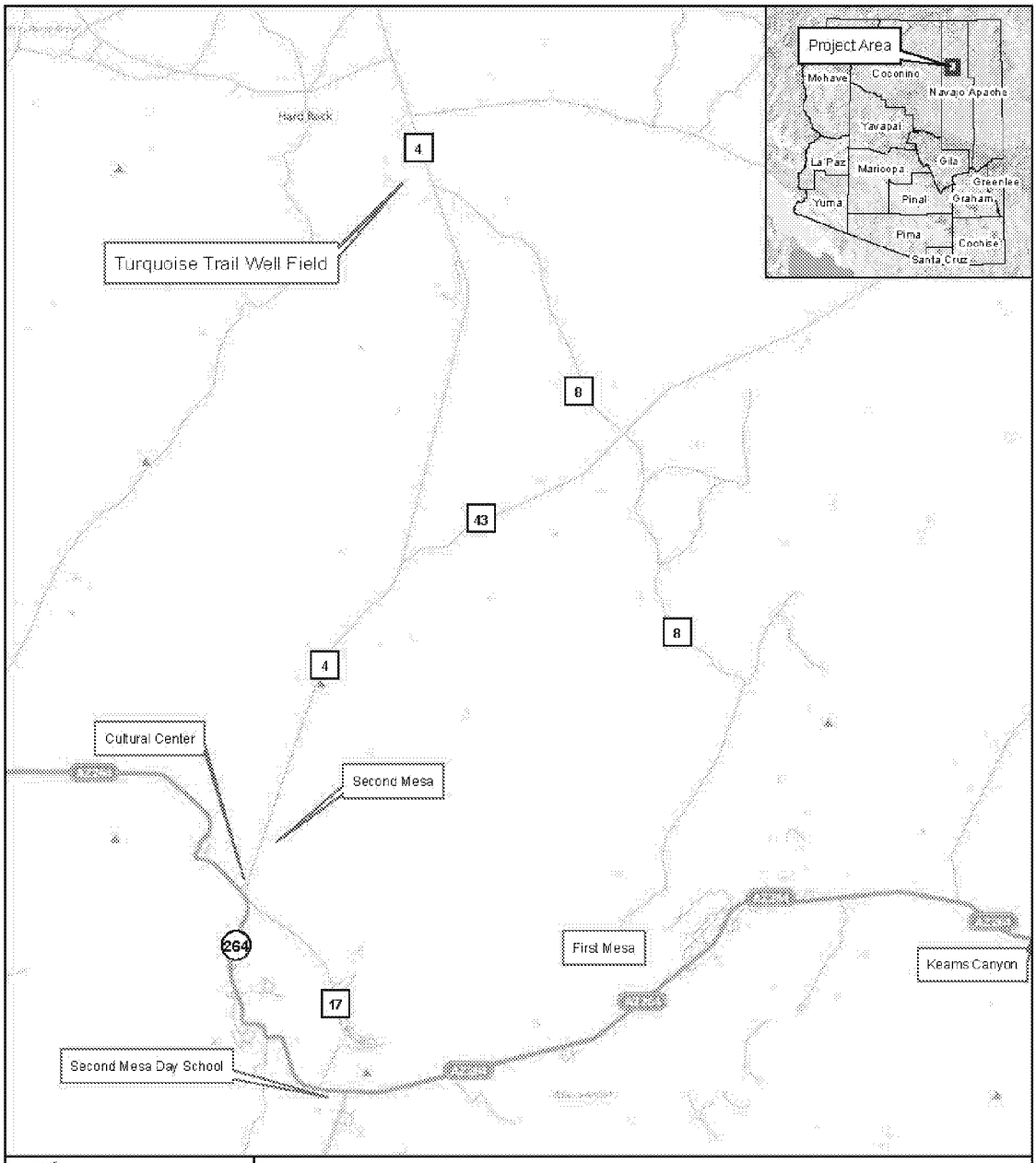

Figure 3.5 Highways in the Vicinity of the Project Area

Hopi Arsenic Mitigation Project, Hopi Indian Reservation, Navajo County, Arizona

Figure 3.6 Indian Route 4 along pipeline route.

3.22 Environmental Justice

Environmental justice addresses disproportionate health and environmental impacts to low income and minority populations. The Hopi Reservation occupied by Census Tract 9400.13 has a 93.8% Native American population compared with a 4.6% Native American population in Arizona (see Table 3.5). Year 2006-2007 median family income was $37,000 in Census Tract 9400.13 compared with $59,840 in Arizona. For these reasons, the project area can be considered a community of concern for environmental justice.

As discussed in Section 1.1, the need to provide drinking water for First and Second Mesa residents is central to the HAMP project and has environmental justice aspects. The purpose of the HAMP is to provide drinking water to the First and Second Mesa regions that meets the USEPA's 10 ppb arsenic standard. In January 2001, the USEPA reduced the arsenic MCL from 50 ppb to 10 ppb. Effective 2006, all public water systems were required to meet this revised standard under the Safe Drinking Water Act. Water systems in the Hopi Reservation's First and Second Mesa regions do not meet the USEPA's 10 ppb arsenic standard. Arsenic concentrations in this area range from 15 ppb to 40 ppb.

3.23 Indian Trust Assets

Indian Trust Assets are legal interests in property held in trust by the United States for Indian Tribes or individuals. The principals for managing Indian Trust Assets are described in Department of Interior Department Manual, Part 303, Chapter 2, *Principles for Managing Indian Trust Assets.* Part 303 of the manual provides the following definitions:

- Indian trust assets means lands, natural resources, money, and other assets held by the federal government in trust or restricted against alienation for Indian Tribes and individual Indians.
- Beneficial owner means both Indian tribe and individuals Indians who are the owners of Indian trust assets held by the federal government in trust or with a restriction against alienation.

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- Persons who manage Indian trust assets means Departmental employees who have been properly delegated specific authority to manage or administer Indian Trust Assets.

The federal government has a trust responsibility to protect and maintain rights reserved or granted by or granted to Indian tribes or Indian individuals by treaties, statute, and Executive Orders. Potential Indian Trust Assets identified for the HAMP include water, land, and money (used to fund the project). In addition, the HAMP project area includes resource related Indian Trust Assets of access, hunting, livestock grazing, and gathering. Part 303 requires that Department of Interior to discharge the trust responsibility with a high degree of skill, care, and loyalty. The Department has a duty to protect and preserve Indian Trust Assets from loss, damage, unlawful alienation, waste, and depletion.

3.24 Controversy

There has been some controversy during the project planning, including a dispute between the Tribe and First Mesa Consolidated Villages over land control at the site of drilling of two test wells. Other potential areas of controversy may include the need for cooperation between villages to implement the HAMP, issues associated with establishment of a water utility (or other organizational structure) to operate the HAMP, user fees associated with water use, and pipeline routes near sensitive cultural areas. Some controversy may occur in the future when water users in villages are required to pay increased fees for water. Many village residents have limited income and additional household expenses can be burdensome.

3.25 Socioeconomics

Since the project area is located in a rural area with limited economic opportunities, incomes tend to be lower than urban areas. For the 2008-2012 period, median Arizona family income was $59,563 compared with $44,928 in Navajo County (see Table 3.5). Median family incomes in Hopi communities were even lower: $43,633 in First Mesa, $31,618 In Second Mesa, $24,609 in Shungopavi, and $41,328 in Keams Canyon. Per capita income followed the same pattern. Poverty rates tend to be high near the project area. In Arizona 17.2% of the population is below the poverty level compared with 27.9% in Navajo County. Community poverty rates ranged from 26.9% in First Mesa to 44.9% in Shungopavi.

Most people in Arizona and near the project area work in education, health care, and social services economic sectors. Retail trade ranked second in providing employment to people in Arizona, Navajo County, and Shungopavi. Public administration ranked second on First Mesa and Second Mesa. It should be noted that the role of agriculture is not represented in the U.S. Census Bureau statistics but is discussed below.

The Hopi Reservation has a high owner-occupancy rate for homes. The proportion of the population living in owner-occupied units is 80.1% in First Mesa, 78.1% in Second Mesa, and 94.6% in Shungopavi. Keams Canyon with 36.5% in owner-occupied housing does not follow this trend. The comparable figure for Arizona is 66.0%.

Since most lands are undeveloped, agriculture is an important part of the Navajo County economy. Of the county's residents, 4,633 Native Americans work in agriculture. In 2007, the average farm had a net negative income of $4,131. Navajo County was ranked 8th among Arizona's 15 counties for the value of agricultural products sold and 5th for the value of livestock products sold. The county's livestock

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numbered 29,957 sheep and lambs and 27,500 cattle and calves in 2007 (National Agricultural Statistics Service, 2012).

Table 3.5 2008-2012 Economic Data

Characteristic	Arizona	Navajo County	First Mesa	Second Mesa	Shungopavi	Keams Canyon
2008-2012 Economic Characteristics						
- Median family income	$59,563	$44,928	$43,633	$31,618	$24,609	$41,328
- Per capita income	$25,571	$16,884	$15,320	$13,063	$6,164	$10,112
- Percent of population below poverty level	17.2%	27.9%	26.9%	40.2%	44.9%	--
2008-2012 Four Largest Employment Sectors						
- Education, health care, social services	1st	1st	1st	1st	1st	1st*
- Retail trade	2nd	2nd	3rd	3rd	2nd	
- Professional, scientific, administrative services	3rd					
- Arts, accommodation, and food services	4th	3rd		3rd	4th	
- Construction		4th	4th	4th		
- Public administration			2nd	2nd	3rd	
Housing Occupancy 2010						
- Owner-occupied housing units	66.0%	71.9%	80.1%	78.1%	94.6%	36.5%
- Renter-occupied housing units	34.0%	28.1%	19.9%	21.9%	5.4%	63.5%

Source: U.S. Census Bureau (2014)
**Only economic sector providing employment.*

3.26 Prime Farmland

No prime farmland, unique farmland, or other farmland of statewide or local importance is located in the project area. No lands in the project area are currently being used for crop cultivation.

3.27 Public Health and Safety

Police protection is provided by the Hopi Tribal Police; the BIA Hopi Agency Fire Rescue provides fire services; and the Department of Community Services provides Hopi Emergency Management Services.

The high arsenic concentrations in the drinking water at First and Second Mesa are a recognized public health problem. Arsenic is known to be a human carcinogen (Agency for Toxic Substances and Disease Registry, 2012). Nevertheless, it is difficult to determine why one person develops cancer while another person does not. According to the National Cancer Institute (2012), research has demonstrated that certain risk factors increase the chance of developing cancer. Common risk factors include growing older, sunlight, ionizing radiation, certain chemicals and other substances, some viruses and bacteria, certain hormones, family history of cancer, poor diet, physical activity, and being overweight. Arsenic is

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just one risk factor, and the chances of any person developing cancer will vary. Arsenic concentrations in First and Second Mesa drinking water have been measured at 15 to 40 ppb. The current USEPA MCL under the Safe Drinking Water Act is 10 ppb. Addressing this problem is the central purpose of the HAMP.

3.28 Airport Clear Zones

The Polacca Airport is located three miles southwest of Polacca. It is the only airport near the project area. There are no civilian airports or Runway Clear Zones within 2,500 feet of the project area. There are no military airfields, military Airfield Clear Zones, or military airfield Accident Potential Zones within 15,000 feet of the project area.

3.29 Explosive and Flammable Operations

The project area was reviewed for the presence of explosive and flammable operations. There are no current or planned aboveground storage tanks of more than 100 gallon capacity that contain common liquid or industrial fuels or hazardous liquids or gases that are not liquid industrial fuels. No industrial facilities handling explosive or fire-prone materials (such as liquid propane, gasoline, or storage tanks) are visible from the project area. The project area is not within 300 feet of a stationary storage tank of 1,000 gallons or more of flammable or explosive materials. No high-pressure gas lines are located within or adjacent to the project area. No oil or gas wells are located within one mile of the project area.

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4.0 Environmental Impacts

This section describes the environmental consequences associated with the alternatives. NEPA requires consideration of context, intensity, and duration of impacts, direct or indirect impacts, cumulative impacts, and measures to mitigate for impacts.

4.1 Population

Alternatives A, Revised A, B, C and No Action Alternative Environmental Impacts – The alternatives would not affect current populations or future growth trends. No widespread in-migration or out-migration would be expected. The Hopi Tribe would continue to experience steady population growth into the foreseeable future.

4.2 Topography

Alternatives A, Revised A, B, C Environmental Impacts – Construction activities would make minor modifications to the ground surface, but overall topography would remain the same. Existing landforms would not be affected.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on topography.

4.3 Geology

Alternatives A, Revised A, B, C Environmental Impacts – The alternatives would affect Navajo Sandstone, Kayenta Formation, Moenave Formation, and Wingate Sandstone that make up the N or Navajo Aquifer. Water would be obtained from these geological formations, but the formations would remain intact. Construction activities would have minor effects on surface Quaternary and Tertiary – volcanic geologic deposits. No existing mining operations would be affected, but opportunities to extract minerals at the project area would be foregone for the foreseeable future by the presence of water pipelines, tanks, and other water system facilities.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on the geology of the project area.

4.4 Soils

Alternative A Environmental Impacts – Alternative A would affect approximately 425 acres of soil. The soil mapping units most affected would be the Penistaja-Begay complex followed by the Jeddito loamy sand. Soils with a sandy texture would be the most vulnerable to wind erosion. Measures would be implemented to minimize soil erosion and sediment transport including the preparation of a SWPPP that specifies BMPs. Exposed soils would be reseeded with native weed-free plant species mix.

Revised Alternative A Environmental Impacts – Alternative A would affect approximately 420 acres of soil. The soil mapping units most affected would be the Penistaja-Begay complex followed by the Jeddito loamy sand. Soils with a sandy texture would be the most vulnerable to wind erosion. Measures would be implemented to minimize soil erosion and sediment transport including the SWPPP that specifies BMPs. Exposed soils would be reseeded with native weed-free plant species mix.

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Alternative B Environmental Impacts

Alternative B would affect approximately 408 acres of soil. The soil mapping units most affected would be the Penistaja-Begay complex followed by the Jeddito loamy sand. Soils with a sand texture would be the most vulnerable to wind erosion. Measures would be implemented to minimize soil erosion and sediment transport including the preparation of a SWPPP that specifies BMPs. Exposed soils would be reseeded with native plant species

Alternative C Environmental Impacts

Alternative C would affect approximately 350 acres of soil. The soil mapping units most affected would be the Penistaja-Begay complex followed by the Jeddito loamy sand. Soils with a sandy texture would be the most vulnerable to wind erosion. Measures would be implemented to minimize soil erosion and sediment transport including the preparation of a SWPPP that specifies BMPs. Exposed soils would be reseeded with native plant species

No Action Alternative Environmental Impacts

The No Action Alternative would have no impact on soils. Ongoing soil forming and erosional processes would occur at their current rate.

4.5 Climate and Air Quality

Alternatives A, Revised A, B, and C Environmental Impacts – The alternatives would have minor impact on air quality. Short-term impacts would occur as soils exposed during construction are vulnerable to wind erosion and produce dust. As an indirect and long-term impact, electric power use would result in slight increases in emissions at an off-site electric generating station, including greenhouse gases, but the increases would fall within permitted limits and not result in any exceedances. The alternatives would not change the attainment status of Navajo County for criteria pollutants under the Clean Air Act. The project would be consistent with the State Implementation Plan. No building demolition or renovation of buildings, including buildings with asbestos containing materials, would occur.

No Action Alternative Environmental Impacts – Since the No Action Alternative does not propose any construction or operation activities that would modify air quality, the No Action Alternative would have no effect on air quality.

4.6 Wetlands

Alternatives A, Revised A, B, and C Environmental Impacts – The alternative project areas do not include any wetlands. The alternatives would have no effect on wetlands.

No Action Alternative – The No Action Alternative would have no effect on wetlands.

4.7 Groundwater Resources, Including Sole Source Aquifers

Alternatives A, Revised A, B, and C Environmental Impacts – Water would be obtained from the Navajo Aquifer. In the construction year of 2015, water would be pumped at a rate of 205.8 gpm (see Table

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1.2). In the design year of 2035, water would be pumped at a rate of 392.0 gpm. Testing of Turquoise Trail Wells #2 and #3 confirmed that water was available in sufficient quantity and quality to meet this demand (John Shomaker and Associates, Inc., 2014). The Navajo Aquifer is a good source of groundwater. Groundwater extraction from the Turquoise Trail well field is not expected to have detrimental effects on the aquifer system. A small amount of drawdown is expected at the well field, at a rate of three feet annually. Use of more groundwater, over the life of the project, may have a minor impact on the Navajo aquifer, although flow rates from springs in the vicinity are not expected to be reduced significantly. The aquifer has adequate water for more than the 40 year life of the project.

The alternatives would extract groundwater below the 10 ppb USEPA arsenic standard, and no treatment for removal of arsenic would be required (IHS, 2014; John Shomaker and Associates, Inc., 2014). This water would be provided to villages in the Hopi Reservation's First and Second Mesa regions. Thus, the groundwater would provide better quality drinking water than the water currently consumed in this part of the Hopi Reservation. Improved water would eventually be provided to other areas of the Hopi Reservation such as Keams Canyon.

No designated Sole Source Aquifers are located on the Hopi Reservation. The alternatives would have no effect on Sole Source Aquifers.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on groundwater resources including Sole Source Aquifers. The Turquoise Well Field would not be developed under the HAMP, but the groundwater resources would remain available for future use.

4.8 Floodplains

Alternatives A, Revised A, B, and C Environmental Impacts – The waterlines for the alternatives would cross drainages subject to periodic flooding. Oraibi Wash, Wepo Wash, and Wepo Wash Tributary are located within the 100-year floodplain and would be traversed by waterlines (see Appendix C). The waterlines will be buried at sufficient depth and covered with adequate fill material to ensure that the pipelines are not exposed or ruptured during a flood event. Construction of the HAMP would not modify any floodplains or cause increased flood damage to any occupied buildings. IHS, as lead federal agency, will comply with E.O. 11988, utilizing the 8-step process to assure the protection of human health and safety and the protection of natural floodplain values. This includes identifying floodplains in the project area, public involvement and agency coordination, considering alternatives, assessing and minimizing flood effects, re-evaluating alternatives with documented effects, notifying the public, and assuring flood protection measures are implemented.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on floodplains.

4.9 Wild and Scenic Rivers

Alternatives A, Revised A, B, and C and No Action Alternative Environmental Impacts – Since there are no designated Wild and Scenic Rivers in the project area, the action and No Action alternatives would have no effect on Wild and Scenic Rivers.

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4.10 Wilderness Areas

Alternatives A, Revised A, B, and C and No Action Alternative Environmental Impacts – Since there are no designated Wilderness Areas in the project area, the action and No Action alternatives would have no effect on Wilderness Areas.

4.11 Vegetation

Alternative A Environmental Impacts – Alternative A would affect approximately 425 acres of vegetation. Of this total, a few areas have been previously disturbed or have noxious weed cover. During construction, noxious weeds growing in the project area would be removed. Weed free seed mixes would be used in reseeding, and weed control measure will be implemented to prevent weed infestations from occurring on lands disturbed by construction activities.

Revised Alternative A Environmental Impacts – Alternative A would affect approximately 420 acres of vegetation. Of this total, a few areas have been previously disturbed or have noxious weed cover. During construction, noxious weeds growing in the project area would be removed. Weed free seed mixes would be used in reseeding, and weed control measure will be implemented to prevent weed infestations from occurring on lands disturbed by construction activities.

Alternative B Environmental Impacts – Alternative B would affect approximately 408 acres of vegetation. Of this total, a few areas have been previously disturbed or have noxious weed cover. During construction, noxious weeds growing in the project area would be removed. Weed free seed mixes would be used in reseeding, and weed control measures will be implemented to prevent weed infestations from occurring on lands disturbed by construction activities.

Alternative C Environmental Impacts – Alternative C would affect approximately 350 acres of vegetation. Of this total, a few areas have been previously disturbed or have noxious weed cover. During construction, noxious weeds growing in the project area would be removed. Weed free seed mixes would be used in reseeding, and weed control measures will be implemented to prevent weed infestations from occurring on lands disturbed by construction activities.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on vegetation. Existing vegetation communities would remain intact. Noxious weed infestations would continue to displace native plant species in some areas.

4.12 Fish and Wildlife

Alternatives A, Revised A, B, and C Environmental Impacts – Construction activities may affect small reptiles and mammals present on the ground surface or burrowed in the soil. Larger mammals and birds will be able to move away from construction activities. Potential bird nesting sites in shrubs and trees along the corridor would be lost to construction activities. It is recommended that trees and shrubs be cleared outside of the migratory bird nesting season (March 1 through August 30) and that construction not take place near active migratory bird nests. Construction activity impacts would be temporary and not have any long-term effects on reptile, bird, and mammal populations.

The project area is considered potential foraging habitat for the golden eagle, and there is an active golden eagle nest location within one-half mile of the proposed project area. The Hopi WEMP identified

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the Revised Alternative A waterline reroute along Indian Route 8 as area where project activities may impact or adversely affect golden eagle and red-tail hawk breeding, occupancy, and prey base habitat. Disturbance of native habitat along the pipeline, near other water infrastructure, and along the power line may impact potential foraging habitat for the red-tailed hawk and golden eagle, but the effects on these birds would be insignificant.

In accordance with the Hopi WEMP recommendations, no construction activity will be allowed during the golden eagle and red-tailed hawk nesting seasons in the vicinity of occupied eagle and hawk nests. Golden eagle and red-tailed hawk habitat occurs near portions of the Alternatives A, Revised Alternative A, and Alternative B project areas. If an eaglet or nestling hawk needs additional protection, construction will be delayed in the vicinity of the nest until the Hopi WEMP approves the initiation of work. The Hopi WEMP will also provide an observer to assess the potential effects on active eagle and hawk nests and to ensure that construction does not adversely affect the nests. As a result of these mitigation measures, the project may affect but is not likely to adversely affect the Hopi Tribe protected golden eagle and red-tailed hawk.

Electric power lines have the potential to impact raptors. To prevent raptor electrocutions, the transmission line would have a 60-inch separation between conductors. For distribution lines and other electric facilities, avian-protective design and insulations features should be utilized as appropriate per guidance from the Avian Power Line Interaction Committee (2006).

4.13 Endangered or Threatened Species

Alternatives A, Revised A, B, and C Environmental Impacts – The alternatives would have no effect on federally listed endangered and threatened species. The WEMP report reconfirmed there would be no effect on federally listed endangered species, threatened species, or species of concern. Based on the field surveys conducted for the HAMP, there is no known presence or habitat for federally listed endangered or threatened species within the project area or within 750 feet of the project area. No critical habitat is located within the project area.

No Action Alternative Environmental Impacts – Since no habitat disturbance activities are proposed, the No Action Alternative would have no effect on federally listed endangered or threatened species.

4.14 Environmental Sensitive Areas

Alternatives A, Revised A, B, and C Environmental Impacts – Project designs would include suitable design specifications for the slope sensitive areas located along the sides of First and Second Mesa. The construction specifications would include measures to minimize the potential for erosion and land subsidence. The project area would avoid culturally sensitive areas identified by the Hopi Tribe and villages.

During construction of the HAMP, noise would be produced by heavy equipment (e.g., scrapers, bulldozers, graders, loaders, dump trucks, and pneumatic hammers), and utility/building construction equipment (e.g., saws, drills, compressors, hammers, welding equipment, and other such equipment). Federal workplace standards for protection from hearing loss allow a time-weighted average of 90 dBA over an 8-hour period, 85 dBA averaged over a 16-hour period, and 70 dBA averaged over a 24-hour period. There are concerns about noise associated with the proposed project, particularly in villages. Construction activities including trenching activities will create excessive noise. The duration of

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construction noise will last up to one year. The project engineers and Hopi Water Resources Program will work closely with villages to define appropriate time periods for construction work. Construction equipment would be maintained to minimize extraneous noise.

4.15 National Natural Landmarks

Alternatives A, Revised A, B, and C and No Action Alternative Environmental Impacts – Since there are no designated National Natural Landmarks in the project area, the action and No Action alternatives would have no effect on National Natural Landmarks.

4.16 Prehistoric, Historic, Architectural, Archaeological, and Cultural Sites

Alternatives A, Revised A, B, and C Environmental Impacts – Thirty-eight cultural resource sites were identified along the project route and evaluated for project impacts (Yeatts, 2013; Yeatts 2014a and 2014b; see abstracts in Appendix F). Typical mitigation measures for sites are listed in Section 4.30. In terms of cultural resources, Revised Alternative A is preferred. The preferred alternative and the other alternatives would have no adverse effect on historic properties, including archaeological sites and historic buildings. There were several pipeline alignment changes, and the water storage tank planned for the Sipaulovi community was moved from the original location due to cultural and visual impacts to mitigate potential adverse effects. None of these three alternatives are located within the boundaries of an historic district. All alternatives have been discussed with village traditional leaders who have taken an active role in selecting the alignment that will mitigate cultural impacts, such as rerouting pipelines to avoid TCPs and other National Register eligible sites. The IHS will schedule project construction activities in coordination with traditional leaders to avoid conflicts with ceremonies. Based on consultation with the Hopi Tribe and Hopi villages, Revised Alternative A would have no impact on TCPs.

In accordance with 36 CFR 800.2(c)2(ii), IHS consulted with Indian tribes that attach religious and cultural significance to historic properties that may be affected by the undertaking. Due to the location of the proposed project, the Arizona State Historic Preservation Office (SHPO) had identified the Navajo Nation and Zuni Tribe as tribes that may be affected by the project. IHS consulted with the tribes to inquire whether they had any input, concerns, or advise regarding cultural resources situated near any of the three HAMP alternative alignments for the project. IHS did not receive a response from either tribe and concluded that the Navajo Nation and Zuni Tribe had no comments or concerns. Per the requirements of Section 106 of the National Historic Preservation Act, consultation for Alternative A was conducted with the HCPO, and they concurred the proposed undertaking under Revised Alternative A would have no adverse effect on historic properties. IHS will consult with the SHPO in accordance with Section 106 of the National Historic Preservation Act. In a previous SHPO consultation regarding drilling test wells for the project, which is included in Appendix F, drilling two test wells was determined to have no effect on historic properties.

Per the policy of the HCPO, the following mitigation measure will be implemented: In the event of an unanticipated discovery including the encounter of any previously unidentified or incorrectly identified cultural resource including, but not limited to, archaeological deposits, human remains, or places reported to be associated with Native American religion beliefs and practices not considered in the cultural assessment, all operations in the area of the discovery will cease and the HCPO will be contacted. An assessment of the discovery will be made by the HCPO. If the discovery is deemed

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significant, the SHPO will be notified by IHS and HCPO and appropriate recordation will be prepared prior to any resumption of work in the discovery area.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on historic properties.

4.17 Aesthetic and Visual Resources

Alternatives A, Revised A, B, and C Environmental Impacts – Varying levels of visual modification would occur with the development of the HAMP. Placement of waterlines would create strips of modified landscapes. In most areas with time, the waterline locations would blend into the landscape as permanent vegetation becomes established. Along mesa edges, the waterlines would remain visible for a longer period of time because of the lack of vegetation cover. Water tanks and pump stations would add a man-made element to the landscape. Painting the tanks and pump stations a tan or earth-tone color would help blend them into the landscape. Electric transmission and distribution lines would also modify the landscape. This would be a permanent change, but most lines would be located along roadways where landscape modification has already occurred. Visual impacts have been considered in the siting of water storage tanks, booster stations, and other major above-ground facilities, and the Sipaulovi water storage tank was moved as a result of visual and cultural issues.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on aesthetic and visual resources.

4.18 Hazardous, Toxic, Radioactive, and Solid Waste Materials

Alternatives A, Revised A, B, and C Environmental Impacts – Since no environmental contaminant sources were identified within the project area or appropriate search distances, the alternative would have no effect upon nor be affected by hazardous, toxic, radioactive, or solid waste materials. Chlorine used for water treatment would be handled and stored according to state and federal standards. Any solid waste produced during construction would be disposed of at a USEPA or state licensed landfill. Fuels, lubricants, and hazardous materials used in construction and operations of the HAMP would be managed according to tribal, federal, and state standards to ensure that no releases (above the *de minimis* level) into soil, surface water, or groundwater occur. Contractors will be required to prepare and comply with an Environmental Protection Plan (EPP), which will be reviewed and approved by the Hopi Environmental Protection Office. The EPP will require:

(1) A total disclosure of all gases, liquids, explosives, fuels, hazardous wastes, and wastewater;
(2) A copy of storage and disposal requirements and plans for each item on the inventory list;
(3) A copy of the Material Safety Data Sheet for each item on the inventory list;
(4) A copy of a site safety plan, which shows how an emergency will be handled in case of an emergency or spill event;
(5) Method of disposal and name of disposal contractor for each item on the inventory list; and
(6) Storm water control plans and methods.

No Action Alternative – The No Action Alternative would have no effect on hazardous, toxic, radioactive, or solid waste materials. At the village level, chlorine used for water treatment would be handled and stored according to state and federal standards.

4.19 Present Land Use, Status and Related Facilities

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Alternatives A, Revised A, B, and C Environmental Impacts – The alternatives would result in little change to land use, status, and facilities. The approximate land area affected varies between the alternatives: Alternative A – 425 acres, Revised Alternative A - 420 acres, Alterative B – 408 acres, and Alternative C – 350 acres. Most of the project area lands would return to use for livestock grazing after reseeded vegetation becomes established. Existing land uses including residential, commercial, and public facilities would continue to be used. The alternatives would allow for future development by providing a reliable drinking water source.

No Action Alternative – The No Action Alternative would have no effect on present land use, status, and related facilities.

4.20 Surface Water Resources, Water Quality Problems

Alternatives A, Revised A, B, and C Environmental Impacts – No permanent surface water features would be impacted by the alternatives. The alternatives would impact several ephemeral streams (washes) cross the project pipeline routes including Orabi Wash, Wepo Wash, and Wepo Tributary Wash. Construction activities at these washes have the potential to create erosion and sediment transport, which can affect water quality. Measures would be implemented to minimize soil erosion and sediment transport including the preparation of a SWPPP that specifies best management practices BMPs. In addition, the washes may be considered jurisdictional waters of the United States under Section 404 of the Clean Water Act. For each jurisdictional wash crossing, permit coverage under Nationwide Permit 12 – Utility Line Activities would be obtained from the U.S. Army Corps of Engineers, and a Section 401 Water Quality Certification would be obtained from the Hopi Tribe Water Resources Program.

4.21 Transportation

Alternative A and Revised A Environmental Impacts – The northern end of Alternative A is along Indian Route 4. The main trunk line is located along Indian Route 8, and at the Y, the waterline to First Mesa continues along Indian Route 8. The waterline to Second Mesa is located along Indian Routes 43 and 4. A short branch at the base of Second Mesa follows AZ 264 to Shungopavi. Alternative A has much less of its alignment along AZ 264, than Alternatives B and C. The waterlines would not affect the roadways except for temporary impacts when the waterline crossings are constructed under the roadways, and during construction, when construction trucks and equipment would travel occasionally on the roadways.

Alternative B Environmental Impacts – The northern end of Alternative B is along Indian Route 4. The waterline follows Indian Route 8 to First Mesa. At First Mesa, the waterline follows AZ 264 west to Second Mesa, and it has a short branch east along AZ 264 to Polacca. In the Second Mesa region, one pipeline branch follows the roadway into Mishongnovi and Sipaulovi and another branch follows AZ 264 to Shungopavi. The waterlines would not affect the roadways except for temporary impacts when the waterline crossings are constructed under the roadways, and during construction, when construction trucks and equipment would travel occasionally on the roadways.

Alternative C Environmental Impacts – The northern end of Alternative C is along Indian Route 4. The waterline to Second Mesa is located along Indian Routes 43 and 4. There is a short branch along AZ 264 near Shungopavi. At the base of Second Mesa, the waterline follows AZ 264 to Polacca, where the

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pipeline changes direction, and is oriented to the west to reach First Mesa. The waterlines would not affect the roadways except for temporary impacts when the waterline crossings are constructed under the roadways, and during construction, when construction trucks and equipment would travel occasionally on the roadways.

No Action Alternative Environmental Impacts – The No Action Alternative would have no effect on transportation. No roadway crossings would be needed, and there would be no construction traffic on roadways.

4.22 Environmental Justice

Alternatives A, Revised A, B, and C Environmental Impacts – The alternatives would have no disproportionate negative environmental or health impacts on the Hopi Tribe. The alternatives would provide drinking water to residents of First Mesa, Second Mesa, and potentially other areas on the Hopi Reservation that meets the USEPA's 10 ppb arsenic standard. Arsenic concentrations in drinking water currently range from 15 ppb to 40 ppb. As a result, all four alternatives would improve environmental justice for the persons served by HAMP.

No Action Alternative – The No Action Alternative would not reduce arsenic levels in drinking water for residents of First Mesa, Second Mesa, and other areas on the Hopi Reservation. This would disproportionately impact Hopi residents for arsenic related health issues. No other disproportionate negative environmental or health impacts on the Hopi Tribe would occur.

4.23 Indian Trust Assets

Alternatives A, Revised A, B, and C Environmental Impacts – The HAMP would involve Indian Trust Assets such as water, land, and money that are held in trust for the Hopi Tribe and Hopi villages. Within the Department of Interior, the BIA and BOR will have trust responsibilities per their respective agency and Department of Interior policies. HAMP will help the Department of Interior and its bureaus to meet their trust responsibilities.

No Action Alternative – The No Action Alternative would have no impact on Indian Trust Assets.

4.24 Controversy

Alternatives A, Revised A, B, and C Environmental Impacts – A central concern has been how villages and homeowners will fund ongoing operation and maintenance costs for the HAMP. Separate water systems are located in the villages and the systems would need to connect to the HAMP. Total annual HPUA operating costs would range from $559,000 in 2015 to $680,000 in 2025. Revenues would range from $559,000 in 2015 to $691,000 in 2025. Recommended fees include the following: (1) Base fee of $33.42 is recommended per connection or equivalent residential unit; and (2) usage fee of $2.55 per 1,000 gallons of water used (GHD, 2014). The average monthly user cost per connection is $49.82. In addition to this cost, villages will continue to operate and maintain water distribution systems and wastewater systems at an average user cost of $22.17 per month. The combined average user cost per connection is $71.99. In addition, users within the villages may need to raise water rates, improve metering systems, and assess fees for connecting and using water from the HAMP. This could create controversy, as some villages do not currently charge homeowners for water service and some other villages have very low monthly user charges. Villages may elect to use village funds rather than just

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individual user fees. The Strategic Plan, which delineates operations costs and revenue alternatives, has been reviewed by village and tribal leadership, to assure understanding and acceptance of anticipated, ongoing costs of operation for each village. This will be confirmed by signed agreements between the tribal HAMP operational utility, HPUA, and each of the villages.

Table 4.1 HPUA 10 Year Total Cost and Revenue Projection

Year	Total Costs	Total Revenue
2015	$559,000	$559,000
2016	$570,000	$571,000
2017	$581,000	$583,200
2018	$592,000	$596,000
2019	$603,000	$608,000
2020	$615,000	$622,000
2021	$627,000	$635,000
2022	$639,000	$648,000
2023	$653,000	$662,000
2024	$666,000	$677,000
2025	$680,000	$691,000

Source: GHD (2014)

No Action Alternative – Controversy could develop if the HAMP were not constructed. Users of village water systems may voice concerns about the high arsenic content in their water systems. There would need to be other remedies developed, which could create debate.

4.25 Socioeconomics

Alternatives A, Revised A, B, and C Environmental Impacts – The alternatives would have a neutral to slightly beneficial effect on socioeconomics. As mentioned above, the alternatives would not affect current populations or future growth trends. There would be short-term benefits produced from construction jobs on the HAMP that are expected to occur in 2015. In the long-term, a water utility organization would be created to manage the HAMP, which would provide some economic benefit to the Hopi Tribe (GHD, 2014). If a separate water utility were established, initially, there would be two full-time operator positions for the water utility organization. A utility manager would be hired along with additional staff as HAMP operations expand. There would also be periodic contracting opportunities for tasks such as inspection of pumps, tanks, and electrical equipment as well as laboratory analysis. The improved drinking water quality would help with any future economic development by ensuring a dependable water supply for future commercial projects. Water rates will need to be increased to pay for operation and maintenance of the HAMP. Recommended fees are discussed in Section 4.24.

No Action Alternative – The No Action Alternative would not change current socioeconomic trends. No additional employment opportunities with a water utility organization would be created. Future economic development could be restrained by the quality and quantity of water available from the existing water systems.

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4.26 Prime Farmland

Alternatives A, Revised A, B, and C and No Action Alternative Environmental Impacts – Since no farmland is located within the project area, no prime farmland, unique farmland, or other farmland of statewide or local importance would be affected by the alternatives.

4.27 Public Health and Safety

Alternatives A, Revised A, B, and C Environmental Impacts – The alternatives would not require additional police, fire, or emergency services. No increase in crime, fire, or need for emergency services would occur as a result of the alternatives. In some villages, water flow rates for fire fighting would improve as a result of additional water availability, increased water storage capacity, and to some extent, larger pipeline diameters.

The alternatives would reduce the arsenic concentrations in drinking water at First Mesa and Second Mesa and other areas to be served by the HAMP. This would provide a direct benefit to Hopi Reservation residents by reducing their exposure to arsenic in drinking water, and therefore, reducing the arsenic-related cancer risk level in this population.

No Action Alternative Environmental Impact – The No Action Alternative would not require additional police, fire, or emergency services. No increase in crime, fire, or need for emergency services would occur as a result of the alternatives.

The No Action Alternative would not reduce the arsenic concentrations in drinking water at First Mesa and Second Mesa and other areas to be served by the HAMP. Hopi Reservation residents would continue to be exposed to high arsenic levels in drinking water with an associated increased arsenic-related cancer risk level in this population.

4.28 Airport Clear Zones

Alternatives A, Revised A, B, and C and No Action Alternative Environmental Impacts – The alternatives will have no effect on civilian airport, military airfields, or designated clear zones. There are no civilian airports or Runway Clear Zones within 2,500 feet of the project area. There are no military airfields, military Airfield Clear Zones, or military airfield Accident Potential Zones within 15,000 feet of the project area.

4.29 Explosive and Flammable Operations

Alternatives A, Revised A, B, and C and No Action Alternative Environmental Impacts – Since no explosive or flammable operations have been identified in the vicinity of the project area, the alternatives would not affect nor be affected by any facility with explosive or flammable operations. Fuel storage tanks for back-up generators will incorporate safety measures to minimize fire and explosion risks.

4.30 Significant Impacts and Mitigation Measures

No significant impacts have been identified for the Alternatives A, B, or C. The environmental impact analysis conducted for the HAMP has not identified any resource or issue that would be significantly

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affected by the proposed action. The following mitigation measures will be implemented to reduce the level of environmental impact.

Slope Stability – Project designs will include suitable design specifications for the slope sensitive areas located along the sides of First and Second Mesa. The specifications will include measures to minimize the potential for erosion and land subsidence.

Soil, Water, and Vegetation – A SWPPP would be developed and specify BMPs to minimize soil erosion and sediment transport during construction. At the completion of construction, exposed soils will be reseeded with weed-free native vegetation and additional invasive species control measures will be implemented in accordance with recommendations from the Hopi Tribe Pesticide Officer. In areas with steep slopes such as mesa sides and arroyo banks, measures such as use of rip-rap and terracing will be used to prevent soil erosion. The fuel storage tanks for the back-up generators will be double walled with leak prevention and spill containment measures.

Migratory Birds and Raptors – Trees and shrubs will be cleared outside of the migratory bird nesting season (March 1 through August 30), and construction will not take place near active migratory bird nests. If this is not possible, a preconstruction survey will be conducted prior to construction and clearing any trees or shrubs during the nesting season. In accordance with the Hopi WEMP recommendations, no construction activity will be allowed during the golden eagle and red-tailed hawk nesting seasons in the vicinity of occupied eagle and hawk nests. If an eaglet or nestling hawk needs additional protection, construction will be delayed in the vicinity of the nest until the Hopi WEMP approves the initiation of work. The Hopi WEMP will also provide an observer to assess the potential effects on active eagle and hawk nests and to ensure that construction does not adversely affect the nests. To prevent raptor electrocutions, the transmission line will have a 60-inch separation between conductors. For distribution lines and other electric facilities, avian-protective design and insulations features should be utilized as appropriate per guidance from the Avian Power Line Interaction Committee (2006).

Cultural Resources – IHS has consulted with representatives of village traditional leaders to assure waterlines and other facilities will not adversely impact TCPs or other cultural sites. Per the policy of the HCPO, the following mitigation measure will be implemented: In the event of an unanticipated discovery including the encounter of any previously unidentified or incorrectly identified cultural resource including, but not limited to, archaeological deposits, human remains, or places reported to be associated with Native American religion beliefs and practices not considered in the cultural assessment, all operations in the area of the discovery will cease and the HCPO will be contacted. An assessment of the discovery will be made by the HCPO. If the discovery is deemed significant, the SHPO will be notified by IHS and HCPO and appropriate recordation will be prepared prior to any resumption of work in the discovery area.

- Several cultural site impacts will be avoided by keeping the water pipelines as far away as possible from the sites, which would decrease the likelihood of the discovery of buried cultural artifacts.
- Several cultural site boundaries within the project area will be flagged prior to ground disturbing activities, and a monitor from the HCPO will observe initial blading and trenching in proximity to each of the sites.

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- While one site is not believed to be eligible to the National Register of Historic Places, the site will be avoided by routing the pipeline through the southern portion of the project area in the vicinity of this site.
- In one area, the pipeline will follow an existing road around the side of the site to avoid impacts to a site. Because this route will follow a portion of an access road to a house, approval for this route should be requested from the homeowner. A monitor from the HCPO will observe initial blading and trenching, and work will not occur in this area during times when the shrine (TCP) needs to be visited.
- Two cultural sites extend totally across the planned pipeline route and cannot be avoided under Alternatives B or C. Because of the disturbance caused by previous construction of a roadway and the site's located around drainage features, there may be little if any subsurface deposits present. If either Alternative B or C is selected, the pipeline would be placed as close as possible to the road. The sites should be remapped, surface collected, analyzed, and tested for subsurface deposits. Construction monitoring would occur after this documentation. These mitigations will not be required since under Revised Alternative A these sites would not be impacted.
- The pipelines, once installed, will not impact ceremonial trails. Work will not occur in these areas when trails are used for ceremonial purposes, which will most likely be during the months of September through December, or if a ceremonial dance is to occur.
- Since portions of the pipeline route will be installed within or in close proximity to several villages, village coordination will be conducted to ensure that construction activities do not impact buildings, structures, shrines, or other features within the villages. Construction work will not interfere with ceremonies or other village functions. Construction work will stay within existing roads in the villages.
- Construction and ground disturbance will not occur during the month of December, or Kyannmuya. Hopi cultural practices do not allow extensive ground disturbance during the period designated to observe respect for the earth and provide a time of rest and annual renewal.
- No construction impacts will occur to orchard trees or agricultural fields without the prior approval of the owner.

Noise – The project engineers and Hopi Water Resources Program will work closely with villages to define appropriate time periods for construction work. Construction equipment will be maintained to minimize extraneous noise.

Solid and Hazardous Waste Management – Chlorine used for water treatment will be handled and stored according to state and federal standards. Any solid waste produced during construction will be disposed of at a licensed landfill. Fuels, lubricants, and hazardous materials used in construction and operations of the HAMP will be managed according to federal and state standards to ensure that no releases (above the *de minimis* level) into soil, surface water, or groundwater occur. Fuel storage tanks for back-up generators will incorporate safety measures to minimize fire and explosion risks. Contractors will be required to prepare and comply with an Environmental Protection Plan (EPP), which will be reviewed and approved by the Hopi Environmental Protection Office. The EPP will require:

(1) A total disclosure of all gases, liquids, explosives, fuels, hazardous wastes, and wastewater;
(2) A copy of storage and disposal requirements and plans for each item on the inventory list;
(3) A copy of the Material Safety Data Sheet for each item on the inventory list;

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(4) A copy of a site safety plan, which shows how an emergency will be handled in case of an emergency or spill event;
(5) Method of disposal and name of disposal contractor for each item on the inventory list; and
(6) Storm water control plans and methods.

Visual and Aesthetic Impacts – The visual impact of HAMP facilities will be reduced where feasible. Lands disturbed for pipelines will be recontoured to their original form and revegetated. Tanks and pump stations will be painted a tan or earth-tone color to help them blend into the landscape. Most transmission and distribution lines will be locate along roadway corridors where the landscape has been modified.

Surface Water Quality – To reduce the potential to create erosion and sediment transport, which can affect water quality, measures will be implemented to minimize soil erosion and sediment transport including the preparation of a SWPPP that specifies best management practices BMPs. In addition, the stream where pipeline crossings are proposed are considered jurisdictional waters of the United States under Section 404 of the Clean Water Act. For each stream crossing, permit coverage under Nationwide Permit 12 – Utility Line Activities will be obtained from the U.S. Army Corps of Engineers, and a Section 401 Water Quality Certification will be obtained from the Hopi Tribe Water Resources Program.

Future Alternative – A supplemental EA will be prepared to evaluate the environmental effects of electrical power line development and/or connecting the HAMP to the BIA/BIE water systems, after the Tribe decides how they want to proceed on these issues. Biological and cultural resource field surveys will study the project area covered by these future alternatives.

4.31 Short-term Use of the Environment versus Long-term Productivity

The HAMP would result in a short-term disturbance of surface lands. The approximate land area affected varies between the alternatives: Alternative A – 425 acres, Revised Alternative A – 420 acres, Alterative B – 408 acres, and Alternative C – 350 acres. Most of the project area lands would return to use for livestock grazing after reseeded vegetation becomes established. The reestablished vegetation would provide habitat for a variety of reptiles, birds, and mammals. The alternatives would allow for future development by providing reliable drinking water sources. In terms of long-term productivity, the Navajo Aquifer would be depleted at a gradual rate. Groundwater extraction from the Turquoise Trail well field is not expected to have detrimental effects on the aquifer system or on flow rates from springs. A small amount of drawdown is expected at the well field, but it will be managed by providing at least one mile of spacing between wells. The Navajo Aquifer provides a long-term sustainable source of groundwater for the HAMP.

4.32 Irreversible and Irretrievable Commitment of Resources

Land used for the HAMP would be restricted for future use. The entire project area would not be available for mineral development such as mines, oil/gas wells, or sand and gravel quarries. Water tank, pump, and electric power line sites would not be available for future development for other purposes. The lands above the water pipelines would be available for limited surface uses with excavation depth limitations such as roadways and parking lots. Once the reseeded vegetation becomes established, lands above the pipelines as well as lands below the electric powerlines would remain available for watershed management, livestock grazing, and wildlife habitat.

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Groundwater in the Navajo Aquifer at the Turquoise Well Field would be used primarily by the HAMP. Little water would be available for other users. The Navajo Aquifer would remain available for use in other areas, but careful planning would be needed to ensure that HAMP water supplies are not affected.

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5.0 Cumulative Impacts

Cumulative impacts include the overall impacts to a resource from past, present, and reasonable foreseeable actions. For this analysis, the area of potential cumulative impacts was assumed to be areas within 10 miles of the Alternatives A, Revised Alternative A, Alternative B, and Alternative C project areas. Anticipated cumulative impacts are listed in Table 5.1.

Table 5.1 Cumulative Impacts Summary

Resource	Past and Present Impacts	Foreseeable Future Impacts
Population	Population has grown steadily. The population in the HAMP project area was 3,952 in 2010 consisting of 1,555 in First Mesa, 962 in Second Mesa, 831 in Shungopavi, and 304 in Keams Canyon (see Tables 1.1 and 3.1).	The population is expected to increase at a 1.8% growth rate. The HAMP is designed to serve this population. No projects that would cause large-scale migrations into the Hopi Reservation have been identified.
Topography	Building construction, road development, and site development have made minor changes to the topography.	The HAMP and future building construction and site development will make additional minor changes to topography.
Geology	Building construction, road development, and site development have excavated into geologic formations.	The HAMP and future building construction and site development will make additional excavations into geologic formations.
Soils	Past and present construction activities have disturbed soils. Exposed soils were covered with roadways, buildings, and scattered vegetation.	Future construction, such as electric facilities, the HAMP extension to serve BIA/BIE water systems and Tawa'ovi Community Development Project, will disturb soils. Exposed areas will be subject to wind and water erosion until recovered with buildings, roads, or vegetation.
Climate and Air Quality	Past and present activities near the HAMP project have had little impact on climate and regional air quality. Emissions sources such as vehicles, fire smoke, and dust are limited and dispersed. On a global basis, climate change caused by incremental increases in worldwide greenhouse gas emissions is causing a gradual change in global temperature averages.	Planned projects would have minor effects on climate and regional air quality. Emissions from vehicles may increase slightly, but the emissions will remain limited and dispersed. On a global basis, climate change will continue to occur for the foreseeable future as a result of historical and expected short-term increases in worldwide greenhouse gas emissions.
Wetlands	Past and present construction activities likely impacted a few wetlands.	No HAMP wetland impacts would occur, but other future construction contracts may impact wetlands near the HAMP project area.
Groundwater Resources	Past and present groundwater extraction has occurred primarily near the First and Second Mesa villages, Keams Canyon, and development near AZ 264.	The HAMP project would shift groundwater extraction to the Turquoise Trail area. As village water systems connect to the HAMP, groundwater extraction near First and Second Mesa, Keams Canyon, and AZ 264 would decrease.
Floodplains	Roadway construction and scattered development has made minor modifications to floodplains.	The HAMP would not modify the floodplains. Future roadway and construction projects may result in minor modifications to floodplains.
Vegetation	Building construction, road development, and site development have disturbed vegetation.	The HAMP project would disturb 420 acres of vegetation. The electric facilities and HAMP extension to serve BIA/BIE water systems would disturb additional vegetation. The planned Tawa'ovi Community Development project would disturb 463.75 acres of

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Resource	Past and Present Impacts	Foreseeable Future Impacts
		vegetation. On-going development near the HAMP project would disturb additional areas of vegetation.
Fish and Wildlife	Past and present building construction, roadway development, and site development have had low level impacts wildlife populations. Habitat has been lost near major roadways, such as AZ 264, and near Hopi villages. Most of the Hopi Reservation remains undeveloped with much wildlife habitat available.	Future development such as the HAMP, electric facilities development, connections to BIA/BIE water systems, and Tawa'ovi Community Development Project will affect wildlife. Temporary construction impacts will affect small reptiles and mammals. Some permanent habitat loss will occur. Most of the Hopi Reservation will remain undeveloped, and wildlife habitat will continue to support wildlife populations.
Endangered or Threatened Species	No endangered or threatened species occur regularly near the HAMP project area.	Planned projects are expected to have no impact on endangered or threatened species near the HAMP project area.
Environmentally Sensitive Areas	Past building construction and roadway development has affected slopes in the First and Second Mesa areas. Noise levels are higher in the First and Second Mesa areas as well as near AZ 264.	The HAMP will affect slopes along proposed pipeline routes at First and Second Mesa. Construction activities on mesa slopes will be limited in future years. Temporary short-term noise impacts will occur during construction of the HAMP and Tawa'ovi Community Development Project. There will be a long-term gradual noise increase in the First and Second Mesa as traffic and development increases.
Cultural Resources	Some past construction activities have affected archaeological sites and historic buildings. The Hopi Tribe has worked to direct construction away from cultural resources.	The HAMP, electric facilities development, connections to BIA/BIE water systems, Tawa'ovi Community Development Project, and other future development projects will be designed to minimize impacts to cultural resources. Accidental cultural resource impacts may occur periodically.
Aesthetic and Visual Resources	Past building construction, roadway development, and site development has modified aesthetic and visual resources primarily in the southern part of First Mesa, Second Mesa, and near AZ 264. The overall landscapes- remains intact.	Minor modifications to the visual landscape would continue from building construction, roadway development, and site development. The overall landscape is expected to remain intact.
Hazardous Materials, Toxic Substances, Waste	Few hazardous materials sites occur on the Hopi Reservation. Typical hazardous materials spills have occurred on roadways. Sheep dip vats have also created hazardous materials sites.	As environmental management practices improve on the Hopi Reservation, hazardous materials spills, and releases to the environment are expected to decrease in the foreseeable future.
Land Use	Building construction, road development, and site development have converted undeveloped rangeland to residential, commercial, and public facility uses.	The HAMP, Tawa'ovi Community Development Project, and other future development projects will continue to convert undeveloped rangeland to residential, commercial, and public facility uses.
Surface Water	Building construction, road development, and site development have impacted ephemeral streams. Most impacts have been related to road and utility crossings of streams. Erosion and sediment transport has occurred during construction when vegetation cover has been cleared.	The HAMP project, the planned Tawa'ovi Community Development project, and future development projects would have the potential to cause erosion and sediment transport during construction when vegetation cover has been cleared. Construction across ephemeral streams will also have potential impacts. BMPs will need to be developed for

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Resource	Past and Present Impacts	Foreseeable Future Impacts
		future construction projects.
Transportation	Roadways have been constructed across much of the Hopi Reservation. Vehicles have been the primary transportation mode.	Roads would be constructed as part of the planned Tawa'ovi Community Development project, and future development projects. Since the Hopi Reservation is a rural area, vehicles are expected to remain the principle transportation mode although there will be opportunities for increased transit.
Environmental Justice	The Hopi Reservation has historically had less access to health and environmental services than other parts of northeastern Arizona. In recent years, there have been health facilities constructed on the reservation and improved delivery of health services. Environmental management has also gradually improved.	In future years, there should be improved delivery of health services and protection of the environment on the Hopi Reservation. The HAMP will be part of this effort.
Indian Trust Assets	The Hopi Tribe has gradually taken a more active role in the management of their assets. Land, water, and grazing rights have historically been important assets to the tribe.	It is expected that the Hopi Tribe will assume greater responsibility for management of their assets, and there will be fewer assets held in trust for the tribe.
Socioeconomics	As economic activity has increased on the Hopi Reservation, there have been more jobs and income for the Hopi. Nevertheless, many individuals need to find employment off the reservation.	Projects such as the HAMP, electric facilities development, connections to BIA/BIE water systems, Tawa'ovi Community Development project, and future development projects should create more jobs and income for the Hopi.
Public Health and Safety	Police, fire, and emergency services are provided on the Hopi Reservation. In recent years, there have been health facilities constructed on the reservation and improved delivery of health services.	There should be improved delivery of health services on the Hopi Reservation. The HAMP will be part of this effort. Illness rates should gradually decrease and lifespans increase on the Hopi Reservation.

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7.0 Persons and Agencies Contacted

Table 7.1 lists persons and agencies consulted for this EA.

Table 7.1 Individuals and Organizations Consulted

Organization	Individual	IHS Consultation	Date
Arizona State Land Department	Jim Adams, Real Estate Director	Sent letter	August 16, 2012
Arizona Department of Environmental Quality	Byron James, Northeast Arizona Community Liaison	Sent letter	August 16, 2012
Arizona Department of Environmental Quality	Byron James, Northeast Arizona Community Liaison	Received letter	September 24, 2012
Arizona Game and Fish Department	Larry D. Voyles, Director	Sent letter	August 16, 2012
Arizona Game and Fish Department	David Weedman, Aquatic Habitat Supervisor	Received letter	August 27, 2012
Arizona Department of Water Resources	Gerry Wildeman, Tribal Issues and Statewide Strategic Planning	Sent letter	August 16, 2012
Arizona State Historic Preservation Office	David Jacobs	Sent letter	August 16, 2012
Arizona State Historic Preservation Office	David Jacobs	Sent letter on Exploratory Drilling	September 11, 2012
Arizona State Historic Preservation Office	David Jacobs	Received No Historic Properties Affected Determination on Exploratory Drilling	September 17, 2012
First Mesa Consolidated Villages	Ivan Sidney, Business Manager	Sent letter	September 24, 2012
Hopi Cultural Preservation Office	Michael Yeatts	Received Finding of No Historic Properties for Two Well Locations	August 22, 2012
Hopi Cultural Preservation Office	Michael Yeatts	Received Finding of No Historic Properties	January 8, 2014
Hopi Tribe, Wildlife and Ecosystems Management Program	Darren Talayumptewa, and Clayton Honyumptewa	HOPI WEMP Comments	April 11, 2013
Navajo County	James Jayne, County Manager	Sent letter	August 16, 2012
Navajo Nation	Ben Shelly, President	Sent Traditional Cultural Properties Consultation Letter	September 11, 2012
Shungopavi Village Administration	Gene Kuwanquaftewa, CSA	Received letter with comments on Preliminary Engineering Report	September 18, 2012
Shungopavi Village	Gene Kuwanquaftewa, CSA	Sent letter	September 24, 2012
Sipaulovi Village	Kim Secakuku, Chairman, Board of Directors	Received questions, comments, and concerns	June 20, 2012
Sipaulovi Village	Anita Bahnimptewa, CSA	Sent letter	September 24, 2012
Tawa'ovi Community Development	George Mase	Sent letter	September 18, 2012
Tawa'ovi Community Development	George Mase	Sent letter	February 11, 2013

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Organization	Individual	IHS Consultation	Date
Tewa Village	Donovan Gomez, CSA	Sent letter	September 24, 2012
US Army Corps of Engineers	Ann Palaruan, Regulatory Division	Consultation on Section 404 permit	September 2012
USDA Natural Resources Conservation Service	Keisha Tatem, State Conservationist	Sent letter	August 16, 2012
USDA Rural Development	Walt Ellsworth, State Architect / State Environmental Coordinator	Sent and received email	January 25, 2012
USDA Rural Development	Loretta Orona, Area Specialist	Letter	April 30, 2013
US Department of Housing and Urban Development	Cristal Quinn, Grants Management Specialist	Sent and received email	October 25, 2012
USDI Bureau of Indian Affairs, Hopi Agency	Wendell Honanie, Superintendent	Received Summary of Tawa'ovi Community Development Project Programmatic EA	October 9, 2012
USDI Bureau of Indian Affairs, Hopi Agency	Gilbert Vicente	Telephone call	October 25, 2012
USDI Bureau of Land Management	Ray Suazo, Arizona State Director	Sent letter	August 16, 2012
USDI Bureau of Land Management	Leah Baker, Planning and Environmental Coordinator	Received email	September 19. 2012
USDI Bureau of Reclamation	Randy Chandler, Manager, Phoenix Area Office	Sent letter	May 30, 2012
USDI Bureau of Reclamation	Randy Chandler, Manager, Phoenix Area Office	Received letter	July 12, 2012
USDI Fish and Wildlife Service	John Nystedt, Southwest Forest Science Complex	Sent letter	August 16, 2012
USDI Fish and Wildlife Service	John Nystedt, Southwest Forest Science Complex	Telephone call	September 18, 2012
US Environmental Protection Agency, Region 9	Bessie Lee, Drinking Water Office	Ongoing meetings and consultation	2012
Walpi Village	Gail Poley, CSA	Sent letter	September 24, 2012
Zuni Pueblo	Arlen Quetawki, Sr., Governor	Sent Traditional Cultural Properties Consultation Letter	September 11, 2012

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8.0 List of Preparers

The following individuals were involved in the preparation of this document:

Table 8.1 EA Preparers

Preparer	Title	Affiliation	Area of Input
John Hamilton	NEPA Coordinator	IHS	Document review
Adam Hughes	Senior Environmental Engineer	IHS	Alternative development, 2014 PER preparation
Joshua Van Vleet	Senior Environmental Engineer	IHS	Alternative development, 2012 PER preparation
Marcus Felter	Environmental Engineer	IHS	Alternative development, 2012 PER preparation
Eric Johnson	Senior Environmental Project Manager	Marron and Associates	Affected environment and environmental impact analysis
Micah Loma'omvaya	Natural Resources Planner	Hopi Tribe	Document review
Lionel Puhuyesva	Water Resource Manager	Hopi Water Resources	Tribal Project Manager
Jennifer Hill	Project Engineer	Bohannan-Huston	Floodplain and drainage analysis
Brad Sumrall	Project Engineer	Bohannan-Huston	Floodplain and drainage analysis
Olin Brown	Drainage Engineer	Bohannan-Huston	Floodplain and drainage analysis

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