Lake Powell Pipeline

Draft Study Report 2
Aquatic Resources

March 2011

Aquatic Resources Study Report
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Aquatic Resources Study Report
Executive Summary

ES-1 Introduction

This study report describes the results and findings of an analysis to evaluate aquatic resources along the proposed alternative alignments of the Lake Powell Pipeline Project (LPP Project), No Lake Powell Water Alternative, and No Action Alternative. The purpose of the analysis, as defined in the 2008 Aquatic Resources Study Plan prepared for the Federal Energy Regulatory Commission (Commission), was to identify potential impacts from construction and operations of the alternatives and identify measures to mitigate impacts from the LPP project as necessary.

ES-2 Methodology

The analysis of impacts on aquatic resources follows the methodology identified and described in the Preliminary Application Document, Scoping Document No. 1 and the Aquatic Resources Study Plan filed with the Commission.

ES-3 Key Results of the Aquatic Resources Impact Analyses

The LPP Project study area contains five perennial streams and two reservoirs that have the potential to be directly or indirectly affected by the LPP Project and its alternatives. The streams include: Paria River, Kanab Creek upstream of Kanab, Virgin River, LaVerkin Creek, and lower Ash Creek. The reservoirs include Lake Powell and Sand Hollow Reservoir.

ES-3.1 LPP Project Alignment Alternatives

Aquatic resources could be directly affected by the LPP Project alignment alternatives in the Paria River and LaVerkin Creek during construction of pipeline crossings. Construction of the pipeline crossings at both sites would be performed using open cut trench and backfill techniques combined with temporary diversions of the streams during low flows to minimize impacts on aquatic resources and habitat (water quality - turbidity and sediment recruitment; stream bed substrates; and riparian vegetation). The implementation of mitigation measures at both sites during construction would result in minor impacts on aquatic resources that could not be measured and they would not be significant. Construction activities at Lake Powell and Sand Hollow Reservoir would have no measurable impacts on aquatic resources.

LPP Project operation would not have any significant impacts on aquatic resources.

ES-3.2 No Lake Powell Water Alternative

Construction of the No Lake Powell Water Alternative would have no measurable impacts on aquatic resources.

Operation of the No Lake Powell Water Alternative would cause indirect impacts resulting from restrictions on residential outdoor watering, which would reduce groundwater recharge that currently reports to the Virgin River and its tributary streams during the summer and fall months in the St. George

metropolitan area. The Virgin River and tributary streams from Hurricane to the Utah-Arizona state line would become losing reaches during the summer and fall months, reducing the streamflow, reducing aquatic resource habitat area, increasing water temperature, changing aquatic resource food supplies, and diminishing the areal extent and functions of riparian areas along the streams. These would be significant indirect impacts on aquatic resources and habitats in the St. George metropolitan area under the No Lake Powell Water Alternative.

Chapter 1
Introduction

1.1 Introduction

This chapter presents a summary description of the alternatives studied for the Lake Powell Pipeline (LPP) project, located in north central Arizona and southwest Utah (Figure 1-1) and identifies the issues and impact topics for the Aquatic Resources Study Report. The alternatives studied and analyzed include different alignments for pipelines and penstocks and transmission lines, a no Lake Powell water alternative, and the No Action alternative. The pipelines would convey water under pressure and connect to the penstocks, which would convey the water to a series of hydroelectric power generating facilities. The action alternatives would each deliver 86,249 acre-feet of water annually for municipal and industrial (M&I) use in the three southwest Utah water conservancy district service areas. Washington County Water Conservancy District (WCWCD) would receive 69,000 acre-feet, Kane County Water Conservancy District (KCWCD) would receive 4,000 acre-feet and Central Iron County Water Conservancy District (CICWCD) could receive up to 13,249 acre-feet each year.

1.2 Summary Description of Alignment Alternatives

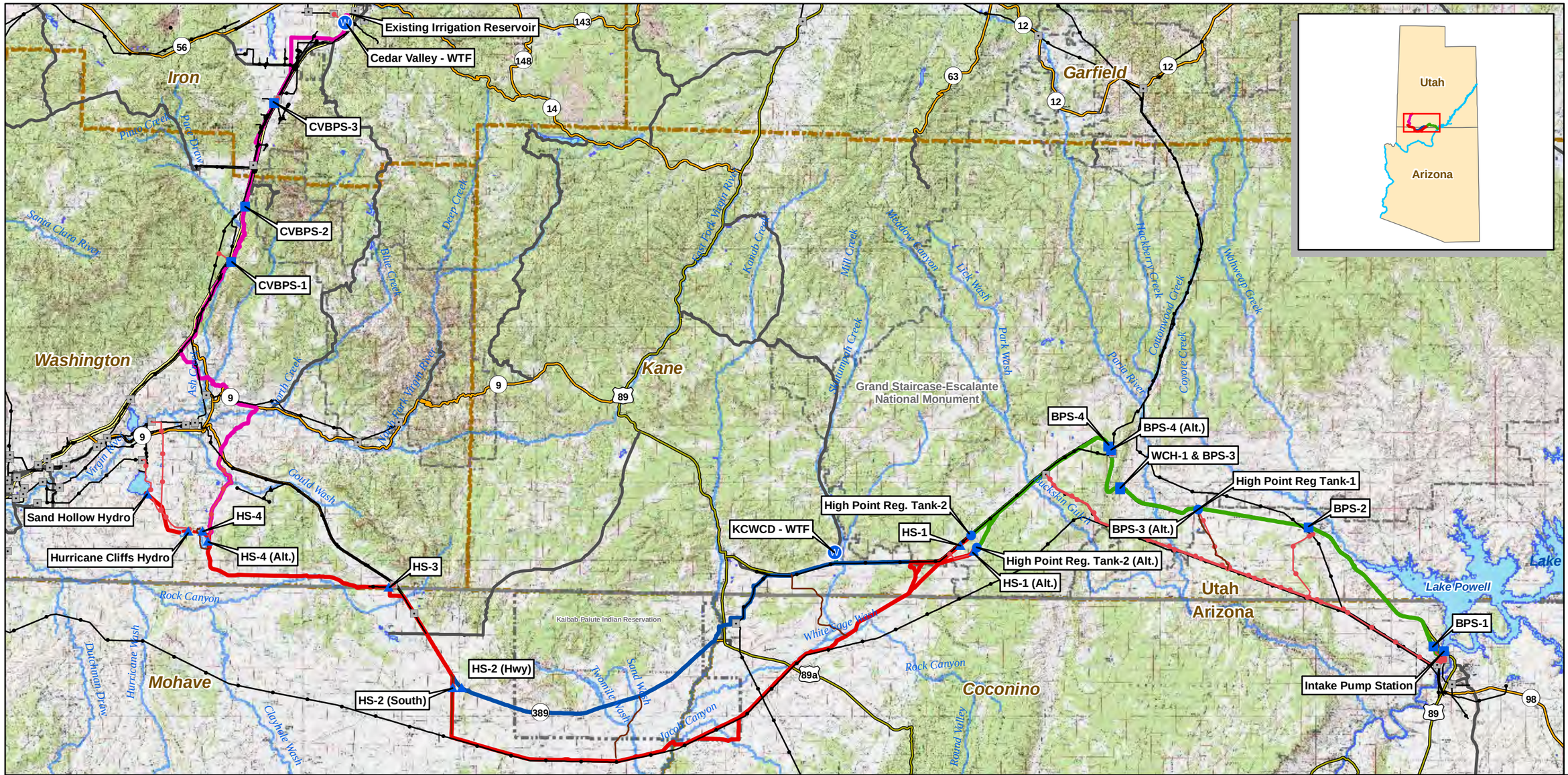
Three primary pipeline and penstock alignment alternatives are described in this section along with the electrical power transmission line alternatives. The pipeline and penstock alignment alternatives share common segments between the intake at Lake Powell and delivery at Sand Hollow Reservoir, and they are spatially different in the area through and around the Kaibab-Paiute Indian Reservation. The South Alternative extends south around the Kaibab-Paiute Indian Reservation. The Existing Highway Alternative follows an Arizona state highway through the Kaibab-Paiute Indian Reservation. The Southeast Corner Alternative follows the Navajo-McCullough Transmission Line corridor through the southeast corner of the Kaibab-Paiute Indian Reservation. The transmission line alignment alternatives are common to all the pipeline and penstock alignment alternatives. Figure 1-1 shows the overall proposed project and alternative features from Lake Powell near Page, Arizona to Sand Hollow and Cedar Valley, Utah.

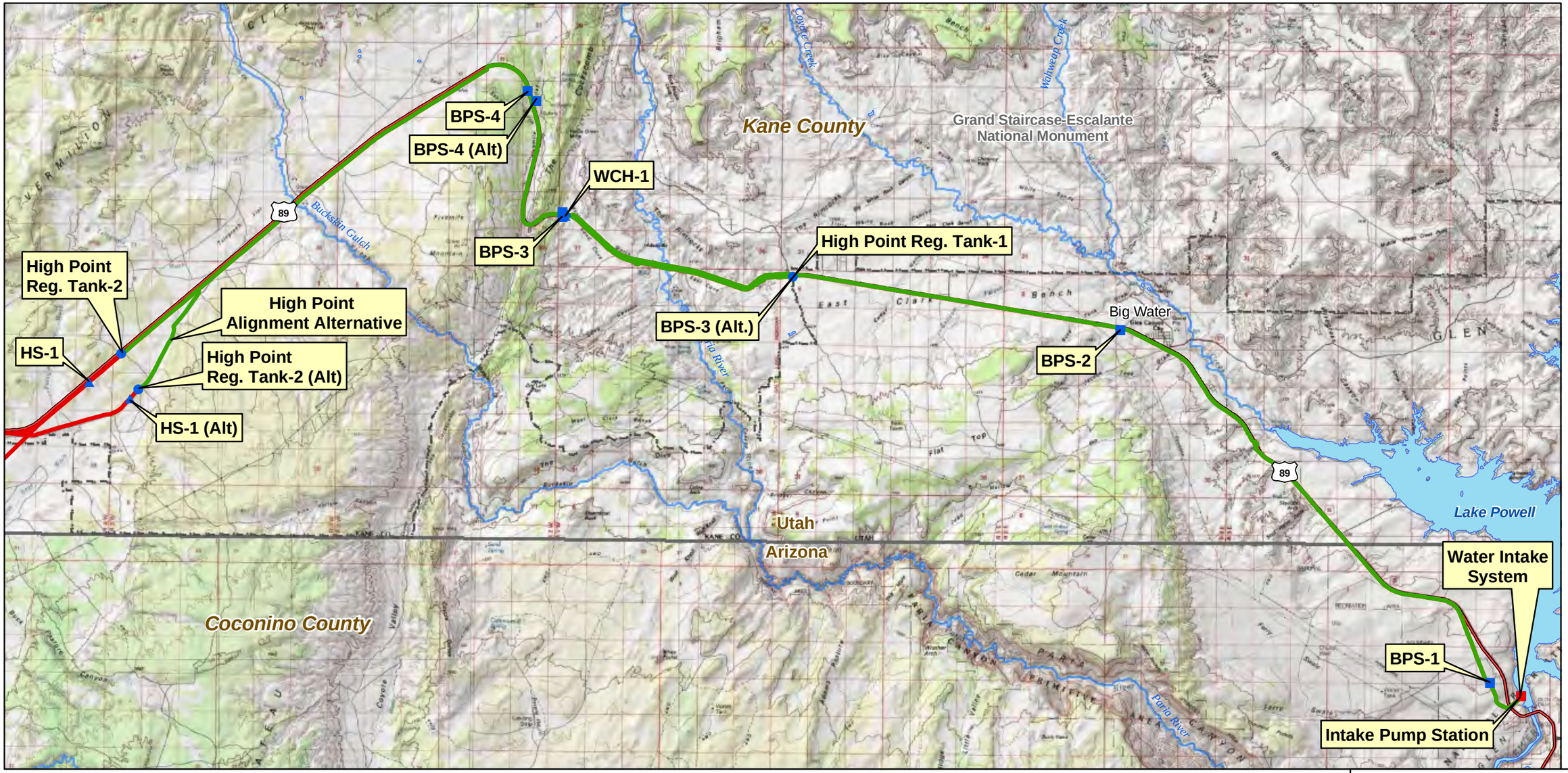
1.2.1 South Alternative

The South Alternative consists of five systems: Intake, Water Conveyance, Hydro, Kane County Pipeline, and Cedar Valley Pipeline.

The **Intake System** would pump Lake Powell water via submerged horizontal tunnels and vertical shafts into the LPP. The intake pump station would be constructed and operated adjacent to the west side of Lake Powell approximately 2,000 feet northwest of Glen Canyon Dam in Coconino County, Arizona (Figure 1-2). The pump station enclosure would house vertical turbine pumps with electric motors, electrical controls, and other equipment at a ground level elevation of 3,745 feet mean sea level (MSL).

The **Water Conveyance System** would convey the Lake Powell water from the Intake System for about 51 miles through a buried 69-inch diameter pipeline parallel with U.S. 89 in Coconino County, Arizona and Kane County, Utah to a buried regulating tank (High Point Regulating Tank-2) on the south side of U.S. 89 at ground level elevation 5,695 feet MSL, which is the LPP project topographic high point


Existing Irrigation Reservoir
Cedar Valley - WTF
CVBPS-3
CVBPS-2
CVBPS-1
Sand Hollow Hydro
HS-4
HS-4 (Alt.)
Hurricane Cliffs Hydro
HS-3
HS-2 (Hwy)
HS-2 (South)
KCWCD - WTF
High Point Reg. Tank-2
HS-1
High Point Reg. Tank-2 (Alt.)
HS-1 (Alt.)
BPS-4
BPS-4 (Alt.)
WCH-1 & BPS-3
High Point Reg Tank-1
BPS-3 (Alt.)
BPS-2
BPS-1
Intake Pump Station
Iron
Washington
Kane
Garfield
Mohave
Coconino
Utah
Arizona
Grand Staircase-Escalante National Monument
Kaibab-Paiute Indian Reservation
Lake Powell
Lake
Utah
Arizona
Water Treatment Facility
Project Pump Station
Project Regulating Tank
Project Hydro Station
Project Transmission Line
Existing Substation
Existing Transmission Line
Water Conveyance
Hydro System - South Alignment Alternative
Hydro System - Highway Alignment Alternative
KCWCD Pipeline System
Cedar Valley Pipeline
Interstate
US Highway
ST Highway
Hwy
Major Road
Access Roads
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
GSENM-Boundary
Tribal Lands
State Boundaries
County Boundaries
FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472
N
0 2.5 5 10 15 20
Miles
Lake Powell Pipeline Project
Spatial Reference: UTM Zone 12N, NAD-83
UDWR Figure 1-1
MWH
Lake Powell Pipeline
Proposed Project and
Alternative Features



- Project Intake Pump Station
- Project Booster Pump Station
- Project Regulating Tank
- Project Hydro Station
- Water Conveyance System
- Hydro System - South Alignment Alternative
- Interstate
- US Highway
- ST Highway
- Hwy
- Major Road
- Lakes & Reservoirs
- Major Rivers & Streams
- National Park/Monument
- GSENM Boundary
- State Boundaries

NGS USA Topographic Maps

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

0 0.5 1 2 3 4 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-2** MWH

Lake Powell Pipeline Intake and Water Conveyance Systems

(Figure 1-2). The pipeline would be sited within a utility corridor established by Congress in 1998 which extends 500 feet south and 240 feet north of the U.S. 89 centerline on public land administered by the Bureau of Land Management (BLM) (U.S. Congress 1998). Four booster pump stations (BPS) located along the pipeline would pump the water under pressure to the high point regulating tank. Each BPS would house vertical turbine pumps with electric motors, electrical controls, and other equipment. Additionally, each BPS site would have a substation, buried forebay tank and a surface emergency overflow detention basin. BPS-1 would be sited within the Glen Canyon National Recreation Area adjacent to an existing Arizona Department of Transportation maintenance facility located west of U.S. 89. BPS-2 would be sited on land administered by the Utah School and Institutional Trust Lands Administration (SITLA) near the town of Big Water, Utah on the south side of U.S. 89. BPS-3 and an in-line hydro station (WCH-1) would be sited at the east side of the Cockscomb geologic feature in the Grand Staircase-Escalante National Monument (GSENM) within the Congressionally-designated utility corridor. BPS-3 (Alt) is an alternative location for BPS-3 on land administered by the BLM Kanab Field Office near the east boundary of the GSENM on the south side of U.S. 89 within the Congressionally-designated utility corridor. Incorporation of BPS-3 (Alt.) into the LPP project would replace BPS-3 and WCH-1 at the east side of the Cockscomb geologic feature. BPS-4 would be sited on the west side of U.S. 89 and within the Congressionally-designated utility corridor in the GSENM on the west side of the Cockscomb geologic feature.

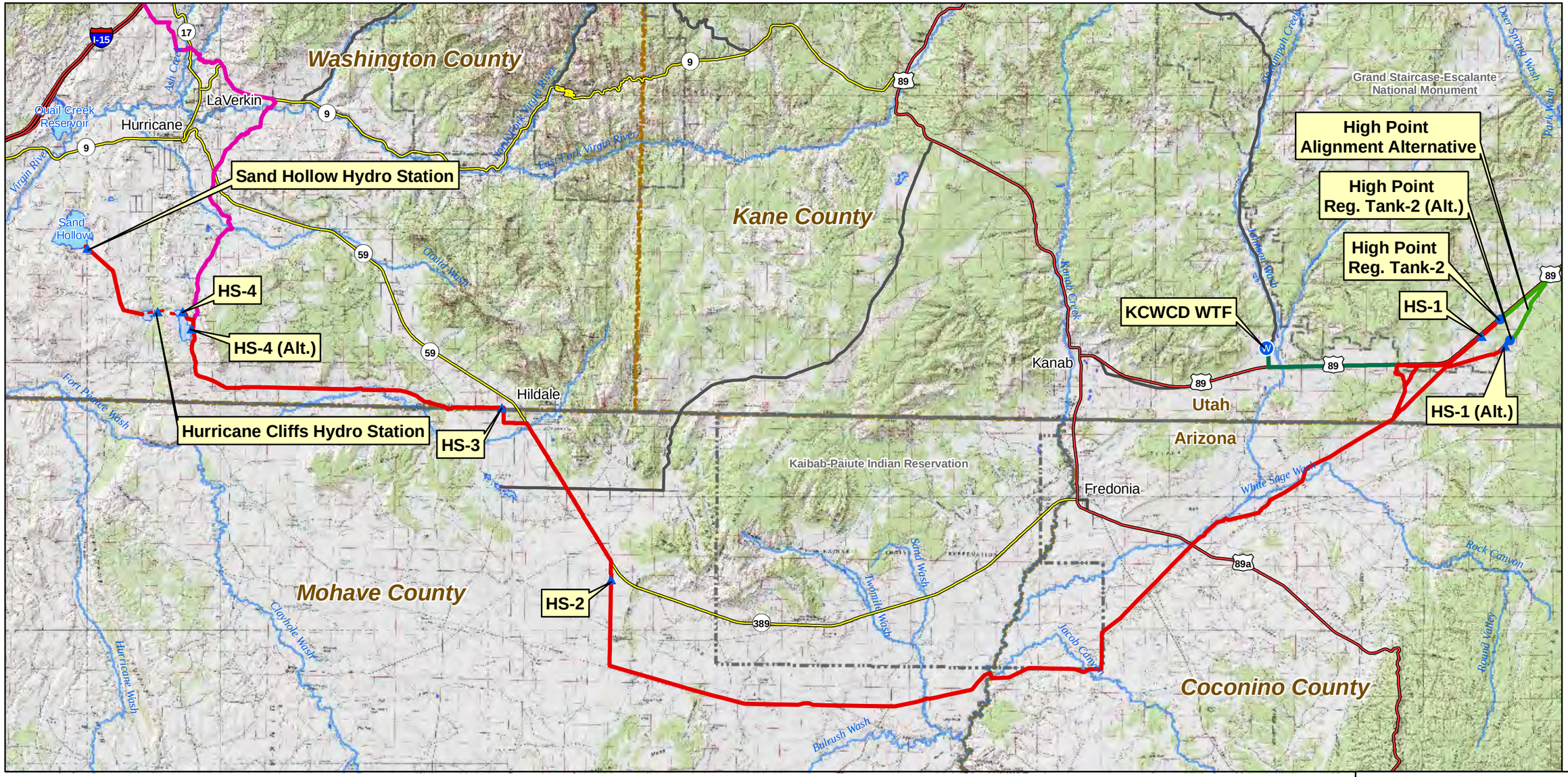
The High Point Alignment Alternative would diverge south from U.S. 89 parallel to the K4020 road and continue outside of the Congressionally-designated utility corridor to a buried regulating tank (High Point Regulating Tank-2 (Alt.) at ground level elevation 5,630 feet MSL, which would be the topographic high point of the LPP project along this alignment alternative (Figure 1-2). The High Point Alignment Alternative would include BPS-4 (Alt.) on private land east of U.S. 89 and west of the Cockscomb geologic feature (Figure 1-2). Incorporation of the High Point Alignment Alternative and BPS-4 (Alt.) into the LPP project would replace the High Point Regulation Tank-2 along U.S. 89, the associated buried pipeline and BPS-4 west of U.S. 89.

A rock formation avoidance alignment option would be included immediately north of Blue Pool Wash along U.S. 89 in Utah. Under this alignment option, the pipeline would cross to the north side of U.S. 89 for about 400 feet and then return to the south side of U.S. 89. This alignment option would avoid tunneling under the rock formation on the south side of U.S. 89 near Blue Pool Wash.

A North Pipeline Alignment option is located parallel to the north side of U.S. 89 for about 6 miles from the east boundary of the GSENM to the east side of the Cockscomb geological feature.

The **Hydro System** would convey the Lake Powell water from High Point Regulating Tank-2 at the high point at ground level elevation 5,695 feet MSL for about 87 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah and Coconino and Mohave counties, Arizona to Sand Hollow Reservoir near St. George, Utah (Figure 1-3). The High Point Alignment Alternative would convey the Lake Powell water from High Point Regulating Tank-2 (Alt.) at the high point at ground level elevation 5,630 feet MSL for about 87.5 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah and Coconino and Mohave counties, Arizona to Sand Hollow Reservoir near St. George, Utah (Figure 1-3). Four in-line hydro generating stations (HS-1, HS-2 HS-3 and HS-4) with substations located along the penstock would generate electricity and help control water pressure in the penstock. HS-1 would be sited on the south side of U.S. 89 within the Congressionally-designated utility corridor through the GSENM. The High Point Alignment Alternative would include HS-1 (Alt.) along the K4020 road within the GSENM and continue along a portion of the K3290 road.

The proposed penstock alignment and two penstock alignment options are being considered to convey the water from the west GSENM boundary south through White Sage Wash. The proposed penstock



- Water Treatment Facility
- Project Regulating Tank
- Project Hydro Station
- Hurricane Cliffs Forebay/Afterbay
- Lakes & Reservoirs
- Major Rivers & Streams
- Hydro System - South Alignment Alternative
- Water Conveyance System
- Cedar Valley Pipeline
- KCWCD Pipeline System
- Interstate
- US Highway
- ST Highway
- Hwy
- Major Road
- National Park/Monument
- GSENM Boundary
- Tribal Lands
- State Boundaries
- County Boundaries

FERC Project Number: 12966-001
BLM Serial Numbers: AZA-34941 UTU-85472

N

0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR Figure 1-3 MWH

Lake Powell Pipeline Hydro System South Alternative

alignment would parallel the K3250 road south from U.S. 89 and follow the Pioneer Gap Road alignment around the Shinarump Cliffs. One penstock alignment option would parallel the K3285 road southwest from U.S. 89 and continue to join the Pioneer Gap Road around the Shinarump Cliffs. The other penstock alignment option would extend southwest through currently undeveloped BLM land from the K3290 road into White Sage Wash.

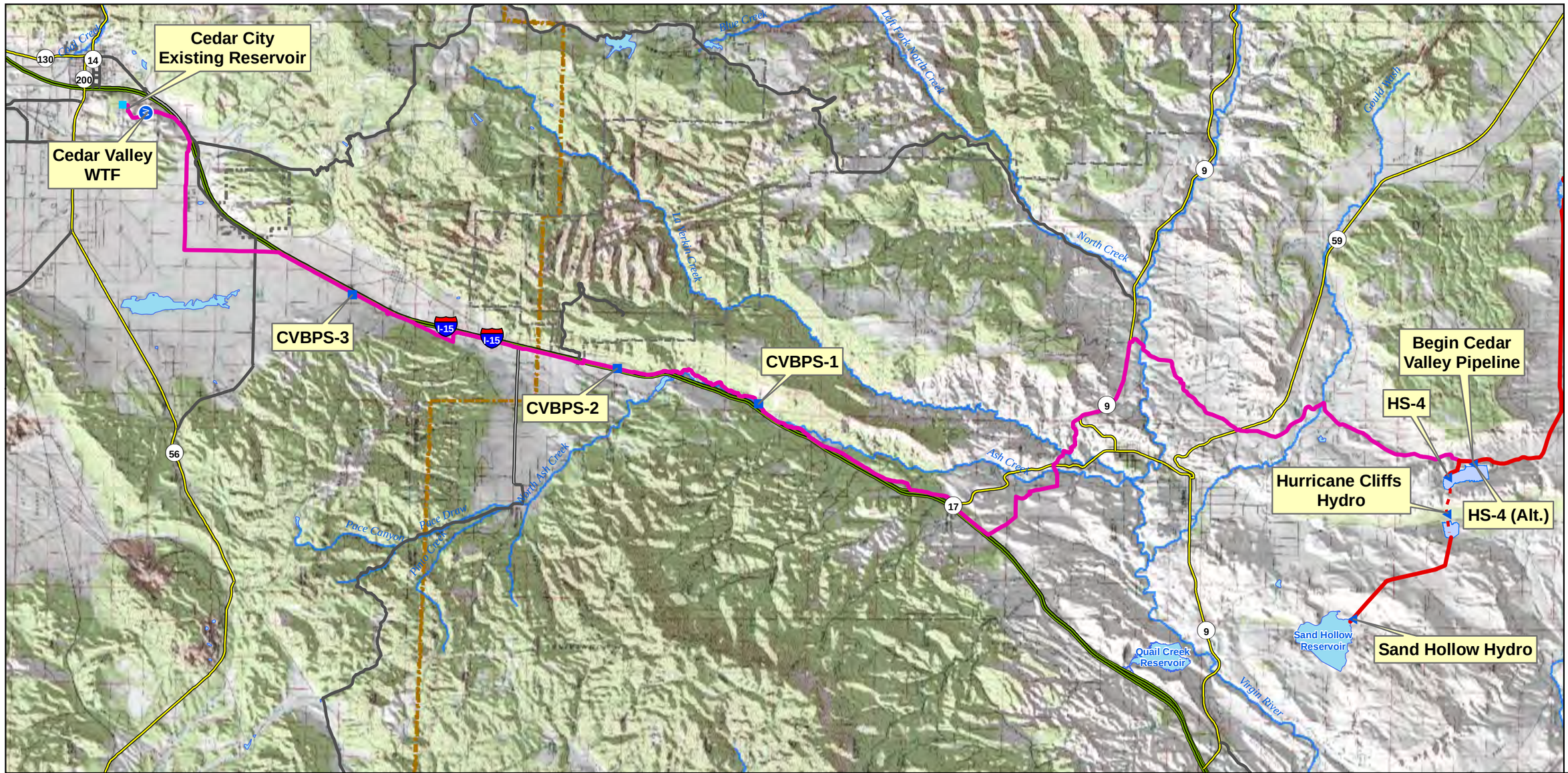
The penstock alignment would continue through White Sage Wash and then parallel to the Navajo-McCullough Transmission Line, crossing U.S. 89 Alt. and Forest Highway 22 toward the southeast corner of the Kaibab Indian Reservation. The penstock alignment would run parallel to and south of the south boundary of the Kaibab Indian Reservation, crossing Kanab Creek and Bitter Seeps Wash, across Moonshine Ridge and Cedar Ridge, and north along Yellowstone Road to Arizona State Route 389 west of the Kaibab Indian Reservation. HS-2 would be sited west of the Kaibab Indian Reservation. The penstock alignment would continue northwest along the south side of Arizona State Route 389 past Colorado City to Hildale City, Utah and HS-3.

The penstock alignment would follow Uzona Road west through Canaan Gap and south of Little Creek Mountain and turn north to HS-4 (Alt.) above the proposed Hurricane Cliffs forebay reservoir. The forebay reservoir would be contained in a valley between a south dam and a north dam and maintain active storage of 11,255 acre-feet of water. A low pressure tunnel would convey the water to a high pressure vertical shaft in the bedrock forming the Hurricane Cliffs, connected to a high pressure tunnel near the bottom of the Hurricane Cliffs. The high pressure tunnel would connect to a penstock conveying the water to a pumped storage hydro generating station. The pumped storage hydro generating station would connect to an afterbay reservoir contained by a single dam in the valley below the Hurricane Cliffs. A low pressure tunnel would convey the water northwest to a penstock continuing on to the Sand Hollow Hydro Station. The water would discharge into the existing Sand Hollow Reservoir.

The peaking hydro generating station option would involve a smaller, 200 acre-foot forebay reservoir with HS-4 discharging into the forebay reservoir, with the peaking hydro generating station discharging to a small afterbay connected to a penstock running north along the existing BLM road and west to the Sand Hollow Hydro Station. A low pressure tunnel would convey the water to a high pressure vertical shaft in the bedrock forming the Hurricane Cliffs, connected to a high pressure tunnel near the bottom of the Hurricane Cliffs. The high pressure tunnel would connect to a penstock conveying the water to a peaking hydro generating station, which would discharge into a 200 acre-foot afterbay reservoir. A penstock would extend north from the afterbay reservoir along the existing BLM road and then west to the Sand Hollow Hydro Station. The water would discharge into the existing Sand Hollow Reservoir.

The **Kane County Pipeline System** would convey the Lake Powell water from the Lake Powell Pipeline at the west GSENM boundary for about 8 miles through a buried 24-inch diameter pipe in Kane County, Utah to a conventional water treatment facility located near the mouth of Johnson Canyon. The pipeline would parallel the south side of U.S. 89 across Johnson Wash and then run north to the new water treatment facility site (Figure 1-3).

The **Cedar Valley Pipeline System** would convey the Lake Powell water from the Lake Powell Pipeline just upstream of HS-4 or HS-4 (Alt.) for about 58 miles through a buried 36-inch diameter pipeline in Washington and Iron counties, Utah to a conventional water treatment facility in Cedar City, Utah (Figure 1-4). Three booster pump stations (CVBPS) located along the pipeline would pump the water under pressure to the new water treatment facility. The pipeline would follow an existing BLM road north from HS-4, cross Utah State Route 59 and continue north to Utah State Route 9, with an aerial crossing of the Virgin River at the Sheep Bridge. The pipeline would run west along the north side of Utah State Route 9 and parallel an existing pipeline through the Hurricane Cliffs at Nephi's Twist. The pipeline



- Water Treatment Facility
- Project Pump Station
- Project Hydro Station
- Hydro System - South Alignment Alternative
- Water Conveyance System
- Hurricane Cliffs Pressure Tunnel
- Cedar Valley Pipeline
- Interstate
- US Highway
- ST Highway
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0 1 2 4 6 8 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-4** MWH

Cedar Valley Pipeline System

would continue across LaVerkin Creek, cross Utah State Route 17, and make an aerial crossing of Ash Creek. The pipeline would continue northwest to the Interstate 15 corridor and then northeast parallel to the east side of Interstate 15 highway right-of-way. CVBPS-1 would be sited adjacent to an existing gravel pit east of Interstate 15. CVBPS-2 would be sited on private property on the east side of Interstate 15 and south of the Kolob entrance to Zion National Park. CVBPS-3 would be sited on the west side of Interstate 15 in Iron County. The new water treatment facility would be sited near existing water reservoirs on a hill above Cedar City west of Interstate 15.

1.2.2 Existing Highway Alternative

The Existing Highway Alternative consists of five systems: Intake, Water Conveyance, Hydro, Kane County Pipeline, and Cedar Valley Pipeline. The Intake, Water Conveyance and Cedar Valley Pipeline systems would be the same as described for the South Alternative.

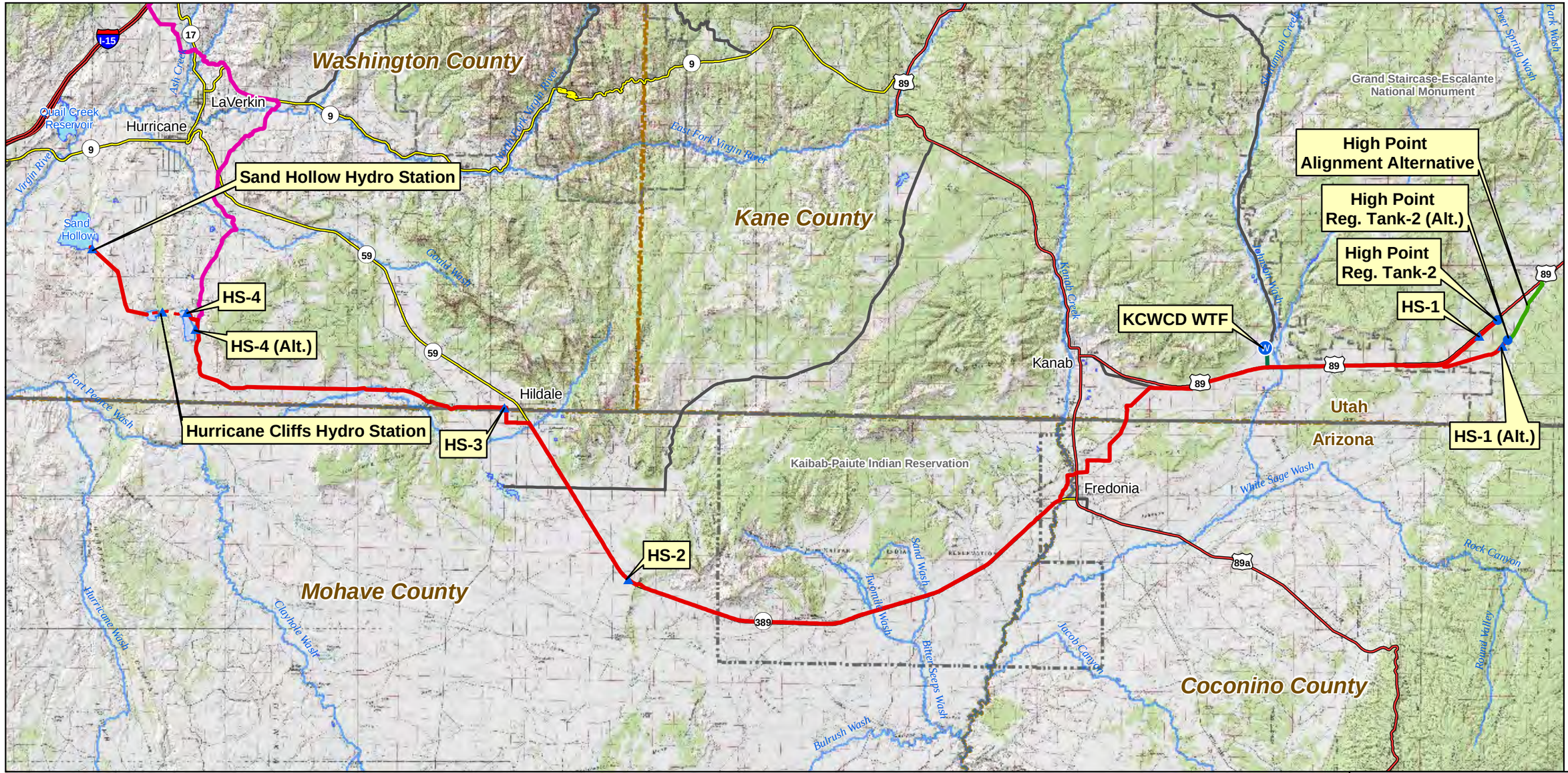
The **Hydro System** would convey the Lake Powell water from the regulating tank at the high point at ground elevation 5,695 feet MSL for about 80 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah and Coconino and Mohave counties, Arizona to Sand Hollow Reservoir near St. George, Utah (Figure 1-5). The High Point Alignment Alternative would convey the Lake Powell water from High Point Regulating Tank-2 (Alt.) at the high point at ground level elevation 5,630 feet MSL for about 80.5 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah and Coconino and Mohave counties, Arizona to Sand Hollow Reservoir near St. George, Utah (Figure 1-3). The High Point Alignment Alternative would rejoin U.S. 89 about 2.5 miles east of the west boundary of the GSENM. Four in-line hydro generating stations (HS-1, HS-2 HS-3 and HS-4) located along the penstock would generate electricity and help control water pressure in the penstock. HS-1 would be sited on the south side of U.S. 89 within the Congressionally-designated utility corridor through the GSENM. The High Point Alignment Alternative would include HS-1 (Alt.) along the K4020 road within the GSENM and continue along a portion of the K3290 road to its junction with the pipeline alignment along U.S. 89.

The penstock would parallel the south side of U.S. 89 west of the GSENM past Johnson Wash and follow Lost Spring Gap southwest, crossing U.S. 89 Alt. and Kanab Creek in the north end of Fredonia, Arizona. The penstock would run south paralleling Kanab Creek to Arizona State Route 389 and run west adjacent to the north side of this state highway through the Kaibab-Paiute Indian Reservation past Pipe Spring National Monument. The penstock would continue along the north side of Arizona State Route 389 through the west half of the Kaibab-Paiute Indian Reservation to 1.8 miles west of Cedar Ridge (intersection of Yellowstone Road with U.S. 89), from where it would follow the same alignment as the South Alternative to Sand Hollow Reservoir. HS-2 would be sited 0.5 mile west of Cedar Ridge along the north side of Arizona State Route 389.

The **Kane County Pipeline System** would convey the Lake Powell water from the Lake Powell Pipeline crossing Johnson Wash along U.S. 89 for about 1 mile north through a buried 24-inch diameter pipe in Kane County, Utah to a conventional water treatment facility located near the mouth of Johnson Canyon (Figure 1-5).

1.2.3 Southeast Corner Alternative

The Southeast Corner Alternative consists of five systems: Intake, Water Conveyance, Hydro, Kane County Pipeline, and Cedar Valley Pipeline. The Intake, Water Conveyance, Kane County Pipeline and Cedar Valley Pipeline systems would be the same as described for the South Alternative.



- Water Treatment Facility
- Project Regulating Tank
- Project Hydro Station
- Hurricane Cliffs Forebay/Afterbay
- Lakes & Reservoirs
- Major Rivers & Streams
- Water Conveyance
- Hydro System - South Alignment Alternative
- Hurricane Cliffs Pressure Tunnel
- Cedar Valley Pipeline
- KCWCD Pipeline System
- Interstate
- US Highway
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- Hwy
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- National Park/Monument
- GSENM Boundary
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FERC Project Number:
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UTU-85472

N

0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-5** MWH

Lake Powell Pipeline
Hydro System
Existing Highway Alternative

The **Hydro System** would be the same as described for the South Alternative between High Point Regulating Tank-2 and the east boundary of the Kaibab-Paiute Indian Reservation. The penstock alignment would parallel the north side of the Navajo-McCullough Transmission Line corridor in Coconino County, Arizona through the southeast corner of the Kaibab Indian Reservation for about 3.8 miles and then follow the South Alternative alignment south of the south boundary of the Kaibab-Paiute Indian Reservation, continuing to Sand Hollow Reservoir (Figure 1-6).

1.2.4 Transmission Line Alternatives

Transmission line alternatives include the Intake (3 alignments), BPS-1, Glen Canyon to Buckskin, Buckskin Substation upgrade, Paria Substation upgrade, BPS-2, BPS-2 Alternative, BPS-3 North, BPS-3 South, BPS-3 Underground, BPS-3 Alternative North, BPS-3 Alternative South, BPS-4, BPS-4 Alternative, HS-1 Alternative, HS-2 South, HS-3 Underground, HS-4, HS-4 Alternative, Hurricane Cliffs Afterbay to Sand Hollow, Hurricane Cliffs Afterbay to Hurricane West, Sand Hollow to Dixie Springs, Cedar Valley Pipeline booster pump stations, and Cedar Valley Water Treatment Facility.

The proposed new **Intake Transmission Line** would begin at Glen Canyon Substation and run parallel to U.S. 89 for about 2,500 feet to a new switch station, cross U.S. 89 at the Intake access road intersection and continue northeast to the Intake substation. This 69 kV transmission line would be about 0.9 mile long in Coconino County, Arizona (Figure 1-7). One alternative alignment would run parallel to an existing 138 kV transmission line to the west, turn north to the new switch station, cross U.S. 89 at the Intake access road intersection and continue northeast to the Intake substation. This 69 kV transmission line alternative would be about 1.2 miles long in Coconino County, Arizona (Figure 1-7). Another alternative alignment would bifurcate from an existing transmission line and run west, then northeast to the new switch station, cross U.S. 89 at the Intake access road intersection and continue northeast to the Intake substation. This 69 kV transmission line alternative would be about 1.3 miles long in Coconino County, Arizona (Figure 1-7).

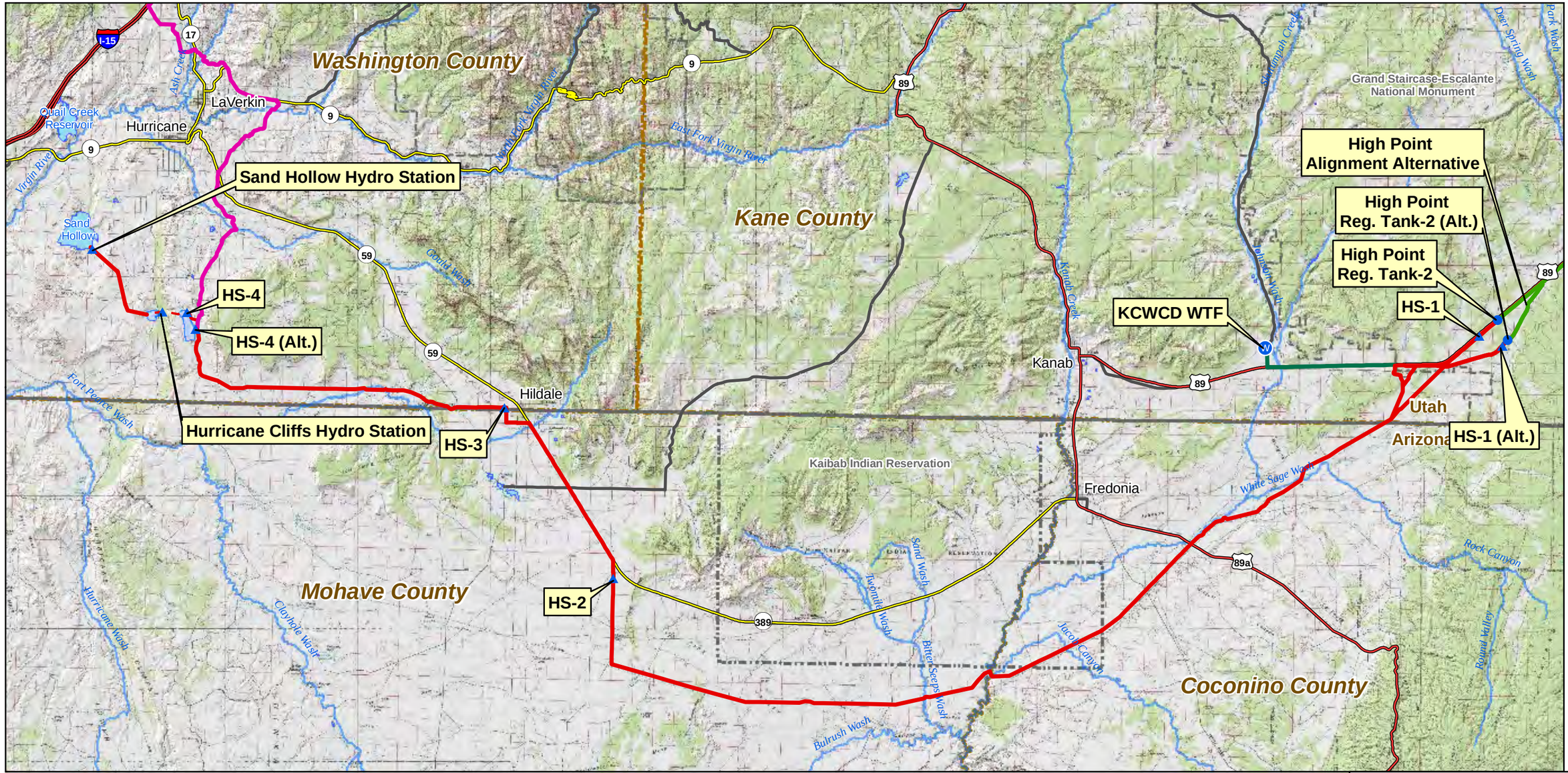
The proposed new **BPS-1 Transmission Line** would begin at the new switch station located on the south side of U.S. 89 and parallel the LPP Water Conveyance System alignment to the BPS-1 substation west of U.S. 89. This 69 kV transmission line would be about 1 mile long in Coconino County, Arizona (Figure 1-7).

The proposed new **Glen Canyon to Buckskin Transmission Line** would consist of a 230 kV transmission line from the Glen Canyon Substation to the Buckskin Substation, running parallel to the existing 138 kV transmission line. This transmission line upgrade would be about 36 miles long through Coconino County, Arizona and Kane County, Utah (Figure 1-7).

The existing **Buckskin Substation** would be upgraded as part of the proposed project to accommodate the additional power loads from the new 230 kV Glen Canyon to Buckskin transmission line. The substation upgrade would require an additional 5 acres of land within the GSENM adjacent to the existing substation in Kane County, Utah (Figure 1-7).

The existing **Paria Substation** would be upgraded as part of the proposed project to accommodate the additional power loads to BPS-4 Alternative. The substation upgrade would require an additional 2 acres of privately-owned land adjacent to the existing substation in Kane County, Utah (Figure 1-7).

The proposed new **BPS-2 Transmission Line** alternative would consist of a new 3-ring switch station along the existing 138 kV Glen Canyon to Buckskin Transmission Line and a new transmission line from the switch station to a new substation west of Big Water and a connection to BPS-2 substation in Kane



Water Treatment Facility
Project Regulating Tank
Project Hydro Station
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams

Water Conveyance System
Hydro System - Southeast Corner Alternative
Kane County Pipeline System
Cedar Valley Pipeline System

Interstate
US Highway
ST Highway
Hwy
Major Road

National Park/Monument
GSENM Boundary
Tribal Lands
State Boundaries
County Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

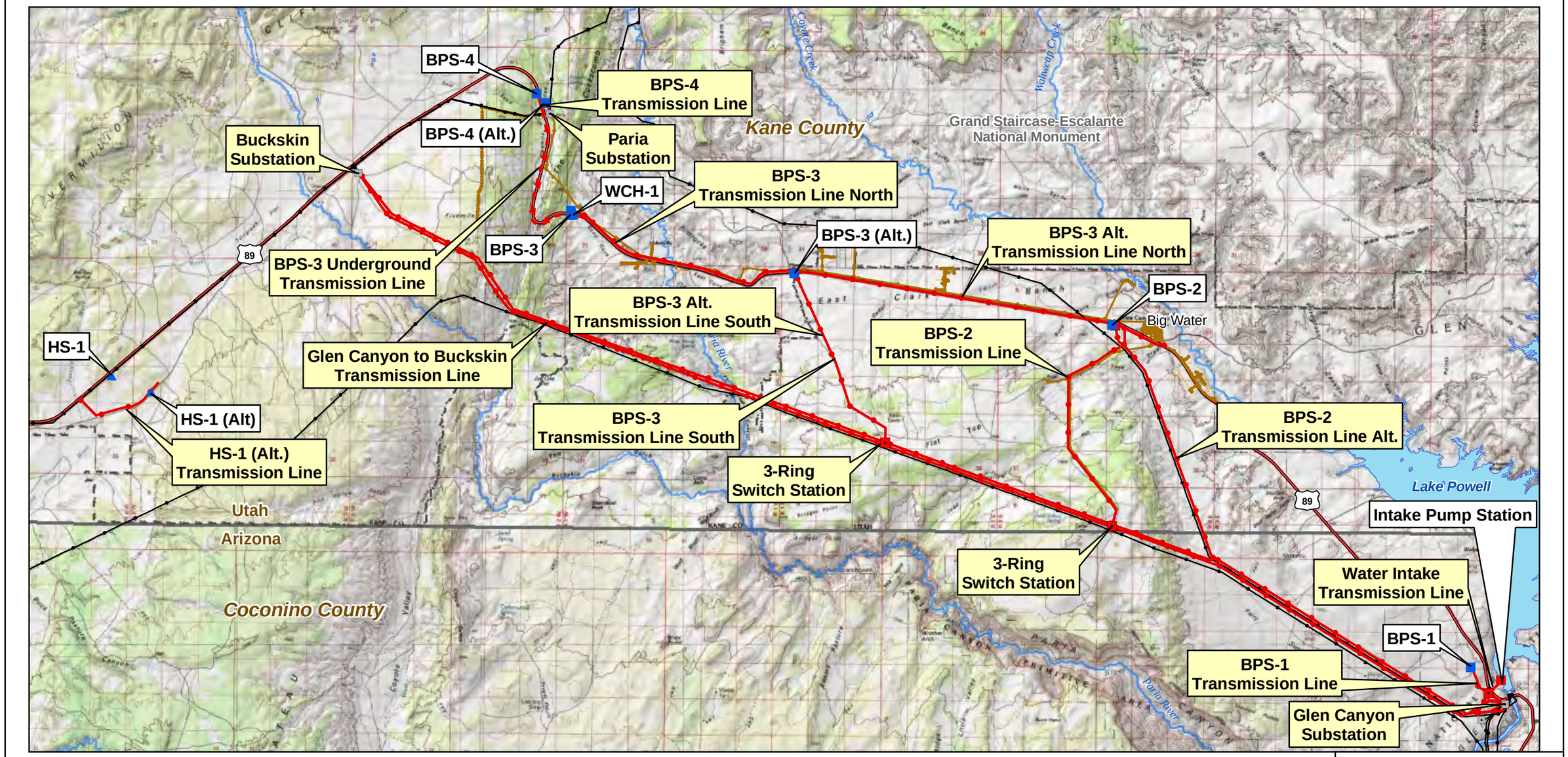
0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-6** MWH

Lake Powell Pipeline
Hydro System
Southeast Corner Alternative



Project Intake Pump Station
Project Booster Pump Station
Project Hydro Station
Existing Substation
Proposed Substation
Project Transmission Line
Underground Project Transmission Line
Existing Transmission Line
Existing OH Primary Line
Existing UG Primary Line
Interstate
US Highway
ST Highway
Hwy
Major Road
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
GSENM Boundary
State Boundaries
NGS USA Topographic Maps

FERC Project Number: 12966-001
BLM Serial Numbers: AZA-34941 UTU-85472

N

0 0.5 1 2 3 4 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-7** MWH

Lake Powell Pipeline Transmission Line Alternatives East

County, Utah. The new transmission line would parallel an existing distribution line that runs northwest, north and then northeast to Big Water. This new 138 kV transmission line alternative would be about 7 miles long across Utah SITLA-administered land, with a 138 kV connection to the BPS-2 substation (Figure 1-7).

The new **BPS-2 Alternative Transmission Line** would consist of a new 138 kV transmission line from Glen Canyon Substation parallel to the existing Rocky Mountain Power 230 kV transmission line, connecting to the BPS-2 substation west of Big Water. This new 138 kV transmission line alternative would be about 16.5 miles long in Coconino County, Arizona and Kane County, Utah crossing National Park Service-administered land, BLM-administered land and Utah SITLA-administered land (Figure 1-7).

The new **BPS-3 Transmission Line North** alternative would consist of a new 138 kV transmission line from BPS-2 paralleling the south side of U.S. 89 within the Congressionally designated utility corridor west to BPS-3 at the east side of the Cockscomb geological feature. This new 138 kV transmission line alternative would be about 15.7 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-3 Transmission Line South** alternative would consist of a new 3-ring switch station along the existing 138 kV Glen Canyon to Buckskin Transmission Line and a new transmission line from the switch station north along an existing BLM road to U.S. 89 and then west along the south side of U.S. 89 within the Congressionally designated utility corridor to BPS-3 at the east side of the Cockscomb. This new 138 kV transmission line alternative would be about 12.3 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-3 Underground Transmission Line** alternative would consist of a new buried 24.9 kV transmission line (2 circuits) from the upgraded Paria Substation to BPS-3 on the east side of the Cockscomb geological feature. This new underground transmission line would be parallel to the east and south side of U.S. 89 and would be about 4.1 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-3 Alternative Transmission Line North** alternative would consist of a new 138 kV transmission line from BPS-2 paralleling the south side of U.S. 89 west to BPS-3 Alternative near the GSENM east boundary within the Congressionally-designated utility corridor. This new 138 kV transmission line alternative would be about 9.3 miles long in Kane County, Utah (Figure 1-7).

The proposed new **BPS-3 Alternative Transmission Line South** alternative would consist of a new 3-ring switch station along the existing 138 kV Glen Canyon to Buckskin Transmission Line and a new transmission line from the switch station north along an existing BLM road to BPS-3 Alternative near the GSENM east boundary and within the Congressionally-designated utility corridor. This new 138 kV transmission line alternative would be about 5.9 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-4 Transmission Line** alternative would begin at the upgraded Paria Substation and run parallel to the west side of U.S. 89 north to BPS-4 within the Congressionally designated utility corridor. This new 138 kV transmission line would be about 0.8 mile long in Kane County, Utah (Figure 1-7).

The proposed new **BPS-4 Alternative Transmission Line** would begin at the upgraded Paria Substation and run north to the BPS-4 Alternative. This 69 kV transmission line would be about 0.4 mile long in Kane County, Utah (Figure 1-7).

The proposed new **HS-1 Alternative Transmission Line** would begin at the new HS-1 Alternative and run southwest parallel to the K4020 road and then northwest parallel to the K4000 road to the U.S. 89 corridor where it would tie into the existing 69 kV transmission line from the Buckskin Substation to the

Johnson Substation. This 69 kV transmission line would be about 3 miles long in Kane County, Utah (Figure 1-7).

The proposed new **HS-2 South Transmission Line** alternative would connect the HS-2 hydroelectric station and substation along the South Alternative to an existing 138 kV transmission line paralleling Arizona State Route 389. This new 34.5 kV transmission line would be about 0.9 mile long in Mohave County, Arizona (Figure 1-8).

The proposed new **HS-3 Underground Transmission Line** would connect the HS-3 hydroelectric station and substation to the existing Twin Cities Substation in Hildale City, Utah. The new 12.47 kV underground circuit would be about 0.6 mile long in Washington County, Utah (Figure 1-8).

The proposed new **HS-4 Transmission Line** would consist of a new transmission line from the HS-4 hydroelectric station and substation north along an existing BLM road to an existing transmission line parallel to Utah State Route 59. The new 69 kV transmission line would be about 8.2 miles long in Washington County, Utah (Figure 1-8).

The new **HS-4 Alternative Transmission Line** alternative would connect the HS-4 Alternative hydroelectric station and substation to an existing transmission line parallel to Utah State Route 59. The new 69 kV transmission line would be about 7.5 miles long in Washington County, Utah (Figure 1-8).

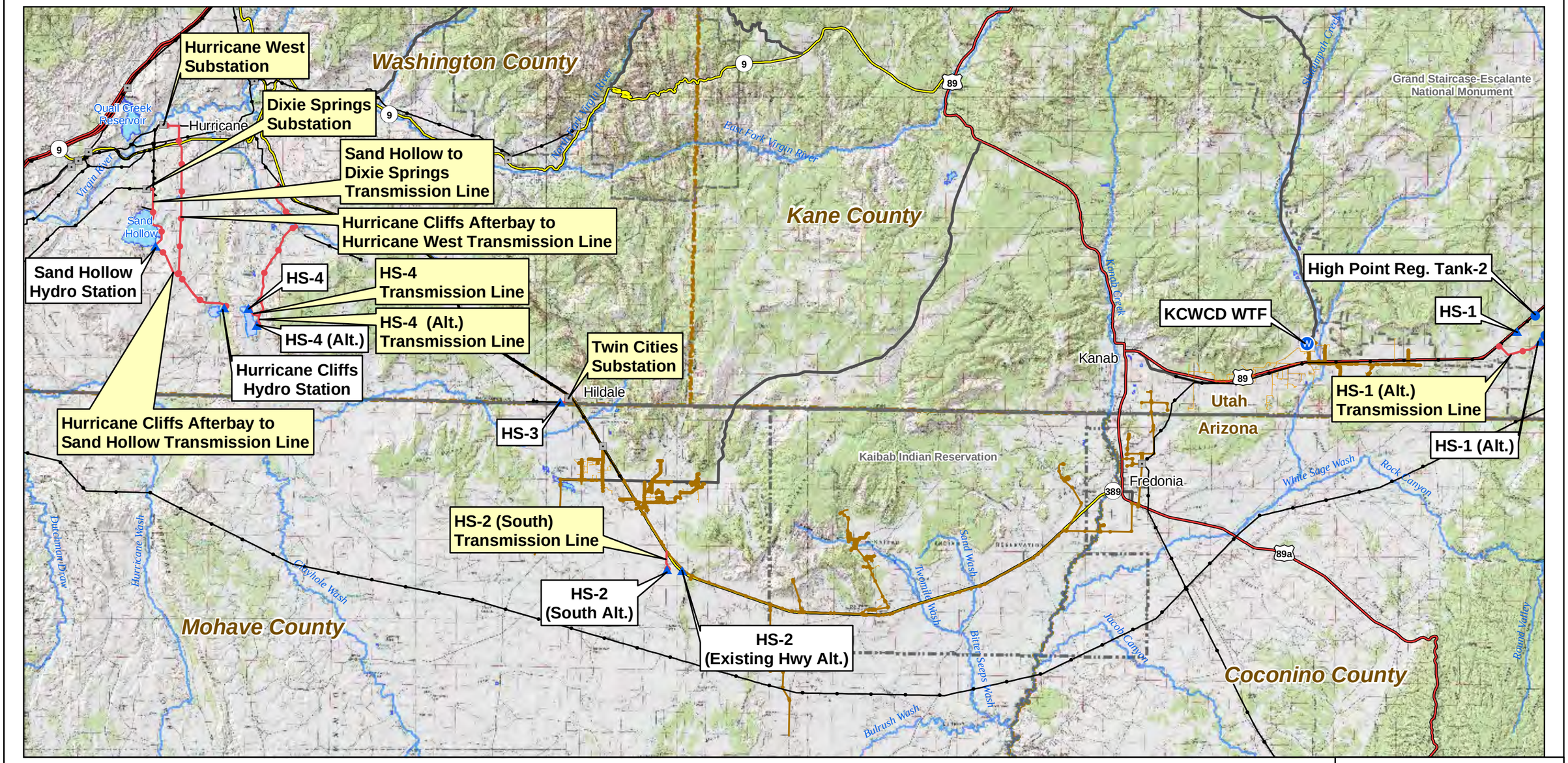
The proposed new **Hurricane Cliffs Afterbay to Sand Hollow Transmission Line** would consist of a new 69 kV transmission line from the Hurricane Cliffs peaking power plant and substation, and run northwest to the Sand Hollow Hydro Station substation. This new 69 kV transmission line would be about 4.9 miles long in Washington County, Utah (Figure 1-8).

The proposed new **Hurricane Cliffs Afterbay to Hurricane West Transmission Line** would consist of a new 345 kV transmission line from the Hurricane Cliffs pumped storage power plant and run northwest and then north to the planned Hurricane West 345 kV substation. This new 345 kV transmission line would be about 10.9 miles long in Washington County, Utah (Figure 1-8).

The proposed new **Sand Hollow to Dixie Springs Transmission Line** would consist of a new 69 kV transmission line from the Sand Hollow Hydro Station substation around the east side of Sand Hollow Reservoir and north to the existing Dixie Springs Substation. This new 69 kV transmission line would be about 3.4 miles long in Washington County, Utah (Figure 1-8).

The three **Cedar Valley Pipeline** booster pump stations would require new transmission lines from existing transmission lines paralleling the Interstate 15 corridor. The new CVBPS-1 transmission line would extend southeast over I-15 from the existing transmission line to the booster pump station substation for about 1.3 miles in Washington County, Utah (Figure 1-9). The new CVBPS-2 transmission line would extend east over I-15 from the existing transmission line to the booster pump station substation for about 0.2 mile in Washington County, Utah (Figure 1-9). The new CVBPS-3 transmission line would extend west over I-15 from the existing transmission line and southwest along the west side of Interstate 15 to the booster pump station substation for about 0.6 mile in Iron County, Utah (Figure 1-9).

The **Cedar Valley Water Treatment Facility Transmission Line** would begin at an existing substation in Cedar City and run about 1 mile to the water treatment facility site in Iron County, Utah (Figure 1-9).



Water Treatment Facility
Project Regulating Tank
Project Hydro Station
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams

Existing Substation
Project Transmission Line
Existing Transmission Line
Existing OH Primary Line
Existing UG Primary Line

Interstate
US Highway
ST Highway
Hwy
Major Road

National Park/Monument
GSENM Boundary
Tribal Lands
State Boundaries
County Boundaries

FERC Project Number: 12966-001
BLM Serial Numbers: AZA-34941 UTU-85472

N

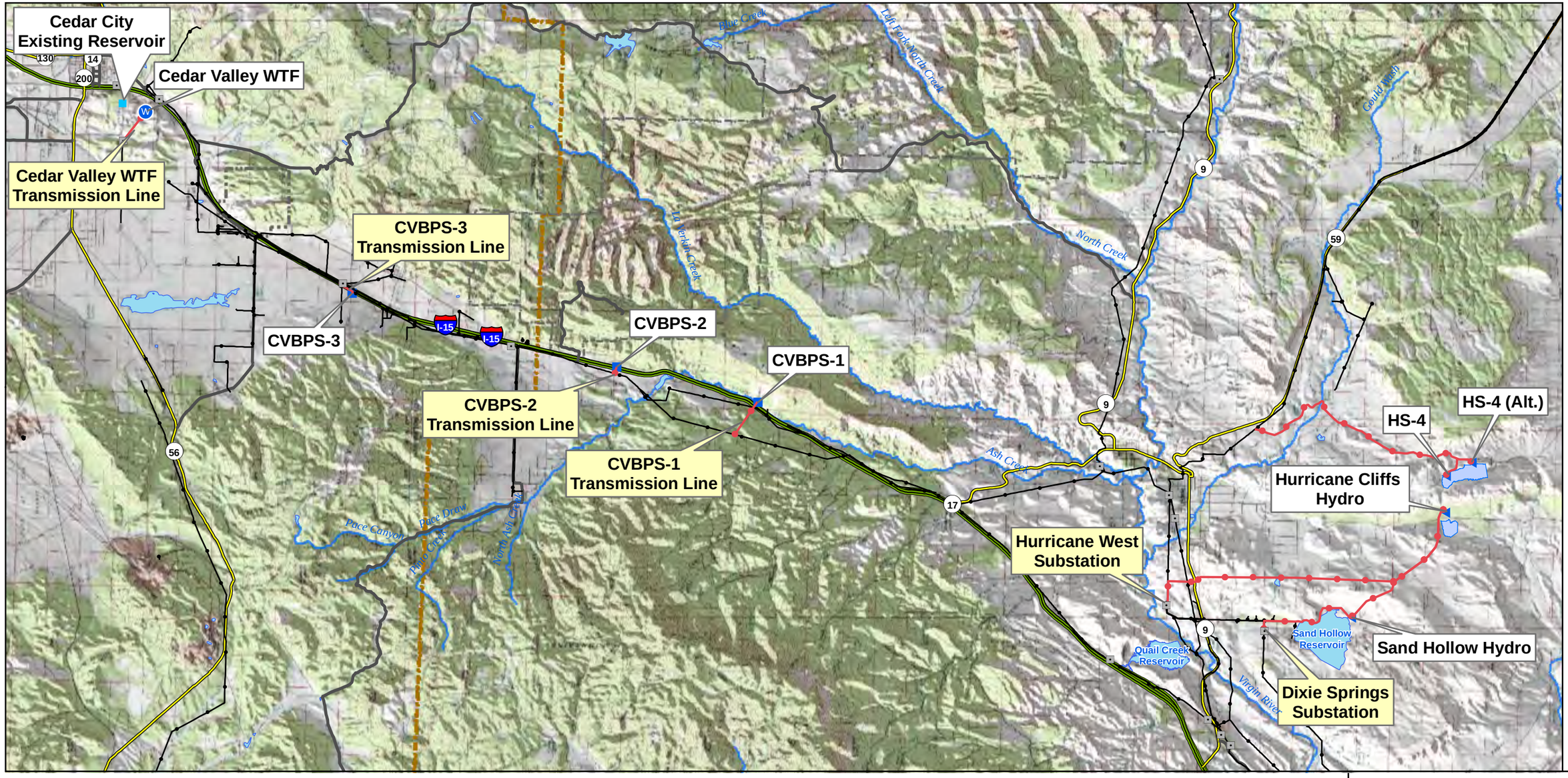
0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-8** MWH

Lake Powell Pipeline Transmission Line Alternatives West



Water Treatment Facility
Project Pump Station
Project Hydro Station

Existing Substation
Project Substation
Project Transmission Line
Existing Transmission Line
Existing OH Primary Line
Existing UG Primary Line

Interstate
US Highway
ST Highway
Hwy
Major Road

Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
County Boundaries
Tribal Lands

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

0 1 2 4 6 8 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-9** MWH

Cedar Valley Transmission Line Alternatives

1.3 Summary Description of No Lake Powell Water Alternative

The No Lake Powell Water Alternative would involve a combination of developing remaining available surface water and groundwater supplies, developing reverse osmosis treatment of existing low quality water supplies, and reducing residential outdoor water use in the WCWCD and CICWCD service areas. This alternative could provide a total of 86,249 acre-feet of water annually to WCWCD, CICWCD and KCWCD for M&I use without diverting Utah's water from Lake Powell.

1.3.1 WCWCD No Lake Powell Water Alternative

The WCWCD would implement other future water development projects currently planned by the District, develop additional water reuse/reclamation, and convert additional agricultural water use to M&I use as a result of urban development in agricultural areas through 2020. Remaining planned and future water supply projects through 2020 include the Ash Creek Pipeline (5,000 acre-feet per year), Crystal Creek Pipeline (2,000 acre-feet per year), and Quail Creek Reservoir Agricultural Transfer (4,000 acre-feet per year). Beginning in 2020, WCWCD would convert agricultural water to secondary use and work with St. George City to maximize existing wastewater reuse, bringing the total to 96,258 acre-feet of water supply per year versus demand of 98,427 acre-feet per year, incorporating currently mandated conservation goals. The WCWCD water supply shortage in 2037 would be 70,000 acre-feet per year, 1,000 acre-feet more than the WCWCD maximum share of the LPP water. Therefore, the WCWCD No Lake Powell Water Alternative needs to develop 69,000 acre-feet of water per year to meet comparable supply and demand requirements as the other action alternatives.

The WCWCD would develop a reverse osmosis (RO) advanced water treatment facility near the Washington Fields Diversion in Washington County, Utah to treat up to 40,000 acre-feet per year of Virgin River water with high total dissolved solids (TDS) concentration and other contaminants. The RO advanced water treatment facility would produce up to 36,279 acre-feet per year of water suitable for M&I use. The WCWCD would develop the planned Warner Valley Reservoir to store the diverted Virgin River water, which would be delivered to the RO advanced water treatment facility. The remaining 3,721 acre-feet per year of brine by-product from the RO treatment process would require evaporation and disposal meeting State of Utah water quality regulations.

The remaining needed water supply of 32,721 acre-feet per year to meet WCWCD 2037 demands would be obtained by reducing and restricting outdoor residential water use in the WCWCD service area. The Utah Division of Water Resources (UDWR) estimated 2005 culinary water use for residential outdoor watering in the communities served by WCWCD was 97.4 gallons per capita per day (gpcd) (UDWR 2009). This culinary water use rate is reduced by 30.5 gpcd to account for water conservation attained from 2005 through 2020, yielding 66.9 gpcd residential outdoor water use available for conversion to other M&I uses. The equivalent water use rate reduction to generate 32,721 acre-feet per year of conservation is 56.6 gpcd for the 2037 population within the WCWCD service area. Therefore, beginning in 2020, the existing rate of residential outdoor water use would be gradually reduced and restricted to 10.3 gpcd, or an 89.4 percent reduction in residential outdoor water use.

The combined 36,279 acre-feet per year of RO product water and 32,721 acre-feet per year of reduced residential outdoor water use would equal 69,000 acre-feet per year of M&I water to help meet WCWCD demands through 2037.

1.3.2 CICWCD No Lake Powell Water Alternative

The CICWCD would implement other future groundwater development projects currently planned by the District, purchase agricultural water from willing sellers for conversion to M&I uses, and convert additional agricultural water use to M&I use as a result of urban development in agricultural areas through 2020. Remaining planned and future water supply projects through 2020 include additional groundwater development projects (3,488 acre-feet per year), agricultural conversion resulting from M&I development (3,834 acre-feet per year), and purchase agricultural water from willing sellers (295 acre-feet per year). Beginning in 2020, CICWCD would have a total 19,772 acre-feet of water supply per year versus demand of 19,477 acre-feet per year, incorporating required progressive conservation goals. The CICWCD water supply shortage in 2060 would be 11,470 acre-feet per year. Therefore, the CICWCD No Lake Powell Water Alternative needs to develop 11,470 acre-feet of water per year to meet comparable supply and demand limits as the other action alternatives.

The remaining needed water supply of 11,470 acre-feet per year to meet CICWCD 2060 demands would be obtained by reducing and restricting outdoor residential water use in the CICWCD service area. The UDWR estimated 2005 culinary water use for residential outdoor watering in the communities served by CICWCD was 84.5 gpcd (UDWR 2007). A portion of this residential outdoor water would be converted to other M&I uses. The equivalent water use rate to obtain 11,470 acre-feet per year is 67.8 gpcd for the 2060 population within the CICWCD service area. Therefore, the existing rate of residential outdoor water use would be gradually reduced and restricted to 16.7 gpcd beginning in 2023, an 80 percent reduction in the residential outdoor water use rate between 2023 and 2060. The 11,470 acre-feet per year of reduced residential outdoor water use would be used to help meet the CICWCD demands through 2060.

1.3.3 KCWCD No Lake Powell Water Alternative

The KCWCD would use existing water supplies and implement future water development projects including new groundwater production, converting agricultural water rights to M&I water rights as a result of urban development in agricultural areas, and developing water reuse/reclamation. Existing water supplies (4,039 acre-feet per year) and 1,994 acre-feet per year of new ground water under the No Lake Powell Water Alternative would meet projected M&I water demand of 6,033 acre-feet per year within the KCWCD service area through 2060. The total potential water supply for KCWCD is about 12,140 acre-feet per year (4,039 acre-feet per year existing culinary plus secondary supply, and 8,101 acre-feet per year potential for additional ground water development up to the assumed sustainable ground water yield) without agricultural conversion to M&I supply. Short-term ground water overdrafts and new storage projects (e.g., Jackson Flat Reservoir) would provide reserve water supply to meet demands during drought periods and other water emergencies.

1.4 Summary Description of the No Action Alternative

No new intake, water conveyance or hydroelectric features would be constructed or operated under the No Action Alternative. The Utah Board of Water Resources' Colorado River water rights consisting of 86,249 acre-feet per year would not be diverted from Lake Powell and would continue to flow into the Lake until the water is used for another State of Utah purpose or released according to the operating guidelines. Future population growth as projected by the Utah Governor's Office of Planning and Budget (GOPB) would continue to occur in southwest Utah until water and other potential limiting resources such as developable land, electric power, and fuel begin to curtail economic activity and population in-migration.

1.4.1 WCWCD No Action Alternative

The WCWCD would implement other future water development projects currently planned by the District, develop additional water reuse/reclamation, convert additional agricultural water use to M&I use as a result of urban development in agricultural areas, and implement advanced treatment of Virgin River water. The WCWCD could also limit water demand by mandating water conservation measures such as outdoor watering restrictions. Existing and future water supplies under the No Action Alternative would meet projected M&I water demand within the WCWCD service area through approximately 2020. The 2020 total water supply of about 96,528 acre-feet per year would include existing supplies, planned WCWCD water supply projects, wastewater reuse, transfer of Quail Creek Reservoir supplies, and future agricultural water conversion resulting from urban development of currently irrigated lands. Each future supply source would be phased in as needed to meet the M&I demand associated with the forecasted population. The No Action Alternative would not provide WCWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses). Maximum reuse of treated wastewater effluent for secondary supplies would be required to meet the projected M&I water demand starting in 2020. The No Action Alternative would not provide adequate water supply to meet projected water demands from 2020 through 2060. There would be a potential water shortage of approximately 139,875 acre-feet per year in 2060 under the No Action Alternative (UDWR 2008b).

1.4.2 CICWCD No Action Alternative

The CICWCD would implement future water development projects including converting agricultural water rights to M&I water rights as a result of urban development in agricultural areas, purchasing "buy and dry" agricultural water rights to meet M&I demands, and developing water reuse/reclamation. The Utah State Engineer would act to limit existing and future ground water pumping from the Cedar Valley aquifer in an amount not exceeding the assumed sustainable yield of 37,600 ac-ft per year. Existing and future water supplies under the No Action Alternative meet projected M&I water demand within the CICWCD service area during the planning period through agricultural conversion of water rights to M&I use, wastewater reuse, and implementing "buy and dry" practices on irrigated agricultural land. Each future water supply source would be phased in as needed to meet the M&I demand associated with the forecasted population. The CICWCD No Action Alternative includes buying and drying of agricultural water rights covering approximately 8,000 acres between 2005 and 2060 and/or potential future development of West Desert water because no other potential water supplies have been identified to meet unmet demand. The No Action Alternative would not provide CICWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses) after 2010 (i.e., after existing supplies would be maximized).

1.4.3 KCWCD No Action Alternative

The KCWCD would use existing water supplies and implement future water development projects including new ground water production, converting agricultural water rights to M&I water rights as a result of urban development in agricultural areas, and developing water reuse/reclamation. Existing water supplies (4,039 acre-feet per year) and 1,994 acre-feet per year of new ground water under the No Action Alternative would meet projected M&I water demand of 6,033 acre-feet per year within the KCWCD service area through 2060. The total potential water supply for KCWCD is about 12,140 acre-feet per year (4,039 acre-feet per year existing culinary plus secondary supply, and 8,101 acre-feet per year potential for additional ground water development up to the assumed sustainable ground water yield) without agricultural conversion to M&I supply. Short-term ground water overdrafts and new storage projects (e.g., Jackson Flat Reservoir) would provide reserve water supply to meet demands during drought periods and other water emergencies.

1.5 Identified Issues and Topics

1.5 Aquatic Resources Specific Issues and Topics

The potential specific significant issues identified for the LPP Project and the identified impact topics with regard to aquatic resources include the following:

- Entrainment of fish and other aquatic species in the intake water from Lake Powell.
- Biota transfer of potential aquatic invasive species from Lake Powell to other drainages and resources as a result of the LPP Project delivery and the alternatives.
- Operational concerns regarding the physical facilities for the LPP Project and problems with zebra and quagga mussels and other invasive species if those species were to become established in Lake Powell.
- Potential impacts on aquatic habitat as a consequence of construction activities (pipelines, pump stations, etc.) related to the LPP Project.
- Potential impacts on the Virgin River drainage if current diversions for Virgin River water for domestic and irrigation use can be reduced when the LPP Project is implemented.
- Economic and/or social (i.e., recreation, visual, etc.) impacts that could affect aquatic resources or the aquatic environment as a result of the LPP Project.
- LPP Project and its alternatives regarding the potential impact on aquatic species of special concern.

Chapter 2
Methodology

2.1 Introduction

The aquatic resources analysis for the LPP Project was developed using existing information available from a variety of Federal and state resource agencies. The existing data base was determined adequate to document the baseline conditions for aquatic resources. To date, that assumption has not changed and the basis for the evaluation of the LPP Project and alternatives relies on existing published and unpublished documentation.

2.2 Data Used

The data that was used to compile the Aquatic Resources Study Report includes the references presented in the Aquatic Resources Study Plan approved by the Commission as well as additional documents that have been collected during the development of this report. No original field work, sampling, surveys or other site-specific investigations were performed. Existing range and occurrence data for aquatic resources were derived from digital data bases where available: the U.S. Fish and Wildlife Service (USFWS), Nature Serve, the Utah Conservation Data Center (UCDC), the Arizona Natural Heritage Program Data Management System (AHDMS), species descriptions from standard field guides and online resources (NatureServe), available scientific literature and best professional judgment.

2.3 Assumptions

The analysis used the following assumptions of construction disturbance and LPP Project operation on aquatic resources, including species and habitats.

- Aquatic species and their habitats occur only in and around perennial streams, rivers, reservoirs, springs and other water sources. Intermittent and ephemeral streams and washes do not contain suitable habitat for sustaining aquatic species, populations and their habitats.

- Construction activities in and around intermittent and ephemeral streams and washes could have impacts on downstream aquatic resources during periods when precipitation runoff flows are in the channels.

- Potential effects or impacts on a water body (stream, river, reservoir, spring or other water source) that would be crossed by the LPP Project pipeline, penstock or other feature also must consider aquatic species migration and passage potential upstream and downstream into habitats not directly affected by construction.

- Aquatic resources habitat includes the lotic or lentic components and surrounding riparian areas which provide allochthonous sources of organic matter and is an integral part of the food chain in aquatic ecosystems.

- Electric power transmission line alternatives would have no measurable impacts on aquatic resources including aquatic species and their habitats. Existing access roads are available to

provide construction access to the transmission line alignment alternatives and no new roads would have to be constructed near study area water bodies.

- Conveyance of water from Lake Powell to Sand Hollow Reservoir, the Kane County Water Treatment Facility and Cedar Valley Water Treatment Facility could potentially have an impact on aquatic resources in perennial streams and reservoirs where the water could flow.

2.4 Impact Analysis Methodology

A detailed and intensive data compilation and review of existing aquatic species and habitat was performed. The compiled information and data was used to evaluate the impacts the proposed LPP Project and alternatives may have aquatic species and their habitats. No field investigations specific to aquatic species were performed. Field investigations were performed by engineers and scientists at each drainage crossing along the pipeline and penstock alignments. Occurrence data for aquatic species were derived from the Utah Geographic Information System (GIS) database (AGRC 2010) and the Arizona GIS database (AHDMS 2010).

The results of surface water resource and surface water quality modeling of the proposed LPP Project were used to estimate the potential impacts on aquatic species and their habitats. The baseline conditions of the aquatic species and their habitats were determined from the compiled data and information, and potential impacts were determined by assessing the intensity, duration and magnitude of changes associated with the LPP Project and alternatives. Aquatic resource habitats were analyzed using GIS to integrate the compiled baseline data, information, and potential project effects on wetland and riparian resources, surface water resources, surface water quality, groundwater resources, aquatic resources, wildlife resources, special status wildlife species, special status aquatic species and habitats, vegetation communities and wildlife resources.

The potential for unavoidable adverse impacts was evaluated following application of mitigation measures to avoid, minimize or reduce effects and impacts on aquatic species and their habitats.

The potential for adverse effects from transferring water from Lake Powell to Sand Hollow was evaluated as part of the study. The issue of potentially introducing invasive species involved addressing their potential for affecting aquatic indigenous (current) species as a specific part of this study.

2.5 Impacts Evaluation

Impacts on the various aquatic resources were evaluated based upon the aquatic resource value (active flowing perennial vs. ephemeral drainages) that may be affected, the sensitivity of the aquatic species or resources (common vs. sensitive) potentially impacted, and the probability the project alternative could have a measureable effect on the resource, species and/or the aquatic habitat. Special status aquatic species, including Federally listed species, associated designated critical habitats, and aquatic species of concern to federal, state and local agencies are analyzed and evaluated in Study Report 11, Special Status Aquatic Species and Habitats (UBWR 2011a).

The value of aquatic resources of the area between Lake Powell and the termination points of the LPP Project, Sand Hollow Reservoir, the Kane County Water Treatment Facility, and the Cedar Valley Water Treatment Facility are generally limited to perennial drainages including the Paria River, Virgin River, Ash Creek and LaVerkin Creek. The majority of the geographically defined drainages the pipeline would

cross or run parallel to are either dry (ephemeral) with limited flow during periods of rainfall and seasonal runoff and/or are documented as not being capable of supporting aquatic organisms and habitat on a sustained basis.

The LPP Project and its alternatives would not contribute water to or divert from any of the study area drainages except those manmade features targeted to receive water (i.e. Sand Hollow Reservoir, Kane County WTF, and Cedar Valley WTF). Incidental water discharges through project operational components (i.e., air relief valves, low point drains, etc.) would be very limited and/or can be contained and mitigated.

The probability of an accidental release of water as a result of a system failure is low; however, the conveyance system would be provided with emergency response instrumentation to control catastrophic water releases.

Chapter 3
Affected Environment

3.1 Study Area

The LPP Project study extends from Lake Powell near Glen Canyon Dam east to Sand Hollow Reservoir in Washington County and north to the site of the proposed Cedar Valley Water Treatment Plant. Figure 1-1 provides a location map of the study area. However, the aquatic resources assessment considers only those impacts that could be caused by the construction and operation of the water transmission system (intake, pump stations, hydro stations and pipelines) and the potential discharge of Lake Powell water, either by accident or as an operational necessity or as the Lake Powell product water supply discharged at the planned points of final delivery and use.

This report is intended to document potential impacts of implementing the LPP Project and associated water delivery projects (Cedar Valley Pipeline (CVP), Kane County System) and their alternatives would have on the aquatic resources of the study area.

The LPP Project involves lands and waters in two states (Utah and Arizona) and crosses a variety of federal, state and privately managed property. The drainage basins include both Lake Powell and the Colorado River and into Lake Mead. There are numerous seasonal and intermittent washes, gulches and creeks that are potentially affected by the LPP Project, however, only the Paria and Virgin rivers and Kanab, LaVerkin and Ash creeks carry perennial flows within the study area and can be expected to support aquatic resources.

Lake Powell itself was not considered as part of the LPP Project study area for aquatic resources, except that the intake screens could potentially entrain native fish from the lake and facilitate the transfer of invasive aquatic species to other drainages. The primary potential impacts associated with the important stream and drainage areas for aquatic resources involve: 1) the impact of pipeline construction in or near perennial streams, 2) the accidental release of water from the pipeline to other drainages, and 3) the resultant potential transfer of invasive or exotic species from water releases.

3.1.1 Lake Powell and Colorado River

The Colorado River below Glen Canyon Dam has been extensively studied and analyzed over the last 15+ years with regard to the discharge of water and the movement of sediments and settleable solids in the river. The impact of water withdrawal by the LPP Project has not been considered a major concern because of the relatively minor scope of the withdrawal in comparison to the normal daily, monthly, seasonal and annual variations. However, for the LPP Project, the impacts on downstream flows and water quality were modeled by the Bureau of Reclamation (Reclamation) in 2010 (Grantz, et.al. 2010 and Williams 2010). The Reclamation hydrologic model evaluated the proposed LPP Project water withdrawal during the period from 2020 through 2060. The conclusion presented, based upon the model results, was that Lake Powell elevations and the flow in the Colorado below Glen Canyon Dam were essentially the same with or without the Project (Proposed Action vs. No Action Alternative) under the proposed annual withdrawal of 86,249 acre feet of water.

The Reclamation water quality model simulated a number of important water quality parameters under the LPP Project water withdrawals and projected water quality changes during the period from 2043 through 2060 (full withdrawal of the LPP Project water). The model results indicated that there was no measurable difference for downstream temperature profiles, total dissolved solids (TDS), dissolved

oxygen (DO), and nutrients between the Proposed Action and No Action alternative in the water released from Glen Canyon Dam.

The Reclamation modeling studies and other modeling results demonstrate the LPP Project would have no measurable impacts on aquatic resources in Lake Powell or the aquatic resources habitat downstream of Glen Canyon Dam.

3.1.2 Water Intake

The proposed Lake Powell intake is located near the south end of the lake adjacent to Glen Canyon Dam (Figure 3-1). The current conceptual design has the intake site located at a nearly vertical cliff adjacent to the lake at a point where the water depth is approximately 510 feet. The intake would consist of drilled vertical caissons with six horizontal valved lake intake tunnels spaced approximately 100 feet apart vertically along two parallel vertical shafts, with the uppermost intakes stationed approximately 125 feet below the high water level (El. 3,700 ft). Each of the horizontal intakes would be designed for screens to reduce the intake velocity to less than 0.5 feet per second. Typically most healthy fish and actively motile aquatic species can avoid being entrained in an intake suction flow if the velocity is maintained below the escape velocity (swimming speed) of those organisms. For most fish, other aquatic vertebrates and many active motile larval stages and invertebrates, the escape velocity ranges from 0.5 to 0.6 feet per second. Non-motile or very small organisms are typically not able to escape the intake suction and would be collected in the incoming water and, as necessary, must be removed or inactivated by other methods prior to point of use, depending on the application of the water.

The proposed screening method and water intake design precautions to avoid fish collection and entrapment have generally been well defined and have been developed over years of study and practical application. If designed and operated properly to meet the conventional federal and state agency requirements for fish entrapment avoidance, then fish species in Lake Powell near the dam would not be entrapped or entrained by the fish screens.

The intake is to be fitted with six separate horizontal extraction tunnels (Figure 3-2) that would provide the option for diverting water at various depths. This would allow for operational temperature control as well as providing some level of management oversight to avoid regions of the water body that may contain concentration of species (invertebrates, algae, etc.), that can be avoided by varying the depth of the diversion intake depth.

Construction of the intake would occur from the shore using deep vertical access caissons and horizontal tunnels drilled using microtunnel boring machines (MTBM). The spoil from the tunnel construction would be extracted from the landside and not deposited in the lake. Final installation of screens and appurtenances would be by divers working off construction barges. Geotechnical studies of the Navajo Sandstone formation where the intake is to be constructed indicates the material is reasonably competent with a low permeability. Unusual construction problems have not been indentified and intake system installation would not have measurable impacts on aquatic resources in Lake Powell.

3.1.3 Pipeline and Penstock Crossings of Streams

The potential direct impacts of the LPP Project involve the alignment and construction of the pipeline, and to a minor extent, the supporting facilities (pump station, tanks, etc.) as they cross the perennial drainages in the study area. The discharge of water for pipe maintenance purposes or through blow-off valves (minor amounts) or from a pipe breach or accident are evaluated as a potential source impact on the existing aquatic resources.

LPP Alternative Alignment
Intake Pump Station Facility
Bureau of Reclamation Management Area

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

0 100 200 400 600 800 Feet

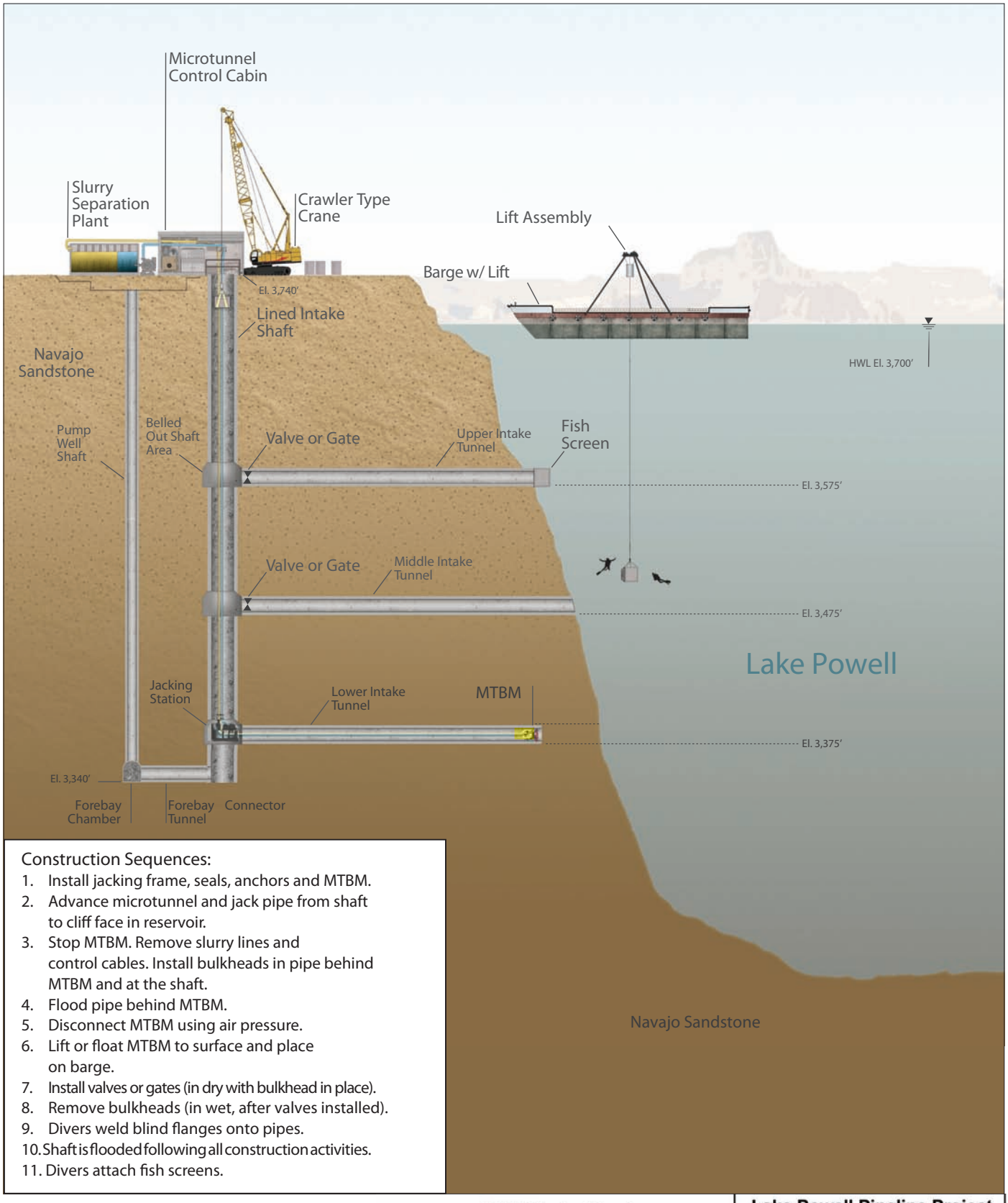
N

Lake Powell Pipeline Project

1:4,800 Scale
Spatial Reference: UTM Zone 12N, NAD-83

UDWR Figure 3-1 MWH

Lake Powell Pipeline Intake System



Construction Sequences:

1. Install jacking frame, seals, anchors and MTBM.
2. Advance microtunnel and jack pipe from shaft to cliff face in reservoir.
3. Stop MTBM. Remove slurry lines and control cables. Install bulkheads in pipe behind MTBM and at the shaft.
4. Flood pipe behind MTBM.
5. Disconnect MTBM using air pressure.
6. Lift or float MTBM to surface and place on barge.
7. Install valves or gates (in dry with bulkhead in place).
8. Remove bulkheads (in wet, after valves installed).
9. Divers weld blind flanges onto pipes.
10. Shaft is flooded following all construction activities.
11. Divers attach fish screens.

NOTE:
MTBM, Slurry Separation Plant, Microtunnel Control Cabin, Fish Screens, Bulkhead and Valves are not to scale.

This figure shows each step of construction occurring concurrently for illustrative purposes only.

FERC Project Number: 12966-001
BLM Serial Numbers: AZA-34941 UTU-85472

1 inch = 80 feet

0 20 40 80 120 160 Feet

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 3-2** MWH

LPP IPS
Intake Cross Section

3.2 Overview

For this analysis, only those project components that would affect water resources or aquatic environment habitat were considered. The affected environment considered was limited to perennial streams and drainages that could sustain aquatic resources.

Intermittent streams and drainages and ephemeral channels were not considered as relevant to the project in terms of sustainable aquatic resources. The following definitions were adopted for defining the importance of drainages.

> **Perennial Stream** – A body of water flowing in a natural or man-made channel year-round, except during periods of severe drought. The term "water body with perennial flow" includes perennial streams, and lakes and ponds that form the source of a perennial stream, or through which the perennial stream flows, are a part of the perennial stream. Generally, the water table is located above the streambed for most of the year and groundwater could be the primary source or a significant portion of the stream flow. In the absence of chronic pollution or other man-made disturbances, a perennial stream is assumed to be capable of supporting aquatic resources for most, if not all, of the year on a continual basis.
>
> **Intermittent Stream** – A body of water flowing in a natural or man-made channel that contains water for brief periods of the year. During the dry season and periods of drought, these streams do not exhibit surface flow. Geomorphological characteristics are not well defined and are often inconspicuous. In the absence of external limiting factors (pollution, thermal modifications, etc.), aquatic resources are scarce or nonexistent and must be adapted to the wet and dry conditions of the fluctuating water level or be able to migrate to more habitable areas when flows decline.

A subjective field protocol was developed for assessing the condition of each drainage that would be impacted by the LPP Project components. The objective was to determine if a drainage was perennial or intermittent/ephemeral. This protocol relied on field reconnaissance observations to determine which of the defined drainages, washes, gulches, canyons, rivers, streams, creeks, etc., that would be transected by the pipeline or where construction would be in such a proximity, could impacts occur.

Existing drainages were identified on available mapping and aerial photographs. A project scientist and engineer reviewed the project pipeline and penstock alignments by vehicle and/or on foot to review each potential water body and to assess its condition. After observing each segment of a candidate drainage at different times during the 2008 through 2010 field seasons, investigators developed a representative understanding of what drainages appeared to be perennial and contain measurable aquatic resources.

The following criteria were used to evaluate drainages:

- Presence or absence of flowing water
- Presence of high groundwater seeps or springs
- Presence of leaf litter in stream bed that would indicate the hydraulic transport of plant material. In flowing streams, there is little or no leaf litter or only small accumulations at the high water mark.
- Sediment build-up that would indicate seasonal flows.
- General geomorphological conditions including riffle-pool sequences, bank condition, soil features.
- Vegetation established in a channel bottom that could not occur in flowing stream.

- Benthic macroinvertebrate populations

These criteria were evaluated at each drainage crossing to determine if it possessed characteristics that would indicate perennial flow and related aquatic resources.

This was a subjective evaluation and may be subject to modification based on additional evidence; however, for this study report the drainages considered to have a potential for aquatic resources are limited to the following within the study area.

- Lake Powell (biota transfer, intake)
- Paria River
- Kanab Creek at U.S. Highway 89 Bridge in Fredonia, AZ
- Sand Hollow Reservoir
- Virgin River
- LaVerkin Creek
- Ash Creek near Toquerville, UT

3.2.1 LPP Intake Pump Station and Invasive Species Management

The proposed LPP Project water diversion from Lake Powell is an issue of increasing probability that the invasive zebra and quagga mussels will essentially become a more serious problem in the lake and could be transferred (biota transfer) to other drainages. The concerns relating to the impact of the quagga mussel (*Dreissena bugensis*) and to a lesser concern (2010) the zebra mussel (*Dreissena polymorpha*) in Lake Mead are well documented and this problem has significantly affected operation of local domestic water intakes at the Lake, has resulted in the temporary closure of the Cold Water fish Hatchery at Lake Mead, impacted surface water withdrawals for the Central Arizona Project and the California water system and has had a real impact on recreational use of the resources throughout the western United States and Canada.

As of 2011, the Utah Division of Wildlife Resources has not found definitive evidence of either zebra or quagga mussels in Lake Powell. However in 2007, the Utah Division of Wildlife Resources reportedly detected quagga mussel larvae near Wawheap Marina near Glen Canyon Dam. Follow-up studies involving DNA tests did not confirm the presence of a viable population. The Utah Division of Wildlife Resources considers Lake Powell to be non-affected by *dreissenid* mussels as of December 2010. The controversy regarding the presence or absence of mussels in Lake Powell must be evaluated with concern for the future operation of the LPP Project. Since the mussels have been positively identified in Lake Mead and other water bodies in Utah and Arizona, contingency requirements for the LPP Project should be considered for the future because establishment of these organisms is a serious potential, regardless of the significant inspection, boat cleaning and monitoring efforts being employed to protect Lake Powell from their introduction and proliferation.

The current “Quagga Mussel Alerts” being used to reduce the introduction of mussels by recreational water craft, “bait buckets” and other outside sources may not, in the long run, prove to be successful and contingencies need to be in place. Future project design efforts should include measures to protect and/or exclude invasive species from becoming an operational problem for the LPP Project or from being transported to other water bodies (biota transfer).

For this evaluation of the LPP Project, the implementation of future mitigation measures to avoid the impact of mussel infestation must be considered as part of the current Project. This is necessary to both protect the operation of the water supply system and prevent the biota transfer of these organisms to other water systems.

3.2.1.1 Invasive Species Management

The use of any water intake and water supply system must consider the potential negative impacts aquatic species may have on the successful operation of the system. Water treatment plants can provide a number of opportunities and methods (settling, filtration, etc.) for removal of organisms prior to distribution for final use. However, the impact of these organisms prior to treatment or when the water is used only for agriculture, recreation or replacement and effective treatment is not provided, must be considered with regard to the operation water supply facilities.

Of particular and significant concern in the past 20 years in the United States have been the mussels of the *dreissenids* bivalve family. Zebra mussels together with the more recent occurrence of the quagga mussel have proven to be very difficult to control. These non-native invasive mussels are a potential environmental and economic nuisance throughout the United States. They have demonstrated the potential to both damage ecosystems and to require significant and costly, but often fruitless, investment to manage and control their effects on structures and equipment in the water supply industry.

Quagga and zebra mussels are aggressive structural and mechanical equipment bio-foulers. When present in a source water supply system, they become a potential serious problem for operating industrial, agricultural, recreational, and municipal facilities.

Larvae, juvenile and adult mussels can all move in the water column through a variety of active and passive transport methods. Control of *dreissenids* in water conveyance systems is both an operational and environmental issue. For this analysis, of particular concern would be the prevention of mussel entrainment at the LPP Project intake and into water conveyance facilities. Of significant interest for the LPP Project would be the potential bio-fouling impacts on facilities such as the intake screen, water conveyance pipeline and initial pumping facilities which would primarily occur during the larval life-stage (gamete, veliger and post-veliger) when the organisms are most motile.

Invasive mussels can be found in the region surrounding the proposed LPP Project intake and initial pumping plant (Lake Mead, Imperial Valley Irrigation District, etc.) according to available records, and provisions for removing and/or mitigating for the organisms would need to be included in the development of the intake and pump station for the LPP Project raw water supply. However, during the actual design of the facilities, this decision would be revisited to provide, as possible, for the inclusion of future additional treatment facilities or new methods to protect the LPP Project supply system from mussel infestation if they were to become endemic in Lake Powell.

Significant research is ongoing to develop an effective method for mussel control because of the continued proliferation of quagga mussels throughout the major water supply systems in the western United States. It would be anticipated that these future control strategies could be integrated into LPP Project to prevent *dreissenids* or other invasive aquatic organisms from becoming problematic.

The careful provisional consideration of potential problems now can help facilitate control of bio-fouling problem in the future. There are two main types of fouling created by mussels: acute and chronic. It is essential that any facility that could experience mussel fouling be prepared to detail with both types. Chronic fouling occurs when juvenile quagga mussels attach themselves to external and internal

structures. The juvenile mussels grow in place, develop into larger adult mussels, and reduce or cut off water flow through intakes and pipes.

Acute fouling occurs when a large build up of adult mussel shells, alive or dead, becomes detached from upstream locations and are carried by the water flow into piping systems. The large quantities of mussel shells quickly plug small diameter pipes, fixed strainers, filters and heat exchangers, or damage pumping equipment. Such events can occur at unexpected times and, if not anticipated, can have rapid and significant consequences.

The areas of concern for the LPP Project include (but are not limited) the screened intakes, pumping facilities, piping systems and support facilities (instrumentation, utility water, etc.). The following provides a brief discussion of each.

- **Water Intakes.** For plants utilizing a surface water intake, the mussel infestation causes problems when the raw water reaches the intake coarse screen entrance of the pump facilities. At the entrance into the pump house, fixed trash racks and screens are frequently used to trap larger debris. Trash racks are often the first visible structure fouled when mussels arrive. At the Monroe, Michigan power plant, trash bars which are set on 3-inch centers became badly fouled within one season. The design of inlet screens and trash racks with low velocities to avoid fish entrainment often facilitates mussel development. More than 75 percent of the straining surface at the Monroe Power Plant was occluded. Anywhere below the first 2 meters, the mussel layer spanned the 7.6 cm (3 inch gap) between vertical slats, and also extended as much as 15.2 cm (6 inches) past the downstream side of the rack. Similar observations have since been reported from a number of different industries in a variety of geographic locations including the southwestern United States and the Colorado River system.

- **Pump System and Structures.** Within the pumphouse, the large pump wells are generally made of concrete or steel pipe and the roughness of the surface can be subject to heavy colonization by *dreissenids*. The walls as well as the pump bells, which are immersed in water and through which water is withdrawn, can be the source of adult mussel clumps and individual shells discharged to downstream systems, if those systems are not protected by up-front strainers.

  All pumps have air cooled or water cooled motors. If motors are air cooled, *dreissenids* have no impact on their operation. If the motors are water cooled (as in the case with most larger intake pumps), the motor windings, motor thrust and guide bearings, pump guide bearing and pump shaft seal may all require cooling water. Most cooling water for such applications is passed through strainers. The strainers are effective at preventing adult mussels or mussel shells large enough to cause plugging problems from entering into the piping system. However, the veligers (larval form) can readily pass through most strainers and can settle in areas of the piping that are not made of copper or copper alloy or not subjected to high velocities.

  Any pump shaft seal water system may be exposed to small shell fragments, and some increased wear may be experienced. The seal cavity may become a settlement area for mussels.

- **Piping Systems.** As water is drawn into the various systems, so are the free swimming larvae during the reproductive periods. Larvae may settle where the water flow is less than 0.5 feet per second, reducing laminar flow at the pipe surface as they grow. This creates ideal conditions for further settlement. In some instances, areas which on paper have design flow rates high enough to preclude attachment have been found full of juvenile mussels. This may happen during partial

outages or when the flows are reduced for a period of time, diurnally or seasonally, or where localized short-circuiting occurs.

Valves are also vulnerable; particularly valves which do not operate frequently. For example, at one facility, a 10-inch butterfly valve failed to close because the disc was completely covered by mussels. Mechanical pipe joints are another possible attachment area.

Adult mussels which may be carried into the system or have detached from upstream locations will continue to move downstream until an in-line strainer or other impingement prevents further movement. At such locations, large aggregates of mussels may form, even when the overall infestation is light. These areas may limit flow to the downstream system and cause unexpected operational problems.

- **Auxiliary System.** Any instruments in direct contact with the raw water, such as level and pressure gauges, are at high risk of infestation. Whenever possible, replacing direct contact instrumentation with non-contact type instrumentation (e.g. ultrasonic, electromagnetic and laser) is desirable.

- **Others.** Utility water systems and fire protection facilities frequently utilize treated city water. In these cases, the systems are typically safe from mussels. If, however, they draw raw water directly from a surface water source, they are as vulnerable as other raw water systems. Utility systems are typically designed to be filled with water and maintained in a static, "ready to go" state. In real life, these systems are frequently tested and used in-between test periods for other tasks. This means that a constant stream of water is needed to replace the volume of water used. This make-up stream is the main point of entry for *dreissenids*. It also provides food and oxygen necessary for their survival. Mussels may enter these systems as larvae or as adult translocators if there are no strainers present at the discharge of the pumps.

Potential future mussel infestation in Lake Powell may require mitigative precautions and active or passive treatment methods should be considered necessary for the LPP Project intake and water supply. During the project design phase opportunities for providing cost effective future provisional facilities need to be considered. As additional best management practices are developed for mussel management resulting from ongoing research, these may provide better potential methods for control of aquatic nuisance species.

Various methods to remove, prevent attachment or reproductively inactivate mussel species have been attempted and/or proposed. The most common approach to date has been the application of chlorine solution to water entering intakes. This can destroy the larval forms but may not affect adults that can close their shells in response to toxic chemicals and survive for some time without additional raw water. Since the veligers can be the most motile, this treatment approach can be effective on this life stage in some cases. Other potential *dreissenid* control methods include filtration, mechanical and electronic screening, anti-fouling coatings, UV irradiation, other chemicals including oxidants and molluscicides, the use of biological agents and others. To date no specific "best" solution has been accepted for mussel control.

The use of chemical agents for control of biological contaminants, while common, is problematic. Chlorine and chlorine derivatives (chloramines, chlorine dioxide, etc.) have a potential to produce regulated disinfection by-products that cannot easily be removed from potable water supplies by traditional treatment methods. Since adult *dreissenids* can detect what they perceive as harmful chemicals and close their shells in response for some time, chemical agents are really only effective on larval forms.

While other chemicals, radiation and biota control agents (bacteria, parasites, etc.) have been proposed, either cost, practical effectiveness and lack of regulatory approval can limit their use in potable water sources.

The use of filtration or screening (mechanical, membrane or media) appears to be the safest and most adaptable method currently available. Filtration below 30 µ (sand filtration limits) with or without coagulation would appear to eliminate most life stages of mussel development. Filtration plus a small dose (1 – 2 mg/l residual) of chlorine or the use of UV irradiation would provide a most positive method of protection. However, it would be very difficult, given current technology, to provide a system that can completely eliminate the presence of mussels in the pipeline delivery system without a significant level of pretreatment. Until the mussels are known to be established in Lake Powell, the design of any pretreatment systems would be included as a contingency for the design of the LPP Project intake and intake pump station.

If the existing Lake Powell mussel protection program is successful in preventing the introduction of both *dreissenids* species, then specific treatment for mussel control would not be required. Early detection through ongoing monitoring programs would provide sufficient time to implement capital and operational changes to water intake supply to address future problems.

Dreissenids are a species of interest because of their current impact on a number of water delivery systems in the Lake Mead and lower Colorado River system. In the future, other as yet-undefined organisms may prove to be invasive or problematic and would need to be addressed. Predicting the type, severity and consequences of any future infestation is impossible to assess, however, the potential for this to occur during the LPP Project life should not be dismissed or overlooked in the planning.

3.2.2 Aquatic Resources in Perennial Drainages

3.2.2.1 Lake Powell

The construction activities of the LPP Project have several distinct elements but all involve various levels of disturbance to the existing environment. The intake structure and intake pump station construction would not involve the aquatic resources or aquatic resource habitat in Lake Powell.

Construction of the pipeline and associated pump stations, tanks and hydroelectric facilities, while a major civil engineering undertaking, would for the most part, involve lands with little or no aquatic resource value. The majority of the pipeline alignment and the location of ancillary facilities involve land that does not sustain drainages with perennial flows. Numerous ephemeral washes draining directly to Lake Powell do not sustain surface flows nor do they support any aquatic resource habitat.

3.2.2.2 Paria River Drainage

Between the Lake Powell intake and the Virgin River drainage (140± miles) the only stream that maintains a perennial flow is the Paria River, which flows from Utah to Arizona. The pipeline would cross the Paria River drainage several times, once across the main Paria River immediately adjacent to U.S. Highway 89 (Figure 3-3), three times across Sand Gulch which joins the Paria River at the U.S. Route 89 crossing, and once across Buckskin Gulch, a tributary to the Paria River (Figure 3-4). These pipeline crossings would be in Utah. The Sand Gulch and Buckskin Gulch crossings are ephemeral and have no aquatic resource value.

The Paria River drainage including the Buckskin Canyon is, in part, managed as wilderness study area and includes some of the most scenic resources in the southwest. The points where the LPP would cross these drainages are not in wilderness study area land and would be adjacent to existing highway bridge and culvert crossings. While Buckskin Gulch is dry most of each year, the Paria River maintains some flow (19.8 cubic feet per second annual average base flow) throughout each year. The Paria River is a "muddy" river, hence the name in Spanish. The flow is subject to flash flooding during periods of rainfall and seasonal runoff. The Paria Canyon is a narrow geologically incised gorge throughout a significant portion of its flow path to the Colorado River. The area of the water conveyance pipeline crossing of the Paria River can be characterized as a flat desert environment devoid of vegetation within the active channel and riparian vegetation (willows, tamarisk) growing in the floodway. The proposed crossing area is composed of fine silt, sand and small gravel and runoff debris on the surface.

The Paria River releases significant amounts of sediment to the Colorado River below Glen Canyon Dam each year that is carried further down into the Colorado River system by planned dam releases. Reaches of the river above the Paria Canyon wilderness (Primitive) areas are known to be impaired as a result of grazing and other human uses.

Five species of fish are reported to be occasionally found in the Paria River.

Reaches of the Paria River may provide habitat for flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*Catostomus discobolus*), razorback sucker (*Xyrauchen texanus*), rainbow trout (*Oncorhynchus mykiss*) and speckled dace (*Rhinichthys osculus*). These fish, with the exception of rainbow trout and speckled dace, are considered sensitive by the State of Utah. The Razorback sucker is federally listed as endangered and is discussed in further detail in the Special Status Aquatic Species and Habitats Study Report. The bluehead sucker feeds on algae from the bottom of stream substrate and typically inhabits large rivers and mountain streams with variable turbidity and temperature. The flannelmouth sucker is also a bottom feeder consuming algae, other fragmented vegetation, seeds and invertebrates. The species lives within moderate to large rivers and is typically affected by nonnative species, hybridization, habitat alteration and blockage of migration routes. The flannelmouth sucker and bluehead sucker are managed under a Conservation Agreement that has precluded federal species listing (UDWR 2006). Rainbow trout is a game fish common in Utah reservoirs and rivers and can be found in water bodies associated with the Project area. Its sustained presence in the reach of the Paria River potentially impacted by the LPP Project construction is questionable without hatchery supplementation. The speckled dace is a minnow common in many western waters. It is a bottom-dwelling species and is an important forage fish.

While a definitive assessment of the condition of these species in the Paria River near the area of potential impact for the LPP Project was not found in the literature, it is assumed that durability of the populations are dependent upon climate and the availability of flow from seasonal precipitation. There would be no proposed releases of LPP Project water into the Paria River.

Figure 3-3
Paria River at U.S. Highway 89 Pipeline Crossing

Figure 3-4
Buckskin Gulch Dry Streambed at U.S. Highway 89 Pipeline Crossing

Current proposed planning would have the crossing of the Paria River completed by open-cut excavation and fill during no or low flow conditions. The pipeline crossing construction would involve a temporary diversion of any low stream flows to another portion of the broad river channel bottom (340 feet wide adjacent to the highway bridge). The Paria River crossing would be on private land and would be immediately upstream or downstream of the existing highway bridge. Buckskin Gulch is essentially dry during the majority of the year and can be crossed using open cut and fill construction techniques.

3.2.2.3 Kanab Creek Drainage

The penstock crossing alternatives of Kanab Creek and its associated drainages (Jacob Canyon, Bitter Seeps Wash) is the next westerly drainage along the proposed LPP Project alignment where a possible aquatic resource impact could occur. There are two alternative alignments for the penstock that could cross Kanab Creek. The Existing Highway alignment crossing site (Figure 3-5) is east of the Kaibab-Paiute Indian Reservation near Fredonia. The South Alternative crossing site is south of the Reservation's southern boundary (Figure 3-6).

Kanab Creek north of Kanab has perennial flow through the narrow, rock canyon upstream of the LPP Project penstock alignment. Pools and groundwater seeps are present in some reaches south of Kanab. The alternative alignment penstock crossings of Kanab Creek and its principal drainages (Jacob Canyon and Bitter Seeps Wash) have been dry on most occasions during the 2007 through 2010 field seasons. Kanab Creek near Fredonia supports no populations of sport or native fish because of the intermittent flows associated with this part of the drainage. Flannelmouth sucker, a sensitive species, may be present in Kanab Creek farther upstream and north of the pipeline alternative alignment (Speas 2003). Speckled dace are present in Kanab Creek upstream from the town of Kanab. Upstream users of Kanab Creek in Utah divert flows for irrigation purposes, leaving it mostly dry in the summer season where the alignments would cross the creek (BLM 2007a). Kanab Creek is a naturally intermittent stream. Water projects developed for irrigation prior to the beginning of the twentieth century have further altered the natural flow and have reduced or eliminated the aquatic habitat in downstream reaches.

Kanab Creek is the largest tributary canyon system to the Grand Canyon on the north side of the Colorado River. Upper Kanab Creek upstream of the town of Kanab passes areas with potential wilderness characteristics. The lower reach through the Kaibab-Paiute Indian Reservation is not considered to have the same recreational opportunities or support any aquatic resources.

Kanab Creek at the penstock crossing along the Existing Highway Alternative near Fredonia is characterized as a dry wash with little evidence of flow. The abundant vegetation includes willow and tamarisk which would indicate the presence of soil moisture but little surface flow. The penstock crossing reach is heavily grazed and trampled by livestock.

Figure 3-5
Existing Highway Alternative Crossing of Kanab Creek

Figure 3-6
South Alternative Crossing of Kanab Creek

The South Alternative, outside the Reservation boundary including Kanab Creek, Jacob Canyon and Bitter Seeps Wash, all show little sign of surface flow. Remnant pools in Kanab Creek Canyon (Figure 3-7) are a result of storm water runoff entrapment and the vegetation development would indicate that actual water flow is limited in volume and duration. Jacob Canyon (Figure 3-8) and Bitter Seeps Wash (Figure 3-9) are dry washes with only one recorded surface flow in each during the LPP field studies from 2008 through 2010. None of these crossings would need to be constructed during periods when measurable flow would be expected in Kanab Creek or its tributaries, therefore they all could be installed by open cut techniques without having any measurable impact on potential aquatic resources.

3.2.2.4 Sand Hollow Reservoir

Sand Hollow Reservoir is an off-stream reservoir constructed, operated and maintained by WCWCD and would be the terminal reservoir for the WCWCD share of the LPP Project water. The Reservoir is a popular recreational destination for local St. George metropolitan residents and regional users, with a put and take fishery, boat launch, swimming beaches, and campsites adjacent to the shores. The Utah Division of Wildlife Resources stocks the lake with catchable sport fish and manages the reservoir for bluegill and largemouth bass recreational fishing. Quagga mussel was confirmed to inhabit Sand Hollow Reservoir in 2010 based on samples collected from the boat ramp and tested for DNA.

3.2.2.5 Virgin River Drainage

The Virgin River is the most significant water resource in the LPP Project area and hence has the highest aquatic resource potential. The Virgin River is a perennial stream with wide variation in flow dependent on seasonal precipitation, climate and runoff. The flow in the Virgin River is substantial throughout the year from its source in Utah to its confluence with the Colorado River at Lake Mead. The base flow of the North and East forks of the river is approximately 40 cfs with extreme flood flows estimated to exceed 20,000 cfs near the town of Virgin.

The Virgin River drainage, including LaVerkin Creek and Ash Creek, provides habitat for various aquatic resources. The Virgin River Resource Management and Recovery Program has been established to help recover various sensitive and listed species within the river including the woundfin (*Plagopterus argentissimus*) and the Virgin River chub (*Gila seminuda*), which are both federally listed as endangered species and are discussed in further detail in the Special Status Aquatic Species and Habitats Study Report. The desert sucker and the Virgin spinedace are managed through a Conservation Agreement (UDWR, 2006).

The Cedar Valley Pipeline crossing of the Virgin River is proposed as an aerial structure adjacent to the Sheep Bridge over the river (Figure 3-10). No construction within the active stream channel has been proposed.

There are two other perennial streams in Washington County that would be crossed by the Cedar Valley element of the LPP Project. These include Ash Creek and LaVerkin Creek, both of which would be crossed by the Cedar Valley Pipeline.

Figure 3-7
Remnant Pools in Kanab Creek Canyon

Figure 3-8
Jacob Canyon at South Alternative Crossing

Figure 3-9
Bitter Seeps Wash at South Alternative Crossing

Figure 3-10
Virgin River at Sheep Bridge and Cedar Valley Pipeline Aerial Crossing

LaVerkin Creek is a perennial stream with aquatic resource habitat in the study area. It flows into the Virgin River immediately upstream of the Ash Creek confluence with the Virgin River near the Town of LaVerkin. It is currently anticipated that the pipeline crossing of LaVerkin Creek can be accomplished using an open cut trench during low flow periods. LaVerkin Creek has aquatic resource habitat potential at the proposed Cedar Valley Pipeline crossing (Figure 3-11).

There is currently an aerial pipe crossing near the anticipated location of the new Cedar Valley Pipeline crossing. The existing pipeline is part of the WCWCD water system. The aquatic value of LaVerkin Creek appears to provide more aquatic habitat potential than most other drainages in the study area with the exception of the Virgin River.

Figure 3-11
LaVerkin Creek at Cedar Valley Pipeline Crossing

Flow in Ash Creek ranges from five to less than one cubic feet per second seasonally and the habitat is limited to the native fish mentioned above. Ash Creek contains no sport fish species and flow can be reduced in flow to almost a dry condition. The Cedar Valley Pipeline crossing of lower Ash Creek is proposed as an aerial supported pipeline because of the topography and the extremely steep banks (Figure 3-12) on either abutment.

Figure 3-12
Ash Creek at Lower Crossing of Cedar Valley Pipeline

The Cedar Valley Pipeline would cross upper Ash Creek near the proposed location of Cedar Valley Booster Pump Station No. 1 (Figure 3-13). Ash Creek is ephemeral at this crossing site and is essentially dry during non-storm runoff periods and offers limited opportunity and habitat for aquatic resources.

A tributary to Ash Creek near the Ash Creek Reservoir outlet would be crossed by the Cedar Valley Pipeline. This Ash Creek tributary is essentially dry during non-storm runoff periods and provides no aquatic resource habitat (Figure 3-14).

Fish species in the Virgin River drainage of the LPP Project are generally limited to those discussed in the Aquatic Resources Study Plan. No additional native species have been identified. Based upon the information available, the only two Virgin River tributary drainages that will continuously support these species are lower LaVerkin Creek and lower Ash Creek. During periods of higher runoff and sustained flow, other drainages may provide temporary habitat for some species but based upon recent study, this would be limited because of little to no flow and high water temperature.

Figure 3-13
Ash Creek at Upper Crossing of Cedar Valley Pipeline

Figure 3-14
Ash Creek Tributary Near Ash Creek Reservoir at Cedar Valley Pipeline Crossing

Chapter 4
Environmental Consequences

4.1 Significance Criteria

The NEPA regulations require a discussion of the significance of potential impacts on each of the specific resource areas. A rating of an impact as significant under NEPA requires a consideration of both the context and intensity. Context relates to a number criteria including the affected society, region and affected interests of the locality under study. This would include the duration of the significant (short-term or long-term) impact and rating the consequence of an action as a result of direct or indirect considerations. Intensity refers to the actual severity of an impact. Intensity can be beneficial and/or adverse, be unique or universal and have regulatory or local implications. Intensity assessment is a subjective decision in some cases with regard to certainty or potential of an impact and can be an objective assessment for other issues and concerns.

Key factors that influence significance of most impacts can include:

- Magnitude (i.e., with this action element the value of resource)
- Duration or frequency (how long and how often)
- Global extent or aerial implication
- Certainty or potential likelihood of actually occurring

The various factors, when not quantifiable, are typically rated using a subjective analysis similar to the following*:

Magnitude:
- major
- moderate
- minor

Extent:
- large
- medium (localized)
- small (limited)

Duration:
- long-term
- medium term (intermittent)
- short-term

Likelihood:
- probable
- possible
- unlikely

*Adopted from U.S. Forest Service Guidelines

For the aquatic resources of that could be affected by the LPP Project, this procedure can be used to evaluate the impacts of project alternatives to determine the potential consequences.

4.2 Potential Impacts and Alternatives Eliminated from Further Analysis

The impact of the electrical power transmission line(s) construction and/or operation would have no meaningful impact on aquatic resources as a result of implementing the LPP Project or identified alternatives and are eliminated from further analysis.

Impacts resulting from changes in existing water supply, use and diversions would not be considered an impact on aquatic resources because none of the alternatives would have a potential effect on the existing conditions of the drainages, except for Sand Hollow Reservoir which is currently managed as a put and take fishery and for municipal/industrial water supply.

The proposed LPP Project diversion of less than 0.6 percent of the current annual average flow withdrawn from Lake Powell would not have a significant effect on the availability of water for downstream water users, habitat conditions or aquatic resources or species. The LPP Project would not be expected to have a direct or significant indirect sustained effect on sports fishery resources or the recreational use of water or aquatic resources within the Project area. These issues are not considered further in this analysis.

Ephemeral streams, washes, gullies, etc. that do not measurably contribute to perennial streams within the project area are, by the earlier definition, not significant contributors to the available aquatic habitat or resources and are not considered further in this analysis.

Potential impacts on manmade storage reservoirs, tanks and other artificial water supply structures were not considered because these facilities are typically managed in a non-natural manner and any aquatic resources are subject to regular alterations through seasonal filling and withdrawals, introduction of hatchery or other fish species (native and non-native) and other planned and unplanned management activities. The impact of the LPP Project alternatives would not be considered to have significant adverse impacts on the aquatic habitat unless: 1) invasive species were introduced that could escape to natural waters, or 2) use of LPP Project water was curtailed or eliminated once it was fully committed and other local supplies would need to be relied upon to replace the LPP Project water. Both of these conditions have a very low probability.

4.3 Assessment of Environmental Consequences

Four significance factors were considered during the assessment of environmental consequences. The definitions developed for each alternative present the potential of impact and terms defined for significance attached to the potential consequences. Tables 4-1 through 4-4 present an assessment of the significance of each of the action alternatives in relationship to the current and anticipated future aquatic resources of the LPP Project study area.

The primary aquatic resource impacts under the South Alternative could occur at the Paria River and LaVerkin Creek pipeline crossings. Potential impacts on aquatic resources at either crossing would not be significant.

Table 4-1
Significance of South Alternative Impacts on Aquatic Resources

Term	Definition
Magnitude	
Minor to NA	Eliminate valuable aquatic habitat in any of the drainages considered
Minor to NA	Would substantially interfere with existing aquatic life or human uses dependent on instream flow
Minor to NA	Observable reduction in existing aquatic life (diversification and/or biomass) in any drainage considered
Duration	
Long-Term	Operation greater than 50 years – no flowing water impacts
Short-Term	Construction – one day to weeks at each crossing – no impact on flowing waters if scheduled as proposed
Extent	
Small (limited)	Affects only immediate area of project construction – little or no measurable downstream effects. Upon completion of construction, residual short-term impacts would be mitigated.
Likelihood	
Unlikely	Significant measurable impacts on aquatic habitat
Unlikely	Significant impact during construction on fish or other aquatic species
Unlikely	Impacts occurring because of system failure/malfunction resulting in discharge of LPP water to a drainage

NA = Non-applicable

The primary aquatic resource impacts under the Southeast Corner Alternative could occur at the Paria River and LaVerkin Creek pipeline crossings. Potential impacts on aquatic resources at either crossing would not be significant.

Table 4-2
Significance of Southeast Corner Alternative Impacts on Aquatic Resources

Term	Definition
Magnitude	
Minor to NA	Eliminate valuable aquatic habitat in any of the drainages considered
Minor to NA	Would substantially interfere with existing aquatic life or human uses dependent on instream flow
Minor to NA	Observable reduction in existing aquatic life (diversification and/or biomass) in any drainages considered
Duration	
Long-Term	Operation greater than 50 years – no flowing water impacts
Short-Term	Construction – one day to weeks at each crossing – no impact on flowing waters if construction is scheduled as proposed
Extent	
Small (limited)	Affects only immediate area of project construction – little or no measurable downstream effects. Upon completion of construction, residual short-term impacts would be mitigated.
Likelihood	
Unlikely	Significant measurable impacts on aquatic habitat
Unlikely	Significant impact during construction on fish or other aquatic species
Unlikely	Impacts occurring because of system failure/malfunction resulting in discharge of LPP water to a drainage

NA = Non-applicable

The primary aquatic resource impacts under the Existing Highway Alternative could occur at the Paria River and LaVerkin Creek pipeline crossings. Potential impacts on aquatic resources at either crossing would not be significant.

Table 4-3
Significance of Existing Highway Alternative Impacts on Aquatic Resources

Term	Definition
Magnitude	
Minor to NA	Eliminate valuable aquatic habitat in any of the drainages considered
Minor to NA	Would substantially interfere with existing aquatic life or human uses dependent on instream flow
Minor to NA	Observable reduction in existing aquatic life (diversification and/or biomass) in any drainages considered
Duration	
Long-Term	Operation greater than 50 years – no flowing water impacts
Short-Term	Construction – one day to weeks at each crossing – no impact on flow in waters if construction is scheduled as proposed
Extent	
Small (limited)	Affects only immediate area of project construction – little or no measurable downstream effects. Upon completion of construction, residual short-term impacts would be mitigated.
Likelihood	
Unlikely	Significant measurable impacts on aquatic habitat
Unlikely	Significant impact during construction on fish or other aquatic species
Unlikely	Impacts occurring because of system failure/malfunction resulting in discharge of LPP water to a drainage

NA = Non-applicable

The primary aquatic resource impacts under the No Lake Powell Water Alternative would be indirect impacts resulting from restrictions on residential outdoor watering, which would reduce groundwater recharge that currently reports to the Virgin River and its tributary streams during the summer and fall months in the St. George metropolitan area. The Virgin River and tributary streams from Hurricane to the Utah-Arizona state line would become losing reaches during the summer and fall months, reducing the streamflow, reducing aquatic resource habitat area, increasing water temperature, changing aquatic resource food supplies, and diminishing the areal extent and functions of riparian areas along the streams. These would be significant indirect impacts on aquatic resources and habitats in the St. George metropolitan area under the No Lake Powell Water Alternative.

Table 4-4
Significance of No Lake Powell Water Alternative Impacts on Aquatic Resources

Term	Definition
Magnitude	
Major to moderate	Eliminate valuable aquatic habitat in any of the drainages considered
Major to moderate	Would substantially interfere with existing aquatic life or human uses dependent on instream flow
Major to moderate	Observable reduction in existing aquatic life (diversification and/or biomass) in any drainages considered
Duration	
Long-Term	Operation greater than 50 years – flowing water impacts
Short-Term	No direct or indirect change or impact anticipated
Extent	
Large	Affects Virgin River and tributaries in St. George metropolitan area – measurable downstream effects from operation, impacts could not be mitigated.
Likelihood	
Probable	Significant measurable impacts on aquatic habitat
Probable	Significant impact during operation on fish or other aquatic species

NA = Non-applicable

The No Action Alternative would have no direct or indirect impacts on aquatic resources in the LPP Project study area.

Chapter 6
Unavoidable Adverse Impacts

6.1 Introduction

This chapter summarizes unavoidable adverse impacts on aquatic resources. Unavoidable adverse impacts may or may not be significant.

Unavoidable adverse impacts are identified as those that meet the following two criteria:

- There are no reasonably practicable mitigation measures to eliminate identified impacts; and
- There are no reasonable alternatives to the proposed project that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar significant adverse impacts.

6.2. LPP Project Alignment Alternatives

6.2.1 Construction

The LPP Project alignment alternatives would not have any unavoidable adverse construction impacts on aquatic resources. Mitigation measures implemented as described in Chapter 5 at the pipeline crossings of perennial streams would avoid or minimize impacts on water quality, aquatic resources and aquatic habitats. The residual impacts after applying mitigation would not be measurable.

6.2.2 Operation

The primary concern that has been expressed for the LPP Project, with regard to aquatic resources, is the diversion of Lake Powell water for use in Washington, Kane and Iron counties in Utah. The LPP Project would divert less than 0.6 percent of the historic (1906 to 2004) average annual flow of the Colorado River downstream of Glen Canyon Dam. It would be anticipated that if a severe drought were to occur, that the LPP Project sponsors would cooperate to reduce their water use as part of any regional water conservation plan.

An accidental pipeline discharge would be unlikely, and instrumentation to detect a loss of pressure and subsequently shut down the intake and booster pumping stations until the event is resolved would be incorporated in the design.

Any water that needs to be drained from the pipeline because of maintenance requirements should be directed to a land application area. Depending upon location, this could be a containment pond or an infiltration area. Any planned maintenance would be undertaken during January and routine disposal of any drainage should occur without measurable impacts. If the water in the pipeline were chemically treated, any maintenance discharges would need to be handled to remove these residual materials (i.e. chlorination followed by dechlorination) similar to the methods used in municipal water delivery systems when fire hydrants are used as blow offs during system maintenance.

Since Lake Powell does not, at present, have a problem with invasive non-native species and an established management program is in place to prevent the introduction of organisms as a result of recreational water craft use of Lake Powell, the problem of invasive species being transferred from Lake Powell to other drainages as a result of the LPP Project or its alternatives is hypothetical but of concern. The design of the water withdrawal system would need to be planned to allow for treatment of raw Lake Powell water at the point where it is removed. However, eliminating all potential biota transfer is not a reasonable assumption and some risk would always remain as an unavoidable adverse impact of the project.

6.3 No Lake Powell Water Alternative

6.3.1 Construction

The No Lake Powell Water Alternative would not have any unavoidable adverse construction effects on aquatic resources.

6.3.2 Operation

The No Lake Powell Water Alternative would have unavoidable adverse effects on the aquatic resources resulting from the indirect impacts of restricting residential outdoor watering, which would eliminate groundwater recharge in the St. George metropolitan area that reports back to the river during the summer and fall months. The Virgin River and its local tributary streams would become a losing stream through the St. George metropolitan area during the summer months and result in reducing stream flows, reducing habitat, increasing water temperatures, changing the food supply for aquatic resources, and diminishing the areal extent and functions of the riparian corridor from LaVerkin Creek to the Utah-Arizona state line. These would be unavoidable adverse impacts on aquatic resources and its connected ecosystem.

4.4 Summary

The LPP Project alignment alternatives would not have any significant impacts on aquatic resources and habitat if constructed and operated as proposed.

- No water from Lake Powell would be intentionally transferred to any natural drainage. It is possible for water from Sand Hollow Reservoir to be transferred by pipeline to Quail Creek Reservoir. Both reservoirs can supply the water treatment plant at St. George, Utah with raw water. While both of the reservoirs are contained and do not, under normal conditions, discharge to each other or to any natural water bodies, if the minimum flows in the Virgin River are not met due to upstream diversions or other conditions, Quail Creek Reservoir can discharge water to the Virgin River. If this were to occur, aquatic organisms in Quail Creek Reservoir could be introduced to the Virgin River. If water in the Quail Creek Reservoir included flow from Sand Hollow Reservoir then it would be possible that organisms from Lake Powell could be introduced into the Virgin River. This is a very unlikely scenario but possible given the existing pipe connections.
- Accidental water discharges would be very unlikely and of very short duration.
- Operational water releases during cleaning, blow offs or other water discharges would be controlled. It is not intended that the pipeline be completely drained but if that were necessary, the water discharge from the conveyance system would be land applied and not directed to perennial streams.
- Crossing of ephemeral drainages would be through open cut and cover construction. Perennial flowing streams would be crossed by open cut and cover construction involving temporary stream diversions.

It is not anticipated that any activity associated with the LPP Project alignment alternatives would have long-term construction or operations-related impacts on aquatic resources.

The No Lake Powell Water Alternative would have significant indirect impacts on aquatic resources in the St. George metropolitan area.

Chapter 5
Mitigation and Monitoring

5.1 Introduction

The LPP Project alignment alternatives are not anticipated to have any significant impacts on the aquatic resources of the study area. Important mitigation measures would be focused on avoiding construction activities in ephemeral drainages during periods of high runoff and flow and ensuring that all construction areas are suitably reclaimed prior to season runoff periods. This is both a safety issue (flash flooding) and to protect the local and downstream resources. Construction in and around the few perennial streams in the study area would be performed using open cut trench excavation and fill techniques, with temporary diversions of active flow around the pipeline crossing sites. At perennial streams, best management practices (BMPs) would need to be implemented to reduce impacts on water quality, aquatic resources and habitat.

5.2 LPP Project Alignment Alternatives

The most significant mitigation measure for the alignment alternatives would be to protect LaVerkin Creek at the pipeline crossing. LaVerkin Creek at this site has year-round flow and higher aquatic values than other local small drainages in the study area. At LaVerkin Creek, an aerial crossing would avoid any significant aquatic resource impacts.

Monitoring should include both construction related and long-term monitoring to utilize an adaptive management approach for assessing any future issues or impacts and provide for operational modifications. Monitoring of flow, water quality and benthic macroinvertebrates prior to and following any instream construction of the project pipeline should be considered. Sampling of fish and other vertebrates can be avoided if proper mitigation measures are in place during construction. Since a variety of other natural resource agencies regularly study/monitor the fish and other species in the live streams of the LPP Project study area, additional sampling and monitoring would not appear to be warranted.

Longer term monitoring should include routine visual inspection of any exposed pipe sections and construction areas. Flow and pressure measurement provisions, to assess any pipeline leakage, should be included in the design of the project. It is unlikely that the system, in operation, would result in any measureable unregulated discharges. If the system required maintenance, cleaning or other activities requiring sections of the system to be drained pipeline at low points in the hydraulic grade line, the impact and effects of this action on the surrounding drainages should be reviewed and a monitoring plan developed to assess potential impacts.

5.3 No Lake Powell Water Alternative

Under the No Lake Powell Water Alternative, there are no apparent mitigation measures to avoid, minimize or reduce the significant impacts on the aquatic resources in the Virgin River and tributary streams in the St. George metropolitan area. The only mitigation options for these significant indirect impacts on aquatic resources would be restoration and/or enhancement in other drainage basins or compensation for lost aquatic resources and habitat. Long-term monitoring would be performed to document the decline of aquatic resources in the affected waters of the study area.

Chapter 6
Unavoidable Adverse Impacts

6.1 Introduction

This chapter summarizes unavoidable adverse impacts on aquatic resources. Unavoidable adverse impacts may or may not be significant.

Unavoidable adverse impacts are identified as those that meet the following two criteria:

- There are no reasonably practicable mitigation measures to eliminate identified impacts; and
- There are no reasonable alternatives to the proposed project that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar significant adverse impacts.

6.2. LPP Project Alignment Alternatives

6.2.1 Construction

The LPP Project alignment alternatives would not have any unavoidable adverse construction impacts on aquatic resources. Mitigation measures implemented as described in Chapter 5 at the pipeline crossings of perennial streams would avoid or minimize impacts on water quality, aquatic resources and aquatic habitats. The residual impacts after applying mitigation would not be measurable.

6.2.2 Operation

The primary concern that has been expressed for the LPP Project, with regard to aquatic resources, is the diversion of Lake Powell water for use in Washington, Kane and Iron counties in Utah. The LPP Project would divert less than 0.6 percent of the historic (1906 to 2004) average annual flow of the Colorado River downstream of Glen Canyon Dam. It would be anticipated that if a severe drought were to occur, that the LPP Project sponsors would cooperate to reduce their water use as part of any regional water conservation plan.

An accidental pipeline discharge would be unlikely, and instrumentation to detect a loss of pressure and subsequently shut down the intake and booster pumping stations until the event is resolved would be incorporated in the design.

Any water that needs to be drained from the pipeline because of maintenance requirements should be directed to a land application area. Depending upon location, this could be a containment pond or an infiltration area. Any planned maintenance would be undertaken during January and routine disposal of any drainage should occur without measurable impacts. If the water in the pipeline were chemically treated, any maintenance discharges would need to be handled to remove these residual materials (i.e. chlorination followed by dechlorination) similar to the methods used in municipal water delivery systems when fire hydrants are used as blow offs during system maintenance.

Since Lake Powell does not, at present, have a problem with invasive non-native species and an established management program is in place to prevent the introduction of organisms as a result of recreational water craft use of Lake Powell, the problem of invasive species being transferred from Lake Powell to other drainages as a result of the LPP Project or its alternatives is hypothetical but of concern. The design of the water withdrawal system would need to be planned to allow for treatment of raw Lake Powell water at the point where it is removed. However, eliminating all potential biota transfer is not a reasonable assumption and some risk would always remain as an unavoidable adverse impact of the project.

6.3 No Lake Powell Water Alternative

6.3.1 Construction

The No Lake Powell Water Alternative would not have any unavoidable adverse construction effects on aquatic resources.

6.3.2 Operation

The No Lake Powell Water Alternative would have unavoidable adverse effects on the aquatic resources resulting from the indirect impacts of restricting residential outdoor watering, which would eliminate groundwater recharge in the St. George metropolitan area that reports back to the river during the summer and fall months. The Virgin River and its local tributary streams would become a losing stream through the St. George metropolitan area during the summer months and result in reducing stream flows, reducing habitat, increasing water temperatures, changing the food supply for aquatic resources, and diminishing the areal extent and functions of the riparian corridor from LaVerkin Creek to the Utah-Arizona state line. These would be unavoidable adverse impacts on aquatic resources and its connected ecosystem.

Chapter 7
Cumulative Impacts

This chapter analyzes cumulative impacts that may occur from construction and operation of the proposed LPP project when combined with the impacts of other past, present, and reasonably foreseeable future actions and projects after all proposed mitigation measures have been implemented. Only those resources with the potential to cause cumulative impacts are analyzed in this chapter.

7.1 LPP Project Alignment Alternatives

(The cumulative impacts analysis is pending completion for identification of inter-related projects that would cause cumulative impacts with the LPP project.)

7.2 No Lake Powell Water Alternative

(The cumulative impacts analysis is pending completion for identification of inter-related projects that would cause cumulative impacts with the LPP project.)

7.3 No Action Alternative

The No Action Alternative would have no cumulative impacts.

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