Lake Powell Pipeline

Draft Study Report 11
Special Status Aquatic Species and Habitats

March 2011

Special Status Aquatic Species and Habitats Study Report
Table of Contents

Page

Executive Summary ES-1

ES-1 Introduction ES-1
ES-2 Methodology ES-1
ES-3 Key Results of the Special Status Aquatic Species and Habitats Effects and Impact Analyses ES-1
ES-3.1 Threatened, Endangered and Candidate Aquatic Species and Habitats ES-1
ES-3.2 Aquatic Species of Concern ES-3

Chapter 1 Introduction 1-1

1.1 Introduction 1-1
1.2 Summary Description of Alignment Alternatives 1-1
1.2.1 South Alternative 1-1
1.2.2 Existing Highway Alternative 1-8
1.2.3 Southeast Corner Alternative 1-8
1.2.4 Transmission Line Alternatives 1-10
1.3 Summary Description of No Lake Powell Water Alternative 1-17
1.3.1 WCWCD No Lake Powell Water Alternative 1-17
1.3.2 CICWCD No Lake Powell Water Alternative 1-18
1.3.3 KCWCD No Lake Powell Water Alternative 1-18
1.4 Summary Description of the No Action Alternative 1-18
1.4.1 WCWCD No Action Alternative 1-19
1.4.2 CICWCD No Action Alternative 1-19
1.4.3 KCWCD No Action Alternative 1-19
1.5 Identified Issues 1-20
1.6 Impact Topics 1-20

Chapter 2 Methodology 2-1

2.1 Introduction 2-1
2.2 Data Used 2-1
2.3 Assumptions 2-1
2.4 Affects and Impacts Analysis Methodology 2-2

Chapter 3 Affected Environment (Baseline Conditions) 3-1

3.1 Effects or Impact Area 3-1
3.2 Overview 3-1
3.3 Threatened, Endangered, and Candidate Aquatic Species and Designated Critical Habitats 3-1
3.3.1 Apache Trout 3-5
3.3.1.1 Listing History and Status 3-5
3.3.1.2 Distribution 3-5
3.3.1.3 Life History and Ecology 3-6

3.3.1.4 Designated Critical Habitat 3-6
3.3.2 Bonytail Chub 3-6
3.3.2.1 Listing History and Status 3-6
3.3.2.2 Distribution 3-6
3.3.2.3 Life History and Ecology 3-6
3.3.2.4 Designated Critical Habitat 3-6

3.3.3 Colorado Pikeminnow 3-7
3.3.3.1 Listing History and Status 3-7
3.3.3.2 Distribution 3-7
3.3.3.3 Life History and Ecology 3-7
3.3.3.4 Designated Critical Habitat 3-7
3.3.4 Humpback Chub 3-7
3.3.4.1 Listing History and Status 3-7
3.3.4.2 Distribution 3-8
3.3.4.3 Life History and Ecology 3-8
3.3.4.4 Designated Critical Habitat 3-8
3.3.5 Kanab Ambersnail 3-8
3.3.5.1 Listing and History Status 3-8
3.3.5.2 Distribution 3-9
3.3.5.3 Life History and Ecology 3-9
3.3.5.4 Designated Critical Habitat 3-9
3.3.6 Little Colorado Spinedace 3-9
3.3.6.1 Listing History and Status 3-9
3.3.6.2 Distribution 3-9
3.3.6.3 Life History and Ecology 3-9
3.3.6.4 Designated Critical Habitat 3-10
3.3.7 Razorback Sucker 3-10
3.3.7.1 Listing History and Status 3-10
3.3.7.2 Distribution 3-10
3.3.7.3 Life History and Ecology 3-10
3.3.7.4 Designated Critical Habitat 3-11
3.3.8 Virgin River Chub 3-11
3.3.8.1 Listing History and Status 3-11
3.3.8.2 Distribution 3-11
3.3.8.3 Life History and Ecology 3-11
3.3.8.4 Designated Habitat 3-12
3.3.9 Woundfin 3-12
3.3.9.1 Listing History and Status 3-12
3.3.9.2 Distribution 3-12
3.3.9.3 Life History and Ecology 3-13
3.3.9.4 Designated Habitat 3-13
3.4 Federal, State and Local Agency Aquatic Species of Concern 3-13
3.4.1 Flannelmouth Sucker 3-13
3.4.2 Bluehead Sucker 3-14
3.4.3 Speckled Dace 3-15
3.4.4 Desert Sucker 3-15
3.4.5 Virgin Spinedace 3-16

Chapter 4 Environmental Consequences (Effects and Impacts) 4-1

4.1 Introduction 4-1
4.2 Effects Determinations and Significance Criteria 4-1
4.2.1 Federally Listed Species 4-1
4.2.2 Federal, State, and Local Agency Aquatic Species of Concern 4-2
4.3 Potential Effects and Impacts and Alternatives Eliminated From Further Analysis 4-3
4.3.1 Transmission Line Alternatives 4-3
4.3.2 Virgin River Critical Habitat 4-3
4.3.3 Virgin River Crucial Habitat 4-3
4.3.4 Paria River Aquatic Habitat at U.S. Highway 89 4-4
4.3.5 Interbasin Transfer of LPP Water 4-5
4.3.6 LPP Project Diversions from Lake Powell and the Colorado River 4-5
4.3.6.1 Colorado River Hydrologic Simulation Methodology 4-6
4.3.6.1.1 Analyses Performed 4-6
4.3.6.1.1.1 Final Planning Study Analysis 4-6
4.3.6.1.1.2 No Additional Depletions Analysis 4-6
4.3.6.1.2 Alternatives Modeled 4-6
4.3.6.1.2.1 No Action Alternative 4-6
4.3.6.1.2.2 Lake Powell Pipeline 86kaf Alternative 4-7
4.3.6.1.3 Inflow Hydrology Scenarios Modeled 4-7
4.3.6.1.3.1 Direct Natural Flow, Index Sequential Method Inflows 4-7
4.3.6.1.3.2 Nonparametric Paleo-conditioned Inflows 4-7
4.3.6.2 Summary of Potential Hydrologic Impacts 4-7
4.3.6.2.1 General Observations 4-7
4.3.6.2.2 Final Planning Study Analysis 4-7
4.3.6.2.2.1 Reservoir Storage 4-7
4.3.6.2.2.2 Reservoir Releases 4-8
4.3.6.2.3 No Additional Depletions Analysis 4-8
4.3.6.2.3.1 Reservoir Storage 4-8
4.3.6.2.3.2 Reservoir Releases 4-9
4.3.6.3 Summary of Reclamation Hydrologic Modeling Results 4-9
4.3.6.4 Reclamation Water Quality Modeling Results 4-9
4.3.6.4.1 CRSS Salinity Modeling Methodology 4-9
4.3.6.4.2 CE-QUAL-W2: Water Quality Modeling Methodology 4-10
4.3.6.4.3 Water Quality Modeling Results 4-10
4.3.6.4.3.1 Lake Powell 4-10
4.3.6.4.3.1 Lake Powell 4-10
4.3.6.5 Summary of Reclamation Water Quality Modeling Results 4-12
4.3.7 Apache Trout 4-12
4.3.8 Kanab Ambersnail 4-13
4.4 Effects and Impacts Analysis 4-13
4.4.1 LPP Project Alignment Alternatives 4-13
4.4.1.1 Virgin River Chub 4-13
4.4.1.2 Woundfin 4-14
4.4.1.3 Desert Sucker 4-14
4.4.1.4 Virgin Spinedace 4-14
4.4.2 No Lake Powell Water Alternative 4-15

4.4.2.1 Virgin River Chub 4-15
4.4.2.2 Woundfin 4-15
4.4.2.3 Desert Sucker 4-16
4.4.2.4 Virgin Spinedace 4-16
4.4.3 No Action Alternative 4-16

Chapter 5 Conservation Measures and Mitigation and Monitoring 5-1

5.1 Conservation Measures 5-1
5.1.1 LPP Project Alignment Alternatives 5-1
5.1.1.1 Virgin River Chub and Woundfin 5-1
5.1.2 No Lake Powell Water Alternative 5-2
5.2 Mitigation Measures 5-2
5.2.1 LPP Project Alignment Alternatives 5-2
5.2.1.1 Desert Sucker and Virgin Spinedace 5-2
5.2.2 No Lake Powell Water Alternative 5-2

Chapter 6 Unavoidable Adverse Effects and Impacts 6-1

6.1 Introduction 6-1
6.2 LPP Project Alignment Alternatives 6-1
6.2.1 Construction 6-1
6.2.2 Operation 6-1
6.3 No Lake Powell Water Alternative 6-2
6.3.1 Construction 6-2
6.3.2 Operation 6-2

Chapter 7 Cumulative Effects and Impacts 7-1

7.1 LPP Project Alignment Alternatives 7-1
7.2 No Lake Powell Water Alternative 7-1
7.3 No Action Alternative 7-1

References Cited R-1
List of Preparers LP-1

Tables

Table Number	Table Title	Page
Table ES-1	Summary of Effects Determinations	ES-2
Table ES-2	Summary of Impact Analysis Results	ES-3
Table 3-1	Federally Listed Threatened and Endangered Aquatic Species by County	3-5
Table 4-1	Glen Canyon Dam Release – Monthly Simulated Temperatures (^{o}C), 2045-2060	4-11
Table 4-2	Glen Canyon Dam Release –Simulated October Temperatures (^{o}C), 2045-2060	4-12

Figures

Figure Number	Figure Title	Page
Figure 1-1	Lake Powell Pipeline Proposed Project and Alternative Features	1-2
Figure 1-2	Lake Powell Pipeline Intake and Water Conveyance System	1-3
Figure 1-3	Lake Powell Pipeline Hydro System South Alternative	1-5
Figure 1-4	Cedar Valley Pipeline System	1-7
Figure 1-5	Lake Powell Pipeline Hydro System Existing Highway Alternative	1-9
Figure 1-6	Lake Powell Pipeline Hydro System Southeast Corner Alternative	1-11
Figure 1-7	Lake Powell Pipeline Transmission Line Alternative East	1-12
Figure 1-8	Lake Powell Pipeline Transmission Line Alternative West	1-15
Figure 1-9	Cedar Valley Transmission Line Alternative	1-16
Figure 3-1	Lake Powell Pipeline Water Conveyance System and Study Area	3-2
Figure 3-2	Lake Powell Pipeline Hydro System Study Area	3-3
Figure 3-3	Cedar Valley Pipeline Study Area	3-4

Special Status Aquatic Species and Habitats Study Report
Executive Summary

ES-1 Introduction

This study report describes the results and findings of an analysis to evaluate threatened, endangered and candidate aquatic species and designated critical habitats and aquatic species of concern 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 Special Status Aquatic Species and Habitats Study Plan prepared for the Federal Energy Regulatory Commission (Commission), was to identify potential effects and impacts from construction and operations of the alternatives and identify measures to mitigate effects and impacts from the LPP project as necessary.

ES-2 Methodology

The analysis of impacts on special status aquatic species and habitats follows the methodology identified and described in the Preliminary Application Document, Scoping Document No. 1 and the Special Status Aquatic Species and Habitats Study Plan filed with the Commission.

ES-3 Key Results of the Special Status Aquatic Species and Habitats Effects and Impact Analyses

ES-3.1 Threatened, Endangered and Candidate Aquatic Species and Habitats

Table ES-1 summarizes the effects determinations for threatened, endangered and candidate aquatic species and effects determinations for listed aquatic species of special concern.

Table ES-1
Summary of Effects Determinations

Alternative	Species	Effects Determination*
Threatened, Endangered and Candidate Species		
LPP Project Alignment Alternatives	Apache trout	No
	Bonytail chub [C]	No [C]
	Colorado pikeminnow [C]	No [C]
	Humpback chub [C]	No [C]
	Kanab ambersnail	No
	Little Colorado spinedace	No
	Razorback sucker [C]	No [C]
	Virgin River chub [C]	May [C]
	Woundfin [C]	May [C]
Transmission Line Alternatives	Apache trout	No
	Bonytail chub [C]	No [C]
	Colorado pikeminnow [C]	No [C]
	Humpback chub [C]	No [C]
	Kanab ambersnail	No
	Little Colorado spinedace	No
	Razorback sucker [C]	No [C]
	Virgin River chub [C]	No [C]
	Woundfin [C]	No [C]
No Lake Powell Water Alternative	Apache trout	No
	Bonytail chub [C]	No [C]
	Colorado pikeminnow [C]	No [C]
	Humpback chub [C]	No [C]
	Kanab ambersnail	No
	Little Colorado spinedace	No
	Razorback sucker [C]	No [C]
	Virgin River chub [C]	Likely [C]
	Woundfin [C]	Likely [C]
No Action Alternative	All Species	No

Notes:
*Effects Determinations:
No = No effect
May = May affect, not likely to adversely affect
Likely = Likely to adversely affect
[C] = Designated Critical Habitat
No Candidate aquatic species are identified on the current USFWS list for potentially affected counties.

Six special status aquatic species have designated critical habitat; effects on these designated critical habitats would be:

- Bonytail chub – no effect
- Colorado pikeminnow – no effect

- Humpback chub – no effect
- Razorback sucker – no effect

LPP Project alignment alternatives

- Virgin River chub – may affect, not likely to adversely affect
- Woundfin – may affect, not likely to adversely affect

No Lake Powell Water Alternative

- Virgin River chub – likely to adversely affect
- Woundfin – likely to adversely affect

ES-3.2 Aquatic Species of Concern

Table ES-2 summarizes the results of impact analyses for aquatic species of special concern.

Table ES-2
Summary of Impact Analysis Results

Alternative	Species	Impact Result*
Aquatic Species of Concern		
LPP Project Alignment Alternatives	Flannelmouth sucker	No
	Bluehead sucker	No
	Speckled dace	No
	Desert sucker	Not Significant
	Virgin spinedace	Not Significant
Transmission Line Alternatives	Flannelmouth sucker	No
	Bluehead sucker	No
	Speckled dace	No
	Desert sucker	No
	Virgin spinedace	No
No Lake Powell Water Alternative	Flannelmouth sucker	No
	Bluehead sucker	No
	Speckled dace	No
	Desert sucker	Significant
	Virgin spinedace	Significant
No Action Alternative	All Species	No

Notes:
*Impact Result:
No = No impacts
Not Significant = Impacts would not exceed the significance criteria
Significant = Impacts would exceed the significance criteria

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 Special Status Aquatic Species 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

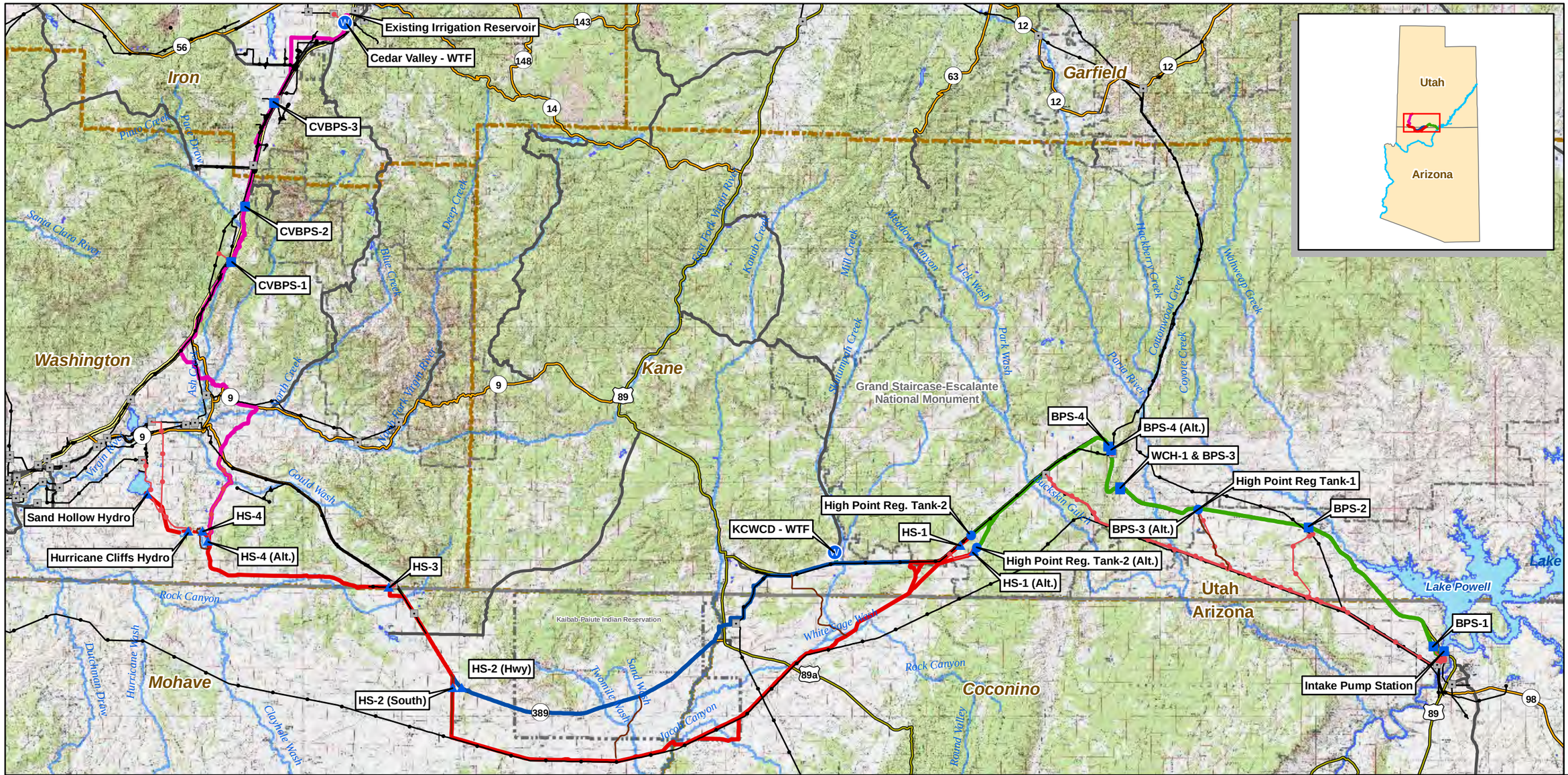
Three primary pipeline and penstock alignment alternatives are described in this section along with the electrical power transmission line alternatives. The pipeline and penstock alignment alternatives share common segments between the intake at Lake Powell and delivery at Sand Hollow Reservoir, and 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.

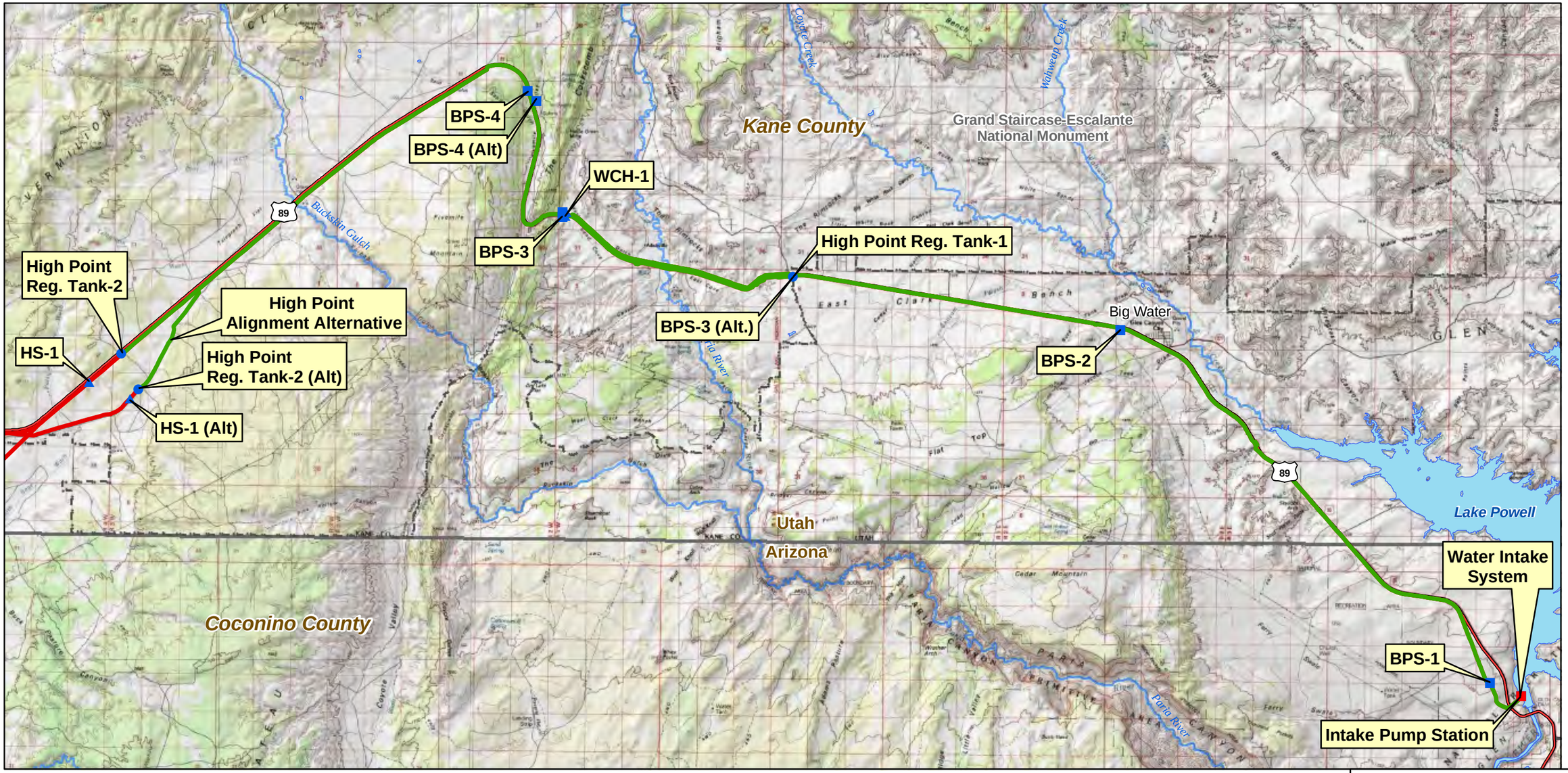
1.2.1 South Alternative

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.

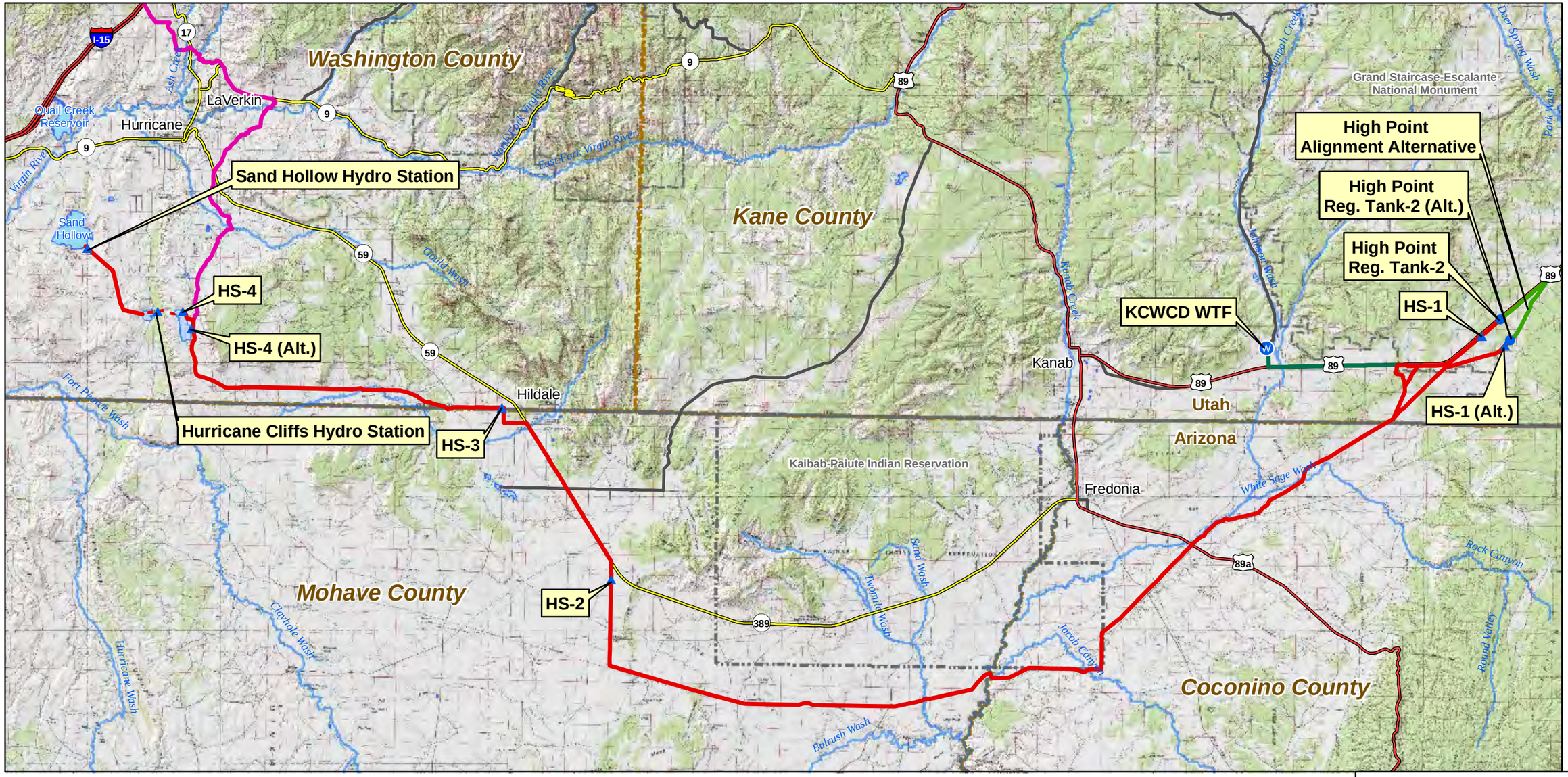
The High Point Alignment Alternative would diverge south from U.S. 89 parallel to the K4020 road and continue outside of the Congressionally-designated utility corridor to a buried regulating tank (High Point Regulating Tank-2 (Alt.) at ground level elevation 5,630 feet MSL, which would be the topographic 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.

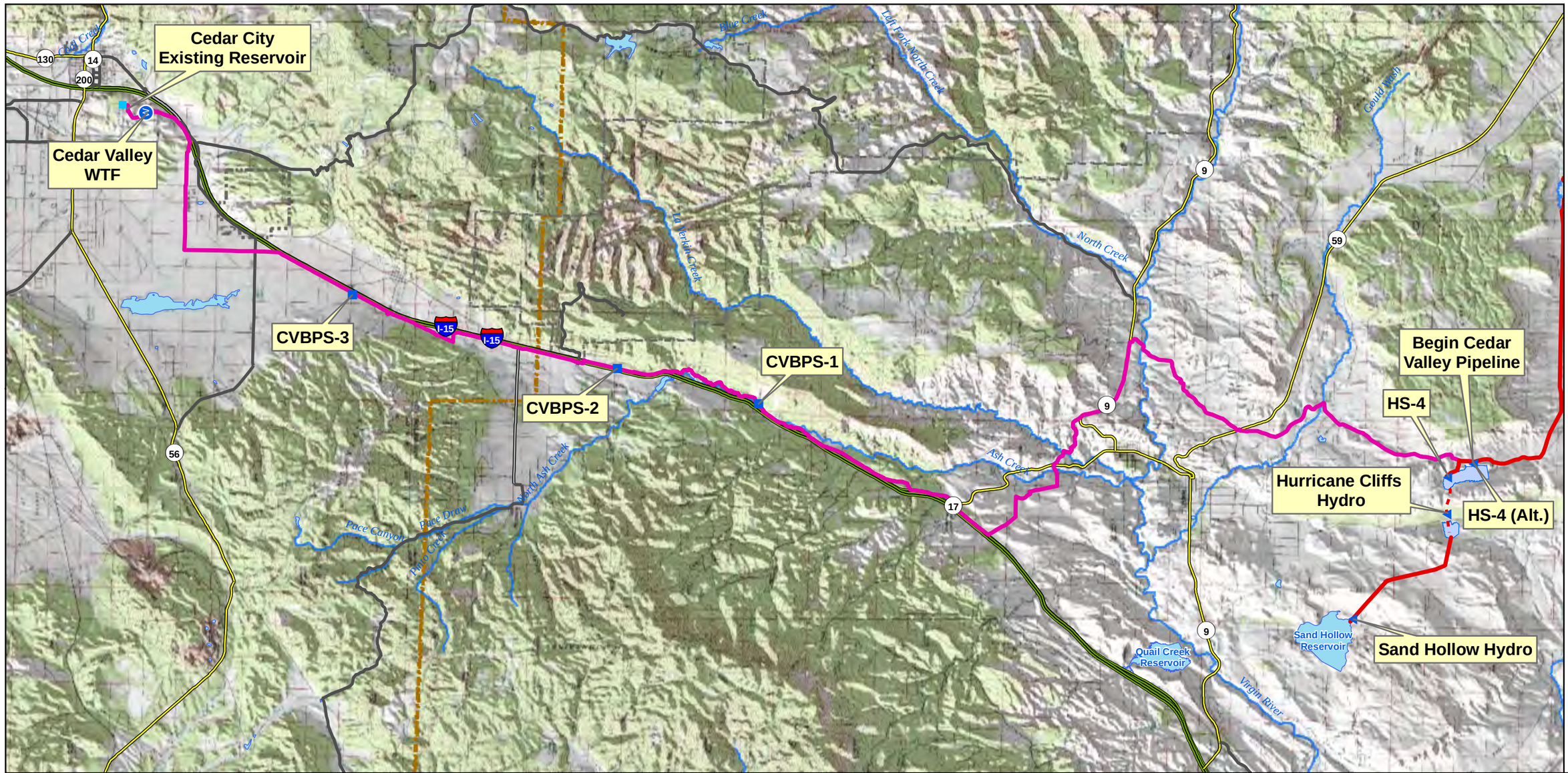
The penstock alignment would continue through White Sage Wash and then parallel to the Navajo-McCullough Transmission Line, crossing U.S. 89 Alt. and Forest Highway 22 toward the southeast corner of the Kaibab Indian Reservation. The penstock alignment would run parallel to and south of the south boundary 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
- 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 1-4** 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.

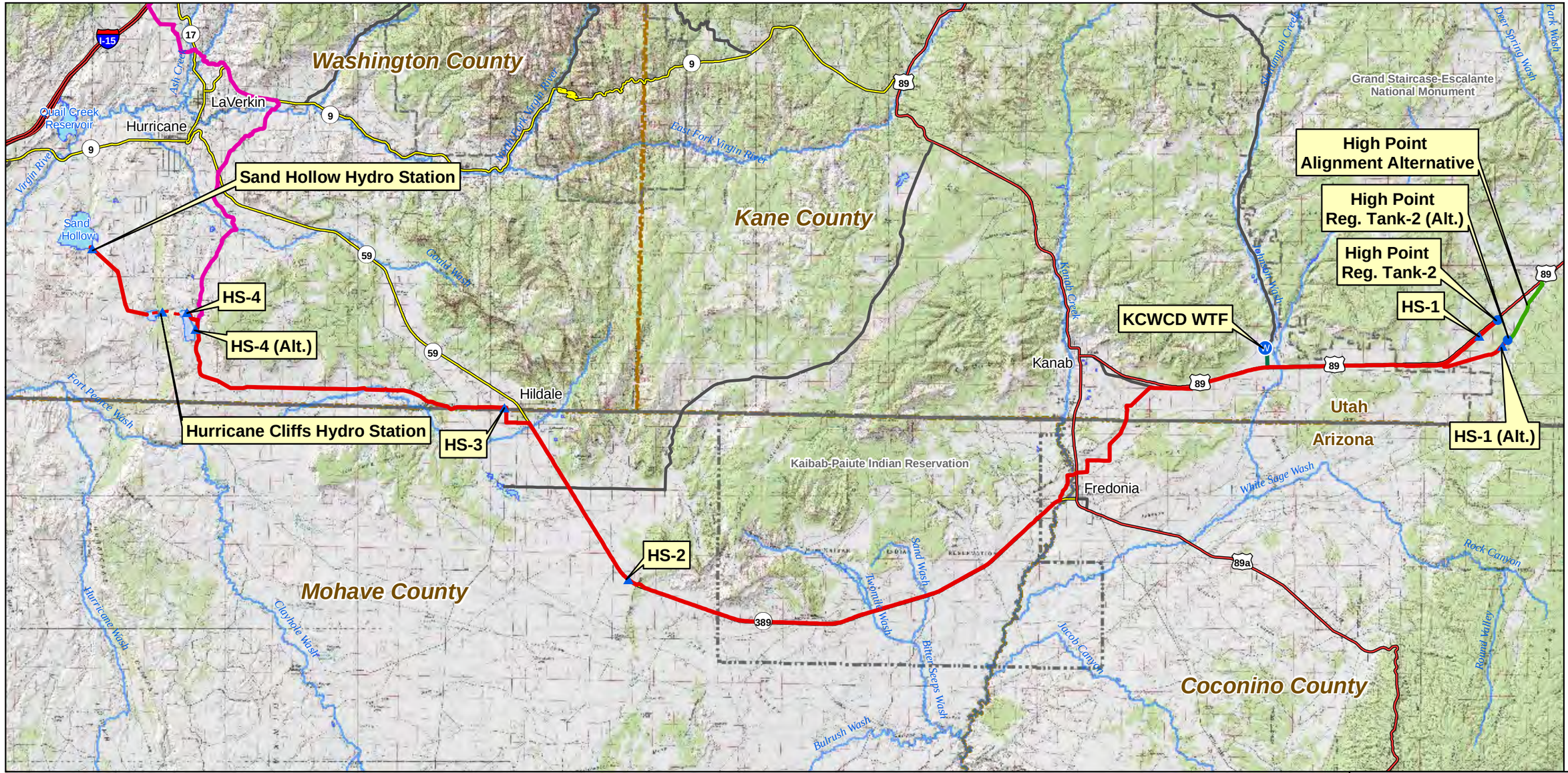
The **Hydro System** would convey the Lake Powell water from the regulating tank at the high point at ground elevation 5,695 feet MSL for about 80 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah and Coconino and Mohave counties, Arizona to Sand Hollow Reservoir 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
- 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 1-5** 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).

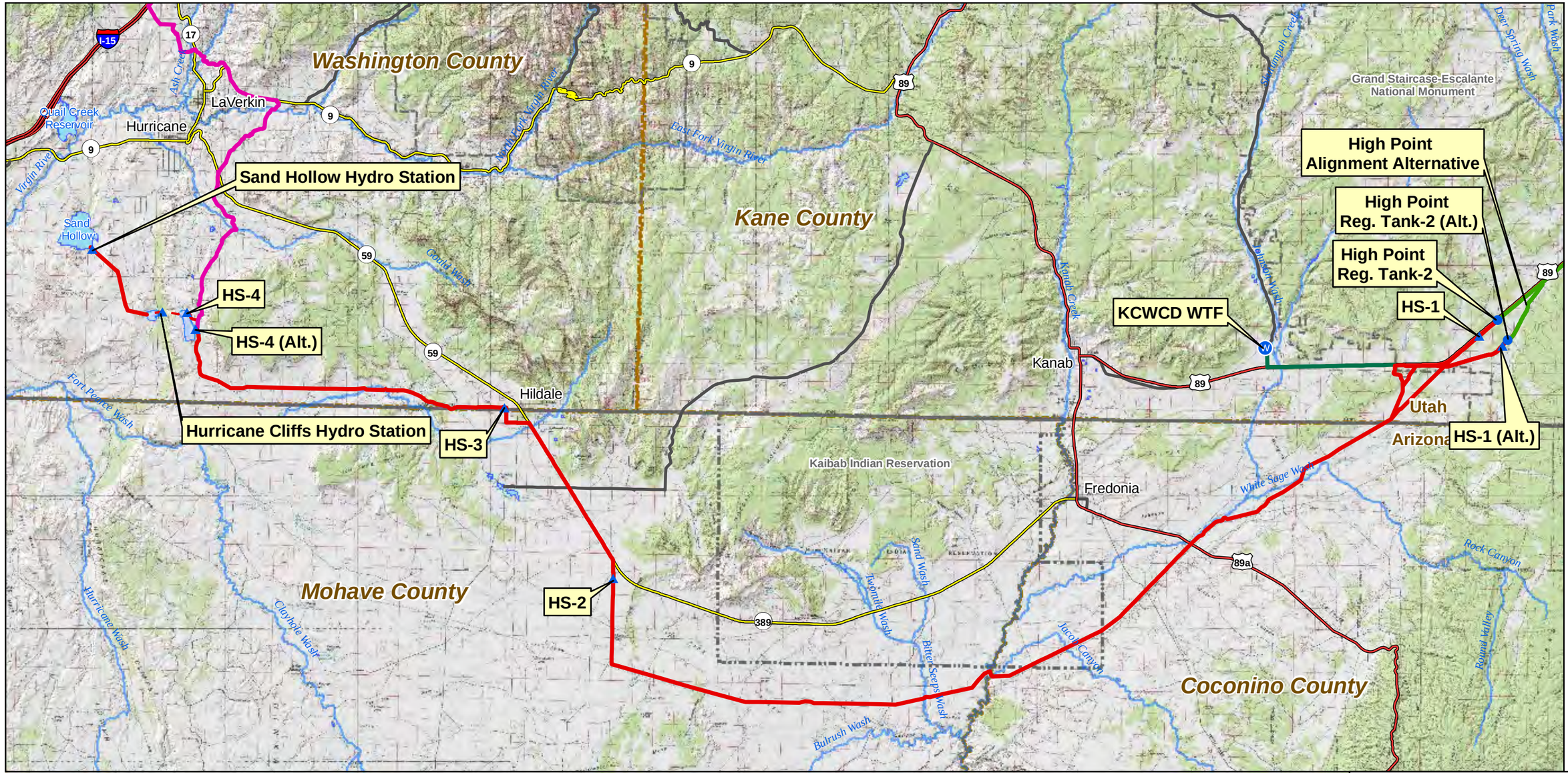
The proposed new **BPS-1 Transmission Line** would begin at the new switch station located on the south side of U.S. 89 and parallel the LPP Water Conveyance System alignment to the BPS-1 substation west of U.S. 89. This 69 kV transmission line would be about 1 mile long in Coconino County, Arizona (Figure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

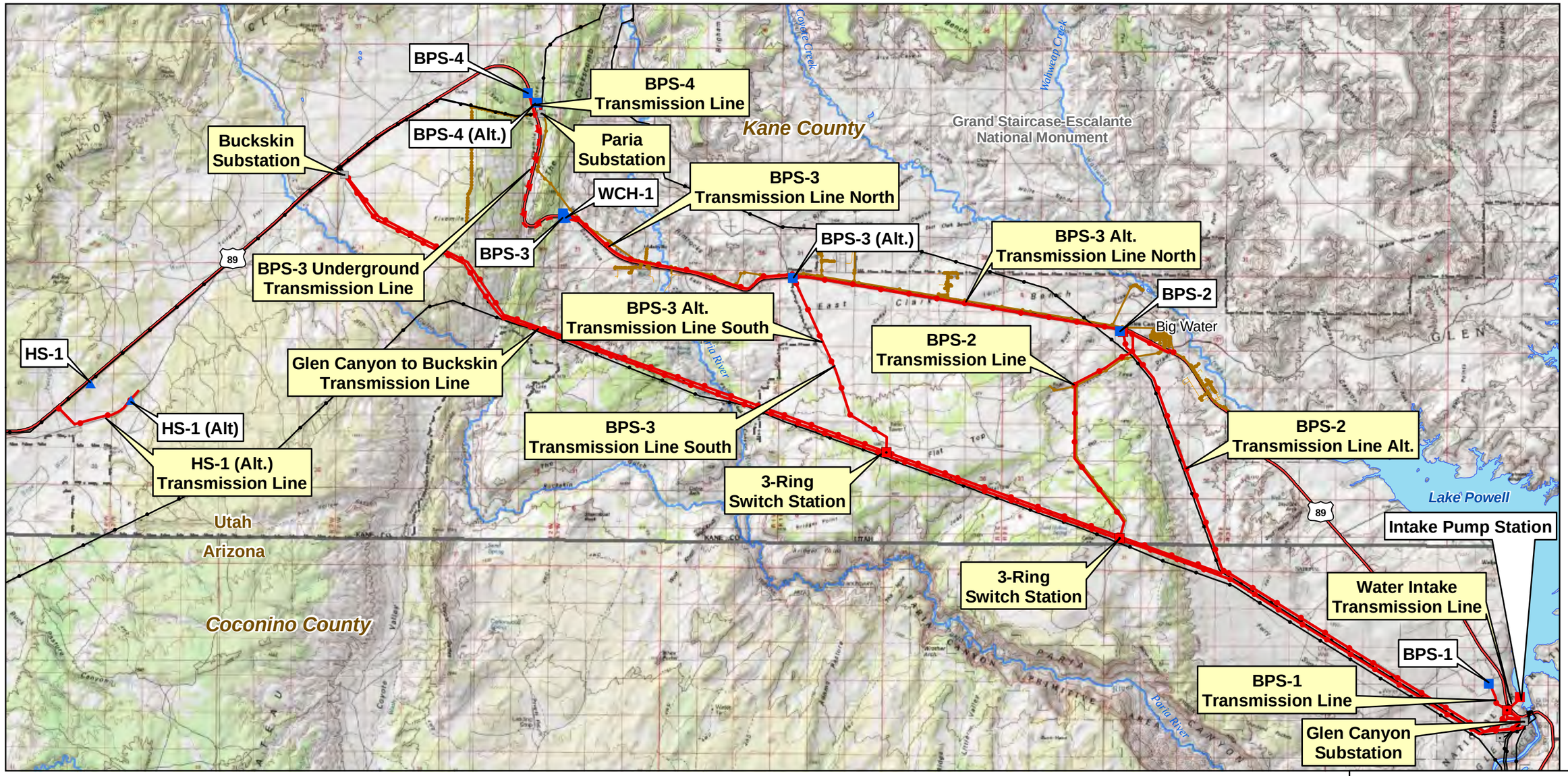
0 1.25 2.5 5 7.5 10 Miles

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).

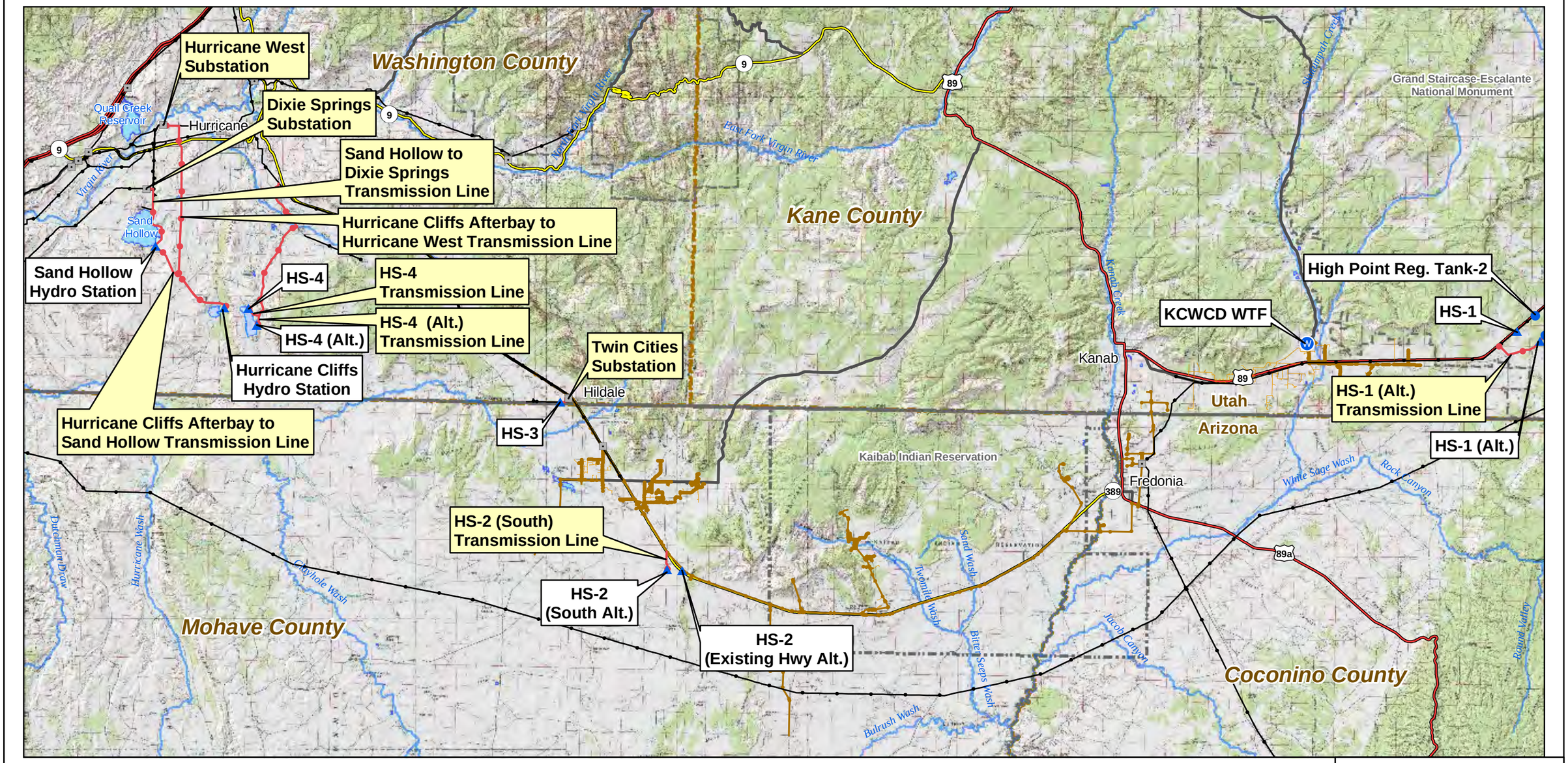
The proposed new **Hurricane Cliffs Afterbay to Sand Hollow Transmission Line** would consist of a new 69 kV transmission line from the Hurricane Cliffs peaking power plant and substation, and run northwest to the Sand Hollow Hydro Station substation. This new 69 kV transmission line would be about 4.9 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

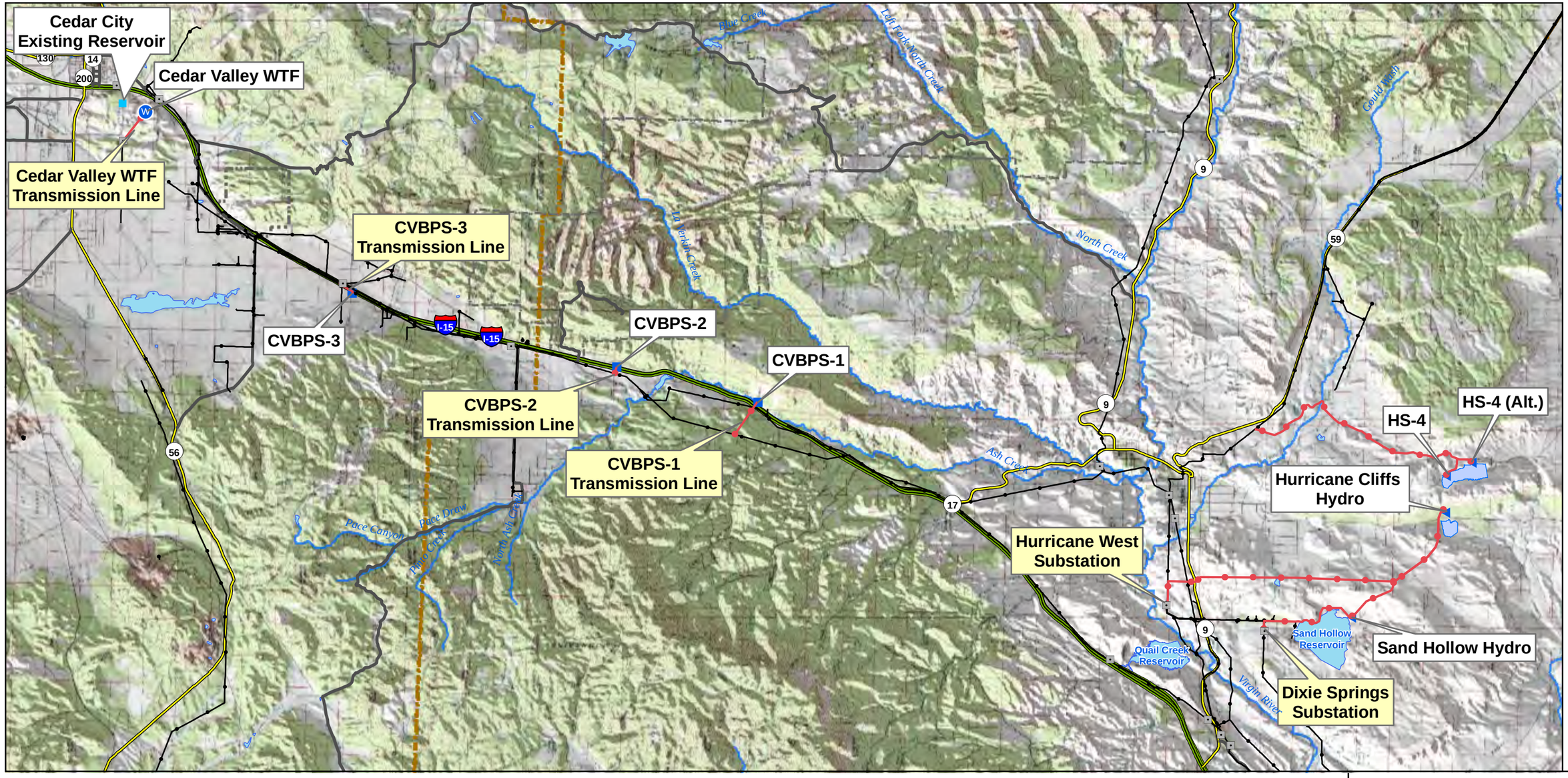
0 1.25 2.5 5 7.5 10 Miles

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 Special Status Aquatic Resources Species and Habitats Specific Issues and Topics

The potential specific significant issues identified for the LPP Project and the identified alternatives with regard to special status aquatic resources species and habitats include the following:

- Loss of special status species aquatic habitat as a result of LPP Project construction activities
- Direct effects on special status species as a result of the LPP Project
- The potential impact of Lake Powell water quality introduced to drainages with special status species
- Introduction of exotic or invasive species into drainages that include special status species

Chapter 2
Methodology

2.1 Introduction

This study report analyzes federally listed threatened, endangered and candidate aquatic species and aquatic species of federal, state and agency concern. No tribal aquatic species of cultural concern were identified. General aquatic species and habitat are analyzed in Study Report 2, Aquatic Resources (UBWR 2011c). This chapter describes the data used in the analysis, assumptions used in the analysis and effects and impacts analysis methodology.

2.2 Data Used

The study plan approved by the Commission describes the evaluation of special status aquatic species would rely on existing information and data. Comments provided on the study plan during agency and public review are incorporated into this study report. The information and data used to develop the study report includes the references presented in the December 2008 Study Plan as well as additional documents and information that were obtained during the study. No original field work, sampling, surveys or other site-specific investigations were performed. Existing range and occurrence data for other listed aquatic species and aquatic species of concern were derived from digital data bases where available: the U.S. Fish and Wildlife Service (USFWS) Critical Habitat Portal, 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 on habitat for federally listed aquatic species and aquatic species of concern.

- Special status aquatic species and their habitats, whether critical or crucial, 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 special status aquatic species, populations and their habitats.

- Federally listed aquatic species may or may not have designated critical habitat that would be analyzed for effects from the proposed LPP Project; this was be determined on a species-specific basis from regulatory notices.

- Aquatic species of special concern identified by federal, state and local agencies have crucial habitat that was analyzed for impacts from the proposed LPP Project.

- 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 special status aquatic species migration and passage potential upstream and downstream into habitats not directly affected by construction.

- Special status aquatic species 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.

2.4 Effects and Impacts Analysis Methodology

A detailed and intensive data compilation and review of existing special status aquatic species and habitat was performed. The compiled information and data was used to evaluate the effects and impacts the proposed LPP Project and alternatives may have with regard to status risk for these species and their habitats. No field investigations specific to special status aquatic species were performed. Occurrence data for federally listed aquatic species were derived from the Utah Geographic Information System (GIS) database (AGRC 2010) and the Arizona GIS database (AHDMS 2010) for listed species.

The results of surface water resource and surface water quality modeling of the proposed LPP Project were used to estimate the potential effects and impacts on special status aquatic species and their habitats. The baseline conditions of the special status aquatic species and their habitats were determined from the compiled data and information, and potential effects and impacts were determined by assessing the intensity, duration and magnitude of changes associated with the LPP Project and alternatives. Information was developed to specifically evaluate the effects of the proposed project on survival and recovery of federally listed aquatic species, aquatic species of special concern identified by federal, state and local agencies, Virgin River critical habitat and potential effects on aquatic species covered by conservation agreements; and effects and possible conservation measures and mitigation for special status aquatic species. Designated critical habitats for special status aquatic species 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, vegetation communities and wildlife resources.

The potential for unavoidable adverse impacts was evaluated following application of conservation measures and mitigation measures to avoid, minimize or reduce effects and impacts on special status 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 of special concern as a specific part of this study.

Chapter 3
Affected Environment (Baseline Conditions)

3.1 Effects or Impact Area

The Lake Powell Pipeline (LPP) effects or impact area for special status aquatic resource species and habitats includes rivers, streams, reservoirs and springs that could experience flow alteration, water level changes, and/or water quality changes from baseline conditions under LPP Project construction and operation. Figure 3-1 shows the study area for the LPP Water Conveyance System alternatives. Figure 3-2 shows the study area for the LPP Hydro System alternatives. Figure 3-3 shows the study area for the Cedar Valley Pipeline System.

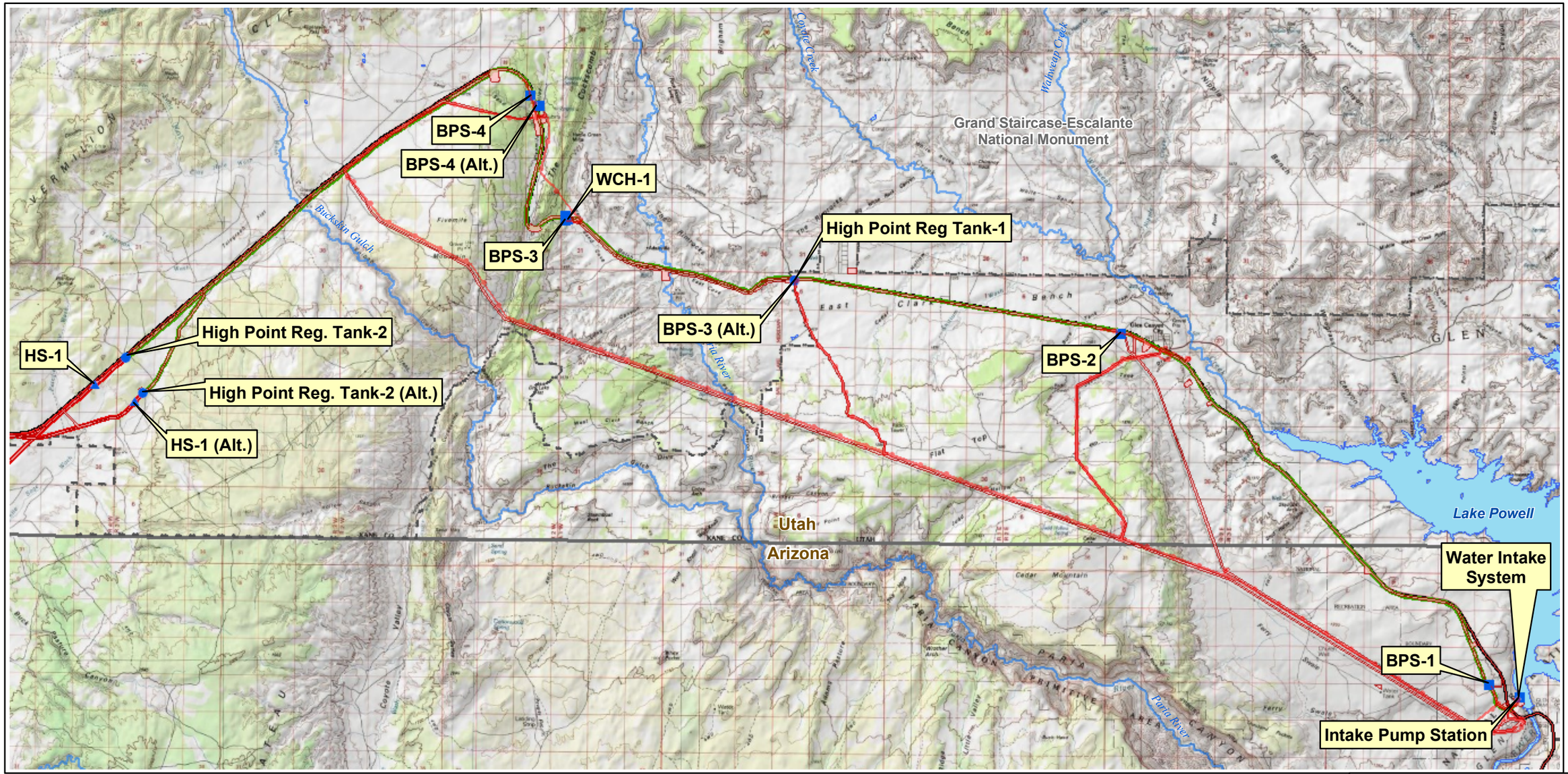
3.2 Overview

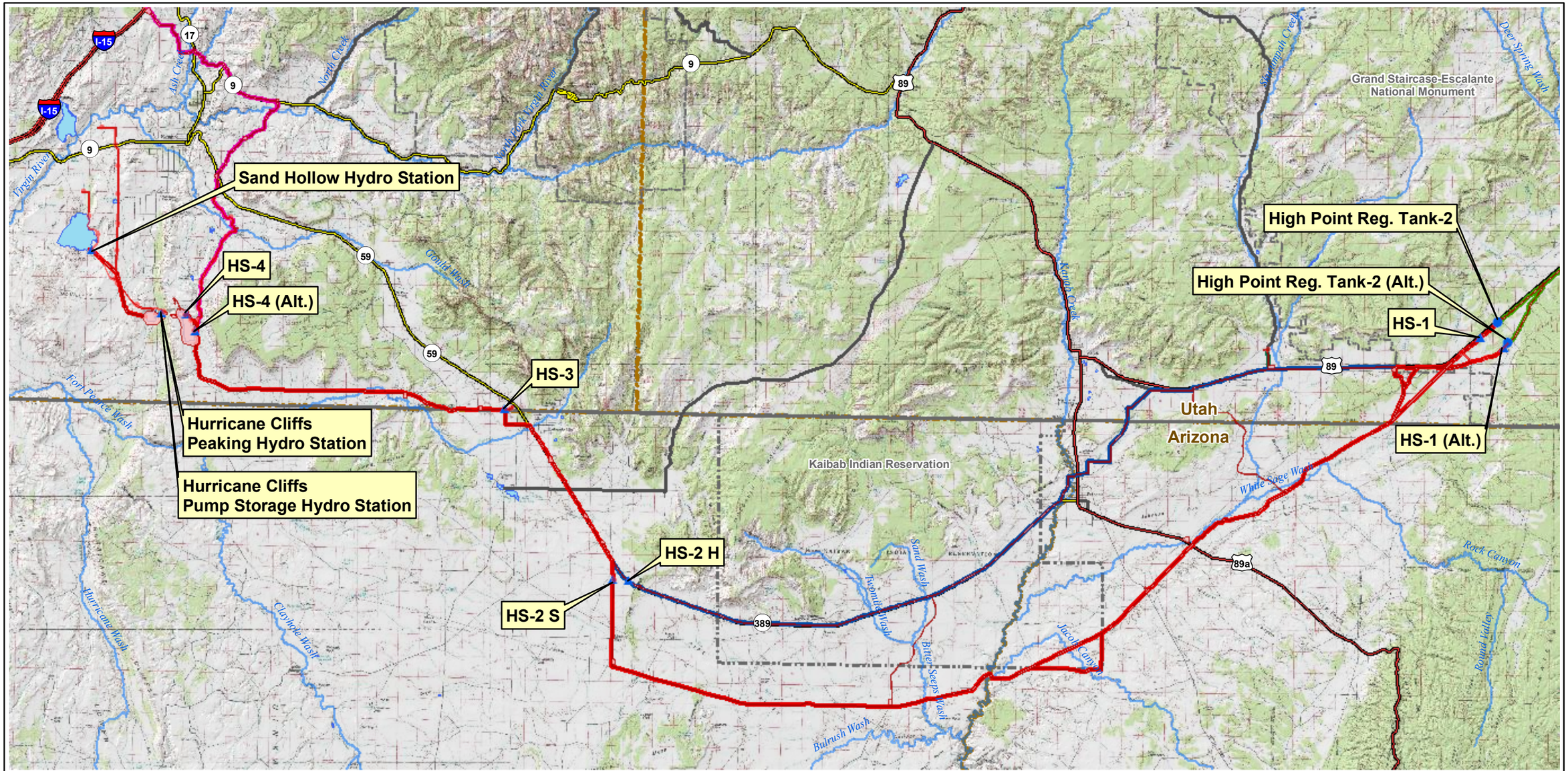
The U. S. Fish and Wildlife Service (USFWS) has designated nine aquatic species listed under the Endangered Species Act of 1973 (ESA) for analysis of effects from the LPP Project (USFWS Letter 3/16/09, confirmed 8/5/10). Critical habitats have been designated for five of the listed aquatic species.

ESA-listed threatened, endangered and candidate species and federal and state agency species of concern are analyzed in separate sections of this study report.

3.3 Threatened, Endangered and Candidate Aquatic Species and Designated Critical Habitats

Table 3-1 summarizes the threatened and endangered aquatic species listed by the USFWS under the ESA for the counties affected by the LPP Project pipeline and transmission line alignments, access roads and staging areas. Each species listing history, distribution, life history and ecology, and critical habitat, if designated, are considered separately for the designated species. There are no candidate aquatic species identified by the USFWS in the counties affected by the LPP Project.


BPS-4
BPS-4 (Alt.)
WCH-1
BPS-3
High Point Reg Tank-1
BPS-3 (Alt.)
BPS-2
High Point Reg. Tank-2
HS-1
High Point Reg. Tank-2 (Alt.)
HS-1 (Alt.)
Grand Staircase-Escalante National Monument
Lake Powell
Water Intake System
BPS-1
Intake Pump Station
Utah
Arizona
Buckskin Gulch
Coyote Creek
Wahweap Creek
Paria River
Paria Canyon
Kane Co
Project Pump Station
Project Regulating Tank
Project Hydro Station
250 ft Study Area
Water Conveyance System
Hydro System - South Alignment Alternative
Proposed Transmission Lines
Interstate
US Highway
ST Highway
Hwy
Major Road
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
GSENM Boundary
State Boundaries
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 3-1
MWH
Lake Powell Pipeline
Water Conveyance System
Study Area



- Project Pump Station
- Project Regulating Tank
- Project Hydro Station
- 250 ft Study Area
- Hurricane Cliffs Forebay/Afterbay
- Lakes & Reservoirs
- Major Rivers & Streams
- Water Conveyance System
- Hydro System - South Alignment Alternative
- Hydro System - Existing Highway Alignment Alternative
- Kane County Pipeline System
- Cedar Valley Pipeline System
- Proposed Transmission Lines
- 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

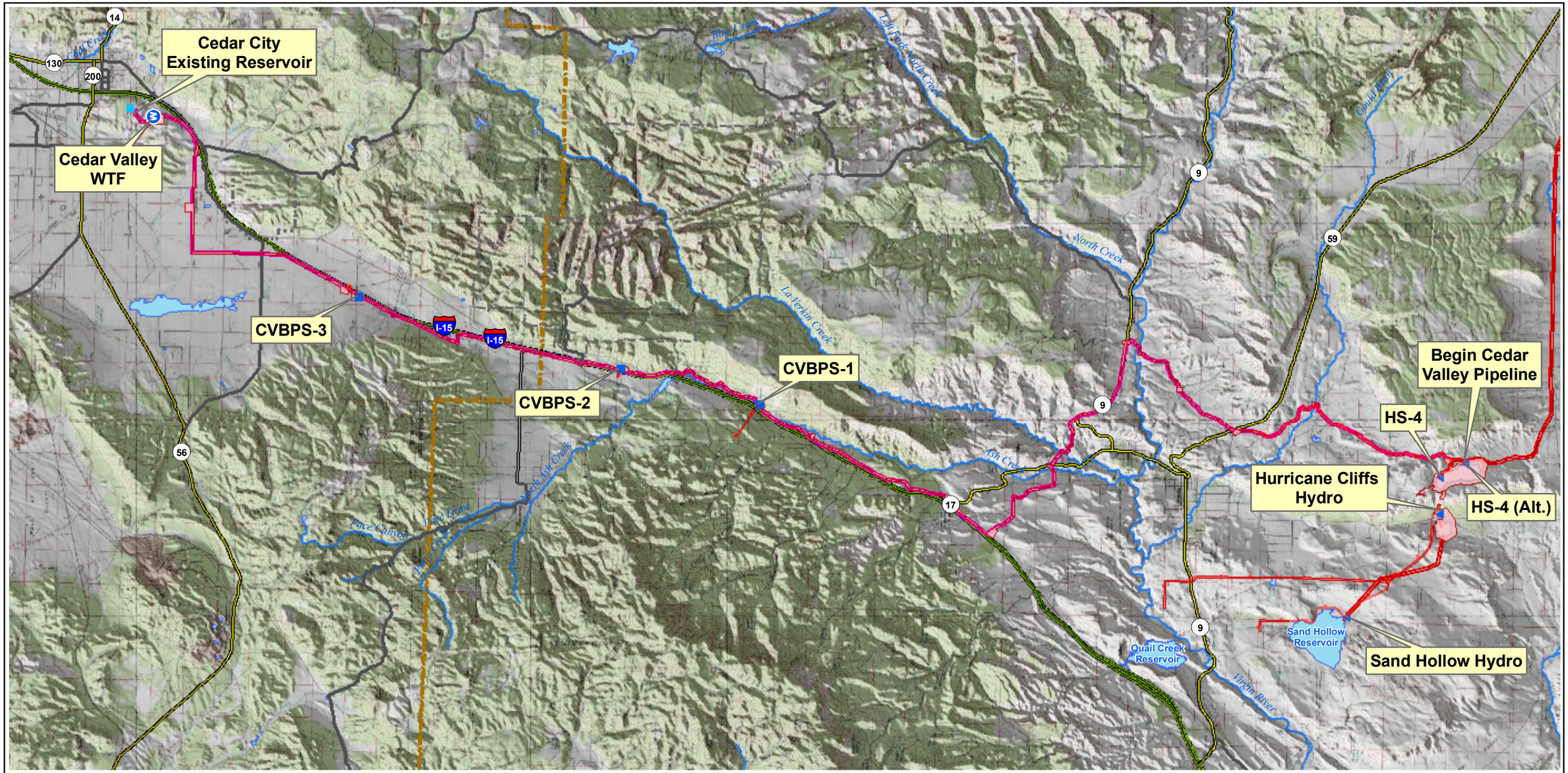
0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 3-2** MWH

Lake Powell Pipeline
Hydro System
Study Area



- Water Treatment Facility
- Project Pump Station
- Project Hydro Station
- 250 ft Study Area
- Hydro System Lake Powell Pipeline
- Hurricane Cliffs Pressure Tunnel
- Cedar Valley Pipeline
- Interstate
- US Highway
- ST Highway
- Hwy
- Major Road
- Proposed Transmission Lines
- 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 1.25 2.5 5 7.5 10 Miles

N

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 3-3** MWH

Cedar Valley Pipeline System Study Area

Table 3-1
Federally Listed Threatened and Endangered Aquatic Species by County

Common Name	Scientific Name	Listing Status[1]	State	County
Apache trout	*Oncorhynchus apache*	T	Arizona	Coconino
Bonytail chub[2]	*Gila elegans*	E	Utah Arizona	Kane Mohave[2]
Colorado pikeminnow	*Ptychocheilus lucius*	E	Utah	Kane
Humpback chub[2]	*Gila cypha*	E	Utah Arizona	Kane Coconino[2], Mohave[2]
Kanab ambersnail	*Oxyloma haydeni kanabensis*	E	Utah Arizona	Kane Coconino
Little Colorado spinedace	*Lepidomeda vittata*	T	Arizona	Coconino
Razorback sucker[2]	*Xyrauchen texanus*	E	Utah Arizona	Kane Coconino[2], Mohave[2]
Virgin River chub[2]	*Gila seminuda (=robusta)*	E	Utah Arizona	Washington[2] Mohave[2]
Woundfin[2]	*Plagopterus argentissimus*	E EXPN	Utah Arizona	Washington[2] Mohave[2]

Notes:
[1] T = threatened, E = Endangered, EXPN = Experimental, Non-Essential
[2] Critical habitat designated for this species
Source: Fish and Wildlife Service, Species Listing Letters 3/16/09 and 8/5/10

3.3.1 Apache Trout

3.3.1.1 Listing History and Status

Apache trout, was listed as endangered under the Endangered Species Conservation Act of 1967 due to "*destruction, drastic modification, or severe curtailment of their habitat*," and hybridization with introduced trout species (32 FR 4001). In 1975, the USFWS recommended a reclassification to threatened status. Apache trout is currently listed as threatened (FR 40 (137): 29863-29864). The Apache Trout Recovery Plan was first released in 1979 and revised in 1983 (USFWS 1983). The US FWS issued the Draft Apache Trout Recovery Plan, Second Revision in 2007.

3.3.1.2 Distribution

The Apache trout, Arizona's state fish, is distributed in the Salt River drainage from east-central Arizona and in the Gila River drainage into west New Mexico. The original distribution of Apache trout was described as upper Salt River drainage (Black and White rivers), San Francisco River drainage (Blue River), and headwaters of Little Colorado River, Arizona (Miller 1972). Its current range is reported to be confined to the White Mountains and only on the Fort Apache Indian Reservation. Apache trout have been reported outside their historic range in a number of streams, including a pure population in North Canyon on the Kaibab National Forest.

3.3.1.3 Life History and Ecology

Apache trout evolved in streams primarily above 1,800 m elevation, within mixed conifer and ponderosa pine forests. Apache trout generally require water temperatures below 25° C (77° F). Adequate stream flow and/or shading are generally required to prevent lethal temperatures and ample stream flow helps maintain pools that are used frequently during periods of drought and temperature extremes. Apache trout require clean coarse gravel substrates for spawning. Recovery streams that are subject to land-use practices such as timber harvest/thinning, prescribed fire, and livestock grazing should be managed to maintain healthy riparian corridors that promote sufficient habitat conditions to allow for all life functions including spawning, hatching, rearing, foraging, loafing, migrating, and over-wintering. Prey of Apache trout consists mostly of invertebrates, which are typically abundant in healthy streams. Apache trout often use cover in the form of woody debris, pools, rocks/boulders, undercut streambanks, or overhanging vegetation at stream margins.

3.3.1.4 Designated Critical Habitat

There is no currently designated critical habitat for the Apache trout in the counties that would be crossed by the LPP Project.

3.3.2 Bonytail Chub

3.3.2.1 Listing History and Status

Bonytail chub was listed under the federal ESA in 1980 (45 FR 27713), with a final determination of critical habitat on March 21, 1994 (59 FR 13374). The bonytail chub is listed as "endangered" under the federal ESA and by the State of Utah. Its Natural Heritage Status in Utah is S1 (critically imperiled). The Bonytail Chub Recovery Plan was approved on May 16, 1984, with a revised plan approved September 4, 1990 (USFWS 1990a).

3.3.2.2 Distribution

An small number of wild adult bonytail chub exist in Lake Mohave on the main stem Colorado River of the Lower Colorado River Basin (i.e., downstream of Glen Canyon Dam), and there are small numbers of wild individuals in the Green River and upper Colorado River sub-basins of the Upper Colorado River Basin (USFWS 2002a).

3.3.2.3 Life History and Ecology

Currently no self-sustaining populations of bonytail chub exist in the wild, and very few individuals have been caught throughout its range (USFWS 2002a). The bonytail chub is considered adapted to main stem rivers where it has been observed in pools and eddies. Similar to other closely related *Gila* sub-species, bonytail chub in rivers probably spawn in spring over rocky substrates, while spawning in reservoirs has been observed over rocky shoals and shorelines. There are no documented collections of bonytail chub from the effects area.

3.3.2.4 Designated Critical Habitat

The USFWS designated seven reaches of the Colorado River system as critical habitat for the bonytail chub in March 1994 (59 FR 13374). These reaches total 499 km (312 mi) as measured along the center

line of the subject reaches. This represents approximately 14 percent of the historical habitat of the species. Critical habitat for the bonytail chub is designated for portions of the Colorado, Green, and Yampa Rivers in the Upper Basin and the Colorado River in the Lower Basin. Critical habitat encompasses the Colorado River from Hoover Dam to Davis Dam and another section of the Colorado River from the northern boundary of Havasu National Wildlife Refuge to Parker Dam including Lake Havasu in Mohave County, Arizona. Additional critical habitat is located in Colorado, Utah, Nevada, and California.

3.3.3 Colorado Pikeminnow

3.3.3.1 Listing History and Status

The Colorado pikeminnow is listed as "endangered" under the federal ESA and by the State of Utah. This species was first included in the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 (32 FR 4001) and was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa). The Colorado squawfish (pikeminnow) was included in the United States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106), and it received protection as endangered under Section 4(c)(3) of the original ESA of 1973. The final rule for determination of critical habitat was published on March 21, 1994 (59 FR 13374). Its Natural Heritage Status in Utah is S1, critically imperiled.

3.3.3.2 Distribution

Wild, reproducing populations occur in the Green River and upper Colorado River sub-basins of the Upper Colorado River Basin (i.e., upstream of Glen Canyon Dam, Arizona), and there are small numbers of wild individuals (with limited reproduction) in the San Juan River sub-basin (FWS 2002b). The species was extirpated from the Lower Colorado River Basin in the 1970s but has been reintroduced into the Gila River sub-basin, where it exists in small numbers in the Verde River (FWS 2002b). Currently, three wild populations of Colorado pikeminnow are found in more than 1,000 miles of riverine habitat in the Green River, upper Colorado River, and San Juan River sub-basins (USFWS 2002b).

3.3.3.3 Life History and Ecology

The Colorado pikeminnow is a long-distance migratory, moving many miles to and from spawning areas. Adults require pools, deep runs and eddy habitats maintained by high spring flows (USFWS 2002b). After hatching and emerging from spawning substrate, larvae drift downstream to nursery backwaters that are restructured by high spring flows and maintained by relatively stable base flows (USFWS 2002b).

3.3.3.4 Designated Critical Habitat

There is no currently designated critical habitat for the Colorado pikeminnow in the counties that would be crossed by the LPP Project.

3.3.4 Humpback Chub

3.3.4.1 Listing History and Status

The humpback chub is listed as "endangered" under the federal ESA and by the State of Utah. This species was first included in the List of Endangered Species issued by the Office of Endangered Species

on March 11, 1967 (32 FR 4001) and was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa). The Humpback chub was included in the United States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106), and it received protection as endangered under Section 4(c)(3) of the original ESA of 1973. The final rule for determination of critical habitat was published on March 21, 1994 (59 FR 13374). Its Natural Heritage Status in Utah is S1, critically imperiled. Recovery goals for humpback chub, which amend and supplement the 1990 Recovery Plan, were finalized in 2002 (U.S. Fish and Wildlife Service 2002a).

3.3.4.2 Distribution

Six extant populations are known: the first five populations are in the Upper Colorado River Basin (i.e., upstream of Glen Canyon Dam), and the sixth population is in the Lower Colorado River Basin (FWS 2002c). Populations of humpback chub occur in the Little Colorado and Colorado rivers in the Grand Canyon, Black Rocks area of the Colorado River, Westwater Canyon, Cataract Canyon, Desolation/Grey Canyon, and Yampa Canyon (Valdez and Clemmer 1982, FWS 1990, FWS 2002). The largest population in the upper basin is in Westwater Canyon, with an estimated population size of about 2,400 adult fish. Humpback chub are currently rare in the Yampa River and in Cataract Canyon (Finney et al. 2004, McAda 2004, Jackson 2004a, 2004b, and Utah Division of Wildlife Resources 2004). Humpback chub in the lower Colorado River basin occurs in the Colorado River in Marble and Grand canyons, and in the lower ten miles of the Little Colorado River, constituting the Grand Canyon population, which also represents the lower basin recovery unit (FWS 2002a). In Grand Canyon, numbers of adult fish appear to have increased from about 4,500 to 5,700 in 2001 to an estimated 5,300 to 6,700 in 2006 (USGS 2007).

3.3.4.3 Life History and Ecology

Populations of humpback chub are restricted to deep, swift, canyon-bound regions of the mainstem and large tributaries of the Colorado River Basin (FWS 2002c). Adults require eddies and sheltered shoreline habitats maintained by high spring flows (FWS 2002c). Young fish require low-velocity shoreline habitats, including eddies and backwaters, that are more prevalent under base-flow conditions (FWS 2002c). Humpback chub are typically omnivorous with a diet consisting of insects, crustaceans, plants, seeds, and occasionally small fish and reptiles. They appear to be opportunistic feeders, capable of switching diet according to available food sources, and they ingest food items from the water's surface, mid-water column, and river bottom.

3.3.3.4 Designated Critical Habitat

Seven reaches of the Colorado River System were designated as critical habitat for the humpback chub over a total river length of 379 miles in the Yampa, Green, Colorado, and Little Colorado rivers in Arizona, Colorado and Utah. Designated reaches in the lower basin are the lower eight miles of the Little Colorado River and from RM 34 (Nautiloid Canyon) to RM 208 (Granite Park) along the Colorado River.

3.3.5 Kanab Ambersnail

3.3.5.1 Listing History and Status

The Kanab ambersnail is listed as endangered (57 FR 13657, April 17, 1992) without critical habitat. A Recovery Plan was published in 1995 (USFWS 1995). The species is currently undergoing a five-year status review.

3.3.5.2 Distribution

Kanab ambersnail is a terrestrial land snail with a restricted distribution in Kane County, Utah and Coconino County, Arizona. The species inhabits perennially wet environments in seeps and springs draining sandstone or limestone cliffs with semi-aquatic vegetation (USFWS 2008o). The currently known distribution of the Kanab ambersnail is restricted to three locations: two springs within the Grand Canyon and springs located at Three Lakes approximately six miles north of Kanab, Utah (USFWS 2008o). The Kanab location is within Three Lakes Canyon in Sections 19 and 30, Township 42 South, Range 6 West (USFWS 1995).

3.3.5.3 Life History and Ecology

The Kanab ambersnail is found in semi-aquatic vegetation watered by springs or seeps at the base of sandstone or limestone cliffs at an elevation of approximately 884 m (2,900 ft). It requires either shallow standing water or a perennially wet soil surface. Grass or sedge cover is also necessary (USFWS 2010o).

The Kanab ambersnail is vulnerable because of the rarity and small area of its habitat in the southwest and the small number of its populations. Threats include habitat alteration or destruction from development and heavy grazing; and possible illegal collecting; recreation; and high flows from Glen Canyon Dam affecting habitat in the Grand Canyon (USFWS 2010o).

3.3.5.4 Designated Critical Habitat

There is no currently designated critical habitat for the Kanab ambersnail.

3.3.6 Little Colorado Spinedace

3.3.6.1 Listing History and Status

The Little Colorado spinedace was listed as threatened with critical habitat designated on October 16, 1987 (USFWS, 1987).

3.3.6.2 Distribution

The spinedace is a small (about four inch) minnow native to the Little Colorado River drainage. This fish occurs in disjunct populations throughout much of the Little Colorado River drainage in Apache, Coconino, and Navajo counties. Extensive collections summarized by Miller (1963) indicated that the spinedace had been extirpated from much of the historical range from 1939 to 1960. Although few collections were made of the species prior to 1939, the species is believed to have inhabited the northward flowing Little Colorado River tributaries of the Mogollon Rim, including the northern slopes of the White Mountains. Mitochondrial DNA work on the spinedace was initiated in the 1990s and indicated the existence of three sub-groups identifiable by geographic area (Tibbets *et al.* 1994): the East Clear Creek drainage, Chevelon Creek, and the upper Little Colorado River including Nutrioso and Rudd creeks.

3.3.6.3 Life History and Ecology

The Little Colorado spinedace is found in a variety of habitats, which is expected for a species adapted to fluctuating physical conditions (Blinn and Runck 1990, Miller 1963, Miller and Hubbs 1960, Nisselson and Blinn 1989). It is unclear whether occupancy of these habitats reflects the local preferences of the

species or its ability to tolerate less-than-optimal conditions. Available information indicates that suitable habitat for the Little Colorado spinedace is characterized by clear, flowing pools with slow to moderate currents, moderate depths, and gravel substrates (Miller 1963, Minckley and Carufel 1967). Cover provided by undercut banks or large rocks is often a feature. Spinedace have also been found in pools and flowing water conditions over a variety of substrates, with or without aquatic vegetation, in turbid and clear water (Denova and Abarca 1992, Nisselson and Blinn 1991). Water temperatures in occupied habitats ranged from 58 to 78 degrees Fahrenheit (Miller 1963). Miller (1963) called the spinedace "trout like" in behavior and habitat requirements, and it is likely that prior to 1900 the spinedace used habitats now dominated by non-native salmonids.

3.3.6.4 Designated Critical Habitat

Forty-four stream miles of critical habitat are designated: 18 miles of East Clear Creek immediately upstream and 13 miles downstream from C.C. Cragin Reservoir (formerly called Blue Ridge Reservoir) in Coconino County; eight miles of Chevelon Creek in Navajo County; and five miles of Nutrioso Creek in Apache County.

3.3.7 Razorback Sucker

3.3.7.1 Listing History and Status

The razorback sucker was first proposed for listing under the Endangered Species Act (Act) on April 24, 1978, as a threatened species, but was later withdrawn for technical reasons. In March 1989, the Fish and Wildlife Service was petitioned by a consortium of environmental groups to list the razorback sucker as an endangered species. The Fish and Wildlife Service made a positive finding on the petition in June 1989, which was published in the Federal Register on August 15, 1989. A final rule was published on October 23, 1991, with an effective date of November 22, 1991 (56 FR 54957). Critical habitat was designated on March 21, 1994 (59 FR 13374). The Razorback Sucker Recovery Plan was released in 1998 (U.S. Fish and Wildlife Service 1998). Recovery Goals were approved in 2002 (USFWS 2002b). Its Natural Heritage Status in Utah is S1, critically imperiled.

3.3.7.2 Distribution

Historically, razorback sucker were widely distributed in warm-water reaches of larger rivers of the Colorado River Basin from Mexico to Wyoming (FWS 2002d). The species is endemic to the Colorado River Basin of the southwestern United States (FWS 2002d). Razorback sucker are currently found in small numbers in the Green River, upper Colorado River, and San Juan River sub-basins; lower Colorado River between Lake Havasu and Davis Dam; reservoirs of Lakes Mead and Mohave; in small tributaries of the Gila River sub-basin (Verde River, Salt River, and Fossil Creek); and in local areas under intensive management such as Cibola High Levee Pond, Achii Hanyo Native Fish Facility, and Parker Strip (FWS 2002d). The lower Paria River may provide suitable habitat for razorback sucker near the confluence with the Colorado River in Grand Canyon.

3.3.7.3 Life History and Ecology

Habitats required by adults in rivers include deep runs, eddies, backwaters, and flooded off-channel environments in spring; runs and pools often in shallow water associated with submerged sandbars in summer; and low-velocity runs, pools, and eddies in winter (FWS 2002d). Spring migrations of adult razorback sucker were associated with spawning in historic accounts, and a variety of local and long-distance movements and habitat-use patterns have been documented (FWS 2002d). Young require

nursery environments with quiet, warm, shallow water such as tributary mouths, backwaters or inundated floodplain habitats in rivers, and coves or shorelines in reservoirs (FWS 2002d).

3.3.7.4 Designated Critical Habitat

Critical habitat was designated in 15 river reaches in the historical range of the razorback sucker on March 21, 1994, with an effective date of April 20, 1994. Critical habitat included portions of the Colorado, Duchesne, Green, Gunnison, San Juan, White, and Yampa rivers in the Upper Colorado River Basin, and the Colorado, Gila, Salt, and Verde rivers in the Lower Colorado River Basin.

3.3.8 Virgin River Chub

3.3.8.1 Listing History and Status

On August 23, 1978, the USFWS proposed listing the Virgin River chub as endangered and designating critical habitat (43 FR 37668). The FWS withdrew this proposal (45 FR 64853; September 30, 1980), due to the 1978 amendments to the Act. On June 24, 1986, the FWS again proposed the listing as endangered and the designation of critical habitat for the Virgin River chub (51 FR 22949). The final rule to list the Virgin River chub as endangered was published on August 24, 1989 (54 FR 35305). The Recovery Plan for Virgin River Fishes was approved on April 19, 1995. The Washington County Habitat Conservation Plan, which analyzed effects on the Virgin River chub, was completed in December 1995. The Virgin River Resource Management and Recovery Program was established in 2002 to implement actions to recover, conserve, enhance and protect native species, including the Virgin River chub, in the Virgin River Basin and to enhance the ability to provide adequate water supplies for sustaining human needs (UDNR, 2002). The Recovery Action Plan includes the following objectives: describe baseline conditions, provide and protect instream flows, protect and enhance habitat, protect and enhance native species communities, maintain genetically appropriate brood stocks, determine ecological factors limiting abundance of native species, monitor habitat conditions and populations, and improve education and communication on resource issues (UDNR, 2002).

3.3.8.2 Distribution

The Virgin River chub was first collected in the 1870s from the Virgin River near Washington, Utah. Historically, it was collected in the mainstem Virgin River from Pah Tempe Springs, Utah, downstream to the confluence with the Colorado River in Nevada (Cope and Yarrow 1875; Cross 1975), though it may have occurred upstream of that point. Presently, the Virgin River chub occurs within the mainstem Virgin River from Pah Tempe Springs, Utah, downstream to at least the Mesquite Diversion, located near the Arizona-Nevada border. Virgin River chub have not been collected below this point, except for a few individuals, since the late 1970's (Virgin River Fishes Data Base). The Virgin River chub also occurs within the Moapa River in Nevada. A captive population of Virgin River chub is currently maintained at the Dexter National Fish Hatchery and Technology Center as a refugium population and for propagation studies.

3.3.8.3 Life History and Ecology

Adult and juvenile Virgin River chub select deep runs or pools with slow to moderate velocities containing boulders or other instream cover over a sand substrate. Generally, larger fish occupy deeper habitats; however, there is no apparent correlation with velocity. Chub are generally found in velocities ranging up to 0.76 m/s (2.5 ft/s). Virgin River chub are omnivorous, showing considerable dietary shifts with age and season. In general, Virgin River chub feed mainly on debris and chironomids in February;

Cladophora and debris in June; debris and Spyrogyra and Cladophora in September; and unidentified drift animals, dragonfly larvae, debris, and Cladophora in December.

3.3.8.4 Designated Critical Habitat

The area designated as critical habitat for the Virgin River chub is the mainstem Virgin River and its 100-year floodplain, extending from the confluence of LaVerkin Creek to Halfway Wash, Nevada. The 100-year floodplain, as defined by the Federal Emergency Management Agency (FEMA), is an area of land that would be inundated by a flood having a one percent chance of occurring in any given year. It is the Federal standard for protection of life and property and is delineated and readily available on FEMA floodplain maps. This boundary was primarily chosen for two reasons: (1) The biological integrity and natural dynamics of the river system are maintained within this area (*i.e.,* allowing the river to meander within its main channel in response to large flow events, thereby recreating the mosaic of habitats necessary for the survival and recovery of Virgin River endangered fishes); and (2) conservation of the 100- year floodplain also helps protect the riparian areas and provide essential nutrient recharge to the Virgin River, which contributes to successful spawning and recruitment of endangered fishes.

3.3.9 Woundfin

3.3.9.1 Listing History and Status

The USFWS listed the woundfin as endangered on October 13, 1970 (35 FR 16047), and proposed critical habitat on November 2, 1977 (42 FR 57329). However, on March 6, 1979, the FWS withdrew the proposal for critical habitat (44 FR 12382) due to the 1978 amendments to the Act, which required proposals to be withdrawn if not finalized within two years. A Woundfin Recovery Plan was originally approved in July 1979 and subsequently revised on March 1, 1984. The Recovery Plan for Virgin River Fishes was approved on April 19, 1995. The Washington County Habitat Conservation Plan, which analyzed effects on the woundfin, was completed in December 1995. The Virgin River Resource Management and Recovery Program was established in 2002 to implement actions to recover, conserve, enhance and protect native species, including the woundfin, in the Virgin River Basin and to enhance the ability to provide adequate water supplies for sustaining human needs (UDNR, 2002). The Recovery Action Plan includes the following objectives: describe baseline conditions, provide and protect instream flows, protect and enhance habitat, protect and enhance native species communities, maintain genetically appropriate brood stocks, determine ecological factors limiting abundance of native species, monitor habitat conditions and populations, and improve education and communication on resource issues (UDNR, 2002).

3.3.9.2 Distribution

On the basis of early records, the original range of woundfin extended from near the junction of the Salt and Verde Rivers at Tempe, Arizona, to the mouth of the Gila River at Yuma, Arizona (Gilbert and Scofield 1898). Woundfin were also likely found in the mainstream Colorado River from Yuma ("Fort Yuma"; Jordan and Evermann 1896; Meek 1904; Follett 1961) upstream to the Virgin River in Nevada, Arizona, and Utah, and into LaVerkin Creek, a tributary to the Virgin River in Utah (Gilbert and Scofield 1898, Snyder 1915, Miller and Hubbs 1960, Cross 1975). The Wheeler expedition maintained a base at Toquerville, Washington County, Utah, in 1872 on LaVerkin Creek (Wheeler 1889), from where they worked on the Virgin River Canyon and traveled to St. George. Woundfin have been extirpated from almost all of their historical range except the mainstem Virgin River. Woundfin presently range from Pah Tempe Springs (also called LaVerkin Springs) on the mainstream of the Virgin River and the lower portion of LaVerkin Creek in Utah, downstream to Lake Mead. A single specimen was taken from the

middle Moapa (Muddy) River, Clark County, Nevada, in the late 1960's (Deacon and Bradley 1972) but none have been collected there since, and the species is considered extirpated from this river. The species has been transplanted by the Arizona Game and Fish Department into the Paria River (Arizona Game and Fish Stocking Records, unpub. data). No woundfin were found during Paria River surveys in May 1974 and May 1975 (Arizona Game and Fish Stocking Records, unpub. data). In addition, a captive population was established in 1988 at Dexter National Fish Hatchery and Technology Center, New Mexico, to assist in research to develop rearing protocols and for propagation studies.

3.3.9.3 Life History and Ecology

Adult and juvenile woundfin inhabit runs and quiet waters adjacent to riffles with sand and sand/gravel substrates. Adults are generally found in habitats with water depths between 0.15 and 0.43 meters (m) (0.5 and 1.4 feet (ft)) with velocities between 0.24 and 0.49 meters per second (m/s) (0.8 and 1.6 feet per second (ft/s)). Juveniles select areas with slower and deeper water, while larvae are found in backwaters and stream margins which are often associated with growths of filamentous algae. Spawning takes place during the period of declining spring flows.

3.3.9.4 Designated Critical Habitat

The area designated as critical habitat for the woundfin is the mainstem Virgin River and its 100-year floodplain, extending from the confluence of LaVerkin Creek to Halfway Wash, Nevada. The 100-year floodplain, as defined by the Federal Emergency Management Agency (FEMA), is an area of land that would be inundated by a flood having a one percent chance of occurring in any given year. It is the Federal standard for protection of life and property and is delineated and readily available on FEMA floodplain maps. This boundary was primarily chosen for two reasons: (1) The biological integrity and natural dynamics of the river system are maintained within this area (*i.e.,* allowing the river to meander within its main channel in response to large flow events, thereby recreating the mosaic of habitats necessary for the survival and recovery of Virgin River endangered fishes); and (2) conservation of the 100- year floodplain also helps protect the riparian areas and provide essential nutrient recharge to the Virgin River, which contributes to successful spawning and recruitment of endangered fishes.

3.4 Federal, State and Local Agency Aquatic Species of Concern

Five aquatic species inhabiting streams and rivers within in the LPP Project study area have been listed as aquatic species of concern by federal, state and local agencies. The aquatic species of concern include the following:

- Flannelmouth sucker (*Catostomus latipinnis*)
- Bluehead sucker *(Catostomus discobolus*)
- Speckled dace (*Rhinichthys osculus reliquus*)
- Desert Sucker (*Catostomus clarkii*)
- Virgin spinedace (*Lepidomeda mollispinus*)

3.4.1 Flannelmouth Sucker

Flannelmouth sucker (*Catostomus latipinnis*) is endemic to the Colorado River Basin. Within the southwest there are populations in western Colorado and south-central Wyoming, but few of these

populations are located on government lands. Flannelmouth sucker is protected under a Conservation Agreement (UDWR 2006). The Paria River provides habitat for the Flannelmouth sucker, which is listed in Utah and Arizona as sensitive.

Flannelmouth sucker is a bottom feeder, consuming algae, other fragmented vegetation, seeds and invertebrates. Flannelmouth sucker live within moderate to large rivers and are typically threatened by nonnative species, hybridization, habitat alteration and blockage of migration routes. The primary threats to the flannelmouth sucker are generally human-induced activities that divert water and change the flow regime in both tributary and main stem streams. Specific threats include (a) construction of passage barriers (e.g., diversion dams and reservoirs) that disconnect habitats and cause habitat fragmentation and (b) introduction of non-native species that are both predators on and competitors with the flannelmouth sucker. Other threats include modification of streambeds through channelization, landscape changes resulting from land use, and local degradation of riparian zones that reduces the natural functions of the stream ecosystem (UDWR 2005).

The Flannelmouth sucker does not have a potential project nexus because suitable habitat in the Paria River is downstream from U.S. Highway 89 where the LPP Project pipeline would cross the river. The Paria River is listed as a perennial stream by the U.S. Geological Survey (USGS), however, the USGS streamflow records for the Paria River at U.S. Highway 89 demonstrate the river has periods during the summer months when there is no flow. The only potential impact of the temporary construction on the Paria River would be changes in water quality that could affect fish and habitat in downstream reaches. Construction of the pipeline crossing of the Paria River at U.S. Highway 89 would be performed during the summer period when there is no flow or low flow to avoid impacts on surface water quality (turbidity and sediment transport).

3.4.2 Bluehead Sucker

The bluehead sucker *(Catostomus discobolus*) is endemic to the Colorado River Basin. Historically, bluehead suckers occurred in streams and rivers in the Colorado River Basin as well as in the drainages of the upper Snake, Weber, and Bear rivers. Although this species sometimes occupies areas of suitable habitat in larger, low elevation, mainstem streams, it is most commonly collected in small or mid-sized tributaries of the Colorado River Basin. Most reaches of the basin receive heavy sediment loads, high annual peak flows, and low base flows. Little is known about the influence of these annual events, but healthy bluehead sucker populations have persisted in habitats with a wide range of annual flows, sediment transport and sediment deposition, providing that these physical events are associated with a natural flow regime.

The Paria River provides habitat for the bluehead sucker, which is listed in Utah and Arizona as sensitive. The bluehead sucker is protected under a Conservation Agreement (UDWR 2006). Bluehead sucker feeds on bottom of stream substrate and algae and typically inhabits large rivers and mountain streams in variable turbidity and temperature. Adult bluehead suckers exhibit a strong preference for specific habitat types (Holden and Stalnaker 1975). In-stream distribution is often related to the presence of rocky substrate which they prefer (Holden 1973). This species has been reported to typically be found in runs or riffles with rock or gravel substrate (Vanicek 1967, Holden and Stalnaker 1975, Carlson et al. 1979, Sublette et al. 1990). Juveniles have been collected from shallow riffles, backwaters, and eddies with silt or gravel substrate (Vanicek 1967). Dam construction and the associated alterations of the thermal and hydrological regimes have reduced bluehead sucker populations in both the Lower and Upper Colorado River basins (Vanicek et al. 1970).

The bluehead sucker does not have a potential project nexus because suitable habitat in the Paria River is downstream from U.S. Highway 89 where the LPP Project pipeline would cross the river. The Paria River

is listed as a perennial stream by the U.S. Geological Survey (USGS), however, the USGS streamflow records for the Paria River at U.S. Highway 89 demonstrate the river has periods during the summer months when there is no flow. The only potential impact of the temporary construction on the Paria River would be changes in water quality that could affect fish and habitat in downstream reaches. Construction of the pipeline crossing of the Paria River at U.S. Highway 89 would be performed during the summer period when there is no flow or low flow to avoid impacts on surface water quality (turbidity and sediment transport).

3.4.3 Speckled Dace

Speckled dace (*Rhinichthys osculus reliquus*) is listed only in Arizona as a state sensitive species and inhabits the lower Paria River in Arizona. The speckled dace is a small minnow common in many western waters. In Utah, the species is quite common, occurring in many of the state's major streams and in numerous desert springs. The speckled dace has adapted to many different types of habitat, ranging from cold swift-flowing mountain headwaters to warm intermittent desert streams and springs.

Speckled dace is a bottom-dwelling species and is an important forage fish. The species is a benthic feeder, eating primarily insect larvae and other invertebrates, although algae and fish eggs are also consumed. The species spawns during the spring and summer over gravel areas that have been cleaned by territorial males. The speckled dace is a schooling species that is most active at night. In many parts of their range, speckled dace are important forage fish for sport fish species.

The speckled dace does not have a potential project nexus because suitable habitat in the Paria River is downstream from U.S. Highway 89 where the LPP Project pipeline would cross the river. The Paria River is listed as a perennial stream by the U.S. Geological Survey (USGS), however, the USGS streamflow records for the Paria River at U.S. Highway 89 demonstrate the river has periods during the summer months when there is no flow. The only potential impact of the temporary construction on the Paria River would be changes in water quality that could affect fish and habitat in downstream reaches. Construction of the pipeline crossing of the Paria River at U.S. Highway 89 would be performed during the summer period when there is no flow or low flow to avoid impacts on surface water quality (turbidity and sediment transport).

3.4.4 Desert Sucker

The desert sucker (*Catostomus clarkii*) is a freshwater species of fish in the sucker family endemic to the Colorado River basin. The desert sucker occurs in the lower Colorado River basin, below the Grand Canyon, particularly in the Gila River, and in streams in the Virgin River basin, the White River basin and others. Their total range area is estimated at 128,000 km^2 (49,000 mi^2).

Desert suckers prefer riffles, rapids and flowing streams with gravelly bottoms. Desert suckers are benthic (bottom dwelling) fish that primarily eat algae, although insects and other invertebrates are also occasionally consumed. Members of the species almost always occur in streams, where spawning occurs in riffles during the winter and spring.

In Utah, the species occurs only in the Virgin River system in the southwestern corner of the state. In addition to its limited distribution, primary threats to the species in Utah include dewatering of the Virgin River (UDWR 2005) system for development and agriculture, pollution, and the introduction of exotic turtles and fishes (which can impact the desert sucker through predation and/or competition). The desert sucker could potentially be impacted by pipeline construction crossing of LaVerkin Creek and by

potential changes in stream flow and water quality in the Virgin River and its tributary streams in the St. George metropolitan area.

3.4.5 Virgin Spinedace

The Virgin spinedace (*Lepidomeda mollispinus*) is a cyprinid fish endemic to the Virgin River, a tributary of the Colorado River. Populations of Virgin spinedace currently exist in the mainstem Virgin River and eleven of its tributaries including East Fork Virgin River, Shunes Creek, North Fork Virgin River, North Creek, La Verkin Creek, Ash Creek, Santa Clara River, Beaver Dam Wash, Coal Pits Wash, Moody Wash and Magotsu Creek. According to Addley and Hardy (1993), the largest populations occur in the upper mainstem above Quail Creek diversion and in drainages of the Santa Clara River and Beaver Dam Wash. Small populations exist in Ash Creek, LaVerkin Creek, and the lower mainstem below Pah Tempe Springs. The remaining areas contain intermediate-sized populations. Although the species has a very restricted range, most of the crucial habitat has been protected under a Conservation Agreement, and the species is not currently listed as endangered because the Conservation Agreement is in place (UDWR 2006).

Virgin spinedace are primarily insectivorous, feeding on a wide range of insects and occasionally plant material and organic debris (Rinne 1971, Greger and Deacon 1988; Angradi et al. 1991). Virgin spinedace feed on drifting prey in midwater and at the surface. They usually maintain equilibrium in the midwater column, darting to the surface to capture prey in a manner similar to drift-feeding salmonids (Rinne 1971, Addley and Hardy 1993).

Virgin spinedace habitat modification and/or elimination has occurred primarily through human activities such as dam and diversion construction, water depletion or diversion, and agricultural practices. The Virgin spinedace could potentially be impacted by pipeline construction crossing of LaVerkin Creek and by potential changes in stream flow and water quality in the Virgin River and its tributary streams in the St. George metropolitan area.

Chapter 4
Environmental Consequences (Effects and Impacts)

4.1 Introduction

This chapter analyzes Lake Powell Pipeline (LPP) Project effects on federally listed threatened and endangered aquatic species and designated critical habitats, and impacts on federal, state and local agency aquatic species of concern.

4.2 Effects Determinations and Significance Criteria

4.2.1 Federally Listed Species

This section describes the criteria used to determine the magnitude of effects from the LPP Project alternatives. The Endangered Species Act of 1973 (ESA) establishes the legal criteria for determining effects on federally threatened and endangered aquatic species. The following are accepted determinations of effects on listed species:

- No Effect: no effect on the listed species or designated critical habitat
- May Affect, Not Likely to Adversely Affect: effects on the listed species or designated critical habitat are insignificant and/or discountable
- Likely to Adversely Affect: effects that would result in a short- or long-term incidental take of the listed species or designated critical habitat

Adverse effects on listed species include the following:

- Taking of threatened or endangered species
- Loss or degradation of utilized or potentially utilized habitat that would exceed the estimated level necessary to maintain viable populations or sub-populations of each species
- Actions that lead to long-term disturbance in species migration and dispersal, breeding behavior or pollination that would threaten the viability of the population or sub-population

Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Through regulations, the term "harm" is defined as "an act which actually kills or injures wildlife." Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." (USFWS 2010p)

Under ESA Section 7, federally listed species must be analyzed in a Biological Assessment (BA) and the findings submitted to the USFWS, which then makes a determination of effect and if there is an affect issues a Biological Opinion (BO). If there is no effect and USFWS concurs, then no BO is issued. Incidental take – take that results from a Federal action, but is not the purpose of the action – may be allowed when the USFWS approves it through an incidental take statement. The statement includes the amount or extent of anticipated take due to the Federal action, reasonable and prudent measures to minimize the take, and terms and conditions that must be observed when implementing those measures (USFWS 2010p).

After the USFWS issues its biological opinion, the [sponsoring] Federal agency then decides how to proceed. If the BO determines that adverse effects would occur from the Proposed Action, the sponsoring agency can adopt the reasonable and prudent measures described in a BO incidental take statement and proceed with the project. If the USFWS makes a jeopardy determination, the Federal agency has several options (USFWS 2010p):

- implement one of the reasonable and prudent alternatives
- modify the proposed project and consult again with the USFWS
- decide not to undertake (or fund, or authorize) the project
- disagree with the opinion and proceed
- apply for an exemption

4.2.2 Federal, State and Local Agency Aquatic Species of Concern

Significance criteria for aquatic species of concern would be the same as those for general aquatic species :

- Project activities resulting in substantial disturbance to aquatic habitat or populations. A substantial disturbance is one that destroys a large area of utilized habitat, disturbs or displaces a resident population or sub-population, or results in losses of a large number of individuals of the species within the LPP project study area. Disturbance may arise from direct construction impacts on habitat or indirectly by noise or human activity that would reduce aquatic habitat values. Substantial disturbance is based on the status, population dynamics, behavior, habitat availability and quality for each species group relative to the type, intensity and duration of a specific impact. Species that are locally common or have a high reproductive potential and ability to re-colonize previously disturbed sites rapidly would have less potential impacts than species with small populations, restricted to limited habitats, have low reproductive potential or limited ability to disperse out of or back into previously disturbed habitats.

4.3 Potential Effects and Impacts and Alternatives Eliminated from Further Analysis

4.3.1 Transmission Line Alternatives

Construction and/or operation of electrical power transmission line(s) would have no effect or impact on special status aquatic resources species and habitats as a result of implementing the proposed LPP Project or identified alternatives and are not considered further. All of the transmission line alternatives near aquatic habitats have existing roads which would be utilized during construction. No new roads that could be sources of sediment recruitment to streams and rivers would be constructed to access transmission line alternative alignments.

4.3.2 Virgin River Critical Habitat

Critical habitat for Virgin River chub (*Gila seminuda (=robusta))* and woundfin (*Plagopterus argentissimus)* along the Virgin River would not be directly or indirectly affected by the Lake Powell Pipeline construction or operation. LPP construction activities would terminate at Sand Hollow Reservoir more than three miles east of the Virgin River. The Cedar Valley Pipeline would cross the Virgin River at the Sheep Bridge with an aerial pipeline crossing. LPP project operation would supply raw water to Sand Hollow Reservoir for treatment in the Quail Creek Water Treatment Plant before distribution throughout the Washington County Water Conservancy District (WCWCD) service area. Following use in homes, businesses and institutions, the wastewater would be treated in wastewater treatment facilities and then further treated in the wastewater reclamation facility for reuse as secondary irrigation water. This water would be stored in existing and approved reservoirs in the St. George metropolitan area and used for outdoor watering. The Utah Division of Water Resources (UDWR) has modeled the Virgin River using the Virgin River Daily Simulation Model (VRDSM) for scenarios involving no LPP water and with LPP water to determine the potential for return flows to the Virgin River that could potentially affect riparian areas. The VRDSM results indicate that LPP return flows to the Virgin River would be within the measurement accuracy of the USGS gages on the Virgin River and changes in river flows would not be measurable. The VRDSM model results demonstrate no measurable changes (increases or decreases) in streamflows from the USGS gage at Virgin to the USGS gage near the Utah-Arizona state line by comparison of base case (full utilization of Virgin River water rights with current facilities) and LPP water deliveries to Sand Hollow Reservoir. The LPP Project construction and operation would have no effect on Virgin River chub or woundfin and would have no effect on critical habitat for Virgin River chub and woundfin. Therefore, potential effects from LPP Project return flows on designated critical habitat for Virgin River chub (*Gila seminuda (=robusta))* and woundfin (*Plagopterus argentissimus)* along the Virgin River are eliminated from further analysis. A detailed description and analysis of the VRDSM model results is included in the draft Surface Water Resources Study Report (UBWR 2011).

4.3.3 Virgin River Crucial Habitat

Crucial habitat for desert sucker (*Catostomus clarkii*) and Virgin spinedace (*Lepidomeda mollispinus*) along the Virgin River would not be directly or indirectly affected by the Lake Powell Pipeline construction or operation. LPP construction activities would terminate at Sand Hollow Reservoir more than three miles east of the Virgin River. The Cedar Valley Pipeline would cross the Virgin River at the Sheep Bridge with an aerial pipeline crossing. LPP project operation would supply raw water to Sand Hollow Reservoir for treatment in the Quail Creek Water Treatment Plant before distribution throughout the Washington County Water Conservancy District (WCWCD) service area. Following use in homes, businesses and institutions, the wastewater would be treated in wastewater treatment facilities and then further treated in the wastewater reclamation facility for reuse as secondary irrigation water. This water

would be stored in existing and approved reservoirs in the St. George metropolitan area and used for outdoor watering. The Utah Division of Water Resources (UDWR) has modeled the Virgin River using the Virgin River Daily Simulation Model (VRDSM) for scenarios involving no LPP water and with LPP water to determine the potential for return flows to the Virgin River that could potentially affect riparian areas. The VRDSM results indicate that LPP return flows to the Virgin River would be within the measurement accuracy of the USGS gages on the Virgin River and changes in river flows would not be measurable. The VRDSM model results demonstrate no measurable changes (increases or decreases) in streamflows from the USGS gage at Virgin to the USGS gage near the Utah-Arizona state line by comparison of base case (full utilization of Virgin River water rights with current facilities) and LPP water deliveries to Sand Hollow Reservoir. Therefore, potential impacts from LPP Project return flows on crucial habitat for desert sucker (*Catostomus clarkii*) and Virgin spinedace (*Lepidomeda mollispinus*) along the Virgin River are eliminated from further analysis. A detailed analysis of the VRDSM model results is included in the draft Surface Water Resources Study Report (UBWR 2011).

4.3.4 Paria River Aquatic Habitat at U.S. Highway 89

The reach of the lower Paria River which maintains perennial stream flow without interruption contains suitable habitat for razorback sucker (*Xyrauchen texanus*), flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker *(Catostomus discobolus*) and speckled dace (*Rhinichthys osculus reliquus*) is miles downstream from U.S. Highway 89 where the LPP Project pipeline would cross the river. The Paria River is listed as a perennial stream by the U.S. Geological Survey (USGS), however, the USGS streamflow records for the Paria River at U.S. Highway 89 demonstrate the river has sustained periods during the summer months when there is no flow. The only potential impact of the temporary construction on the Paria River would be changes in water quality that could affect fish and habitat in downstream reaches. Construction of the pipeline crossing of the Paria River at U.S. Highway 89 would be performed during the summer period when there is no flow or low flow to avoid impacts on surface water quality (turbidity and sediment transport). If the Paria River has low flows during the temporary construction of the pipeline crossing, then water bladder dams would be used to create a temporary cofferdam to divert the flow to another part of the 340-foot wide river bottom or through culvert pipes to avoid active construction in the flowing portion of the river. Best Management Practices (BMPs) would be used to prevent potential water quality impacts on flow in the Paria River during the pipeline crossing construction. These BMP's would include the following:

- Construction of pipeline crossing of the Paria River would be performed when the river has no flow or low flows.
- Water bladder dams or similar structures would be used as necessary to form temporary coffer dams upstream of pipeline crossing for temporary diversion of any Paria River flows into a dry portion of the river bottom during construction. Culvert pipes would be installed as necessary at the existing river slope to divert flow around the pipeline crossing work area. Stream flows would be diverted through the culvert pipes as necessary to control turbidity during construction of the pipeline crossing.
- Equipment usage and operation within temporarily dewatered reaches of the river channel would be minimized to protect river bed substrates.
- Construction equipment working within the temporarily dewatered reaches of the river channel would be checked and regularly monitored for leaking hydraulic fluid, oil, grease, and fuel.
- All construction equipment refueling would be performed on upland areas to prevent fuel spills from contaminating river bed substrates and the dewatered river reach.
- Construction trenches within dewatered stream reaches would be pumped as necessary to remove

subsurface water. The water would be pumped into portable tanks for settling, and then land-applied in uplands away from the river for disposal.

- Silt fences would be installed across the river channel within the dewatered construction areas downstream of the pipeline crossing excavation to capture sediments that may be mobilized by precipitation events during construction activities. The silt fence toe would be anchored into the stream bed with native material. The silt fence would be removed following completion of the pipeline crossing construction and native material used to anchor the silt fence toe would be returned to pre-construction conditions.

Implementation of these BMPs would protect the baseline water quality of the Paria River during the temporary construction activities and avoid impacts on downstream water quality in the lower Paria River. The LPP Project would have no effect on razorback chub or its critical habitat in the lower Paria River. With these BMPs, the Paria River at U.S. Highway 89 is eliminated from further analysis. More detailed stream flow information, data and analyses are provided in the draft Surface Water Resources Study Report (UBWR 2011a). More detailed water quality information, data and analyses are provided in the draft Surface Water Quality Study Report (UBWR 2011b)

4.3.5 Interbasin Transfer of LPP Water

The interbasin transfer of LPP water from Lake Powell to Sand Hollow Reservoir through the proposed pipeline could result in transfer of undesirable and invasive aquatic organisms from the upper Colorado River basin to the Virgin River basin. However, no LPP water would be discharged into the Virgin River or any of its tributary streams. All of the LPP Project water conveyed through the pipeline would flow into Sand Hollow Reservoir for the specific purpose of providing municipal and industrial (M&I) raw water supply for treatment in a water treatment facility and distribution as culinary water. Although Sand Hollow Reservoir may currently be infested with quagga mussel and other species likely transported by recreational boats, the LPP Project would be designed to avoid transfer of aquatic organisms from Lake Powell to Sand Hollow Reservoir. Potential impacts of interbasin transfer of water carrying undesirable and invasive aquatic species are eliminated from further analysis.

4.3.6 LPP Project Diversions from Lake Powell and the Colorado River

The proposed LPP Project diversions from Lake Powell could potentially affect special status aquatic resource species and habitats in the Colorado River downstream from Glen Canyon Dam. The federally listed species with critical habitat downstream of Glen Canyon Dam include the bonytail chub (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and the razorback sucker (*Xyrauchen texanus*). Measurable changes in Glen Canyon Dam releases and water quality could affect these listed species and their designated critical habitat.

The Utah Division of Water Resources contracted with the Department of the Interior's designated expert agency, the Bureau of Reclamation (Reclamation) to simulate the potential effects of the LPP Project diversions from Lake Powell on reservoir levels, Glen Canyon Dam releases, and water quality in Lake Powell and in releases from Glen Canyon Dam. Reclamation performed several hydrologic modeling runs using Reclamation's long-term planning model, Colorado River Simulation System (CRSS). The results of these model runs were provided to the State for use in its planning studies for the Lake Powell Pipeline (LPP) Project to determine potential impacts on the hydrology of the Colorado River system. Reclamation also provided water quality modeling results to the State for use its planning studies for the LPP Project to determine potential impacts on water quality of the Colorado River system.

The results of two sets of hydrologic modeling runs, the Final Planning Study runs and the No Additional Depletions runs, are summarized in the following sections. More detailed analyses are provided in the draft Surface Water Resources Study Report (UBWR 2011a).

4.3.6.1 Colorado River Hydrologic Simulation Methodology

Hydrologic modeling of the Colorado River system for the period 2009 through 2060 was performed to determine the potential hydrologic effects of the alternatives. Modeling provides projections of potential future Colorado River system conditions (i.e., reservoir elevations, reservoir releases, river flows) for comparison of those conditions under the No Action Alternative to conditions under each action alternative. These comparisons are typically expressed in terms of the relative differences in probabilities between the No Action Alternative and the action alternatives. Hydrologic modeling also provides the basis for the analysis of the potential effect of each alternative on other environmental resources such as water quality and hydropower. Multiple simulations were performed in order to quantify the uncertainties of future conditions and as such, the modeling results are expressed in probabilistic terms because of the uncertainty with regard to future inflows into the system.

4.3.6.1.1 Analyses Performed. Two sets of hydrologic model runs are analyzed: the Final Planning Study analysis and the No Additional Depletions analysis. For each of these analyses multiple hydrologic model runs were performed to evaluate all combinations of inflow scenarios and alternatives.

4.3.6.1.1.1 Final Planning Study Analysis. The Final Planning Study analysis assumes future water development in the Upper Colorado River basin would occur according projections provided by the Upper Basin States to the Upper Colorado River Commission (UCRC). In this analysis, the No Action Alternative assumes that if Utah does not develop the Lake Powell Pipeline, that water will be developed somewhere else in the state. This analysis isolates the impact of the geographic location of the water use from the Colorado River system; Utah's total water use remains the same in the action and No Action alternatives.

4.3.6.1.1.2 No Additional Depletions Analysis. The No Additional Depletions analysis assumes water use in the Colorado River basin would remain constant at current levels, except for reasonably foreseeable (pursuant to 43 CFR 46.30) future projects. Under the regulatory definition, a reasonably foreseeable future depletion is one which has state legislation, or a tribal resolution or federal Indian water settlement, or a federal finding of no significant impact (FONSI) or record of decision (ROD). In the No Additional Depletions analysis the No Action alternative assumes that if the Lake Powell Pipeline is not developed, that water will not be developed somewhere else in the state. This analysis isolates the effect of adding a new project (Lake Powell Pipeline) to the mix of existing and reasonably foreseeable depletions in the Colorado River system.

4.3.6.1.2 Alternatives Modeled. Two alternatives were modeled for each of the two analyses described above. These alternatives consist of a No Action Alternative and a Proposed Action alternative, the Lake Powell Pipeline 86kaf Alternative. The Proposed Action alternative reflects pipeline diversion schedules developed by the State and technical input from Reclamation staff regarding how to model the Lake Powell Pipeline in CRSS.

4.3.6.1.2.1 No Action Alternative. The No Action Alternative provides a baseline for comparison of each of the action alternatives. The No Action Alternative represents a projection of future conditions that could occur during the life of the proposed federal action without an action alternative being implemented. For the Final Planning Study analysis, this alternative assumes future water development in the Upper Colorado River basin would occur according projections provided by the Upper Basin States to the Upper Colorado River Commission (UCRC). For the No Additional Depletions analysis, the No

Action Alternative assumes all Upper Basin depletions except those deemed reasonably foreseeable are held constant at 2009 depletion levels for the entire model run

4.3.6.1.2.2 Lake Powell Pipeline 86kaf Alternative. The Lake Powell Pipeline 86kaf Alternative (86kaf Alternative) would divert water from the Colorado River system at Lake Powell. Diversions would begin in 2020 with an annual volume of 1,975 acre-feet per year and increase each year through 2042 to 86,249 acre feet. Diversions would be constant at 86,249 acre-feet per year from full build-out until the end of the model run (2042 through 2060).

4.3.6.1.3 Inflow Hydrology Scenarios Modeled

4.3.6.1.3.1 Direct Natural Flow, Index Sequential Method Inflows. The future hydrology used as input to the model in this scenario consisted of samples taken from the historic record of natural flow in the river system over the 101-year period from 1906 through 2006. Natural flow is the observed flow adjusted for the effects of diversions and the operation of reservoirs upstream of the flow gage.

4.3.6.1.3.2 Nonparametric Paleo-conditioned Inflows. This inflow hydrology scenario uses paleo-hydrologic state information (i.e., wet or dry) to conditionally sample from the historic natural flow record. The paleo-hydrologic state information was derived from annual streamflow reconstructions from tree-ring chronologies of the years 762 to 2005 on the Colorado River at Lees Ferry. This technique generates flows with the same magnitudes as the historic record but with more variety in the sequencing of wet and dry spells.

4.3.6.2 Summary of Potential Hydrologic Impacts

4.3.6.2.1 General Observations. The assumptions of the two analyses, Final Planning Study analysis and No Additional Depletions analysis are significantly different, and as such, the results are also different. Overall, the Final Planning Study analysis shows very little or no hydrologic differences between the Proposed Action and No Action Alternative. The No Additional Depletions analysis, indicate small hydrologic differences between the Proposed Action and No Action Alternative at some percentile levels. The largest differences would occur at lower reservoir elevations and at higher annual reservoir release volumes. Reservoir elevations and the percentage of higher volume reservoir releases are generally higher in the No Additional Depletions analysis compared to the Final Planning Study analysis. The choice of inflow scenario does not significantly affect the differences between the Proposed Action and No Action Alternative.

4.3.6.2.2 Final Planning Study Analysis

4.3.6.2.2.1 Reservoir Storage. Under the Proposed Action and No Action Alternative, the elevations of Lake Powell are projected to fluctuate between full and lower levels during the period of analysis (2009 through 2060). The range of elevations projected using paleo-conditioned inflows is significantly larger, (up to approximately 100 feet lower in the 10^{th} percentile), than elevations projected using direct natural inflows. At the 90^{th} percentile level Lake Powell end-of-December elevation values, the Proposed Action and No Action Alternative are projected to be nearly the same over the period of analysis for both direct natural inflows and paleo-conditioned inflows. At higher elevations the proposed Lake Powell Pipeline is expected to have very little or no effect on lake elevations. At the 50^{th} and 10^{th} percentiles, Lake Powell elevations under the action alternatives are approximately 0.2 feet and approximately 0.4 feet, respectively, lower than under the No Action Alternative, indicating relatively little impact to lake elevations at median and lower lake elevations. Though the projected elevations at the 10^{th} and 50^{th} percentiles are significantly lower for paleo-conditioned inflows than for direct natural inflows,

differences between the Proposed Action and No Action Alternative are nearly the same in both inflow scenarios.

The probability of Lake Powell elevations less than 3,490 feet msl (the approximate minimum elevation for operation of the Glen Canyon powerplant) is nearly the same for both alternatives. The probability is three percent or less assuming natural inflows and fifteen percent or less assuming paleo-conditioned inflows. Inflow scenario does not affect the differences between the Proposed Action and No Action Alternative. This indicates the proposed pipeline would have little or no effect on the ability to generate power at Glen Canyon powerplant.

4.3.6.2.2.2 Reservoir Releases. Under the Proposed Action and No Action Alternative, the water year releases from Lake Powell are projected to fluctuate throughout the period of analysis. The range of releases projected using paleo-conditioned inflows is significantly larger, approximately one million acre feet higher in the 90th percentile, than water year releases projected using direct natural inflows. At the 10th and 50th percentile level Lake Powell water year release values, the Proposed Action and No Action Alternative are projected to be nearly the same over the period of analysis for both direct natural inflows and paleo-conditioned inflows, indicating little or no impact on reservoir releases at lower median water year release values. The 10th and 50th percentile releases reflect the minimum objective release of 8.23 maf or balancing releases. The 90th percentile releases reflect equalization or spill avoidance. At the 90th percentile, the water year release values under the action alternatives are approximately 3,000 acre feet (approximately 0.03 percent) less than the No Action Alternative. Though the projected releases at the 90th percentile are significantly higher for paleo-conditioned inflows than for direct natural inflows, differences between the Proposed Action and No Action Alternative are nearly the same in both inflow scenarios at all percentile levels.

Releases of less than the annual minimum objective release of 8.23 maf occurred with essentially the same frequency (within 0.1 percent of the time) between the Proposed Action and No Action Alternative. Releases above 8.23 maf also occurred with nearly the same frequency.

4.3.6.2.3 No Additional Depletions Analysis

4.3.6.2.3.1 Reservoir Storage. Under the Proposed Action and No Action Alternative, the elevations of Lake Powell are projected to fluctuate but generally increase over time throughout the period of analysis (2009 through 2060). The range of elevations projected using paleo-conditioned inflows is significantly larger, (up to approximately 100 feet lower in the 10th percentile), than elevations projected using direct natural inflows. At the 90th percentile level Lake Powell end-of-December elevation values, the action alternatives and the No Action Alternative are projected to be nearly the same over the period of analysis for both direct natural inflows and paleo-conditioned inflows. At higher elevations the proposed Lake Powell Pipeline is expected to have very little or no effect on lake elevations. At the 50th percentile, Lake Powell elevation under the Proposed Action is approximately 2 feet lower than under the No Action Alternative, assuming observed natural inflows (approximately 1 foot assuming paleo-conditioned inflows). Results at the 10th percentile level show approximately 4 feet and 5 feet average difference for observed natural and paleo-conditioned inflows, respectively, indicating a small potential impact to reservoir elevations at lower levels. To put this in perspective, Lake Powell has an operating range of over 200 feet and typically fluctuates 30 to 40 feet in a normal year.

The probability of Lake Powell elevations less than 3,490 feet msl (the approximate minimum elevation for operation of the Glen Canyon powerplant) is two percent or less assuming natural inflows and thirteen percent or less assuming paleo-conditioned inflows. Results are essentially the same for Proposed Action and No Action Alternative assuming observed natural inflows. With paleo-conditioned inflows the probability of being below 3,490 feet msl is very slightly (two percent or less) higher in the Proposed

Action compared to the No Action Alternative. This indicates the proposed pipeline could have very little impact on the ability to generate power at Glen Canyon powerplant.

4.3.6.2.3.2 Reservoir Releases. Under the Proposed Action and No Action Alternative, the water year releases from Lake Powell are projected to fluctuate throughout the period of analysis. The range of releases projected using paleo-conditioned inflows is significantly larger, approximately one million acre feet higher in the 90th percentile, than water year releases projected using direct natural inflows. At the 10th and 50th percentile level Lake Powell water year release values, the Proposed Action and No Action Alternative are projected to be nearly the same over the period of analysis for both direct natural inflows and paleo-conditioned inflows. The 10th and 50th percentile releases reflect the minimum objective release of 8.23 maf or balancing releases. The 90th percentile releases reflect equalization or spill avoidance. At the 90th percentile, the water year release values under the Proposed Action would be approximately 80,000 acre-feet (or 0.6 percent) less than the No Action Alternative. Though the projected releases at the 90th percentile are significantly higher for paleo-conditioned inflows than for direct natural inflows, differences between the Proposed Action and No Action Alternative are nearly the same in both inflow scenarios at all percentile levels. These results show that the Lake Powell Pipeline would have little (less than one percent difference) or no impact on Lake Powell's annual release volumes.

Releases of less than the annual minimum objective release of 8.23 maf would occur with essentially the same frequency (within 0.3 percent of the time) between the action and No Action alternatives. Releases above 8.23 maf would occur approximately one percent less often under the Proposed Action compared to the No Action Alternative. These results indicate the Lake Powell Pipeline would have little or no impact on Lake Powell's annual release tier.

4.3.6.3 Summary of Reclamation Hydrologic Modeling Results

The Reclamation hydrologic modeling of Lake Powell levels and Glen Canyon Dam releases demonstrate that the hydrologic impacts of the LPP Project would not be measurable, particularly within the variation of river flows resulting from Glen Canyon Dam water releases. The Reclamation model results indicate that the LPP Project would not measurably or adversely affect river flows or hydrology in the Colorado River downstream from Glen Canyon Dam. The LPP Project would have no effect on the four listed fish species in the Colorado River and would have no effect on their critical habitat. The potential hydrologic effects of the LPP Project on the listed aquatic species and their critical habitat in the Colorado River are eliminated from further analysis.

4.3.6.4 Reclamation Water Quality Modeling Results

Computer modeling was utilized by Reclamation to evaluate potential effects of the proposed LPP Project on temperature, total dissolved solids (TDS), and other water quality parameters. The CRSS and Lake Powell CE-QUAL-W2 models were used to simulate water quality parameters in and below Lake Powell for the No Action Alternative and the Proposed Action (86,249 acre-feet per year) diversion from Lake Powell.

4.3.6.4.1 CRSS Salinity Modeling Methodology. The CRSS Model is a rule-based simulation of operations in the Colorado River Basin based in the Riverware^{TM} Modeling framework developed by CADSWES at the University of Colorado at Boulder. The version of the CRSS Model that was used for the hydrological and operational simulations of the Lake Powell Pipeline was also used to simulate salinity, or TDS, in the Colorado River Basin. The salinity model routes salinity through major stream reaches and seven reservoirs (Flaming Gorge, Starvation, Navajo, Powell, Mead, Mohave, and Havasu) in the Colorado River Basin. The model is intended for long-term simulations of salinity (15 to 20 years).

The model simulated the period 2009 to 2060 using two inflow hydrology scenarios, direct natural flow (DNF) and nonparametric paleo-conditioned inflows (NPC). In the DNF scenario the historic record 1906-2006 was used to generate 101 simulations of the period 2009 to 2060. In the NPC scenario inflow hydrology was derived from tree-ring chronologies for 762 to 2005 on the Colorado River at Lee's Ferry. 125 simulations of the period 2009 to 2060 were generated.

4.3.6.4.2 CE-QUAL-W2: Water Quality Modeling Methodology. CE-QUAL-W2 is a water quality model developed by the US Army Corps of Engineers for simulating hydrodynamics and water quality in long, narrow waterbodies such as reservoirs. The Lake Powell CE-QUAL-W2 Model calibrated to the historic time period 1990-2008 was used as the base for simulations of the Lake Powell Pipeline. The model simulates temperature, TDS, dissolved oxygen, nutrients, and algae in the reservoir and releases from Glen Canyon Dam.

The CE-QUAL-W2 simulations used results from the CRSS DNF hydrology simulations as inputs for tributary inflows and dam outflows in the water quality model scenarios. One of the 101 CRSS DNF hydrology simulations was selected to determine these inputs. From the simulation period 2009 to 2060, the years 2043 to 2060 were selected to use directly in the CE-QUAL-W2 model. This period was selected because the simulation years 2043 to 2060 corresponded to the natural flow years 1989-2006. This allowed other CE-QUAL-W2 inputs such as meteorology to use historical data.

4.3.6.4.3 Water Quality Modeling Results. Water quality results from the Proposed Action diversion scenario were compared to the No Action Alternative scenario to determine effects, if any, on water quality. Water quality modeling results included temperature and dissolved oxygen in Lake Powell, temperature, TDS, and dissolved oxygen below Glen Canyon Dam from the CE-QUAL-W2 modeling, and TDS along the Lower Colorado River from the CRSS modeling. Other water quality parameters were simulated by the CE-QUAL-W2 model including nutrients and phytoplankton but quantitative results are not presented for these parameters. Additionally, CE-QUAL-W2 modeling of Glen Canyon Dam release temperatures at varying elevations was performed as part of the "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, Final Environmental Impact Statement" or Shortage Criteria EIS (DOI 2007). Results from that modeling are interpreted based on the projected changes in Lake Powell water surface elevations as a result of the proposed Lake Powell Pipeline.

4.3.6.4.3.1 Lake Powell. Lake Powell temperature and dissolved oxygen concentrations were evaluated at five day intervals for three reservoir locations and five depths. The three locations are above the dam, below the confluence of the San Juan River, and the upstream reservoir. The five depths were 5, 10, 25, 50, and 100 meters. Simulated reservoir temperatures in the Proposed Action simulations were compared with the No Action Alternative simulation and were not different, on average, at depths above 25 meters and were 0.1°C colder at depths greater than 25 meters. Simulated reservoir dissolved oxygen concentrations in the Proposed Action simulations were compared with the No Action Alternative simulation and were 0.1 mg/L lower at 25 and 50 meters and 0.3 mg/L lower at 100 meters.

4.3.6.4.3.2 Glen Canyon Dam Releases. Modeled release results from Glen Canyon Dam for the No Action Alternative and Proposed Action simulations were evaluated for effects on temperature, TDS, and dissolved oxygen concentrations. Simulated mean dam release temperatures for the period 2045 to 2060 are shown in Table 4-1 by month. Generally, the Proposed Action scenario dam release temperatures are slightly colder in winter and spring months and slightly warmer in summer and fall months compared with the No Action Alternative scenario. The temperature modeling results indicate the differences between the No Action Alternative and the Proposed Action would be 0.1 ^{o}C or less, which would not be measurable in the Colorado River downstream of Glen Canyon Dam.

Table 4-1
Glen Canyon Dam Release –Monthly Simulated Mean Temperatures (^{o}C), 2045-2060

Month	NA	PA	Difference
January	9.15	9.05	0.10
February	8.05	7.96	0.09
March	7.81	7.75	0.06
April	8.08	8.04	0.04
May	8.57	8.56	0.01
June	8.95	8.98	0.03
July	9.20	9.23	0.03
August	9.67	9.76	0.09
September	10.26	10.32	0.06
October	10.61	10.69	0.08
November	10.86	10.91	0.05
December	10.52	10.44	0.08

Glen Canyon Dam release temperatures often peak in October and simulated results for that month (Table 4-2) show that when the reservoir is at or near full pool elevations, as would be the case from 2050 to 2056, temperature releases from the dam under the Proposed Action would be colder than under the No Action Alternative scenario. The release temperatures from the dam under the Proposed Action would be colder when the reservoir is near full capacity because of the removal of warmer water from the upper, warm layer of the reservoir by the pipeline. Simulated release temperatures under the Proposed Action would be warmer than the No Action Alternative scenario during summer and fall months when reservoir pool elevations would be below full pool. The largest differences between the Proposed Action and the No Action Alternative scenario coincides with the lowest reservoir pool elevations. The temperature modeling results indicate the differences between the No Action Alternative and the Proposed Action would be 0.72 ^{o}C or less, which would not be measurable in the Colorado River downstream of Glen Canyon Dam.

Table 4-2
Glen Canyon Dam Release – Simulated October Temperatures (^{o}C), 2045-2060

Month	NA	PA	Difference
Oct-45	10.54	10.57	0.03
Oct-46	10.83	11.00	0.17
Oct-47	10.58	10.83	0.25
Oct-48	10.12	10.32	0.20
Oct-49	10.88	11.07	0.19
Oct-50	9.54	9.34	0.20
Oct-51	9.74	9.53	0.21
Oct-52	9.59	9.47	0.12
Oct-53	9.92	9.82	0.10
Oct-54	9.52	9.46	0.06
Oct-55	8.80	8.61	0.19
Oct-56	8.99	8.95	0.04
Oct-57	11.10	11.11	0.01
Oct-58	12.54	12.75	0.21
Oct-59	13.79	14.51	0.72
Oct-60	13.24	13.66	0.42
Average	**10.61**	**10.69**	**0.20**

The average release TDS concentrations from 2045-2060 for the model results are within 1 mg/L of each other. The average release dissolved oxygen concentrations from 2045-2060 for the model results are within 0.11 mg/L of each other, with the Proposed Action slightly lower than the No Action Alternative. The results of the CRSS Salinity modeling with DNF or NPC inflow hydrology demonstrated no appreciable differences between the 90th, 50th, or 10th percentile levels. More detailed water quality modeling results and analyses are included in the draft Surface Water Quality Study Report (UBWR 2011b).

4.3.6.5 Summary of Reclamation Water Quality Modeling Results

The Reclamation water quality modeling of Lake Powell and Glen Canyon Dam releases demonstrate that the water quality impacts of the LPP Project would not be measurable, especially within the variation of conditions resulting from Glen Canyon Dam water releases. The Reclamation water quality modeling results indicate that the LPP Project would not measurably or adversely affect water quality in the Colorado River downstream from Glen Canyon Dam. The LPP Project would have no effect on the four listed fish species in the Colorado River and would have no effect on their critical habitat. The potential water quality effects of the LPP Project on the listed aquatic species and their critical habitat in the Colorado River are eliminated from further analysis.

4.3.7 Apache Trout

Apache trout (*Oncorhynchus apache*) is historically and currently distributed in rivers and streams that would not be affected by LPP Project construction or operation. The Verde River and several tributary streams including North Canyon on the Kaibab National Forest are the closest habitat and location of

known populations, which extend into southern Coconino County south of the Grand Canyon. The LPP Project features would cross through the northern half of Coconino County north of the Grand Canyon. The LPP Project construction and operation would have no effect on Apache trout or its habitat. Potential effects of the LPP Project on Apache trout and its habitat are eliminated from further analysis.

4.3.8 Kanab Ambersnail

Kanab ambersnail (*Oxyloma haydeni kanabensis*) is currently distributed in three known locations, including two springs within the Grand Canyon and at springs near Three Lakes six miles north of Kanab, Utah. The LPP Project construction would not occur within ten miles of any known Kanab ambersnail population. LPP Project operation would not measurably affect Colorado River flows in the Grand Canyon and would affect the spring flows at known population locations. The LPP Project construction and operation would have no effect on Kanab ambersnail or its habitat. Potential effects of the LPP Project on Kanab ambersnail and its habitat are eliminated from further analysis.

4.4 Effects and Impacts Analysis

4.4.1. LPP Project Alignment Alternatives

The LPP Project construction could have indirect effects on two listed aquatic species and could have indirect impacts on two species of concern in LaVerkin Creek from temporary construction of the Cedar Valley Pipeline crossing: Virgin River chub (*Gila seminuda (=robusta)*), woundfin (*Plagopterus argentissimus*), desert sucker (*Catostomus clarkii*), and Virgin spinedace (*Lepidomeda mollispinus*). The LPP Project operation would not have any direct or indirect effects on the two listed aquatic species and would not have any direct or indirect effects on the two aquatic species of concern. The following sections address the potential indirect effects and impacts of LPP Project construction on these special status aquatic species and their habitats.

4.4.1.1 Virgin River Chub

Virgin River chub is not known to inhabit upper LaVerkin Creek at the Cedar Valley Pipeline crossing location near Toquerville. The Virgin River chub may periodically inhabit the lowest reach of LaVerkin Creek near its confluence with the Virgin River, especially as refuge habitat during high runoff flows with high silt and sediment concentrations in the Virgin River. Preferred habitats are deep runs or pools with slow to moderate velocities containing boulders or other instream cover over a sand substrate. LaVerkin Creek at the Cedar Valley Pipeline crossing location is a shallow, higher gradient stream with riffles and small glides and mixed substrates ranging in size from small boulders to cobble to gravel to sand. The LPP construction would have no direct effects on Virgin River chub or potential habitat at the stream crossing site.

Indirect effects could occur on the Virgin River chub and its habitat downstream from the pipeline crossing site as a result of temporary water quality degradation during the pipeline crossing construction. The temporary water quality degradation could include increased turbidity, sediment recruitment to the stream, and sediment transport during active construction in the stream bed. The temporary impacts on stream water quality could be mitigated, as described in Chapter 5 of this study report. Additionally, habitat for benthic invertebrates, a food source for Virgin River chub, would be disrupted and some invertebrates would be lost during the pipeline crossing construction. This potential indirect effect on Virgin River chub and its habitat would be negligible and could not be measured. The potential water

quality and food source indirect effects on Virgin River chub may affect, but are not likely to adversely affect the species and its critical habitat.

4.4.1.2 Woundfin

Woundfin is not known to inhabit upper LaVerkin Creek at the Cedar Valley Pipeline crossing location near Toquerville. Woundfin inhabit the lowest reach of LaVerkin Creek near its confluence with the Virgin River, especially as refuge habitat during high runoff flows with high silt and sediment concentrations in the Virgin River. Preferred habitats are runs and quiet waters adjacent to riffles with sand and sand/gravel substrates. LaVerkin Creek at the Cedar Valley Pipeline crossing location is a shallow, higher gradient stream with riffles and small glides and mixed substrates ranging in size from small boulders to cobble to gravel to sand. The LPP construction is not expected to have direct effects on woundfin or its habitat at the stream crossing site.

Indirect effects could occur on the woundfin and its habitat downstream from the pipeline crossing site as a result of temporary water quality degradation during the pipeline crossing construction. The temporary water quality degradation could include increased turbidity, sediment recruitment to the stream, and sediment transport during active construction in the stream bed. The temporary impacts on stream water quality could be mitigated, as described in Chapter 5 of this study report. Additionally, habitat for benthic invertebrates, a food source for woundfin, would be disrupted and some invertebrates would be lost during the pipeline crossing construction. This potential indirect effect on woundfin and its habitat would be negligible and could not be measured. The potential water quality and food source indirect effects on woundfin may affect, but are not likely to adversely affect the species and its critical habitat.

4.4.1.3 Desert Sucker

Desert sucker is not known to inhabit upper LaVerkin Creek at the Cedar Valley Pipeline crossing location near Toquerville. Desert sucker may inhabit the lowest reach of LaVerkin Creek near its confluence with the Virgin River, especially as refuge habitat during high runoff flows with high silt and sediment concentrations in the Virgin River. Preferred habitats are riffles, rapids and flowing streams with gravelly substrates. LaVerkin Creek at the Cedar Valley Pipeline crossing location is a shallow, higher gradient stream with riffles and small glides and mixed substrates ranging in size from small boulders to cobble to gravel to sand. The LPP construction is not expected to have direct impacts on desert sucker or its habitat at the stream crossing site.

Indirect impacts could occur on the desert sucker and its habitat downstream from the pipeline crossing site as a result of temporary water quality degradation during the pipeline crossing construction. The temporary water quality degradation could include increased turbidity, sediment recruitment to the stream, and sediment transport during active construction in the stream bed. The temporary impacts on stream water quality could be mitigated, as described in Chapter 5 of this study report. Additionally, habitat for benthic invertebrates, a food source for desert sucker, would be disrupted and some invertebrates would be lost during the pipeline crossing construction. This potential indirect impact on desert sucker and its habitat would be negligible and could not be measured. The potential water quality and food source indirect impacts on desert sucker would be negligible on the species and its crucial habitat. There would be no significant impacts on desert sucker from the LPP Project.

4.4.1.4 Virgin Spinedace

Virgin spinedace is not known to inhabit upper LaVerkin Creek at the Cedar Valley Pipeline crossing location near Toquerville. Virgin spinedace may inhabit the lower reaches of LaVerkin Creek closer to its

confluence with the Virgin River. Preferred habitats are clear, cool, swift streams that have interspersed pools, runs, and riffles. Virgin spinedace are most frequently observed in pools with some type of protection such as undercut banks, boulders, or debris. LaVerkin Creek at the Cedar Valley Pipeline crossing location is a shallow, higher gradient stream with riffles and small glides and mixed substrates ranging in size from small boulders to cobble to gravel to sand. The LPP construction is not expected to have direct impacts on Virgin spinedace or its habitat at the stream crossing site.

Indirect impacts could occur on the Virgin spinedace and its habitat downstream from the pipeline crossing site as a result of temporary water quality degradation during the pipeline crossing construction. The temporary water quality degradation could include increased turbidity, sediment recruitment to the stream, and sediment transport during active construction in the stream bed. The temporary impacts on stream water quality could be mitigated, as described in Chapter 5 of this study report. Additionally, habitat for benthic invertebrates, a food source for Virgin spinedace, would be disrupted and some invertebrates would be lost during the pipeline crossing construction. This potential indirect impact on Virgin spinedace and its habitat would be negligible and could not be measured. The potential water quality and food source indirect impacts on Virgin spinedace would be negligible on the species and its crucial habitat. There would be no significant impacts on Virgin spinedace from the LPP Project.

4.4.2 No Lake Powell Water Alternative

The No Lake Powell Water Alternative would have significant indirect effects on two listed aquatic species and would have significant indirect impacts on two species of concern in the Virgin River and its tributary streams under the influence of groundwater recharge from residential outdoor watering: Virgin River chub (*Gila seminuda (=robusta)*), woundfin (*Plagopterus argentissimus*), desert sucker (*Catostomus clarkii*), and Virgin spinedace (*Lepidomeda mollispinus*). The No Lake Powell Water Alternative construction would not have any direct or indirect effects on the two listed aquatic species and would not have any direct or indirect effects on the two aquatic species of concern. The following sections address the potential indirect effects and impacts of the No Lake Powell Water Alternative operation on these special status aquatic species and their habitats.

4.4.2.1 Virgin River Chub

Virgin River chub in the Virgin River from Hurricane, Utah to the Utah-Arizona state line would be adversely affected by reduced streamflows, increased stream temperatures, and changes in food supply resulting from severe restrictions on residential outdoor watering. Gaining reaches of the Virgin River and its tributary streams in the St. George metropolitan area during the summer and fall months would become losing reaches because of the reduced groundwater recharge from restricting residential outdoor watering. Critical habitat for the Virgin River chub would be adversely affected by reduced streamflows and a diminished riparian corridor along both sides of the river. These effects would be likely to adversely affect the Virgin River chub and its designated critical habitat.

4.4.2.2 Woundfin

Woundfin in the Virgin River from Hurricane, Utah to the Utah-Arizona state line would be adversely affected by reduced streamflows, increased stream temperatures, and changes in food supply resulting from severe restrictions on residential outdoor watering. Gaining reaches of the Virgin River and its tributary streams in the St. George metropolitan area during the summer and fall months would become losing reaches because of the reduced groundwater recharge from restricting residential outdoor watering. Critical habitat for woundfin would be adversely affected by reduced streamflows and a diminished

riparian corridor along both sides of the river. These effects would be likely to adversely affect the woundfin and its designated critical habitat.

4.4.2.3 Desert Sucker

Desert sucker in the Virgin River from Hurricane, Utah to the Utah-Arizona state line would be adversely impacted by reduced streamflows, increased stream temperatures, and changes in food supply resulting from severe restrictions on residential outdoor watering. Gaining reaches of the Virgin River and its tributary streams in the St. George metropolitan area during the summer and fall months would become losing reaches because of the reduced groundwater recharge from restricting residential outdoor watering. Crucial habitat for desert sucker would be adversely impacted by reduced streamflows and a diminished riparian corridor along both sides of the river. These permanent impacts would adversely affect the desert sucker and its crucial habitat.

4.4.1.4 Virgin Spinedace

Virgin spinedace in LaVerkin Creek and the Virgin River from Hurricane, Utah to the Utah-Arizona state line would be adversely impacted by reduced streamflows, increased stream temperatures, and changes in food supply resulting from severe restrictions on residential outdoor watering. Gaining reaches of the Virgin River and its tributary streams in the St. George metropolitan area during the summer and fall months would become losing reaches because of the reduced groundwater recharge from restricting residential outdoor watering. Crucial habitat for Virgin spinedace would be adversely impacted by reduced streamflows and a diminished riparian corridor along both sides of the river. These permanent impacts would adversely affect the Virgin spinedace and its crucial habitat.

4.4.3 No Action Alternative

The No Action Alternative would have no effects on the Virgin River chub (*Gila seminuda (=robusta)*) and woundfin (*Plagopterus argentissimus*). It would have no impacts on the desert sucker (*Catostomus clarkii*) and Virgin spinedace (*Lepidomeda mollispinus*). No construction or operation effects and impacts would occur under the No Action Alternative.

Chapter 5
Conservation Measures and Mitigation and Monitoring

5.1 Conservation Measures

5.1.1 LPP Project Alignment Alternatives

Conservation measures for the federally listed aquatic species and their critical habitat would be focused on avoiding, minimizing or reducing adverse water quality changes at the LaVerkin Creek pipeline crossing site. The following sections describe the conservation measures that would be used to protect baseline water quality during construction of the pipeline stream crossing.

5.1.1.1 Virgin River Chub and Woundfin

The conservation measures that would be implemented at the LaVerkin Creek pipeline crossing site to protect water quality during construction include:

- scheduling and performing the stream crossing construction during the seasonal low flow period
- preparing a storm water pollution prevention plan (SWPPP) and obtaining approval prior to commencing construction
- coordinating with federal and state agency aquatic biologists prior to, during and following the pipeline stream crossing construction
- removing fish from the reach and portion of the channel to be dewatered; a qualified aquatic biologist would crowd any fish from the channel area prior to dewatering the construction reach
- diverting the streamflows using a water bladder dam as a coffer dam or as a diversion dam with culvert pipes to convey the stream flow around the construction site
- installing silt fence around the construction site within the dewatered stream channel to contain any runoff and sediments during precipitation events
- removing the surface boulders and cobbles comprising the stream bed substrate and stockpiling them use during stream bed restoration
- pumping water from the excavated trench to settling tanks and using land application in upland areas to dispose of the settled water
- storing excavated earth materials on upland sites where runoff and sediments would not be recruited to the stream
- checking for and maintaining all construction equipment to prevent leaks of hydraulic fluid, oil, grease and fuel prior to and during construction in the dewatered stream channel
- moving construction equipment from the dewatered stream channel to an upland area for refueling
- containing and cleaning up any spills of contaminants from the dewatered stream channel and disposing contaminated earth in an approved landfill
- installing the pipeline to a depth below the scour potential of the stream and encasing the pipeline in contaminant-free concrete as appropriate to prevent it from becoming a grade control and altering the stream channel grade
- backfilling the excavated trench around and above the concrete encasement with clean gravel fill to meet compaction specifications
- restoring the surface of the stream bed to its preconstruction condition using the stockpiled boulders and cobbles

- removing the silt fence from the channel bed
- removing the water bladder dam (and culvert pipes, if used) from the stream channel and restoring the flow back to its original course
- revegetating the stream banks with endemic riparian vegetation
- Removing and disposing excess fill material from stockpile sites in appropriate upland areas where the sediments would not be recruited back to the stream
- Monitoring the restored stream channel and revegetated stream banks for achieving restoration objectives
- Monitoring water quality for turbidity and sedimentation during construction and following construction to make sure baseline water quality conditions are maintained within surface water quality standards

These conservation measures would mitigate potential indirect effects from surface water quality changes during construction to protect habitat and downstream critical habitat of the Virgin River chub and woundfin.

5.1.2 No Lake Powell Water Alternative

There are no conservation measures that would mitigate the significant, permanent, adverse indirect effects of the No Lake Powell Water Alternative on the Virgin River chub and woundfin. Populations of these listed species would decrease in size and health within the Virgin River in the St. George metropolitan area. Similarly, there are no conservation measures that would mitigate the significant, permanent, adverse indirect effects of the No Lake Powell Water Alternative on designated critical habitat from the LaVerkin Creek confluence with the Virgin River to the Utah-Arizona state line.

5.2 Mitigation Measures

5.2.1 LPP Project Alignment Alternatives

Mitigation measures for the aquatic species of concern and their crucial habitat would be focused on avoiding, minimizing or reducing adverse water quality changes at the LaVerkin Creek pipeline crossing site.

5.2.1.1 Desert Sucker and Virgin Spinedace

The mitigation measures that would be implemented at the LaVerkin Creek pipeline crossing site to protect water quality during construction would be the same as the conservation measures described in Section 5.1.1.1 for the federally listed aquatic species. These mitigation measures would protect surface water quality during construction and avoid or minimize impacts on crucial habitat of the desert sucker and Virgin spinedace.

5.2.2 No Lake Powell Water Alternative

There are no mitigation measures to avoid, minimize or reduce the significant, permanent, adverse indirect impacts of the No Lake Powell Water Alternative on the desert sucker and Virgin spinedace. Populations of these species of concern would decrease in size and health within the Virgin River and its tributary streams in the St. George metropolitan area.

Chapter 6
Unavoidable Adverse Effects and Impacts

6.1 Introduction

This chapter summarizes unavoidable adverse effects on threatened and endangered aquatic species and unavoidable adverse impacts on aquatic species of concern. Unavoidable adverse effects or impacts may or may not be significant.

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

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

6.2. LPP Project Alignment Alternatives

6.2.1 Construction

The LPP Project alignment alternatives would not have any unavoidable adverse construction effects on federally listed aquatic species or their critical habitat. The LPP Project alignment alternatives would not have any unavoidable adverse construction impacts on aquatic species of concern or their crucial habitat.

6.2.2 Operation

The probability of unavoidable impacts on any aquatic drainage along the alignment of the Conveyance System pipeline has not been quantified. However, the potential temporary discharge of Lake Powell water into any flowing stream that the pipeline either crosses or is adjacent to would have a potential to transfer invasive and otherwise non-native species into that drainage. This could, however unlikely, result in introducing invasive aquatic species that could compete with or otherwise affect or impact the aquatic special status species that require cooperative protection and management.

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 potential for 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 water intake system design would need to have a contingency to allow for treatment of raw Lake Powell water at the source pump station. However, eliminating all potential biota transfer is not a reasonable assumption and some risk will always remain as an unavoidable adverse effect or 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 federally listed aquatic species or their critical habitat. The No Lake Powell Water Alternative would not have any unavoidable adverse construction impacts on aquatic species of concern or their crucial habitat.

6.3.2 Operation

The No Lake Powell Water Alternative would have unavoidable adverse effects on the Virgin River chub and woundfin 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 designated critical habitat from LaVerkin Creek to the Utah-Arizona state line.

The No Lake Powell Water Alternative would have unavoidable adverse impacts on the desert sucker and Virgin spinedace 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 crucial habitat from LaVerkin Creek to the Utah-Arizona state line.

Chapter 7
Cumulative Effects and Impacts

This chapter analyzes cumulative effects and 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 effects and 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.

References Used and Cited

Bio-West. 2005. Evaluation of Collection Methods for Virgin River Chub and Options for Long-Term Monitoring Plan.

Fonseca, Felica. 2009. Invasive Mussels Imperil Western Water Supply.

Holden, P.J., M.E. Golden, and P.J. Zucker. 2001. An Evaluation of Changes in Woundfin (*Plagopterus argentissimus*) Populations in the Virgin River, Utah, Arizona, and Nevada, 1976-1999. PR-735-1. Prepared for the U.S. Fish and Wildlife Service.

Holtville Tribune. 2009. Imperial Valley Water Infrastructure is Infested with Quagga Mussels.

Korman, J., Wiele, S., Torizzo, M. Modeling Effects to Discharge on Habitat Quality and Dispersal of Juvenile Humpback Chub (Gilacypha) in the Colorado River, Grand Canyon.

MWH Americas, Inc. 2009. Quagga Mussel Mitigation Measures for the San Vicente Dam.

State of Utah Department of Natural Resources. 1998. Description of Baseline Conditions for the Proposed Virgin River Resource Management and Recovery Program.

State of Utah Department of Natural Resources, Division of Wildlife Resources. 2006. Conservation and Management for Three Fish Species in Utah.

_____. Range-Wide Conservation Agreement and Strategy for Roundtail Chub, Bluehead Sucker, and Flannelmouth Sucker. September 2006.

_____. Virgin Spinedace Conservation Agreement and Strategy. 2005.

_____. UCDC Home Page Vertebrate Animals, Insects and Mollusks, Kanab Ambersnail, ND.

State of Utah. 2008. Virgin River Chub Population Monitoring and Status on the Virgin River Pah Tempe to Washington Fields Utah.

United States Dept. of Interior. Bureau of Reclamation. 2009. Result of Dreissenid Monitoring (Memorandum).

_____. Bureau of Reclamation. Operation of Glen Canyon Dam Record of Decision Final Environmental Impacts Statement. October 1996.

_____. Bureau of Reclamation. 2009. Zebra & Quagga Mussels Invade the West.

United States Fish and Wildlife Service (USFWS). 1990. Biological Opinion for the Arizona Strip Resource Management Plan. U.S. Fish and Wildlife Service, Phoenix, AZ, 10pp.

_____. 1995. Recovery Plan for the Virgin River Fishes.

_____. 2000. Draft Environmental Assessment for Federal Agency Participation in the Virgin River Resource Management and Recovery Program.

_____. 2002b. Razorback sucker (*Xyrauchen texanus*) Recovery Goals: amendment and supplement to the Razorback Sucker Recovery Plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, CO

_____. 2004. Virgin River Resource Management Recovery Program – Program Accomplishment Calendar year 2004.

_____. 2005. Biotics Database

_____. 2005. Distribution and Abundance of Fish in the Virgin River Between the Washington Fields Diversion and Pah Tempe, Utah, 2005. Final Report. December 2005.

_____. 2006. Virgin River Basin, 2004 – 2005 Temperature and Flow Monitoring. Final Report. June 2006. Publication No. 06-09.

_____. 2007. Draft Apache Trout Recovery Plan, Second Revision. Albuquerque, New Mexico.

_____. 2008. Virgin River Fishes Population Response Stations 2007. Final Report. February 2008. Publication No. 08-09.

University of Colorado. 20089. Western Water Assessment – Colorado River Stream Flow – Paleo Perspective.

Utah Board of Water Resources. 2008. Lake Powell Pipeline Project Revised Aquatic resources Study Plan.

Utah State University. 2003. Quail Creek Pipeline Gravity Based Return Flow System Feasibility Design to Achieve Summer Temperatures Mitigation within the Main Stem Virgin River above Quail Creek for Native Fish.

Washington County HCP Steering Committee. 1995. Habitat Conservation Plan Washington County, Utah.

List of Preparers

MWH Americas, Inc. Consultant Team		
Name	**Degree(s)**	**Role**
Edwin Cryer MWH, Inc.	M.S. – Civil Engineering M.S.- Environmental Biology B.S. – Biology	Special Status Aquatic Species and Habitats
Brian Liming MWH, Inc.	M.S. – Civil and Environmental Engineering B.S. – Ecosystems Analysis	Report QA/QC Review
Eric Zimmerman MWH, Inc.	M.A. – Geography (Cartography) B.A. – Geography B.A. – Mass Communication	GIS Analysis
Diana Barnes MWH, Inc.	A.A. – Secretarial Science	Word Processing and Formatting