Biological Monitoring Plan for the Delamar, Dry Lake and Cave Valley Stipulation

January 2011
Biologic Resources Team

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Invited Party:	Nevada Department of Wildlife

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Cover photo: Crystal Spring, Pahranagat Valley, May 2009. Photo by Tom Strekal, BIA.

PREFACE

Nothing in this Biological Monitoring Plan is intended to be inconsistent with the terms of the Stipulation regarding SNWA's Groundwater Applications in Delamar, Dry Lake and Cave Valley Hydrographic Basins.

In the event of a conflict, the Stipulation is the controlling document.

This Plan is not intended to amend or alter the Stipulation. This Plan is designed to implement the terms of the Stipulation to achieve the common goal as defined in the Stipulation.

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LIST OF ACRONYMS

ANOVA	Analysis of Variance
ANS	Aquatic Nuisance Species
BLM	Bureau of Land Management
BWG	Biological Work Group
BRT	Biologic Resources Team
°C	Degrees Celsius
CAP	Conservation Action Planning
CPOM	Coarse Particulate Organic Matter
CPUE	Catch Per Unit Effort
DDC	Delamar Valley, Dry Lake Valley, and Cave Valley Hydrographic Basins
DMP	Data Management Plan
DO	Dissolved Oxygen
DOI	U.S. Department of the Interior
EC	Executive Committee
Ec	Electrical conductivity
EPA	Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, Trichoptera
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
°F	Degrees Fahrenheit
FGDC	Federal Geographic Data Committee
FWS	U.S. Fish and Wildlife Service
GPS	Global Positioning System
HACCP	Hazardous Analysis and Critical Control Points
HB	Hydrographic Basin
HMU	Hydro Morphological Unit
KEA	Key Ecological Attribute
LVVWD	Las Vegas Valley Water District
MODFLOW	Modular Three-Dimensional Finite-Difference Groundwater Model
N	Nitrogen
NAC	Nevada Administrative Code
NDOW	Nevada Department of Wildlife
NDWR	Nevada Division of Water Resources
NNHP	Nevada Natural Heritage Program
NSE	Nevada State Engineer
NWR	National Wildlife Refuge
P	Phosphorous
Plan	DDC Biological Monitoring Plan
Pahranagat NWR	Pahranagat National Wildlife Refuge
POD	Point(s) of Diversion

LIST OF ACRONYMS CONTINUED

QA/QC	Quality Assurance and Quality Control
RDBMS	Relational Database Management System
SNVCS	Standardized National Vegetation Classification System
SNWA	Southern Nevada Water Authority
SWCA	SWCA Environmental Consultants
T	Temperature
TNC	The Nature Conservancy
TRP	Technical Review Panel
USDI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMA	Wildlife Management Area
WRCC	Western Region Climate Center
WRFS	White River Flow System

CONVERSION FACTORS

UNITS OF LENGTH

1 inch	=	2.54 centimeters (cm)	1 centimeter	=	0.39 inch (in)
1 foot	=	30.48 centimeters (cm)	1 meter	=	39.37 inches (in)
1 foot	=	0.305 meters (m)	1 meter	=	3.28 feet (ft)
1 yard	=	0.914 meters (m)	1 meter	=	1.09 yard (yd)
1 mile	=	1609 meters (m)	1 kilometer	=	3,281 feet (ft)
1 mile	=	1.609 kilometers (km)	1 kilometer	=	0.62 miles (mi)

UNITS OF AREA

1 square foot	=	929 square centimeters (cm^2)	1 square centimeter	=	0.155 square inches (in^2)
1 square foot	=	0.093 square meters (m^2)	1 square meter	=	10.76 square feet (ft^2)
1 square yard	=	0.837 square meters (m^2)	1 square meter	=	3.59 square yards (yd^2)
1 acre	=	4047 square meters (m^2)	1 hectare	=	2.47 acres (ac)
1 acre	=	0.405 hectares (ha)	1 square kilometer	=	247 acres (ac)
1 square mile	=	2.59 square kilometers (km^2)	1 square kilometer	=	0.386 square miles (mi^2)

UNITS OF VOLUME

1 cubic foot	=	7.48 gallons (gal)	1 gallon	=	0.134 cubic foot (ft^3)
1 acre foot	=	325,851 gallons (gal)	1 cubic meter	=	35.29 cubic feet (ft^3)
1 acre foot	=	43,560 cubic feet (ft^3)	1 cubic meter	=	263.9 gallons (gal)
1 acre foot	=	1233.6 cubic meters (m^3)			

UNITS OF WEIGHT

1 ounce	=	28.4 grams (g)			
1 pound	=	454 grams (g)			
1 pound	=	0.454 kilograms (kg)	1 kilogram	=	2.205 pounds (lbs)

LIST OF MEASUREMENTS

afy	acre-feet per year
cfs	cubic feet per second
cm	centimeter
ft bgs	feet below ground surface
mg/l	milligrams per liter
µS/cm	microSiemens per centimeter

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EXECUTIVE SUMMARY

Overview

This biological monitoring plan is a component of a Stipulated agreement (Stipulation; Appendix A) between the Southern Nevada Water Authority (SNWA) and four Department of Interior (DOI) bureaus (Bureau of Indian Affairs, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service) regarding SNWA's 1989 groundwater applications in Delamar Valley, Dry Lake Valley, and Cave Valley Hydrographic Basins (DDC) in southeastern Nevada. The Stipulation requires that SNWA, in cooperation with the DOI bureaus, develop and implement biological and hydrologic monitoring, management, and mitigation plans. These plans will be administered by a Biologic Resources Team (BRT) and a hydrologic Technical Review Panel (TRP), respectively, that include membership by all Stipulation signatory agencies and report to a management-level Executive Committee (EC).

This Plan is designed to be consistent with the common goal of the Parties, as stated in the Stipulation: To manage the development of groundwater by SNWA in DDC without causing injury to Federal water rights and/or Unreasonable Adverse Effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in DDC (Stipulation page 4 Recital H; Appendix A). This common goal includes taking actions that protect and recover Special Status Species currently listed pursuant to the Endangered Species Act (ESA), and taking actions to avoid additional ESA listings (Stipulation Exhibit A page 2 Paragraph A; Appendix A). The Area of Interest includes DDC, Pahranagat Valley Hydrographic Basin (HB), and southern White River Valley HB.

The Stipulation requires the BRT to develop and implement a biological monitoring plan that will assess baseline conditions at monitoring sites for Special Status Species and groundwater-influenced habitats and to identify and monitor responses with respect to changes in biologic resources resulting from SNWA groundwater withdrawal in DDC. The Stipulation Exhibit A states that biological monitoring should focus on Special Status Species and their habitats within the Area of Interest that are most likely to be affected by any hydrologic changes that may result from SNWA's groundwater withdrawal in DDC.

Specifically, the purpose of biological monitoring is to collect baseline information at monitoring sites on those Special Status Species and/or habitats that have greater probability to be affected by hydrologic changes that may result from SNWA groundwater withdrawal in DDC; further the understanding of groundwater-influenced ecosystem dynamics; and identify and monitor responses of Special Status Species and/or their habitats to hydrologic and biological changes that may result from SNWA's DDC groundwater withdrawal. To carry out this purpose, the BRT identified Special Status Species that depend on groundwater and associated surface water expressions at sites with greater probability to be affected by future SNWA groundwater withdrawal in DDC. Explicit decision-making criteria were used to design and select components of this Plan, as described in Chapters 3 and 4. A lack of sites with potential for impact within DDC, a desire for reference sites, and a need to reach consensus regarding species or areas of special environmental concern also influenced Plan components and design.

This Plan focuses on Special Status Species that are dependent on groundwater-influenced ecosystems for all or part of their life cycles. A groundwater-influenced ecosystem is an ecosystem that is substantially affected by groundwater at least most of the year, where the vegetation utilizes substantial amounts of groundwater on an annual basis, and where the composition, structure, or productivity is dependent on this groundwater utilization. Special

Status Species, as defined in the Stipulation, are groundwater dependent (i.e., dependent on groundwater-influenced ecosystems) and any of the following: 1) listed as threatened or endangered by FWS under the Endangered Species Act (ESA), or a proposed or candidate species for ESA listing; 2) listed as a Sensitive Species by Nevada BLM State Director; 3) listed by the State of Nevada in a category implying but not limited to potential endangerment or extinction; or 4) designated as critically imperiled or imperiled across its entire range (G1 or G2 rank) by the Nevada Natural Heritage Program (NNHP) (Stipulation Exhibit A page 14; Appendix A). Special Status Species were selected to be monitored either directly or indirectly using a habitat-based approach.

Chapter 1 provides an overview of the Plan relative to the Stipulation, and a description of the Study Area, including habitats and their related biological resources. The goals and objectives of the Plan are described in Chapter 2. Chapters 3 and 4 document the approach used to develop the Plan and the Plan framework. Chapter 5 describes the monitoring protocols, Chapter 6 outlines data management and reporting requirements, and Chapter 7 provides the Plan implementation timeline.

Plan Design

The BRT used components of The Nature Conservancy's (TNC) Conservation Action Planning (CAP) process (described in Chapter 3) and explicit decision-making criteria (described in Chapters 3 and 4) to construct the biological monitoring program.

Groundwater-influenced ecosystems within the Area of Interest were chosen for monitoring based on whether they might be impacted by SNWA groundwater withdrawal in DDC, and whether they harbor Special Status Species. The three groundwater-influenced ecosystems included in this Plan are spring complexes, perennial streams and meadows (described in Chapter 4).

Within these groundwater-influenced ecosystems, Special Status Species were chosen to be directly or indirectly monitored (using a habitat- based approach). BRT will directly monitor those Special Status Species that are strongly tied to aquatic ecosystems, providing the best opportunity for correlating species' responses with any ecosystem changes resulting from SNWA groundwater withdrawal in DDC. Other Special Status Species that are more wide-ranging or migratory will be monitored using a habitat-based approach (i.e., particular components of the species' habitat will be monitored but not the species themselves). A description of species to be directly and indirectly monitored is provided in Chapter 4.

Site selection was based on TRP input regarding likelihood of impact, the TRP's hydrologic monitoring network, and whether a site provided habitat for one or more Special Status Species. A total of 16 sites in the Area of Interest were selected for monitoring: six in DDC, five in White River Valley HB, and five in Pahranagat Valley HB. Chapter 4 describes the site selection process and each of the monitoring sites.

Limited surface water resources in DDC complicated site selection in this portion of the Area of Interest. Therefore, DDC site selection primarily focused on whether a given DDC groundwater-influenced ecosystem provided the best available representation of water resources in those hydrographic basins. Site selection in southern White River Valley and Pahranagat Valley HBs was more straight-forward because of the presence of regional valley floor springs and more abundant aquatic resources.

To facilitate site selection for Pahranagat and White River HBs, BRT developed decision-making criteria (Section 4.3.2, Figure 4.2) to use in conjunction with specific input from the

TRP. These criteria included an evaluation of 1) whether or not a Special Status Species (as defined by the Stipulation) was present, 2) the likelihood of potential effects from SNWA groundwater withdrawal in DDC, and 3) whether observed effects could potentially be attributed to SNWA groundwater withdrawal from DDC. The BRT relied heavily on guidance from the TRP relative to the second criteria. Some sites selected for monitoring did not met these criteria due to limited low-elevation surface water resources in DDC, and for some sites there was a lack of BRT and TRP consensus regarding the likelihood of effects. Additional factors influencing site selection included proximity to hydrologic monitoring sites, access, level of anthropogenic or natural disturbance, mitigation potential, and possible use as a reference site.

At each site, BRT identified Key Ecological Attributes (KEAs) and indicators to monitor. KEAs are characteristics that describe groundwater-influenced ecosystems or Special Status Species habitat and potentially are critical to their long-term viability or integrity including biological composition, interactions, and processes (Parrish et al. 2003). Indicators are measures to assess the KEAs. The BRT selected KEAs and indicators based on the following criteria: 1) strongly related to the status or condition of the groundwater-influenced ecosystem or Special Status Species habitat and possibly essential to its viability; 2) good indicator of ecosystem health, and may provide early warning of adverse effects resulting from SNWA groundwater withdrawal; and 3) reasonably feasible and readily measurable. The focus is therefore on features important to Special Status Species and those that will likely respond quickly to changes in groundwater levels or spring discharge, in order to provide early warning of potential Unreasonable Adverse Effects from SNWA groundwater withdrawal.

Specific monitoring protocols were developed by the BRT to measure each indicator or suite of indicators. The goal of protocol development and implementation was to establish a highly repeatable methodology that allows a quantifiable assessment of the indicators. The primary focus during protocol development was building upon the TRP hydrological monitoring network, applying protocols developed for the Biological Monitoring Plan for the Spring Valley Stipulation, and incorporating existing state and federal monitoring programs. Monitoring protocols are presented in Chapter 5.

Tiered Monitoring Approach

At each biological monitoring site, a Site Characterization will be conducted at the beginning of baseline sampling. The Site Characterization will address particular KEAs and indicators of concern at each site (described in Chapters 4 and 5). Site Characterization will provide a snapshot of conditions at the start of the monitoring program, offering an initial description of the natural resources and their condition and allowing for testing and establishing protocols. Site Characterization will be repeated at intervals (described in Section 4.5) to provide updates of site condition.

Prior to and during SNWA groundwater withdrawal from DDC, annual monitoring will be conducted at a Tier 1 or Tier 2 level of intensity.

Tier 1 monitoring will take place at a site when effects are not anticipated for decades or centuries, and at those sites with no to low potential for effect. Tier 1 consists of a basic suite of indicators that vary by site based on resources present, and will allow BRT to monitor general site condition, test assumptions regarding likelihood of impacts, and help determine the need for Tier 2 monitoring. Tier 1 will also describe baseline conditions; allow for on-going evaluation of conditions; establish ranges of variation for indicators; and document changes in particular Special Status Species and/or their habitats prior to any predicted impacts.

Tier 2 monitoring will begin at a site when potential effects are predicted within ten years. Tier 2 will consist of an expanded suite of indicators that will include all Tier 1 variables and additional variables, creating a more comprehensive data set. Tier 2 will accomplish all Tier 1 objectives, as well as facilitate BRT's assessment of biological responses (both species and habitat) to spring flow or groundwater level changes. Tier 2 will also enable the BRT to determine if adverse effects have occurred and, if so, whether they are potentially attributable to SNWA groundwater withdrawal.

The BRT will recommend to the EC that a shift from Tier 1 to Tier 2 be made if evidence suggests that SNWA groundwater withdrawal is affecting or has the potential to affect Special Status Species or their habitat within 10 years. Ten years of Tier 2 monitoring prior to withdrawal effects will create a more comprehensive baseline data set to assist with impact analysis, and will hopefully reveal ranges in variation of Tier 2 indicators under conditions that do not include SNWA groundwater withdrawal (e.g., wet and dry climatic conditions). This tiered approach also allows shifts from Tier 2 back to Tier 1. The following will be evaluated to determine whether a shift between Tier 1 and Tier 2 is warranted:

- hydrologic and biological data collected in accordance with the Stipulation,
- groundwater flow modeling results as interpreted and provided by the TRP, and
- other relevant hydrologic and biological information gathered by outside sources.

The BRT developed a decision-making tree and conducted a charting exercise to evaluate whether a site would be monitored at the Tier 1 or Tier 2 level, and when a shift from one tier to another would occur (see Section 4.5 for details). Based on the results of this risk-sensitivity analysis (shown in Figure 4-5), and using the decision-making criteria (displayed in Figure 4-4), no sites were categorized as high risk with the potential for short-term impacts (i.e., within a decade). Thus, all sites will be monitored at the Tier 1 level until further evidence that Tier 2 is warranted.

Even though the time line for potential effects as documented in the recently-vacated NSE Ruling is at least multiple decades to centuries, SNWA has agreed to more intensive baseline monitoring on a periodic basis at six sites that harbor specific species of concern (see Section 4.5 for details). This will be achieved by collecting data consistent with Tier 2 indicators during the first two years of Tier 1 monitoring, and periodically thereafter unless a shift from Tier 1 to Tier 2 monitoring occurs. This more intensive data collection will be conducted at Flag and Butterfield springs every 5 years, and Pahranagat Ditch and Hiko, Crystal and Ash springs every 10 years. As part of this Plan's adaptive approach, the frequency of monitoring at these six sites and the risk assessment for all monitoring sites are subject to modification with new information, including future NSE rulings, hydrologic data and updated plans of development (e.g., changes to Points of Diversion). Details regarding the adaptive nature of the risk assessment are provided in Section 4.5.

Data Analysis, Reporting, and Schedule of Activities

Data analysis and reporting are presented in Chapter 6. A Data Management Plan and suggested statistical protocols will be developed prior to and during the initial stages of data collection. Per the Stipulation, biological data collected through the Plan shall be made available to the Parties within 90 calendar days of the end of each sampling period using a shared data repository website administered by SNWA.

Following each year of data collection, SNWA shall report the results of all monitoring and sampling pursuant to the Plan in an annual report, which shall be submitted to the EC and the

NSE by March 31 per the Stipulation. The Parties will have an opportunity to provide comments on the annual reports prior to submittal, and can also submit comments to the NSE at their discretion. Final annual reports will be distributed to BRT Party members via a shared data-repository website administered by SNWA; provided to landowners participating in the monitoring program if desired; submitted to the NSE; and available to the public upon request to SNWA. The BRT will also conduct further analyses and interpretation outside of the annual reports, and will prepare a comprehensive report every five years during Plan implementation as a collaborative BRT effort. Final five-year reports will also be available to the public upon request to SNWA. Details on reporting are provided in Chapter 6.

Plan implementation and schedule are presented in Chapter 7. Data collection will begin three years prior to projected SNWA groundwater withdrawal in DDC. As such, it is likely that there may be an interim period following Plan finalization without full implementation of the Plan. However, components of the Plan that are already on-going are expected to continue, such as portions of the DDC Stipulation hydrologic monitoring program and long-term wildlife surveys conducted by NDOW and other entities. A timeline for Plan implementation is presented in Table 7-2.

Future Efforts

Prior to SNWA groundwater withdrawal from DDC, BRT will develop a framework for describing Unreasonable Adverse Effects. The purposes of the framework are to better enable the BRT to predict and detect potential Unreasonable Adverse Effects; identify in a timely manner the need for further data collection and analysis; and recommend management actions to the EC to avoid and/or mitigate Unreasonable Adverse Effects per the Stipulation and the Hydrologic Management and Mitigation Operation Plan (Operation Plan, as described in the Stipulation Exhibit A page 11 Paragraph D; Appendix A). Further discussion of suggested components and intent of the framework can be found in Section 3.4.

This Plan does not specifically address mitigation. Potential mitigation activities will be outlined in the Operation Plan, which is to be developed cooperatively by the Parties prior to DDC groundwater withdrawal for production (Stipulation Exhibit A page 11 Paragraph D; Appendix A). The Operation Plan will define a range of specific mitigation actions that may be implemented if an early warning indicator is reached. Data and information collected under this Plan will inform BRT of potential mitigation opportunities.

Adaptive Framework

The biological monitoring program is designed to be adaptive so that it can evolve in response to new information and technologies, changes in monitoring questions or goals, and changes in analytical approach. As data are collected, BRT will develop an improved understanding of how indicator values vary over time and how indicators respond to different environmental and anthropogenic stressors, which will help BRT refine its definition of Unreasonable Adverse Effect. The adaptive framework also allows for adjustment of monitoring sites and indicators, which could change based on Special Status Species presence, management goals, location of production wells, risk assessment or other factors. Finally, spring discharge and groundwater monitoring well data along with groundwater flow modeling results will be routinely evaluated for the purpose of evaluating whether a shift in the level of monitoring intensity (between Tier 1 and Tier 2) is needed at any particular site. This adaptive monitoring approach allows flexibility for Plan modification as information is obtained, data are analyzed and reviewed, and improvements are identified.

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1.0 INTRODUCTION AND BACKGROUND

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  - **1.3.2.2 Land Ownership and Management**
  - **1.3.2.3 Biological Resources**

The Biological Monitoring Plan for the Delamar, Dry Lake and Cave Valleys Stipulation (Plan) is a component of an agreement (Stipulation; Appendix A) between the Southern Nevada Water Authority (SNWA) and four U.S. Department of the Interior (DOI) bureaus: Bureau of Indian Affairs, Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (FWS), and National Park Service (collectively referred to as the Parties). This Plan is designed to be consistent with the common goal of the Parties, as stated in the Stipulation: To manage the development of groundwater by SNWA in Delamar Valley, Dry Lake Valley, and Cave Valley Hydrographic Basins (DDC) without causing injury to Federal Water Rights and/or Unreasonable Adverse Effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in DDC (Stipulation page 4 Recital H; Appendix A). This common goal includes taking actions that protect and recover Special Status Species currently listed pursuant to the ESA, and taking actions to avoid additional ESA listings (Stipulation Exhibit A page 2 Paragraph A; Appendix A). The Area of Interest includes DDC, Pahranagat Valley Hydrographic Basin (HB), and southern White River Valley HB (Figure 1-1).

The purpose of biological monitoring is to collect baseline information at specific locations on those Special Status Species and/or their habitats that are most likely to be affected by hydrologic changes that may result from SNWA groundwater withdrawal in DDC (per the Stipulation Exhibit A; Appendix A); further the understanding of groundwater-influenced ecosystem dynamics; and identify and monitor responses of Special Status Species and/or their habitats to hydrologic and biological changes that may result from SNWA's groundwater withdrawal. To carry out this purpose, the BRT identified Special Status Species that depend on groundwater and associated surface water expressions at sites with greater probability to be affected by future SNWA groundwater withdrawal in DDC. Explicit decision-making criteria were used to design and select components of this Plan, as described in Chapters 3 and 4. Sites with no to low potential for impact within DDC, a desire for reference sites, and a need to reach consensus regarding species or areas of special environmental concern also influenced Plan components and design.

This Plan focuses on Special Status Species that are dependent on groundwater-influenced ecosystems for all or part of their life cycles. A groundwater-influenced ecosystem is defined in this Plan as an ecosystem that is substantially affected by groundwater at least most of the year, where the vegetation utilizes substantial amounts of groundwater on an annual basis, and where the composition, structure, or productivity is dependent on this groundwater utilization. Special Status Species, as defined in the Stipulation, are groundwater dependent and any of the following: 1) listed as threatened or endangered by FWS under the Endangered Species Act (ESA), or a proposed or candidate species for ESA listing; 2) listed as a Sensitive Species by Nevada BLM State Director; 3) listed by the State of Nevada in a category implying but not limited to potential endangerment or extinction; or 4) designated as critically imperiled or imperiled across its entire range (G1 or G2 rank) by the Nevada Natural Heritage Program (NNHP) (Stipulation Exhibit A page 14; Appendix A).

The use of the term "groundwater-influenced ecosystem" is not meant to amend or alter the Stipulation. The Stipulation employs the term Water Dependent Ecosystem, specifically defined as follows: "Those Special Status Species habitat areas in the Area of Interest that are dependent upon groundwater levels and/or local and regional spring flows" (Stipulation Exhibit A page 12 Paragraph F; Appendix A). The BRT recognizes that Water Dependent Ecosystem as defined in the Stipulation is the controlling term. However, "groundwater-influenced ecosystem" provides BRT with a more biologically-meaningful term, as many species that use groundwater are not completely dependent on groundwater, and some vegetation communities that rely on groundwater can exist without a permanent groundwater table in the rooting zone (albeit at a lower level of productivity). Despite this terminology divergence, the Plan's focus remains on those Special Status Species and habitats within the Area of Interest that may be affected by changes to groundwater levels and/or spring flows, so as not to depart from the Stipulation's intent.

This Plan is a dynamic document to be reviewed on a regular basis and revised as needed. This adaptive approach will allow the Parties to regularly evaluate the effectiveness of the Plan and determine whether monitoring is meeting the goals outlined herein and in the Stipulation. It will also allow the Parties to revise monitoring based on improved understanding of ecosystem dynamics and hydrologic and biological responses to SNWA's groundwater withdrawal, and to adapt monitoring to new management questions and goals.

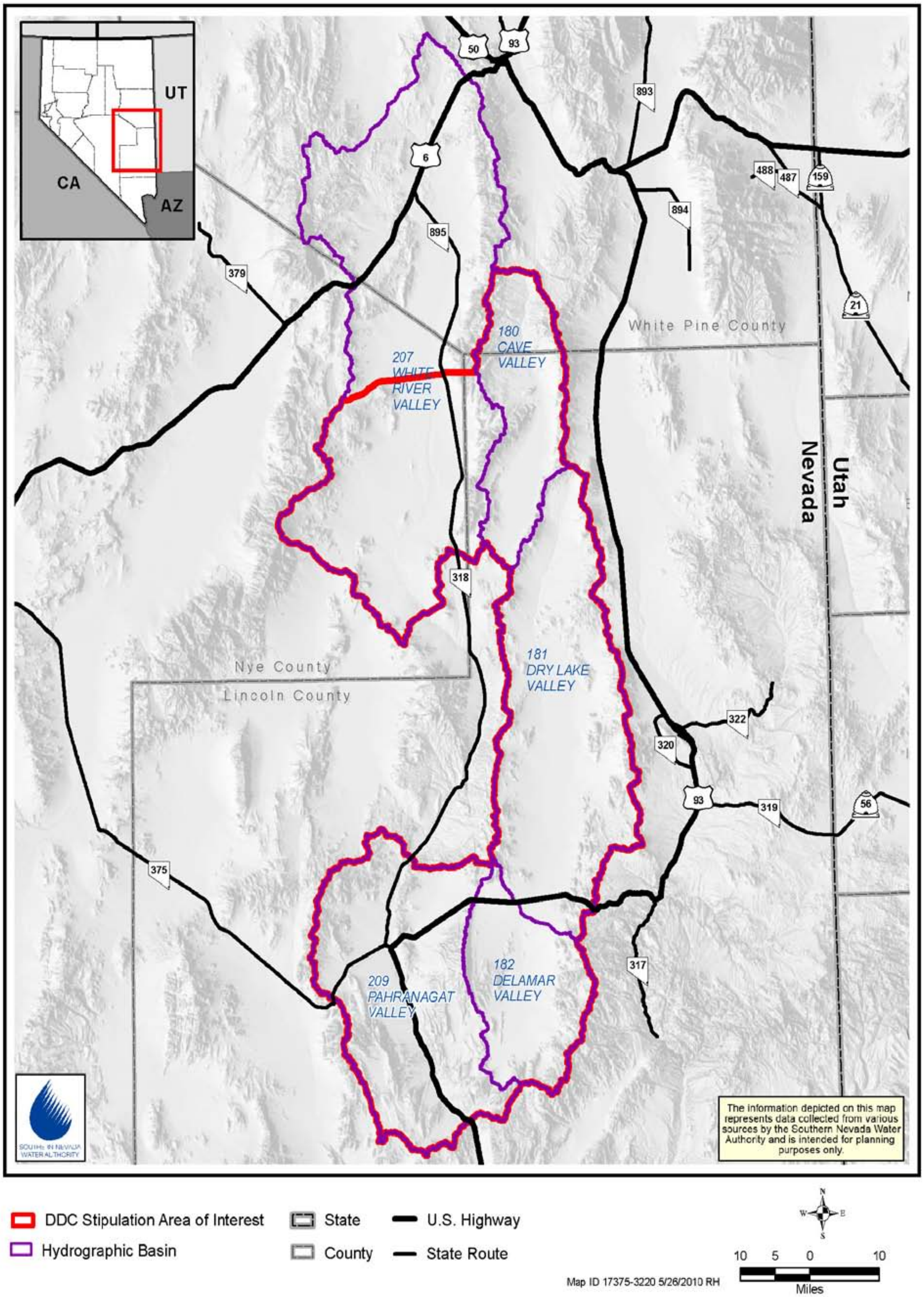

Figure 1-1 Stipulated Area of Interest

1.1 STIPULATION REGARDING SNWA'S GROUNDWATER APPLICATIONS IN DELAMAR, DRY LAKE AND CAVE VALLEY HYDROGRAPHIC BASINS

In October 1989, Las Vegas Valley Water District (LVVWD) filed Applications 53987-53992 with the Nevada State Engineer (NSE) for a combined 48 cubic feet per second (cfs), or approximately 34,752 acre-feet per year (afy), of groundwater withdrawals in DDC. On December 2, 2003, SNWA assumed full interest in these applications by agreement with LVVWD. SNWA intends to develop and export groundwater from DDC for municipal use in the Las Vegas area, subject to conditions set by the NSE.

To protect their water rights and Federal Resources in the Area of Interest, the DOI bureaus protested SNWA's applications. On January 7, 2008, prior to NSE's administrative hearing on SNWA's DDC groundwater applications, SNWA and the DOI bureaus entered into a Stipulation regarding these applications. The Stipulation requires that SNWA, in cooperation with the DOI bureaus, implement hydrologic and biological monitoring, management, and mitigation plans (see Stipulation Exhibit A in Appendix A). The Stipulation requires the formation of a Biologic Resources Team (BRT) to develop and implement a biological monitoring plan. The hydrologic Technical Review Panel (TRP) formed pursuant to the Spring Valley Stipulation will expand its duties to include hydrologic monitoring in the basins that are the subject of the DDC Stipulation. Similarly, the Executive Committee (EC) established pursuant to the Spring Valley Stipulation will expand its duties to include review of BRT and TRP recommendations, negotiation and resolution of issues, and implementation of actions specific to this Stipulation. Membership in each group (BRT, TRP, and EC) consists of representatives from each of the Parties to the Stipulation.

To provide technical expertise to the BRT, the Stipulation allows for participation by Nevada Department of Wildlife (NDOW) as well as other entities with specific biological expertise that may be identified but are not party to the Stipulation. The BRT invited NDOW to participate in development of this Plan, as well as consultants to provide additional expertise (Great Basin Bird Observatory, KS2 Ecological Field Services, and BIO-WEST). The Nature Conservancy (TNC) facilitated development of this Plan using components of its Conservation Action Planning (CAP) process, which will be described in Chapter 3. The NSE was also invited to observe the process of Plan development in an effort to reduce expense and duplication of work, and participated in a BRT/TRP tour of the stipulated Area of Interest and three BRT meetings. The NSE participated to a greater extent during the development of the Biological Monitoring Plan for the Spring Valley Stipulation (BWG 2009), which was approved by the NSE and served as an example for this Plan.

1.1.1 Stipulation Requirements for Biological Monitoring

The Stipulation requires the BRT to develop and implement a biological monitoring plan that will assess baseline conditions at monitoring sites for Special Status Species and groundwater-influenced habitats and to identify and monitor responses with respect to changes in biologic resources resulting from SNWA groundwater withdrawal in DDC (Stipulation Exhibit A page 13; Appendix A). The Stipulation Exhibit A states that biological monitoring should focus on Special Status Species and their habitats within the Area of Interest that are most likely to be affected by any hydrologic changes that may result from SNWA's groundwater withdrawal in DDC (Stipulation Exhibit A page 9 Paragraph A; Appendix A).

Specific provisions of the Stipulation relative to biological monitoring are:

- In coordination with the TRP, identify areas of Special Status Species habitat that are most likely to be affected by hydrologic changes that may result from SNWA groundwater withdrawal in DDC;
- Develop and implement a baseline monitoring program, and assemble available baseline information, for the Area of Interest to help establish natural variability of groundwater-influenced ecosystems that are habitat for Special Status Species;
- Develop and implement a monitoring plan for detecting Unreasonable Adverse Effects to Special Status Species, including identification of indicators to monitor to establish early warning of Unreasonable Adverse Effects resulting from SNWA groundwater withdrawal in DDC;
- Coordinate with the Pahranagat Valley and White River Valley Recovery Implementation Teams;
- Identify and seek funding to implement research projects to help characterize the relationship between groundwater and Special Status Species habitats, including responses to changing groundwater elevations and spring flows;
- Specify procedures for data management, sharing, analysis, and reporting;
- Develop recommendations for the EC on the appropriate course of action to take to avoid and/or mitigate Unreasonable Adverse Effects to Federal Resources and Special Status Species; and
- Monitor the outcome of mitigation actions approved by the EC.

1.1.2 Stipulation Requirements for Hydrologic Monitoring

The Stipulation requires the TRP to establish and oversee implementation of a hydrologic monitoring network comprised of SNWA exploratory wells, SNWA production wells, new and existing monitoring wells, and spring discharge sites. Monitoring well sites will be selected to: 1) help characterize groundwater movement from DDC to White River Valley, Pahroc Valley, and Pahranagat Valley HBs (collectively, these three valleys are referred to below as the “Adjacent HBs”); 2) provide early warning of the spread, if any, of drawdown toward Federal water rights and Federal Resources; 3) help further the understanding of the relationship between the alluvial and bedrock aquifers; and 4) provide data for future groundwater model calibration.

Specific provisions of the Stipulation relative to hydrologic monitoring are:

- Monitor groundwater levels in a total of 15 existing monitoring wells within DDC and Adjacent HBs, nine on a quarterly and six on a continuous basis;
- Monitor groundwater levels continuously at four new monitoring wells in or around DDC and Adjacent HBs;
- Record discharge and water levels in all SNWA production wells within DDC on a continuous basis;
- Monitor spring discharge biannually on as many as eight sites within DDC and monitor spring discharge (either biannually or continuously) on as many as eight sites within the Adjacent HBs. An additional spring on Pahranagat National Wildlife Refuge (Pahranagat NWR) will be monitored by FWS, and the data will be provided to TRP;
- Collect data for at least two years at all new wells and spring discharge sites prior to any groundwater withdrawals, other than for aquifer tests and construction;

- Ensure that at least five years of monitoring data exist for wells and spring discharge sites that are currently being monitored prior to any groundwater withdrawals, other than for aquifer tests and construction;
- In coordination with the BRT, collect water samples twice yearly for water chemistry analysis at 10 of the hydrologic monitoring sites, and once every five years following the start of the groundwater withdrawals by SNWA, other than for aquifer tests and construction;
- Review coverage of existing precipitation stations and recommend additional stations be established, if needed; and
- Cooperate on maintaining, updating, and operating an adequately calibrated and validated regional groundwater flow model that has been agreed upon by all Stipulation parties.

1.2 NEVADA STATE ENGINEER RULING

On July 9, 2008, the NSE issued Ruling 5875 granting in part SNWA applications to appropriate groundwater from DDC. The Seventh Judicial District Court of the State of Nevada later ordered that Ruling 5875 be vacated and remanded back to the NSE for further proceedings (Carter-Griffin Inc., et. al. v. NSE, et. al., October 19, 2009). An opinion by the Nevada Supreme Court in a separate appeal concluded that the NSE must re-notice SNWA's original groundwater applications and reopen the protest period (Great Basin Water Network, et. al. v. NSE, et. al., June 17, 2010). The NSE subsequently released an interpretation of the opinion, indicating that once the applications are re-noticed, the hearing process will be completed within one year from the deadline for filing protests (July 7, 2010).

While NSE Ruling 5875 has been vacated, the information and conclusions regarding technical issues contained in Ruling 5875 remain a foundation of this Plan. The BRT anticipates that after SNWA's DDC applications are re-noticed, a new hearing will take place and a new ruling issued. At that time the BRT will review the ruling and potentially revise this Plan as needed, in accordance with the Plan's adaptive approach. The Stipulation, which was signed prior to Ruling 5875, remains valid and binding, and the BRT intends to continue to implement its requirements. SNWA intends to submit this Plan to the NSE to satisfy potential requirements set forth in future rulings.

1.3 STUDY AREA

1.3.1 Areas of Potential Groundwater Development

SNWA application Points of Diversion (POD) and potential groundwater exploratory areas in DDC are depicted in Figure 1-2. SNWA will likely seek to change the PODs, with the objective of ensuring well production while minimizing effects to senior water rights and Special Status Species and/or their habitats. Geophysical surveys, detailed geologic mapping, exploratory well drilling, and groundwater flow modeling are being conducted as part of SNWA's groundwater exploratory program to determine potential locations of future groundwater development facilities. Selection of sites for production wells will consider hydrogeologic characteristics (e.g., placement relative to fault zones), well spacing requirements, site access, proximity to main or lateral pipelines, avoidance of Wilderness Areas, and minimizing impacts to sensitive environmental resources and sensitive areas to the extent practicable.

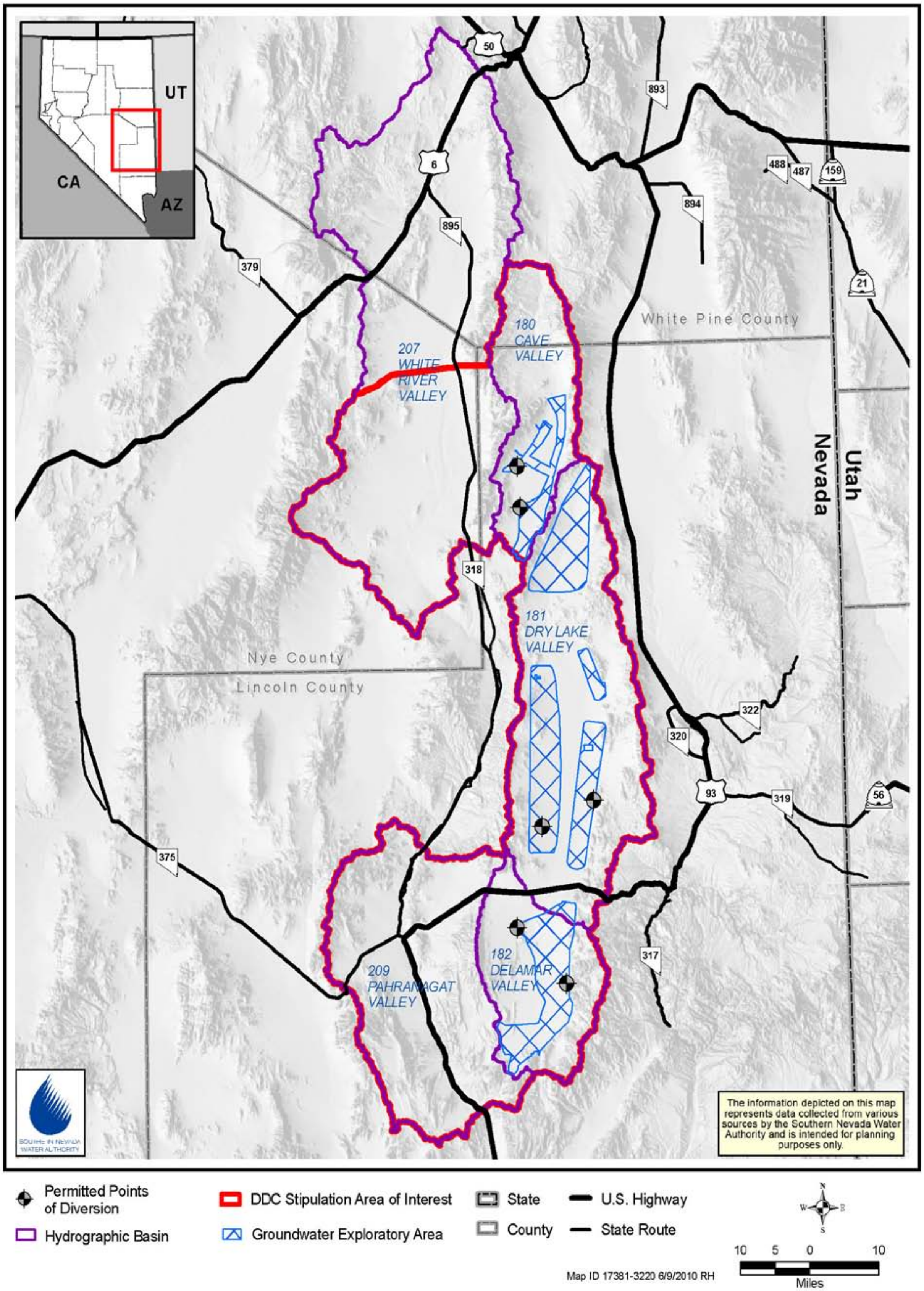

Figure 1-2 SNWA Application Points of Diversion and Groundwater Exploratory Areas within DDC

1.3.2 Area of Interest

The stipulated Area of Interest, which is approximately 110 miles long north to south and encompasses approximately 2 million acres, is located within the WRFS of eastern Nevada (Figures 1-2 and 1-3). It includes all or parts of five HBs: the three basins in which SNWA has applied for groundwater rights (DDC) and two down-gradient basins (Pahranagat Valley HB and the southern portion of White River Valley HB that is south of Hardy Springs). Southern White River Valley and Pahranagat Valley HBs are included in the Area of Interest because of the potential for inter-basin groundwater flow from DDC. Pahroc Valley HB, which lies between Cave Valley and Pahranagat Valley HBs, is excluded from the Area of Interest because no surface water features are present.

The Area of Interest is located in the Basin and Range Province. During the Cenozoic Era, the Earth's crust in this area began to stretch in an east-west direction, forming the mountain ranges of relatively impermeable bedrock that are oriented in a north-south direction (Harper et al. 1998). Erosion of these mountains has carried sediments down to the valleys and created alluvial fans, which are classic geologic features of basin and range topography. Sediments carried to the valley floors have accumulated in layers thousands of feet thick. Major mountain ranges in the Area of Interest include Schell Creek, Highland, Bristol, Fairview, and Delamar in the east; Granite, North Pahroc, and Pahranagat in the west; and South Pahroc and Egan in the middle. Valley floor elevations within the Area of Interest range from approximately 3,500 to 7,000 feet.

The climate in the Area of Interest is characterized by transverse longitudinal and latitudinal gradients of increasing precipitation and decreasing temperature from south to north and west to east, with concomitant changes from low to high elevations. The climate is predominantly dry with wide daily temperature fluctuation. Weather documented at Pahranagat NWR (3400 ft. elevation) between 1964 and 2008 (Western Regional Climate Center <http://www.wrcc.dri.edu/>) characterizes extreme southern and low elevation portions of the Area of Interest. July is the hottest month with an average maximum temperature of 99˚F and an average minimum of 64˚F. December is the coldest month with an average maximum temperature of 53˚ F and an average minimum of 27˚ F. Average total annual precipitation is 6.3 inches. Precipitation occurs throughout the year but is bimodal with most occurring in late winter and early spring followed by another smaller peak in late summer and early fall. Extreme northern and upper elevation weather is characterized by observations recorded at the Cattle Camp Remote Automated Weather Station (7300 ft. elevation) between 1994 and 2009 (Western Regional Climate Center http://www.raws.dri.edu/). In July the average maximum and minimum temperatures are 87˚ F and 49˚ F, respectively. In December the average maximum and minimum temperatures are 41˚ F and 12˚ F, respectively. The average total annual (1995 – 2008) precipitation is 9.6 inches.

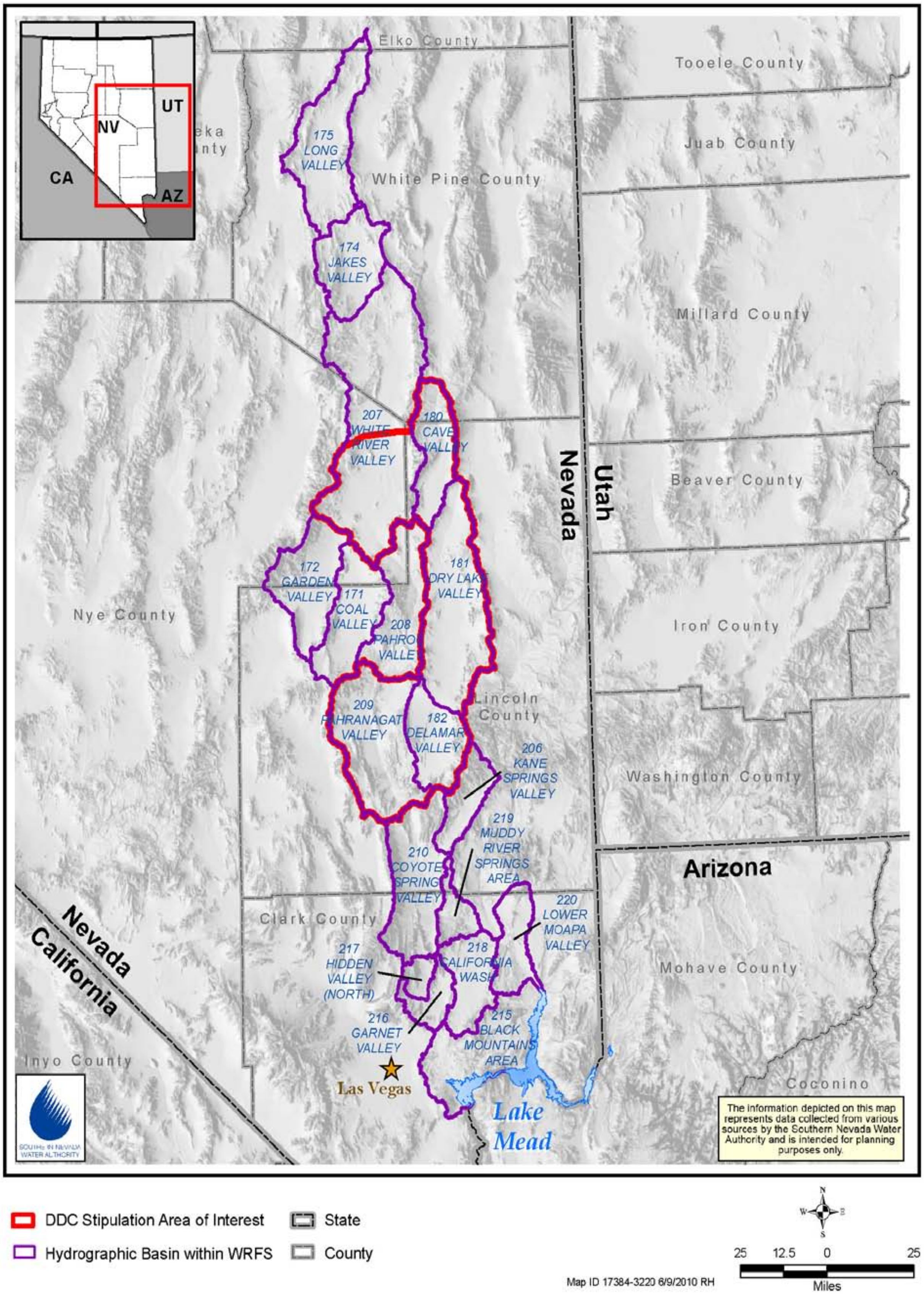

Figure 1-3 White River Flow System and the Stipulated Area of Interest

1.3.2.1 White River Flow System

The White River Flow System (WRFS) is a regional groundwater flow system that occurs within the Basin and Range Province, which is composed of north-south trending arid valleys bounded by mountain ranges (Figure 1-3). As currently described in the groundwater flow model for the draft Environmental Impact Statement for SNWA's Clark, Lincoln, and White Pine Counties Groundwater Development Project, the WRFS consists of 19 hydraulically-interconnected basins spanning across approximately 250 miles, extending from Long Valley, Nevada to the Black Mountains Area, Nevada (Figure 1-3). However, the WRFS has been variously described over the years (Eakin 1966, Dettinger et al. 1995, Prudic et al. 1995, LVVWD 2001). Within the WRFS, the basin-fill aquifer is discontinuous, generally occurring within the valleys between the mountain ranges. Regional groundwater movement is predominantly north to south through the carbonate aquifer, largely facilitated by the north-south trending faults (SNWA 2007a).

Within DDC, discharge from the regional flow system is thought to be primarily through subsurface, inter-basin flow. Inter-basin flow is predominantly north to south, and all DDC springs identified in the recently-vacated NSE Ruling 5875 (Parker Station, Cave, Meloy, Coyote and Grassy springs) were described by the NSE as mountain-block springs not directly connected to the principal groundwater aquifer (NSE Ruling pages 26-27). The recently-vacated NSE Ruling 5875 also acknowledged evidence of inter-basin flow into White River Valley HB and Pahranagat Valley HB (NSE Ruling pages 16-18). Any conclusions made in future NSE rulings in reference to inter-basin flow and potential impacts from SNWA groundwater withdrawal in DDC will be considered by the BRT.

1.3.2.2 Land Ownership and Management

Land ownership or management in the Area of Interest is currently 1.5 % private, 0.6 % state, and 97.9 % federal (95.1 % BLM, 0.7 % US Forest Service, and FWS 2.1 %) (Figure 1-4). The DDC valley floors are primarily publicly owned, with grazing and recreation as the primary land uses. Land use in the valley floors of White River Valley and Pahranagat Valley HBs is primarily private pasture or crops. Key Pittman Wildlife Management Area (WMA) and Pahranagat NWR are located in Pahranagat Valley HB, and Wayne E. Kirch WMA is located in White River Valley HB.

Water rights in DDC are mostly associated with mountain-block springs, with a limited number of water rights associated with intermittent streams and small reservoirs in the lower elevations. The majority of these water rights are for stock water.

In White River Valley HB, south of the Wayne E. Kirch WMA, current water use is primarily associated with irrigation and stock water rights along the ephemeral White River. In the WMA, water is primarily managed to support migratory waterfowl.

Pahranagat Valley HB water use is primarily associated with irrigation at this time. Currently, approximately 60% of the water used for irrigation comes from surface water outflows from regional carbonate springs, with the remainder pumped from carbonate and basin aquifers. According to Nevada Division of Water Resources (NDWR), irrigation in Pahranagat Valley HB in 2009 accounted for approximately 95% of groundwater pumpage (NDWR 2010)]. Water rights held by private landowners and FWS (for Pahranagat NWR) are currently dispersed by season. Private land owners have water rights for the irrigation season, during which time Pahranagat NWR receives tail water. During the non-irrigation season, Pahranagat NWR has a winter water right that supplies their lakes. In Pahranagat NWR and Key Pittman WMA, water is has been primarily managed to support migratory waterfowl.

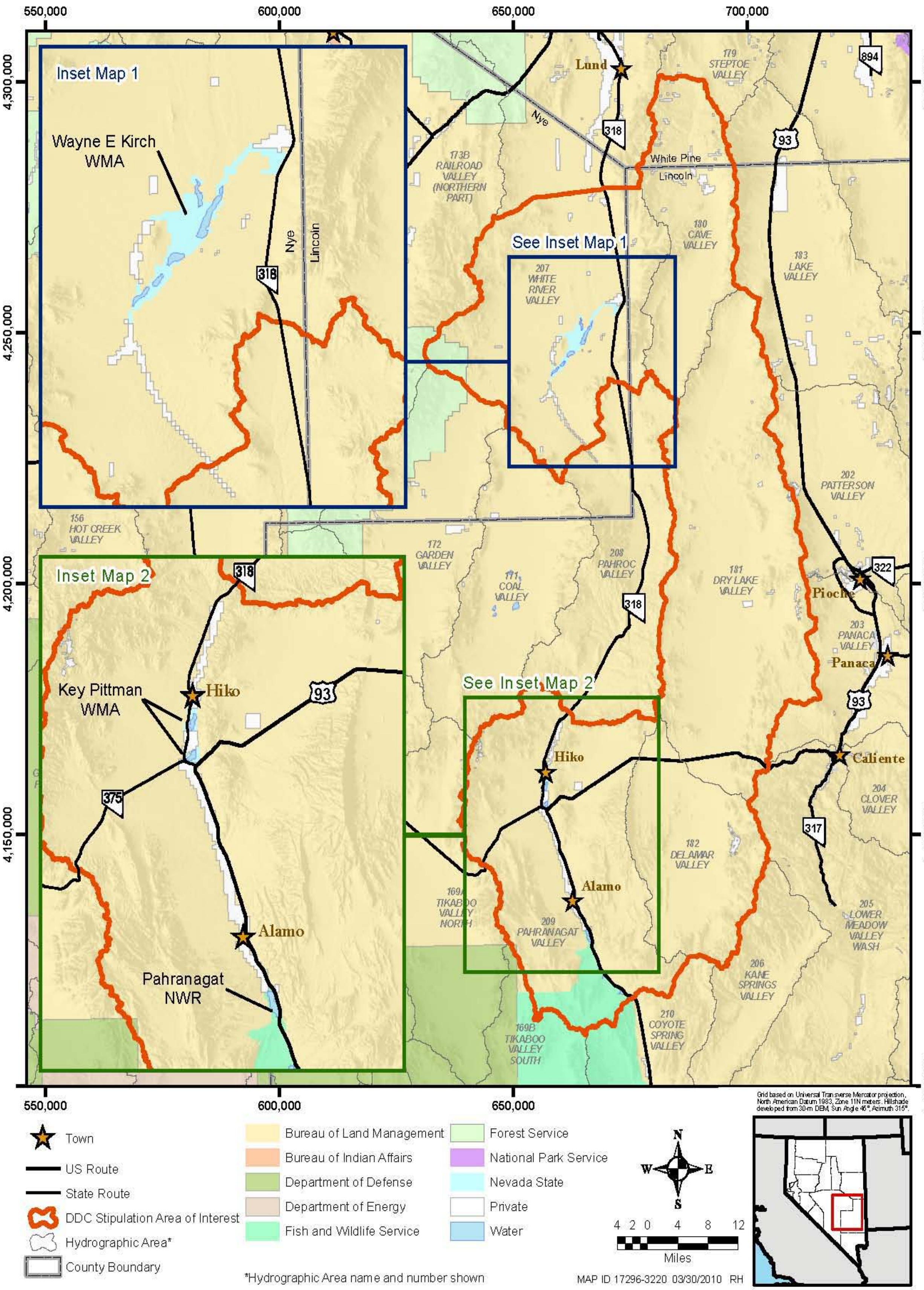

Figure 1-4 Land Status within the Stipulated Area of Interest

1.3.2.3 Biological Resources

The Area of Interest overlaps the Mojave and Great Basin Desert Ecoregions, with Delamar and southern Dry Lake Valley HBs representing a transitional area between the two regions (Hunt 1967). The predominant valley-floor vegetation community within the Great Basin Desert portion of the Area of Interest is sagebrush shrubland, with common species including big sagebrush (*Artemisia tridentata*), black sagebrush (*Artemisia nova*), rabbitbrush (*Chrysothamnus* and *Ericamaria* spp.), shadscale (*Atriplex confertifolia*), and in areas with high soil salinity and higher or perched groundwater tables, greasewood (*Sarcobatus vermiculatus*). Within the Mojave Desert portion of the Area of Interest, the predominant lower elevation native vegetation include creosote bush (*Larrea tridentata*), white bursage (*Ambrosia dumosa*), and indigo bush (*Psorothamnus fremontii*). A large population of Joshua tree (*Yucca brevifolia*) is also known to occur in Delamar Valley HB and the extreme southern end of Dry Lake Valley HB.

Groundwater-influenced ecosystems, which include springs, streams, man-made lakes and reservoirs, wetlands, meadows, playas, riparian woodland characterized by cottonwood (*Populus* spp.) and willow (*Salix* spp.), and phreatophytic shrublands are distributed sporadically across the Area of Interest (Hubert 2004). An extensive emergent wetland system supported by regional spring flows also occurs in Pahranagat Valley HB (e.g., on Pahranagat NWR). Within the Area of Interest, sites with standing water support a variety of submerged aquatic vegetation (e.g., watercress, *Rorippa nasturtium-aquaticum*) and emergent vegetation (e.g., baltic rush, *Juncus arcticus*) and provide habitat for fish, frogs, macroinvertebrates, and springsnails (including rare, and endemic species). The springs, reservoirs, and streams also provide water for animals traversing the Mojave and Great Basin Deserts (e.g., large mammals, migratory waterfowl, bats), and associated riparian, wetland, and meadow vegetation provide habitat for resident and migratory animals (e.g., breeding birds).

Examples of some fauna that occur in valley floor ecosystems within the Area of Interest include large mammal (e.g., pronghorn, *Antilocapra americana*), mid-sized mammals (e.g., pygmy rabbit, *Brachylagus idahoensis*), small mammals (e.g., Pahranagat Valley montane vole, *Microtus montanus fucosus* and Brazilian free-tailed bat, *Tadarida brasiliensis*), birds (e.g., northern harrier, *Circus cyanus*, and greater sage grouse, *Centrocercus urophasianus*), reptiles (e.g., common side-blotched lizard, *Uta stansburiana*), amphibians (e.g., Great Basin spadefoot toad, *Spea intermontana*), fish (e.g., several subspecies of speckled dace, *Rhinichthys osculus*), and invertebrates (e.g., springsnails, *Pyrgulopsis* spp. and *Tryonia clathrata*, and Pahranagat naucorid bug, *Pelocoris biimpressus shoshone*). Five federally-listed species (1 bird, 4 fish) that depend on groundwater-influenced ecosystems are known to occur within the Area of Interest, all within Pahranagat Valley or White River Valley HB: southwestern willow flycatcher (*Empidonax traillii extimus*), Pahranagat roundtail chub (*Gila robusta jordani*), Hiko White River springfish (*Crenichthys baileyi grandis*), White River springfish (*C. baileyi baileyi*), and White River spinedace (*Lepidomeda albivallis*). Extensive wetlands and lakes in Pahranagat and White River Valley HBs provide habitat for migratory and wintering birds, with more than 230 bird species documented on the Pahranagat NWR alone. The valley floor groundwater-influenced ecosystems and associated fauna of interest are more fully described in Chapter 4.

2.0 MONITORING PLAN GOALS AND OBJECTIVES

CONTENTS

2.1 Monitoring Plan Goals
2.2 Monitoring Plan Objectives

This chapter provides an overview of the goals and objectives that are the foundation of the Plan. These goals and objectives were developed to be consistent with the common goal of the Stipulation: to manage development of any water rights permitted to SNWA by the NSE in DDC without causing any injury to Federal water rights and any Unreasonable Adverse Effects to Federal Resources and Special Status Species within the Area of Interest. Biological monitoring, in concert with hydrologic monitoring and groundwater flow modeling, will help the Parties meet this Stipulation goal.

As directed by the Stipulation Exhibit A, the BRT will focus its efforts on Special Status Species and their habitats within the Area of Interest that are most likely to be affected by hydrologic changes resulting from SNWA's DDC groundwater withdrawal (i.e., groundwater-influenced ecosystems). Monitoring intensity will vary spatially and temporally based on the potential for project-related impacts and the status of species (federally listed, etc.) that are known to occur at the site. This is referred to as a tiered monitoring approach. The Plan is designed to be adaptive, such that monitoring sites, indicators, and protocols can be modified based on new information and technologies and future management considerations. The Plan goals and objectives reflect this approach to biological monitoring.

2.1 MONITORING PLAN GOALS

The goals of the Plan are to:

1. Describe baseline condition of Special Status Species and/or their habitats within the Area of Interest that may be affected by SNWA groundwater withdrawal;
2. Identify the range of variability and trends for indicators of the condition of Special Status Species and/or their habitats;
3. Assess the response of Special Status Species and/or their habitats with respect to hydrologic changes resulting from SNWA groundwater withdrawal;
4. Determine if an observed or predicted change in an indicator is likely attributable to SNWA's groundwater withdrawal;
5. Detect and provide early warning of potential Unreasonable Adverse Effects to Federal Resources, Special Status Species and/or their habitat; and
6. Provide recommendations to the EC regarding potential actions and timeline to avoid and mitigate Unreasonable Adverse Effects to Federal Resources, Special Status Species, and/or their habitat.

2.2 MONITORING PLAN OBJECTIVES

Achievement of the following objectives will help the BRT meet the goals of the Plan:

1. Develop (or refine previously-developed) conceptual models of groundwater-influenced ecosystems.

Conceptual models can identify processes and factors that maintain and/or shape groundwater-influenced ecosystems within the Area of Interest, as well as system disturbances ("stressors"), both natural and anthropogenic. Conceptual models of groundwater-influenced ecosystems were developed for the Spring Valley biological monitoring plan (BWG 2009), and with little to no modification are applicable to DDC. These models will help BRT understand the potential effects of stressors on groundwater-influenced ecosystems and the Special Status Species that occupy or use these ecosystems, and will help identify gaps in understanding of ecosystem dynamics, thus elucidating areas of potential research. These models can be updated as information is acquired and the systems are better understood. The BRT may choose to develop additional conceptual models (e.g., by site or species) in the future, possibly in conjunction with computational models.

2. Identify which indicators of the condition of groundwater-influenced ecosystems to monitor, focusing on those that could provide early evidence of adverse effects and early warning of Unreasonable Adverse Effects from SNWA groundwater withdrawal on Federal Resources, Special Status Species, and/or Special Status Species habitat within the Area of Interest.

The ecological attributes that will be monitored are those thought to be good indicators of the health and integrity of groundwater-influenced ecosystems, focusing on those features likely important to Special Status Species. The Plan also focuses on monitoring those ecosystem features that will likely respond quickly to changes in groundwater levels or spring discharge, while recognizing that hydrologic monitoring and/or groundwater flow modeling will likely provide the earliest indication of potential adverse effects to biological resources. Early evidence of potential adverse effects from SNWA groundwater withdrawal will provide a basis for initiating BRT consultation (pursuant to the Stipulation, Exhibit A) and management action in a timely manner so as to avoid Unreasonable Adverse Effects.

The Plan requires direct monitoring of certain Special Status Species that are highly dependent on aquatic environments to correlate species' responses with ecosystem changes that may result from groundwater withdrawal. For Special Status Species not directly monitored, habitat components will be monitored instead. Monitoring indicators are described in detail in Chapter 4 (Monitoring Framework).

3. Collect and evaluate a minimum of three years of baseline biological data at monitoring sites prior to initiation of SNWA's groundwater withdrawal in DDC, and a minimum of ten years of intensive baseline biological data prior to predicted onset of potential effects.
4. Gather relevant current and historical data to supplement BRT baseline data for subsequent analysis.
5. Conduct biological monitoring during SNWA groundwater withdrawal and annually evaluate data to determine level of monitoring required (Tier 1 or Tier 2).

Objectives 3, 4 and 5 will help the BRT describe and assess the condition of Special Status Species and/or their habitats (i.e., groundwater-influenced ecosystems) at monitoring sites within the Area of Interest, as well as establish trends in the condition of these ecosystems at monitoring sites over the monitoring periods. Baseline data will help the BRT understand the status and function of these ecosystems at the monitoring sites, such as whether key processes are intact and what the current impact from natural and human stressors is, which will in turn aid with refinement of conceptual models. Baseline data, supplemented with current and historical data from other sources, will also help the BRT to better understand the range of variability of indicators of the condition of these biotic systems prior to potential effects from SNWA's groundwater withdrawal. This will form the basis for understanding the response of these systems to groundwater withdrawal. The BRT recognizes that a timeframe longer than three years is needed to establish baseline condition and understand ecosystem dynamics. Given that it may be decades or centuries until any potential impacts might occur following initiation of groundwater withdrawal (see Section 4.5), the actual baseline should be quite comprehensive.

As described in Chapter 3, the BRT used a tiered monitoring approach such that monitoring intensity at a site is based on which Special Status Species are likely present and the possibility and timeframe for hydrologic changes resulting from SNWA's groundwater withdrawal in DDC. The BRT will meet at least annually to review data and determine whether monitoring should shift from one tier to the other. The intent is to initiate more intensive (Tier 2) annual monitoring at a monitoring site ten years prior to any predicted potential effects to Special Status Species and/or their habitat from SNWA's groundwater withdrawal, thus creating a more extensive baseline data set that will form the basis of the effects analysis during groundwater withdrawal.

6. Identify those indicators that may help differentiate between adverse effects resulting from SNWA's groundwater withdrawal and other stressors.

Objective 6 addresses the issue of what source(s) of stress may be responsible for an observed or predicted adverse effect. If the BRT determines that an adverse effect has occurred or is likely to occur to a Special Status Species and/or its habitat, the BRT (in coordination with TRP) must determine if that effect is likely attributable, in whole or in part, to SNWA's groundwater withdrawal or if it is the result of some other stressor (e.g., groundwater withdrawal by a user other than SNWA, surface water diversion, grazing, recreation, disease, or drought/climate change).

7. Estimate how hydrologic changes might affect Federal Resources and Special Status Species in the Area of Interest.

8. Develop a framework for providing recommendations to the EC regarding what may constitute an Unreasonable Adverse Effect to Federal Resources, Special Status Species and/or their habitats, and when action may be warranted so that Unreasonable Adverse Effects are avoided.

The Stipulation directs that there be no Unreasonable Adverse Effect to Federal Resources and Special Status Species in the Area of Interest as a result of SNWA's groundwater withdrawal in DDC. To satisfy this requirement, BRT, TRP, and EC must understand what conditions may signify an Unreasonable Adverse Effect so that appropriate management actions are initiated to avoid such an effect. Per the Stipulation, prior to groundwater pumping SNWA, in cooperation with the DOI Bureaus, shall prepare a written Hydrologic Management and Mitigation Operation Plan (Operation Plan) that will define early warning indicators for Unreasonable Adverse Effects to Federal Resources and Special Status Species, and define a range of specific mitigation actions that may be carried out if early warning indicators are reached (Stipulation Exhibit A page 11 Paragraph D; Appendix A). Objectives 7 and 8 support this requirement by establishing a link between monitoring and management decision making.

Analytical tools such as statistical analyses and computational modeling could provide information useful for monitoring and management decision making. Analytical tools can help biologists and managers 1) comprehend how hydrologic changes might affect Special Status Species and their habitats, 2) refine the Plan to increase effectiveness and efficiency, and 3) understand risk in management decision making. BRT may seek EC approval to develop these analytical tools as appropriate.

Prior to SNWA groundwater withdrawal from DDC, BRT will develop a framework for describing Unreasonable Adverse Effects. The framework will likely include determining ranges of variation, ecological thresholds, and acceptable ranges of variation for indicators and/or groundwater-influenced ecosystems prior to potential effects from SNWA groundwater withdrawal from DDC. The purposes of the framework are to better enable the BRT to predict and detect potential Unreasonable Adverse Effects; identify in a timely manner the need for further data collection and analysis; and recommend management actions to the EC to avoid and/or mitigate Unreasonable Adverse Effects per the Stipulation and the Operation Plan. The framework will likely include decision criteria to prompt specific BRT actions such as consultation, review, data analysis and investigation, with the ultimate goal of helping BRT recognize a potential Unreasonable Adverse Effect well enough in advance for action to be taken to prevent its manifestation. These tasks will be accomplished in cooperation with the TRP. The BRT recommends that this framework be integrated with the Operation Plan, and be reviewed and revised as needed in keeping with an adaptive monitoring and management approach.

9. Regularly evaluate the components of the Plan and revise as needed.

The BRT will also regularly evaluate and revise the Plan based on the results of both biological and hydrologic monitoring data and groundwater flow modeling. Such an adaptive approach will allow the Plan to evolve based on changes such as location of POD, new information (e.g., changes to the anticipated timeframe, location, and/or magnitude of effects), changes in management, new monitoring questions, and new technologies.

10. Identify information and research needs and implement special studies as appropriate.

Specific research projects may be identified to obtain additional data that will inform monitoring and management decisions. Chapter 4 provides an initial assessment of research and information needs for each groundwater-influenced ecosystem in the Area of Interest. Applied research could help the BRT address the monitoring goals. Thus, the BRT will continually evaluate research needs, seek funding to implement research projects, and make recommendations to the EC for approval to implement projects, as described in Chapter 3 (Plan Methodology).

11. Evaluate mitigation opportunities.

Mitigation planning is not a part of this Plan; it will be addressed separately as part of the Operation Plan required per the Stipulation. BRT can, however, evaluate opportunities for mitigation (e.g., habitat enhancement or site potential for translocation of species) and develop recommendations to mitigate Unreasonable Adverse Effects to Special Status Species and/or their habitats to help inform Operation Plan development.

3.0 BIOLOGICAL MONITORING PLAN APPROACH

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3.6 Peer Review

Development of the Biological Monitoring Plan (Plan) approach was aided by The Nature Conservancy's (TNC) Conservation Action Planning (CAP) process. An overview of the CAP process is provided in Section 3.1. The remaining sections in this chapter focus on Plan design; monitoring framework and protocols are addressed more fully in Chapters 4 and 5, respectively.

3.1 CONSERVATION ACTION PLANNING (CAP) PROCESS

With TNC facilitation, the BRT applied several components of the CAP process to: 1) identify groundwater-influenced ecosystems and Special Status Species that will be the targets of BRT conservation efforts; 2) identify key ecological attributes (KEAs) essential to the long-term viability of those targets; and 3) identify indicators to assess each KEA, including those that may be used to predict potential adverse effects and/or give early warning of effects from SNWA's groundwater withdrawal. Comprehensive information on the CAP process can be found in the CAP Handbook and an online toolbox at http://conserveonline.org/workspaces/cbdgateway/cap.

3.1.1 Groundwater-Influenced Ecosystems and Special Status Species

The first step of the CAP process was to identify groundwater-influenced ecosystems within the Area of Interest that may be affected by SNWA groundwater withdrawal in DDC, and then determine which Special Status Species (as defined by the Stipulation; see chapter 1) occur or have the potential to occur in these systems. In close coordination with TRP, BRT selected sites within these groundwater-influenced ecosystems to monitor, focusing on Special Status Species habitats with greater probability to be affected by hydrologic changes resulting from SNWA's groundwater withdrawals in DDC. As specified in the Stipulation, consideration was given to valley floor and range-front springs where Special Status Species occur and to sage grouse breeding/late brood rearing habitat.

Site selection in DDC was challenging due to the paucity of surface water resources in these HBs that satisfy the site selection criteria set forth in the Stipulation. For instance, there is no known productive valley floor spring in DDC. All DDC springs identified in the recently-vacated NSE Ruling 5875 (Parker Station, Cave, Meloy, Coyote and Grassy springs) were described by the NSE as mountain-block springs not directly connected to the principal groundwater aquifer (any conclusions made in future NSE rulings will also be considered by the BRT) (NSE Ruling pages 26-27). Therefore, Grassy Spring was chosen for biological monitoring in Delamar Valley HB because it is a lower mountain block spring and one of few productive springs known from this valley. Similarly in Dry Lake Valley HB, springs representative of mountain block conditions were selected. Cave Valley HB site selection was straight forward because sage grouse habitat areas were specifically referenced in the Stipulation. Site selection in White River Valley and Pahranagat Valley HBs was facilitated by guidance in the Stipulation and the presence of valley floor springs. Additionally, the Stipulation makes specific reference to Pahranagat NWR, Key Pittman WMA, and Kirch WMA as areas for potential consideration.

Site selection followed a hierarchical approach with specific input from the TRP (see Chapter 4). The TRP first provided guidance on sites with greater probability to be affected as a result of SNWA's groundwater withdrawals in DDC. Secondly, consideration was given to whether effects at some locations could be attributed to SNWA's groundwater withdrawal. Surface water management independent of SNWA's project has the potential to mask or create additional effects at some locations. Finally, additional factors influenced site selection, including proximity to hydrologic monitoring sites, level of anthropogenic or natural disturbance, mitigation potential, measurability and possible use as a reference site.

3.1.2 Key Ecological Attributes and Indicators

The next step in the CAP process was to identify KEAs and indicators of condition for each selected groundwater-influenced ecosystem or Special Status Species habitat. KEAs are characteristics that describe groundwater-influenced ecosystems or Special Status Species habitat and potentially are critical to their long-term viability or integrity including biological composition, interactions, and processes (Parrish et al. 2003). Indicators are measures to assess the KEAs. The BRT selected KEAs and indicators based on the following criteria: 1) strongly related to the status or condition of the groundwater-influenced ecosystem or Special Status Species habitat and possibly essential to its viability; 2) good indicator of ecosystem health, and may provide early warning of adverse effects resulting from SNWA groundwater withdrawal; and 3) reasonably feasible and readily measurable.

3.2 PLAN DESIGN

The BRT designed this Plan to address requirements of the Stipulation as identified in the goals and objectives described in Chapter 2. As outlined in Exhibit A of the Stipulation (Appendix A), the monitoring requirements are three-fold: 1) develop a baseline data set for comparison; 2) implement a monitoring plan to assess effects from groundwater withdrawal by SNWA, and 3) if necessary, provide recommendations for mitigation and monitor the success of such activities. The Plan design incorporates key components – development of conceptual models, setting goals and priorities, developing monitoring and conservation strategies, taking needed action, measuring results, and refining the Plan – for monitoring and assessing groundwater-influenced ecosystems in the Area of Interest. The Plan was designed with different (tiered) levels of monitoring intensity based on potential and timeframe for propagation of potential effects from SNWA's groundwater withdrawal in DDC.

This Plan focuses on sampling prior to and during SNWA groundwater withdrawal. Baseline sampling will involve an initial Site Characterization (described below in Section 3.2.1), followed by monitoring of a select set of KEAs and indicators at each monitoring site. Activities include collecting baseline data; gathering historical data; establishing a framework for describing and detecting Unreasonable Adverse Effects; and identifying research needs. Once SNWA groundwater withdrawal commences, data collection will continue, ranges of variation, threshold levels, and descriptions of Unreasonable Adverse Effects will be refined and the potential for impact and mitigation considered.

3.2.1 Site Characterization

At each biological monitoring site, a Site Characterization will be conducted at the beginning of baseline sampling. The Site Characterization will address particular KEAs and indicators of concern at each site (described in Chapters 4 and 5). Site Characterization will provide a snapshot of conditions at the start of the monitoring program, offering an initial description of the natural resources and their condition and allowing for testing and establishing protocols. Site Characterization will be repeated at intervals (described in Section 4.5) to provide updates of site condition.

3.2.2 Tiered Monitoring

The BRT developed a tiered monitoring approach that is consistent with the overall adaptive framework of the Plan, as described in Section 3.2.3.

Prior to and during SNWA groundwater withdrawal from DDC, annual monitoring will be conducted at a Tier 1 or Tier 2 level of intensity.

Tier 1 monitoring will take place at a site when effects are not anticipated for decades or centuries, and at those sites with no to low potential for effect. Tier 1 consists of a basic suite of indicators that vary by site based on resources present, and will allow BRT to monitor general site condition, test assumptions regarding likelihood of impacts, and help determine the need for Tier 2 monitoring. Tier 1 will also describe baseline conditions; allow for on-going evaluation of conditions; establish ranges of variation for indicators; and document changes in particular Special Status Species and/or their habitats prior to any predicted impacts.

Tier 2 monitoring will begin at a site when potential effects are predicted within ten years. Tier 2 will consist of an expanded suite of indicators that will include all Tier 1 variables and additional variables, creating a more comprehensive data set. Tier 2 will accomplish all Tier 1 objectives, as well as facilitate BRT's assessment of biological responses (both species and habitat) to spring flow or groundwater level changes. Tier 2 will also enable the BRT to determine if adverse effects have occurred and, if so, whether they are potentially attributable to SNWA groundwater withdrawal.

The BRT will recommend to the EC that a shift to Tier 2 be made if evidence suggests that SNWA groundwater withdrawal is affecting or has the potential to affect Special Status Species or their habitat within 10 years. Ten years of Tier 2 monitoring prior to withdrawal effects will create a more comprehensive baseline data set to assist with impact analysis, and will hopefully reveal ranges in variation of Tier 2 indicators under conditions that do not include the stressor of concern (SNWA groundwater withdrawal), e.g., wet and dry climatic conditions. This tiered approach also allows shifts from Tier 2 back to Tier 1. The following will be evaluated to determine whether a shift between Tier 1 and Tier 2 is warranted:

- hydrologic and biological data collected in accordance with the Stipulation,
- groundwater flow modeling results as interpreted and provided by the TRP, and
- other relevant hydrologic and biological information gathered by outside sources.

Spring discharge and monitoring well data along with groundwater flow modeling results will be routinely evaluated to determine if a shift between Tier 1 and Tier 2 is needed for any given site. Changes in groundwater elevation documented at wells located between production wells and biological monitoring sites will provide early warning of propagation of effects. The groundwater flow model agreed upon by all Parties as identified in the Stipulation will also be a key tool in evaluating the potential for effects. This groundwater flow model will be updated regularly with the addition of new hydrologic data, routinely run to produce updated results, and tested and improved over time. Results of other hydrologic modeling efforts for the Area of Interest may also be evaluated and considered by the TRP, as appropriate. Finally, Stipulation Party members may request a data review or consultation by the BRT and/or TRP at any time to evaluate the potential for effects and determine if a shift in monitoring level is needed.

3.2.3 Adaptive Framework

The biological monitoring program is designed to be adaptive so that it can evolve in response to new information and technologies, changes in monitoring questions or goals, and changes in analytical approach, while ensuring the integrity of the long-term data record (Lindenmayer and Likens 2009). As data are collected, BRT will develop an improved understanding of how indicator values vary over time and how indicators respond to different environmental and anthropogenic stressors, which will help BRT refine its definition of Unreasonable Adverse Effect. The adaptive framework also allows for adjustment of monitoring sites, indicators and protocols, which could change based on Special Status Species presence, management goals, location of production wells, risk assessment or other factors. Finally, spring discharge and groundwater monitoring well data along with groundwater flow modeling results will be routinely evaluated for the purpose of evaluating a shift in the level of monitoring intensity (between Tier 1 and Tier 2) is needed at any particular site. This adaptive monitoring approach was designed to be effective and efficient while allowing flexibility for Plan modification as information is obtained, data analysis and reviews conducted, and improvements identified.

The adaptive framework includes designated review periods to evaluate the effectiveness of the Plan. Prior to and during the implementation of this Plan, the BRT will review any new NSE rulings, updated groundwater flow modeling results, Spring Valley Stipulation Biological Monitoring Plan results and revisions, and any new production well sitings. BRT will potentially revise this Plan as needed, in accordance with the Plan's adaptive framework. Biological monitoring will be implemented at least three years prior to SNWA groundwater withdrawal from DDC. During the first three of baseline data collection (1 year of Site Characterization followed by 2 years of tiered monitoring), data will be evaluated by the BRT with a focus on assessing the effectiveness of the Plan. At the completion of the second year of tiered monitoring (Year 3), BRT will submit a comprehensive report to the EC which may include recommendations on Plan modification (including but not limited to modifications of the tiered approach, frequency and/or intensity of sampling, and indicators and/or protocols), and potential schedule adjustments. After groundwater withdrawal commences, the BRT will conduct annual evaluations of Plan components as needed. Chapter 6 discusses data management, analysis, and reporting in detail.

3.3 SUPPLEMENTAL DATA GATHERING

Supplemental data collection may be necessary to provide an understanding of responses of groundwater-influenced ecosystems and Special Status Species habitat to other influences and stressors (e.g., drought, fire, insect outbreaks, pesticide application, invasive species, livestock grazing, and changes in water diversion). Data collection on these factors is not part of this Plan. However, the BRT will compile historic and current data from existing sources that will be used to evaluate and distinguish effects on the groundwater-influenced habitats and ecosystems.

3.4 DESCRIBING UNREASONABLE ADVERSE EFFECT

The common goal of the Parties to the Stipulation is to manage the development of groundwater by SNWA in DDC without causing injury to Federal Water Rights and/or Unreasonable Adverse

Effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in DDC (Stipulation page 4 Recital H; Appendix A). Unreasonable Adverse Effect is a term specific to the Stipulation. What constitutes an Unreasonable Adverse Effect will be determined by the EC, with input from the BRT and TRP. To assist in accomplishing this goal, the BRT plans to develop a framework for describing and detecting Unreasonable Adverse Effect. This framework will be described prior to SNWA groundwater withdrawal in DDC, and will be forwarded to the EC for consideration. The framework can be reviewed and revised as needed in keeping with an adaptive monitoring and management approach.

The framework will likely include determining ranges of variation, ecological thresholds, and acceptable ranges of variation for indicators and/or groundwater-influenced ecosystems prior to potential effects from SNWA groundwater withdrawal from DDC. These values will better enable the BRT to predict and detect potential Unreasonable Adverse Effects, but are not automatically associated with specific EC management actions. Instead, they can alert the BRT of the need for further data collection and analysis, and/or the need to recommend management actions to the EC to avoid and/or mitigate Unreasonable Adverse Effects per the Stipulation and Operation Plan.

The above ecological terms are defined as follows:

- Range of variation consists of maximum and minimum values and related descriptive statistics for an indicator, encompassing natural and anthropogenic influences (e.g., grazing, water diversions, roads, etc.). Range of variation can be based on monitoring data prior to and during groundwater withdrawal, historical data, expert opinion, and inferences from other species and locations.
- An ecological threshold is the level of an indicator or suite of indicators corresponding to the shift from one condition level to another for a species or their habitat.
- The acceptable range of variation will be considered that range in values, rates of change, and frequency of change associated with ecosystem integrity and long-term viability (Parrish et al. 2003).

An adverse effect will be considered to occur if an indicator or suite of indicators falls outside the acceptable range of variation. Some indicator values may already fall outside of the acceptable range, and therefore some of the species and habitats within the monitoring sites may already be experiencing adverse effects caused by existing natural and/or anthropogenic influences. As system behavior becomes better understood, these ecological definitions can be modified. Inherent in this process is the understanding that groundwater-influenced ecosystems do not remain stable, but vary over time, due to both anthropogenic and natural causes.

This framework will serve as a guide for predicting and detecting potential Unreasonable Adverse Effects and forwarding recommended courses of action to the EC. It will likely include decision criteria to prompt specific BRT actions, such as consultation, designated review periods, or possibly additional data analysis or investigation to better inform BRT recommendations to the EC. The intent of this framework is to create a logical and transparent process for making decisions concerning Unreasonable Adverse Effects, and to help BRT recognize the potential for such an effect well enough in advance for action to be taken to prevent its expression. These tasks will be accomplished in cooperation with the TRP. The BRT recommends that this framework be integrated with the Operation Plan, which will be developed by SNWA in cooperation with the DOI Bureaus. The Operation Plan will, in part, identify and define early warning indicators for injury to Federal Water Rights and Unreasonable Adverse Effects to

Federal Resources and Special Status Species, and define a range of specific mitigation actions that may be carried out if early warning indicators are reached (Stipulation Exhibit A page 11 Paragraph D; Appendix A). The EC will use the Operation Plan during its decision-making process as outlined in Exhibit A of the Stipulation. The TRP, in coordination with the BRT, will update the Operation Plan as necessary to ensure early warning indicators and mitigation actions are consistent with the common goals of the Stipulation (Stipulation Exhibit A page 11 Paragraph D; Appendix A).

The above-described framework does not supplant the BRT consultation process described in the Stipulation. The BRT will meet at least annually following the years of data collection to evaluate data collected pursuant to the Plan and trends observed. It will assess whether any observed change is adverse and whether that change is attributable to SNWA groundwater withdrawal. If any member of the BRT believes that a change in an indicator or suite of indicators is attributable to SNWA groundwater withdrawal from DDC and is or has the potential to be an Unreasonable Adverse Effect, the BRT may enter into consultation as outlined in the Stipulation. The BRT will, in coordination with the TRP, develop a consensus-based course of action to address the concern and/or manage or mitigate as appropriate, and submit its recommendation to the EC for consideration. If consensus cannot be reached, BRT will so inform the EC which will then attempt to negotiate a mutually acceptable course(s) of action (Stipulation Exhibit A page 19 Paragraph II.2; Appendix A). If an adverse change is not attributable to SNWA groundwater withdrawal from DDC, the BRT may still conduct investigation into the cause of such change.

3.5 ECOLOGICAL MODELS

3.5.1 Conceptual Models

Ecosystems are complex assemblages of interacting biota that are influenced by and are influencing their associated abiotic environments. Although ecologists understand much about ecosystem components and functions, a complete understanding of composition, structure, and function is lacking for most, if not all, naturally-occurring ecosystems. A foundation of this Plan is an understanding of the various biological processes occurring in the Area of Interest, how they relate, and how they might be influenced by anthropogenic activities.

Conceptual models play an important part in attempting to understand ecological systems. They provide a short-hand method of presenting the state of our understanding of the system. This is important as a means of focusing the thought processes of those working on the system and of communicating the status of our understanding, or perceived understanding, to others. Conceptual models also help identify those areas where our understanding is the weakest, and therefore where to concentrate efforts for further study.

Conceptual models were developed for Spring, Hamlin, and Snake Valleys in the Biological Monitoring Plan for the Spring Valley Stipulation (BWG 2009). As the groundwater-influenced ecosystems in these nearby Great Basin valleys are similar to those in the Area of Interest, the overall broad-scale environmental processes presented in the Spring Valley Stipulation Plan along with certain specifics about groundwater-influenced ecosystems were used to guide the development of this Plan.

Conceptual models specific to certain resources present in the Area of Interest will be developed as monitoring commences to provide a framework of the known physical and biological processes in the Area of Interest, and to facilitate interpretation and transmission of the data.

During any science-based process, conceptual models are subject to revision as information is acquired and understanding of the systems is enhanced.

3.5.2 Computational Models

Ecological models that are run on a computer and produce numerical results are referred to as computational models (T. Starfield, University of Minnesota, pers. comm.). These can include statistical models, State-and-Transition models, and mechanistic (process) models. Computational modeling is a tool that could help inform many aspects of the BRT monitoring program, including refining objectives and indicators, interpreting monitoring data, and testing hypotheses about how groundwater-influenced ecosystems or monitoring indicators might change in response to natural and anthropogenic stressors (e.g., groundwater withdrawal, climate change). Computational models can also be used to help managers evaluate and understand risk in decision-making.

The Stipulation does not require the development of computational (ecological) models. However, BRT would like to better understand how analytical tools such as computational modeling might inform the DDC biological monitoring program and decision-making process. To do this, BRT will observe how ecological modeling proceeds under the Spring Valley Stipulation. The EC has directed the Spring Valley Biological Work Group to identify 3-5 questions to explore with ecological modeling, using a Rapid Prototyping approach (T. Starfield, University of Minnesota, pers. comm.). Rapid Prototyping consists of building the simplest possible model, then using it to reassess objectives, explore data uncertainties, and test the impact of major assumptions in the model. Based in part on review of the Spring Valley process, BRT may seek EC approval to develop Rapid Prototype models or other analytical tools as part of the Plan, and to build on these tools as appropriate.

3.6 SCIENTIFIC REVIEW

Peer review can improve the Plan and enhance its scientific credibility within the scientific community. This Plan was reviewed by scientists with relevant expertise within BRT participant agencies prior to finalization. Additionally, the BRT recognizes that it may be desirable to have certain components of the Plan (e.g., protocols, analyses) undergo external peer review. The BRT will work with the EC to determine if external peer review is appropriate.

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4.0 MONITORING FRAMEWORK

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As discussed in Chapter 1, the purpose of the Plan is to collect baseline information; further the understanding of groundwater-influenced ecosystem dynamics; and identify and monitor responses of Special Status Species and/or their habitats to hydrologic and biological changes that may result from SNWA's groundwater withdrawal. Using the CAP process, the BRT developed a list of groundwater-influenced ecosystems, Special Status Species, and sites to monitor within the Area of Interest. The BRT then selected KEAs (characteristics that describe the systems and potentially are critical to their viability or integrity) and indicators to focus on within the Plan. Although sites, Special Status Species, KEAs, and indicators are directly used to guide the process, the goal remains to protect the ecosystems, not just individual components. As the monitoring plan moves forward, careful examination of the data collected may lead the BRT to focus more directly on certain indicators, specific Special Status Species, or particular groundwater-influenced ecosystems and monitoring sites. This focus may increase confidence that the Plan is being implemented effectively and effects are being detected early.

4.1 GROUNDWATER-INFLUENCED ECOSYSTEMS

4.1.1 Selection of Groundwater-Influenced Ecosystems

The CAP process allowed a broad-based approach for evaluating groundwater-influenced ecosystems and biological resources within the Area of Interest. The focus of the Stipulation is to evaluate Special Status Species and their habitats. Thus, each groundwater-influenced ecosystem within the Area of Interest was evaluated with that focus. The BRT then selected those groundwater-influenced ecosystems that might be directly or indirectly impacted by SNWA withdrawal of groundwater from DDC based on best available information and TRP guidance. The three groundwater-influenced ecosystems identified by the CAP process that meet the Stipulation criteria for monitoring are spring complexes throughout the Area of Interest, perennial streams, and meadows which are sage grouse habitat (Cave Valley HB). Spring complexes include the spring orifices and adjacent riparian (herbaceous and woody) vegetation, wetlands, and meadows (e.g., meadows adjacent to Crystal Spring for Pahranagat Valley montane vole).

Other groundwater-influenced ecosystems within the Area of Interest – mountain block springs and streams, phreatophytic shrublands not associated with spring complexes, and meadows not associated with sage grouse or Pahranagat Valley montane vole – were not selected for monitoring. Although important from an ecological perspective, these ecosystems are either not anticipated to be affected by SNWA groundwater withdrawal in DDC or there are no known Special Status Species. For example, the large phreatophytic (greasewood) shrubland in southern Cave Valley HB was not selected because depth to groundwater is approximately 150 ft bgs in this area, and phreatophytes are not known to utilize groundwater deeper than 50 feet (recently-vacated NSE Ruling 5785 page 26; any conclusions of future NSE rulings will also be considered by the BRT). The southern Cave Valley phreatophytic community is most likely getting water from a perched aquifer that is not directly connected to the principal groundwater aquifer (NSE Ruling 5875 page 26). The BRT also considered monitoring Cave Valley Cave, which supports species (e.g., a newly-discovered macroinvertebrate species) that apparently rely on groundwater. However, evidence regarding recharge, water chemistry, water temperature, intermittent flow and seasonal variation in flow at Cave Spring suggest it to be local, and the TRP does not consider it to have a reasonable potential for impacts from SNWA groundwater withdrawal.

4.1.2 Description of Groundwater-Influenced Ecosystems

The three groundwater-influenced ecosystems identified by the CAP process for inclusion in the Plan are discussed below.

4.1.2.1 Spring Complexes

Spring complexes within the Area of Interest include one or a combination of the following: spring orifices and associated open water, fringing wetlands and meadows, and riparian vegetation communities characterized by hydrophilic plants, including herbaceous and woody species. Springs are important in maintaining the biodiversity of the Great Basin, one of the driest physiographic provinces in North America (Sada and Vinyard 2002, Sada 2003). The hydrologic history of the Great Basin has left many of the spring systems fragmented and isolated from each other, giving rise to a host of endemic aquatic organisms (Sada and Vinyard 2002). Spring systems provide a major source of reliable water in the region, making them critical to the persistence of many plant and animal species (Hershler 1998, Sada and Vinyard 2002, Sada 2003). Aquifer geology, morphology, discharge rates, regional precipitation, and vegetation all control the complex environmental characteristics of springs (Garside and Schilling 1979).

Springs are often classified by morphology into distinct types, such as rheocrene (discharges into a defined channel), limnocrene (discharges into an open pool before a defined channel), and helocrene (without an open pool and discharges into a marshy and relatively shallow wetland). Within the Area of Interest all three types are represented, with rheocrene and limnocrene more prevalent. Morphology influences aquatic biota, as species that inhabit rheocrenes prefer flowing water, species in limnocrenes are more similar to species that occupy lakes and ponds, and species in helocrenes are more similar to species that occupy marshy bogs (Sada 2000).

Physical and chemical characteristics are major factors influencing spring-fed riparian and aquatic plant and animal communities (van der Kamp 1995, Sada and Pohlmann 2006). Most spring environments at or near the springhead are less variable in these characteristics than other aquatic habitats (e.g., streams, lakes, etc.), with comparatively low within-spring variability in population sizes and assemblage structures (van der Kamp 1995). Typically, environmental variation is greater downstream than at the springhead, and the composition of springhead and downstream communities tends to be quite different (Hayford et al. 1995, Herschler 1998). Crenobiontics (species that live only in springs [e.g., springsnails]) appear to be specifically adapted to springhead environments (Sada and Pohlmann 2006). Many additional factors such as food availability, temperature, reproduction, and migration of species along a spring brook can influence the diversity and abundance of aquatic organisms (Varza and Covich 1995).

Wetlands associated with the springs in the Area of Interest are characterized by wet hydrology, hydric (saturated) soils, and hydrophytic vegetation (plants adapted to saturated soils) for some period of the growing season. The presence of water has an overriding influence on characteristics of vegetation and soils. Water may originate from a number of sources, including direct precipitation, groundwater, and runoff. Wetlands require saturated soils during most of the growing season which can result from 1) a high water table, 2) prolonged, substantial amounts of surface flooding, or 3) flooding of low permeability or impermeable soils (McLendon 2008). Wetland areas may form around the perimeter of bodies of flowing or ponded water, or in depressions in the landscape. The largest extent of wetlands within the Area of Interest occurs on the valley floors (e.g. Pahranagat Valley HB), often hydrologically linked to springs and streams through seasonal flooding and groundwater movement.

Wetland plant communities are substantially different from most other associated plant communities in the region. Because wetlands have restricted water flow-through, sediments and nutrients can accumulate to produce highly productive ecosystems. In productive wetlands in the Great Basin, there is often abundant emergent rooted vegetation, such as cattail (*Typha* spp.), common reed (*Phragmites australis*), Baltic rush, common threesquare (*Schoenoplectus pungens*), Nebraska sedge (*Carex nebraskensis*), common spikerush (*Eleocharis palustris*), and cordgrasses (*Spartina* spp.). With the high productivity of these plants, wetlands support diverse communities of macroinvertebrates, which provide habitat and food source for other animals such as amphibians, fish, migratory birds, and bats.

Meadows associated with the springs in the Area of Interest occur down-slope from springs and wetlands, where slope is relatively gentle and overflow water spreads out onto the landscape rather than into a channelized system. They also occur where groundwater rises to within 3 m of the soil surface, phreatophytic shrubs are not abundant, and irrigation often has occurred (McLendon 2006, McLendon et al. 2008). In the Area of Interest, some meadows are partly maintained by agricultural practices, existing because of surface and sub-surface water movement from water diversion ditches. When ditches occur on slopes, some of the water moving through the ditches percolates down slope and can create a meadow. Similarly, irrigation of upslope sites can result in meadows forming down slope from the irrigated site because of subsurface movement of water.

Species composition in meadows is substantially different from most of the associated plant communities in the region. Grasses and sedges usually dominate the vegetation communities of meadows. Meadows are usually more productive than shrublands, although some shrubs may invade meadows. These differences result in meadows providing unique habitats to both flora and fauna in the Area of Interest.

Riparian areas occur along bodies of water such as springs and streams, and provide habitat for a variety of animals such as small mammals, amphibians, bats and birds. Riparian species require the presence of either groundwater or high soil moisture from the surface water body for plant growth and production. Herbaceous riparian areas are the most dominant riparian type within the Area of Interest. Riparian galleries, infrequent in the Area of Interest, are tree-dominated communities that provide more complex habitat for a variety of terrestrial biota, including breeding birds and bats (Stauffer and Best 1980, Rosenberg et al. 2002, Hubert 2004). Riparian galleries that are being monitored in the Area of Interest are associated with Ash Spring, Crystal Spring and Pahranagat Ditch. Shrubs and herbaceous species form two lower strata of vegetation in the community. The size of the gallery is usually dependent on stream flow, the extent of groundwater from the stream, soil conditions, and disturbances.

Differing elevations, soils and water input characteristics will produce different assemblages of plants. With increasing elevation away from the water source, zones of communities that can tolerate dryer soil conditions would be expected. Thus wet meadow communities are often found on the drier fringes of wetlands as soils become less saturated (Hubert 2004). Patches or mosaics of species may also indicate different soil characteristics such as texture or presence of organic matter. Historical uses of the area by native fauna and livestock will also influence the species composition and characteristics of the communities. All of these abiotic and biotic ecosystem components will ultimately determine what species combinations are present within an area (Odum 1971).

Spring complexes in the Area of Interest have been subjected to many stressors – physical, chemical, and biological – since settlers entered the region. Surface water and groundwater diversion and withdrawal, recreation, development, pollution, and introduced species all have played roles over time (Cooke 1981, Bishop 1992, Hall and Henry 1992, Rorabaugh 2005). Most springs, fringing wetlands and meadows, and riparian galleries in the Area of Interest have been or are disturbed by water diversions or livestock use, and several springs have substantial livestock trampling, as well as piped, ponded, or excavated spring heads (BIO-WEST 2007).

4.1.2.2 Perennial Streams

Perennial streams in arid lands usually have springs in the headwaters, outflows from spring-fed ponds, and/or groundwater seeps along the channel as their primary water source. This is the case for both perennial streams being monitored in the Area of Interest. An important feature of streams is the transition among habitat features along its course. Streams have a variety of segment types, including pools, riffles, runs, and glides (Hawkins et al. 1993). Perennial streams usually support numerous invertebrates which are important in the food chain as grazers on periphyton and decomposing vegetation, as well as food for vertebrates. Perennial streams in the Great Basin are usually small, so the associated animals are usually small, including forage fishes (minnow-like) and amphibians.

Pahranagat Ditch and Sunnyside Creek are the two perennial streams being monitored in the Area of Interest. Pahranagat Ditch is an extension of the Ash Spring complex and incorporates water from Crystal Spring as well. Both direct and indirect monitoring for Special Status Species will occur at Pahranagat Ditch because it contains a federally endangered fish species along with an extensive riparian gallery forest that is important for many neotropical migratory birds. Sunnyside Creek is an extension of the Flag Springs complex and will only involve direct monitoring for special status fish species (routinely done by NDOW).

4.1.2.3 Cave Valley Ranch Meadow

Meadows in Cave Valley HB used by sage grouse are grasslands (communities dominated by grasses or grass-like plants) that have saturated soil within the rooting zone for most or all months of the year. If standing water occurs, it is for only part of the growing season. Meadows tend to have relatively high cover values and are typically dominated by saltgrass (*Distichlis spicata*), Baltic rush, alkali sacaton (*Sporobolus airoides*), or wildrye (*Leymus* spp.), either singularly or in combination. Sage grouse use these meadows during the spring and summer for chick rearing and foraging. They then usually move back to lower elevation big sagebrush – grassland communities in the fall.

Meadows require high soil moisture during most of the growing season. Wet soils can result from 1) a shallow water table (i.e., groundwater within 1-3 m of the soil surface) or 2) substantial amounts of surface flooding, either from outflow from adjacent wetlands or from surface runoff following spring snowmelt. These meadows also require perturbations sufficiently frequent to preclude dominance by shrubs (McLendon 2008). Common types of perturbation are high groundwater for at least six months of the year or frequent fires. The most effective high groundwater produces surface flooding in most years, and fire should be frequent enough to effectively reduce shrub establishment. Haying operations or grazing can replace fire as an effective perturbation to reduce shrub establishment.

Meadows in the Area of Interest have had numerous disturbances. Common disturbances include grazing by livestock, modification of hydrology because of water diversions or irrigation, haying operations, and fire. Each of these factors has had, and may continue to have, substantial effects on the composition, productivity, and structure of these plant communities.

4.2 DESCRIPTION OF SPECIAL STATUS SPECIES

There are numerous Special Status Species (as defined by the Stipulation; see Chapter 1) that occur or have the potential to occur within the Area of Interest. For purposes of this Plan, BRT will directly monitor those species that have strong ties to aquatic ecosystems, providing the best opportunity for correlating species' responses with ecosystem changes resulting from SNWA groundwater withdrawal in DDC. Special Status Species that will be directly monitored include the aquatic invertebrates, amphibians, and fish described in Section 4.2.1. Other Special Status Species will be monitored using a habitat-based approach, meaning that particular components of the species' habitat will be monitored, but not the species themselves. Examples of species to be monitored with a habitat-based approach include those that are migratory or have large ranges (southwestern willow flycatcher, yellow-billed cuckoo, and greater sage grouse) or those that may be difficult to monitor due to their rarity or secretive nature (Pahranagat Valley montane vole).

The rationale for the habitat-based approach is that wide-ranging or migratory species (e.g., breeding birds and bats), in particular those that nest or in some way rely on groundwater-influenced ecosystems in the Area of Interest, are affected by many other factors across their range. Therefore, they are not ideal early warning indicators of change resulting from SNWA groundwater withdrawal. Additionally, species that are rare or difficult to detect do not make ideal indicator species. However, ongoing breeding season monitoring will continue by federal and state entities for some of these species in the Area of Interest (e.g., southwestern willow flycatcher and yellow-billed cuckoo in Pahranagat Valley HB, for which SNWA provides funds), and maintaining habitat for these species will presumably allow the species to persist within the Area of Interest. The BRT considered habitat requirements for breeding birds, such as southwestern willow flycatcher, yellow-billed cuckoo, and greater sage grouse, bats, and Pahranagat Valley montane vole when determining appropriate KEAs and indicators to monitor. Habitat requirements evaluated included physical components (e.g., vegetation cover, areal extent of open water, etc.), chemical components (e.g. water quality), and biological components (e.g., macroinvertebrates as a food source).

4.2.1 Direct Monitoring

The BRT selected 19 Special Status Species to directly monitor, as described in Table 4-1.

Table 4-1 Directly-Monitored Special Status Species

Common Name	***Scientific Name***	***Status***[2]
Aquatic Invertebrates		
Flag springsnail	*Pyrgulopsis breviloba*	NNHP: G1/S1
Hubbs springsnail	*Pyrgulopsis hubbsi*	NNHP: G1/S1
Butterfield springsnail	*Pyrgulopsis lata*	NNHP: G1/S1
Hardy springsnail	*Pyrgulopsis marcida*	NNHP: G1/S1
Pahranagat pebblesnail	*Pyrgulopsis merriami*	NNHP: G1/S1
White River springsnail	*Pyrgulopsis sathos*	NNHP: G1/S1
Grated tryonia	*Tryonia clathrata*	BLM: Sensitive; NNHP: G2/S2
Pahranagat naucorid bug	*Pelocorus shoshone shoshone*	NNHP: G1G3T1/S1
Ash Springs riffle beetle	*Stenelmis lariversi*	NNHP: G1/S1
Amphibian		
Northern leopard frog	*Rana pipiens*	BLM: Sensitive; State: Protected; NNHP: G5/S2S3
Fish		
White River springfish	*Crenichthys baileyi baileyi*	Federally Endangered; State Endangered; NNHP: T1G2/S1
Hiko White River springfish	*Crenichthys baileyi grandis*	Federally Endangered; State Endangered; NNHP: T1G2/S1
Moorman White River springfish	*Crenichthys baileyi thermophilus*	BLM: Sensitive; State: Protected; NNHP: T1G2/S1
White River desert sucker	*Catostomus clarki intermedius*	BLM: Sensitive; State: Protected; NNHP: G3G4T1T2Q/S1S2
White River sculpin	*Cottus* sp.	NNHP: G1S1
Pahranagat roundtail chub	*Gila robusta jordani*	Federally Endangered; State Endangered; NNHP: T1QG2G3/S1
White River spinedace	*Lepidomeda albivallis*	Federally Endangered; State Endangered; NNHP: G1/S1
White River speckled dace	*Rhinichthys osculus spp.*	BLM: Sensitive; State: Sensitive; NNHP: T1G2/S1
Pahranagat speckled dace	*Rhinichthys osculus velifer*	BLM: Sensitive; NNHP: T1QG5/S1

[1] Special Status Species (as defined by the Stipulation; see chapter 1) are those known to occur or may potentially occur in the Area of Interest that are dependent upon groundwater-influenced ecosystems or habitats that may be affected by SNWA groundwater withdrawal in DDC.

[2] Federal species listing status noted from the FWS list of Federally Threatened and Endangered Species posted online at http://heritage.nv.gov/animldet.htm current as of September 17, 2009.
Bureau of Land Management (BLM) status noted from the 2003 list of Nevada BLM Sensitive Species posted online at http://www.nv.blm.gov/wildlife/documents/sensitivespecies.pdf on October 4, 2009.
State of Nevada status from Nevada Administrative Code (NAC) 503.065, 503.067, 503.075.
Nevada Natural Heritage Program (NNHP) status noted from the current edition of the Detailed Rare Animal List posted online at http://heritage.nv.gov/animldet.htm on October 4, 2009.

4.2.1.1 Aquatic Invertebrates

Of aquatic invertebrate species to be directly monitored, there are seven mollusks and two arthropods (Table 4-1).

Springsnails

Springsnails (family Hydrobiidae), are small (1-8 mm), sexually reproducing aquatic mollusks (Sada 2001). They are oviparous, with reproduction occurring several times a year, and feed on algae present on submerged vegetation and substrate (Sada 2001). Springsnails are generally most abundant near spring sources, with species within the genus *Pyrgulopsis* being especially abundant in areas with watercress (Sada 2001). The presence of springsnails varies from spring to spring within the Area of Interest, with no more than two species observed at any spring.

Springsnails were chosen for direct monitoring as part of this Plan because they are truly aquatic species that are restricted to persistent (perennial) springs that have suitable water quality and that are minimally affected by drought (Sada 2000). Sada (2001) identified the main threats to springsnails as habitat alteration from surface water diversion, livestock grazing, groundwater depletion, and nonnative macroinvertebrates. Sada (2000) identified the following rationale for springsnail monitoring:

- Springsnail demography in unaltered habitats indicates that population variation may be predictable;
- Springsnails occur in small habitats that can be easily sampled; and
- Springsnail populations are susceptible to comparatively rapid changes in abundance and distribution in response to changes in habitat conditions (e.g. both surface water diversions and excessive groundwater withdrawal).

The following springsnail species inhabit the Area of Interest. Abundance estimates during 1992 sampling were relative to the ability to quickly and easily collect springsnails ('abundant' was commented when >~ 25 springsnails could be captured in a single strainer dip, 'common' when 5 to 25 were captured, and 'scarce' when < 5 were captured; D. Sada, Desert Research Institute [DRI], pers. comm.). Abundance estimates during 2004-2005 sampling were based on springsnail searches at various points along springsnail extents, and were determined relative to the amount of springsnails observed at the other sites included in the survey and based on professional judgment (B. Albrecht, BIO-WEST, pers. comm.).

P. breviloba (Flag springsnail) – This species was commented on as appearing abundant in Meloy Spring in Dry Lake Valley HB in 1992 (Sada 2005). Springsnails in general were commented on as appearing abundant in Flag Springs North (White River Valley HB) in 1992 (Sada 2005) and common in Flag Springs North, Middle and South in 2005 (BIO-WEST 2007); these abundance estimates did not distinguish between *P. breviloba* and *P. sathos* (D. Sada, DRI, and B. Albrecht, BIO-WEST, pers. comm.).

P. hubbsi (Hubbs springsnail) – This species has historically been documented at Hiko Spring and Maynard Spring, and is presently found at Crystal Spring; both located in Pahranagat Valley HB (Sada 2005). Although the species was commented on as appearing s abundant at Hiko Spring in 1992, it was not found during springsnail surveys in 2000 (Sada 2005) or 2006 (BIO-WEST 2007) and appears to be extirpated from that site. There is also apparent historical documentation of Hubbs springsnail at Maynard Spring, but the species appears to be extirpated from that site as well (L. Averill-Murray, FWS, pers. comm.). At Crystal Spring, *P. hubbsi* was commented on as appearing abundant in the springhead in 1992 (Sada 2005), but was commented on as appearing scarce at the site in 2005 (BIO-WEST 2007).

P. lata (Butterfield springsnail) – This species is endemic to Butterfield Spring (White River Valley HB). Springsnails in general were commented on as appearing abundant in Butterfield Spring in 1992; this abundance estimate did not distinguish between *P. lata* and *P. marcida* (D. Sada, DRI, pers. comm.).

P. marcida (Hardy springsnail) – This species is known from Parker Station Spring (Cave Valley HB) and reported from several springs in White River Valley HB, including but not limited to Hardy Springs, Emigrant Springs, and Butterfield Spring (Sada 2005). It is also known to occur at several White River Valley HB sites outside of the Area of Interest. In 1992, the species was commented on as appearing abundant at Parker Station Spring and common in Hardy Springs (Sada 2005). Springsnails in general were commented on as appearing abundant in Butterfield Spring in 1992 (Sada 2005); this abundance estimate did not distinguish between *P. marcida* and *P. lata* (D. Sada, DRI, pers. comm.).

P. merriami (Pahranagat pebblesnail) – This species was commented on as appearing abundant Ash Spring (Pahranagat Valley HB) in 1992. In 2005, springsnails in general were commented on as appearing common in select areas of Ash Spring (BIO-WEST 2007); this abundance estimate did not distinguish between *P. merriami* and grated tryonia (B. Albrecht, BIO-WEST, pers. comm.). Pahranagat pebblesnail was also documented at Moormon Spring (White River Valley HB) and commented on as appearing common in 1992 (Sada 2005). At Hot Creek Spring (White River Valley HB), springsnails in general were commented on as appearing common in 1992 (Sada 1995) and common in select areas of the spring in 2004 (BIO-WEST 2007); these abundance estimates did not distinguish between *P. merriami* and *T. clathrata* (D. Sada, DRI, and B. Albrecht, BIO-WEST, pers. comm.).

P. sathos (White River Valley springsnail) – This species is known from several springs in White River Valley HB, including Flag Springs within the Area of Interest (Sada 2005). Springsnails in general were commented on as appearing abundant in Flag Springs North (White River Valley HB) in 1992 (Sada 2005) and common in Flag Springs North, Middle and South in 2005 (BIO-WEST 2007); these abundance estimates did not distinguish between *P. sathos* and *P. breviloba* (D. Sada, DRI, and B. Albrecht, BIO-WEST, pers. comm.).

T. clathrata (Grated tryonia) – This species has a wider distribution than the other springsnail species mentioned above; it is known from sites in Pahranagat Valley HB, White River Valley HB, and the Muddy River area, which is outside the Area of Interest. The species was commented on as appearing scarce in Ash Spring (Pahranagat Valley HB) in 1992 (Sada 1995). In 2005, springsnails in generally were commented on as appearing common in select areas of Ash Spring (BIO-WEST 2007); this abundance estimate did not distinguish between Pahranagat pebblesnail and *T. clathrata* (B. Albrecht, BIO-WEST, pers. comm.). At Hot Creek Spring (White River Valley HB), springsnails in general were commented on as appearing common in 1992 (Sada 1995) and common in select areas of the spring in 2004 (BIO-WEST 2007); these abundance estimates did not distinguish between *T. clathrata* and *P. merriami* (D. Sada, DRI, and B. Albrecht, BIO-WEST, pers. comm.).

Naucorid Bugs

Creeping water bugs (Naucoridae) are found in a wide variety of habitats. Their body is broad and somewhat flattened and ranges in length from 5 to 16 mm. They feed on aquatic metazoans with anterior legs modified for grasping prey. Movement consists of a rapid, half creeping, half-swimming gait through dense vegetation in ponds, streams, and small lakes. A few species occur in spring brooks (Pennak 1978).

Pahranagat naucorid bug appears to be relatively wide-spread throughout the southern Great Basin (Polhemus 2002). In the Area of Interest, Ash Spring is the only known location for this species.

Riffle Beetles

Riffle beetles (Elmidae) are typically less than 3.5 mm long. They do not swim but crawl slowly underwater clinging to the substrate with long tarsal claws. While underwater, a film of air covers much of their body; they seldom go to the surface to renew their air supply. They are characteristic of running waters but also occur in ponds, swamps and a few forms occur in hot springs. Elmids are thought to feed on algae and debris (Pennak 1978).

Ash Springs riffle beetle is likely endemic to warm springs in southern Nevada and perhaps to the type locality, Ash Spring (Pahranagat Valley HB) (Schmude 1999). The *Stenelmis* sp. recently collected in this location is likely *S. lariversi* (BIO-WEST 2007).

4.2.1.2 Amphibians

Northern leopard frog historically had one of the largest ranges of any amphibian in North America (Stebbins 1985; Conant and Collins 1991). However, as early as the 1960s, the species appeared to decline in abundance throughout a large portion of its range (Smith 2003). Hitchcock (2001) surveyed for it at nine locations in Pahranagat Valley HB, including Ash Spring, Crystal Spring, Hiko Spring, and Maynard Spring, but only found it at Maynard Spring. Hitchcock (2001) surveyed three other locations on Pahranagat NWR but found none. Recent observations (2009 and 2010) have confirmed the presence of northern leopard frog at L Spring on Pahranagat NWR (J. Sjoberg, NDOW, pers. comm.). The species has been documented in the White River Valley HB (J. Sjoberg, NDOW, pers. comm.), but has never been documented in DDC.

Northern leopard frog was chosen for directly monitoring because it is an aquatic species that relies on distribution of water along the valley floor; is sensitive to changes in water quality; and populations are declining throughout much of its range, particularly in the western United States (Rorabaugh 2005). Each developmental stage of northern leopard frog (egg mass, tadpole, metamorph, and adult) requires different habitats that are influenced by quantity and quality of water. Habitat can be categorized as over wintering habitat (generally larger, deeper water that does not freeze solid), breeding and tadpole habitat (shallow ponds, generally with abundant aquatic and emergent vegetation), and summer habitat (wet meadows and upland areas surrounding aquatic habitat which is used for feeding) (Smith 2003). This species over-winters underwater, emerging relatively early in the spring to breed (Smith 2003). Eggs and sperm are shed into the water and egg masses can be found floating near the surface in clumps (Smith 2003), typically attached to vegetation (Kendell 2002). Breeding and hatching are strongly influenced by temperature (K. Wilson, UDWR, pers. comm.). Tadpoles spend two to three months developing in small, shallow water bodies that are heated by the sun and then metamorphose into young frogs (Smith 2003, Smith and Keinath 2007).

Threats to northern leopard frog within the Area of Interest include habitat alteration resulting from groundwater withdrawal, surface water diversions, livestock grazing, and road construction. Pollutants such as pesticides, herbicides, and fertilizers also pose direct threats to northern leopard frogs. The complex life cycle of amphibians and the permeability of their skin make them highly susceptible to water quality alterations, especially ecotoxicological agents (Cooke 1981, Bishop 1992, Hall and Henry 1992). Nonnative aquatic species, in particular bullfrogs and crayfish also pose a threat. Natural disturbances that can affect the species include insect epidemics, disease outbreaks, wildfire, weather, and succession (Smith 2003).

4.2.1.3 Fish

Special Status Species of fish that will be directly monitored are White River desert sucker, White River sculpin, White River spinedace, White River speckled dace, Moorman White River springfish, Hiko White River springfish, White River springfish, Pahranagat roundtail chub, and Pahranagat speckled dace.

White River desert sucker

White River desert sucker is a recognized subspecies of desert sucker endemic to the White River system. Historic distribution included the White River and larger spring outflow streams in the upper White River Valley HB; populations in Preston Big and Lund springs, as well as other locations, appear have been extirpated. Within the Area of Interest White River desert sucker currently occurs only in the Flag Springs complex and Sunnyside Creek (Scoppettone et al. 1992). Monitoring for this species is conducted by NDOW in conjunction with visual (snorkel) surveys for White River spinedace and recent surveys indicate that desert sucker is well-distributed and abundant in lower Flag Springs outflow streams and upper Sunnyside Creek.

White River sculpin

White River sculpin was first identified from the upper reach of Butterfield Spring in 1991. No other sculpin species is known to occur in the White River system or adjacent drainages and the collected individuals from Butterfield Spring were similar to, but showed some putative morphological differences from mottled sculpin *C. bairdi* (Scoppettone et al. 1992). Subsequent morphological and genetic analyses have provided varied and conflicting results. It is still unclear if this fish represents a unique endemic form or was introduced to Butterfield Spring from another location. Sculpin persists in Butterfield Spring and approximately 120 meters of the upper spring brook but regular monitoring has not been conducted due to access issues and a desire to minimize disturbance until systematic issues can be resolved.

White River Spinedace

White River spinedace is the most brightly colored of the four species of *Lepidomeda*, and commonly attains a total length over 100 mm (Miller and Hubbs 1960). This species occurs in cool springs (65-71° F), their outflows, and in White River Valley HB, in the upper part of the ancient White River system (La Rivers 1962). It probably lives 3 to 5 years (Sigler and Sigler 1987).

White River spinedace once inhabited at least seven spring systems in White River Valley HB (Miller and Hubbs 1960), but at the time of listing (1985) the species was restricted to the Flag Springs complex and Lund Spring (Scoppettone et al. 1992, USFWS 1994). By the early 1990s only the Flag Springs population remained. White River spinedace currently persist in the Flag Springs complex (including upper Sunnyside Creek). Semi-annual monitoring of White River spinedace in the Flag Springs complex and Sunnyside Creek has been conducted by NDOW since 1999. Adult population estimates based on visual observation have ranged from 500 to 3,000 individuals varying with season of survey and other factors, with the most recent estimate at 1,500 adult fish (Goldstein and Hobbs 2008).

White River Speckled Dace

White River speckled dace occur in the White River system of southeastern Nevada. It has a short life span, few living beyond 3 years. It is small, only reaching a length of 75 to 100 mm, prey for game fish and parasitized by a variety of organisms (Sigler and Sigler 1987). It has a subterminal mouth and feeds primarily on benthic organisms and algae. White River speckled dace is an undescribed subspecies which may be closely related to Pahranagat specked dace.

White River speckled dace currently persist at Flag Springs and Sunnyside Creek and Butterfield Spring. Numbers vary from rare to abundant at aquatic systems throughout White River Valley HB; the species has been extirpated from at least two locations (Cold Spring and Nicholas Spring).

White River, Hiko White River, and Moorman White River springfish)

White River springfish is a small fish reaching a maximum length of 65 mm and probably lives 3 to 5 years (Sigler and Sigler 1987). It usually exhibits a color pattern of two lateral rows of dark spots against a lighter background on the body. Previously described to a subspecies status under *Cyprinodon macularius* (Gilbert 1893), it is now regarded as a species, *Crenichthys baileyi*. There are five subspecies (Williams and Wilde 1981), all of which are presently listed as endangered or of special concern. Three of these subspecies occur within the Area of Interest, White River springfish, Hiko White River springfish, and Moorman White River springfish.

White River springfish currently inhabit Ash Spring in Pahranagat Valley HB. Mid- to downstream areas of the spring pool on private land provide the majority of occupied habitat for springfish resulting from ongoing disturbance on upper public land portions of the spring from intensive recreational use. Because of the large size and complexity of the Ash Spring pool system, accurate estimates of White River springfish population size are difficult to obtain, but recent visual (snorkel) surveys indicate that springfish remain well-distributed in the private land areas of the spring outflow and suggest a consistent population size of over 1,000 adult fish.

Hiko White River springfish inhabit both Crystal and Hiko springs in Pahranagat Valley HB. Williams and Wilde (1981) noted that Hiko White River springfish had been extirpated from Hiko Spring by 1967. The extirpation appeared to be the result of negative interactions with nonnative fishes, most notably largemouth bass and also shortfin molly and western mosquitofish (Minckley and Deacon 1968, Courtenay et al. 1985, USFWS 1998). Subsequently, a refuge population of Hiko White River springfish was established at Blue Link Spring in Mineral County, Nevada (USFWS 1998). Hiko White River springfish was repatriated in Hiko Spring twice in 1984 (USFWS 1998). The repatriated individuals reproduced and restored a population of Hiko White River springfish to Hiko Spring. Population estimates for Hiko White River springfish in Hiko Spring since repatriation have ranged as high as 8,000 adults, but adult numbers have declined substantially since the illegal introduction of crayfish into Hiko Spring in 2001 or 2002. The 2008 population estimates suggest a maximum population of around 800 adult fish (Goldstein and Hobbs 2008).

Moorman White River springfish are currently found in Moorman Spring, Hot Creek Spring and Moon River Spring in White River Valley HB. NDOW has a long-term monitoring program for Moorman White River springfish that provides mark/recapture population estimates at Moorman and Hot Creek springs, as well as catch per unit effort (CPUE) data at Moon River Spring. Recent sampling by NDOW shows that the population at each of these springs appears to be relatively stable. Williams and Wilde (1981) observed that Moorman White River springfish is not found in association with other native fish species, and subsequent surveys have supported that observation, as no other fish species has been found at Moorman Spring.

Pahranagat Roundtail Chub

Pahranagat roundtail chub is federally listed as endangered. This subspecies is one of the most critically imperiled fish in the Great Basin. Adults can exceed 150 mm in length and live approximately 3 to 5 years. Adult chubs move upstream to spawn in February and March, and this may coincide with the time of year when ambient water temperatures in the system of Ash Spring are at their lowest (Sigler and Sigler 1987).

The current range of Pahranagat roundtail chub is restricted, with the only wild population occurring in the Pahranagat Ditch outflow of Ash Spring. Monitoring surveys in December 2006 observed a total of 86 chub of all age classes in this 2.5 km river reach (Hobbs et al. 2007). The type location for the chub is Hiko Spring (Tanner 1950), but it has been extirpated from that location due to loss of the outflow habitat below the spring pool. The chub is a drift feeder and prefers flowing systems with deep, slow runs and pools and an abundance of structure and debris to provide velocity breaks and feeding sites (Hardy 1982, Tuttle et al 1990). Temperature may be an important limiting factor for Pahranagat roundtail chub within the Ash Spring system (Sigler and Sigler 1987). A refuge population consisting of several thousand individuals is maintained in created habitat at Key Pittman WMA near Hiko, Nevada.

Pahranagat Speckled Dace

Pahranagat speckled dace is a subspecies of speckled dace. While Pahranagat speckled dace have been extirpated from many of the larger springs in Pahranagat Valley HB, populations still exist at Cottonwood Spring, Brownie-Deacon Spring, and the Pahranagat Ditch outflow from Ash Spring. NDOW also found the species during historical sampling at Lone Tree Spring, but no habitat existed during surveys in 1998 and 2004 (Stein et al. 2000, BIO-WEST 2007). NDOW renovated Maynard Spring to remove common carp and western mosquitofish in the mid-1980s, after which Pahranagat speckled dace from the Cottonwood Spring area were introduced (Stein et al. 2000). During surveys conducted in 1999, no speckled dace was found at this location. Little, if any, fish habitat existed at Maynard Spring during a 2004 survey (BIO-WEST 2007).

4.2.2 Indirect Monitoring Using Habitat-Based Approach

Several Special Status Species will be indirectly monitored with a habitat-based approach. This approach will focus on monitoring key habitat components to assess how they might change over time as a result of SNWA groundwater withdrawal in DDC for the following species: Pahranagat Valley montane vole; southwestern willow flycatcher; yellow-billed cuckoo; greater sage grouse; other neotropical birds; and bats. These species are either difficult to directly monitor or only use the Area of interest during parts of the year. For those that migrate, it is beyond the scope of this project to determine what factors may affect them while they are absent from the Area of Interest. Therefore perpetuation of the habitats that these sensitive species utilize, and in conditions that appear to be favorable habitat, is a goal of this project.

Habitat-based monitoring includes establishment of permanent belt and line transects to measures woody species cover and composition, live and dead branches and density of overstory trees and shrubs in gallery forests and riparian woodlands, along with canopy height (neotropical birds) and herbaceous riparian plant height (for voles). Water availability (e.g., aquatic habitat extent) and water quality will be monitored for bats at these sites.

In addition to generic habitat requirements of breeding birds and bats, the BRT selected four Special Status Species for tailored habitat-based monitoring. Brief descriptions of Pahranagat Valley montane vole, greater sage grouse, southwestern willow flycatcher and yellow-billed cuckoo are presented below with an overview of the indirect monitoring approach for each.

4.2.2.1 Greater Sage Grouse

Greater sage grouse range spans the western half of the United States, from southern Canada to southern United States (Sage Grouse Conservation Team 2004). Within the Area of Interest, greater sage grouse is known to occur in Cave Valley HB (SNWA 2007b). While northern Dry Lake Valley HB appears to contain habitat, greater sage grouse has not been documented in the area (Aaron Ambos, SNWA, pers. comm.).

Greater sage grouse was recently found to be warranted for federal listing (range-wide), but that listing is precluded by higher priority listing actions (75 Federal Register 13910, March 23, 2010). It is currently a federal candidate species and a state-protected game species in Nevada.

Primarily a sagebrush obligate species, greater sage grouse can utilize various habitats over the course of the year. (Berry and Eng 1985, Connelly et al. 1988, Schroeder et al. 1999). Greater sage grouse of both sexes may use wet meadows, riparian areas and irrigated agricultural fields during the summer months if these areas are located within sagebrush habitat (Connelly et al. 2000, Sage Grouse Conservation Team 2004). Sage grouse tend to migrate to these wetter areas as upland sagebrush habitats begin to desiccate (Savage 1968, Schlatterer and Pyrah 1970, Oakleaf 1971, Neel 1980, Autenrieth 1981, Klebenow 1985) Hens will generally move broods to these areas about two weeks after males and females without chicks have moved there (Connelly et al. 1988). Use of these areas can vary annually based on climatic conditions, but in central-eastern Nevada generally occurs from May to September (NDOW and SNWA observations in White Pine County; SNWA 2009a).

Habitat monitoring for greater sage-grouse includes establishment of permanent line transects to measure vegetation species cover and composition, and how the plant communities expand or contract over time. Herbaceous canopy cover (perennial grasses, forbs), availability and diversity of forbs, and proximity to sagebrush shrublands are important components of brood-rearing habitat for food and cover/protection (Connelly et al. 2000, Connelly et al. *In Press*). Changes in vegetation cover or plant composition through time may affect the population of greater sage grouse that use Cave Valley Ranch Meadow for summer foraging and chick rearing. Therefore, this monitoring program is designed to measure and monitor these specific habitat indicators.

4.2.2.2 Pahranagat Valley Montane Vole

Pahranagat Valley montane vole is a recognized montane vole subspecies known only from Pahranagat Valley HB in Lincoln County, Nevada. In general, *Microtus* has relatively loose pelage, short tail, and short, rounded, nearly concealed ears (Hall 1946), and *M. montanus* is grizzled brown above, and white to gray below. Montane vole habitat is characterized by grasses, as their diet is comprised entirely of green grasses, and they live in runway systems constructed in and under grassy cover. Above-ground runways are supplemented by sub-surface burrows, and nests of dry grasses are located underground. The runway systems are also utilized by other small mammals, especially harvest mice (*Reithrodontomys* sp.) and deer mice (*Peromyscus* sp.). Pahranagat Valley montane vole is found in mesic areas usually in the vicinity of springs, wet meadows, lakes or irrigated fields with dense patches of green grass and sedges, to provide food and protective cover. Montane voles do not hibernate and remain active year-round. In winter, they have been known to make runways above ground and beneath snow cover (Anderson 1959, Hall 1946).

Pahranagat Valley montane vole has been observed or collected near Hiko (Hall 1946), Crystal Spring (Anderson 1959), Ash Spring (Hall 1946), and various locations on Pahranagat NWR (Tomlinson and Shoneman 1993). As the name implies, most montane vole species are found in higher-elevation mountainous habitat; however, Pahranagat Valley montane vole has adapted to lower elevation wet valleys. This subspecies represents completely isolated remnant population of a species that was more widely distributed and interconnected in the wetter geologic periods following the Pleistocene glaciations. Once connected through more mesic conditions to source populations of montane voles at higher elevations, this valley floor remnant is now isolated from the next nearest montane vole population (NDOW 2006).

Habitat monitoring for the Pahranagat Valley montane vole includes establishment of permanent line transects to measure vegetation species cover, height and composition. Dense and tall vegetation is also needed by the species for visual protection from predators and moist soil conditions are needed for construction of tunnels and burrows. Therefore, this monitoring program is designed to measure and monitor these specific habitat indicators.

4.2.2.3 Southwestern Willow Flycatcher and Yellow-Billed Cuckoo

Southwestern willow flycatcher is a small neotropical migrant bird that is found in select riparian systems in southern Nevada. It is known to breed in Pahranagat Valley HB at a limited number of sites including Pahranagat NWR, private lands and Key Pittman WMA (SWCA 2006, NDOW 2008). Flycatchers typically arrive on their breeding areas by May or June and depart for wintering grounds in late August. Dense vegetation near watercourses or inundated wetlands is required for nesting, thus the species is a riparian obligate breeder. In Pahranagat Valley HB, nesting habitat consists of Goodding's and coyote willow, cottonwood and other riparian vegetation.

Since 1999 NDOW and consultants have conducted standardized flycatcher surveys to document presence and breeding activity throughout the nesting season at sites in Pahranagat Valley HB. SNWA provides funds for these efforts. Habitat characteristics, including average canopy height, cover, presence of surface water or saturated soil, distance to water, nest height and vegetation associated with nest location, have been described (SWCA 2009). It is anticipated that flycatcher population monitoring will continue into the foreseeable future.

Yellow-billed cuckoo is a medium-sized neotropical migratory bird that is found in select riparian systems in southern Nevada. Cuckoos are secretive birds and have unique reproductive characteristics involving a rapid breeding cycle as they arrive in early summer to their breeding grounds. Breeding season surveys for cuckoos have been conducted by NDOW and private consultants since 2000 at various sites to determine distribution and breeding status in suitable riparian habitat in southern Nevada. The species has been documented in Pahranagat Valley HB, but breeding has not been confirmed (NDOW 2008). In addition, there is limited access for surveys given that substantial habitat is on private land. Notes on vegetation have been documented during the bird surveys and, where applicable additional measurements (e.g. average canopy height, percent canopy cover, and distance to water) have been made.

The BRT selected vegetation and soil characteristics to monitor that are known to be important for southwestern willow flycatcher (Sedgwick and Knopf 1992, Koronkewicz et al. 2006, Ellis et al. 2009) and yellow-billed cuckoo nesting and foraging (Johnson et al. 2007). These included density, cover, height and composition of woody species on transects. Cover and composition of herbaceous vegetation that is important for insects in these communities will also be assessed. The density of seedlings, juvenile, and mature trees also indicates the successional status of the woody component of these communities. Wet soils are needed in these riparian habitats to supply water and nutrients for plants, and for production of the insect fauna needed by the neotropical birds for food. Soil moisture in the sampling areas is therefore monitored as well.

4.3 MONITORING SITES

After identifying the locations of groundwater-influenced ecosystems in the Area of Interest, the BRT first evaluated the locations selected by the TRP in their hydrological monitoring network (Section 4.3.1). The BRT then developed an approach that was used to guide the site selection process discussed in Section 4.3.2. Selection of monitoring sites was facilitated by TRP coordination to cover both hydrologic and biological monitoring needs.

4.3.1 TRP Hydrologic Monitoring Network

The TRP hydrologic monitoring network, as currently configured, is comprised of 17 springs and 19 wells (15 existing wells and 4 new monitoring wells) within the Area of Interest (Figure 4-1), as well as any future SNWA exploratory and production wells. Per the Stipulation, the TRP designed the hydrologic monitoring network to meet the requirements of the Stipulation, including establishing baseline hydrologic conditions prior to and during SNWA groundwater withdrawal in DDC, providing early warning of the spread of groundwater drawdown toward Federal Water Rights and Federal Resources, and helping characterize interbasin groundwater flow between DDC and the Adjacent HBs (Stipulation Exhibit A pages 2-8; Appendix A). TRP site selection was coordinated with the BRT to address both hydrologic and biological considerations.

The initial criterion that TRP used to select spring sites followed the Stipulation guideline to monitor spring sites with greater probability to be affected by SNWA groundwater withdrawal in DDC. Not all sites met this criterion, however, as discussed in the paragraph below. TRP also selected sites that were of biological interest; spatially distributed across the Area of Interest; distributed in elevation (valley floor, range front and mountain block); representative of different hydrologic environments (carbonate, volcanic and basin fill); representative of other springs in the basins; and accessible and feasible to monitor. To inform site selection, SNWA initially provided the TRP with a comprehensive spring inventory of the Area of Interest, verifying spring sites during subsequent field trips. An assessment of hydrogeologic conditions was then conducted by considering the following factors: geologic environment (lithology); aquifer character (carbonate, volcanic, basin fill); elevational relationships among aquifers, springs, and other valley floor groundwater-influenced systems; and source of recharge (local or regional) determined in part by historical record of discharge, water temperature and isotope chemistry.

The requirement of the Stipulation to monitor spring sites most likely to be affected by SNWA groundwater withdrawal posed challenges in DDC because of the absence of valley-floor springs. All eight TRP spring monitoring sites in DDC are local or mountain-block springs that appear to be hydrologically disconnected from the regional aquifer and unlikely to be affected by SNWA groundwater withdrawal. The recently-vacated NSE Ruling 5875 specifically mentions Parker Station, Cave, Coyote, Grassy, and Meloy (which has similar hydrogeologic conditions as Littlefield) as having no connection to the principal aquifer (any conclusions made in future NSE rulings will also be considered by the BRT) (NSE Ruling 5875 pages 26-27). These sites were selected to document baseline conditions and ranges of variation. Springs in White River and Pahranagat Valley HBs were selected to either (1) monitor springs of concern for potential impact by groundwater withdrawal (Ash, Crystal, Hiko, and Flag), (2) provide background hydrologic data from areas less likely or unlikely to be affected by SNWA groundwater withdrawal (Hardy, Moorman, Hot Creek), and (3) provide spatial coverage in areas of specific concern (Maynard).

The TRP tried to select groundwater monitoring well sites at strategic locations that would provide representative data (1) spatially across the Area of Interest to characterize intra- and inter-basin flow, and (2) between areas of potential groundwater export and areas of hydrologic and biological concern where water rights and sensitive species are of issue. Monitoring well locations were selected with consideration of the hydrogeologic conditions at each location. The monitoring well network was designed to provide long-term monitoring and warning of significant drawdown propagation, if any, induced by SNWA groundwater development.

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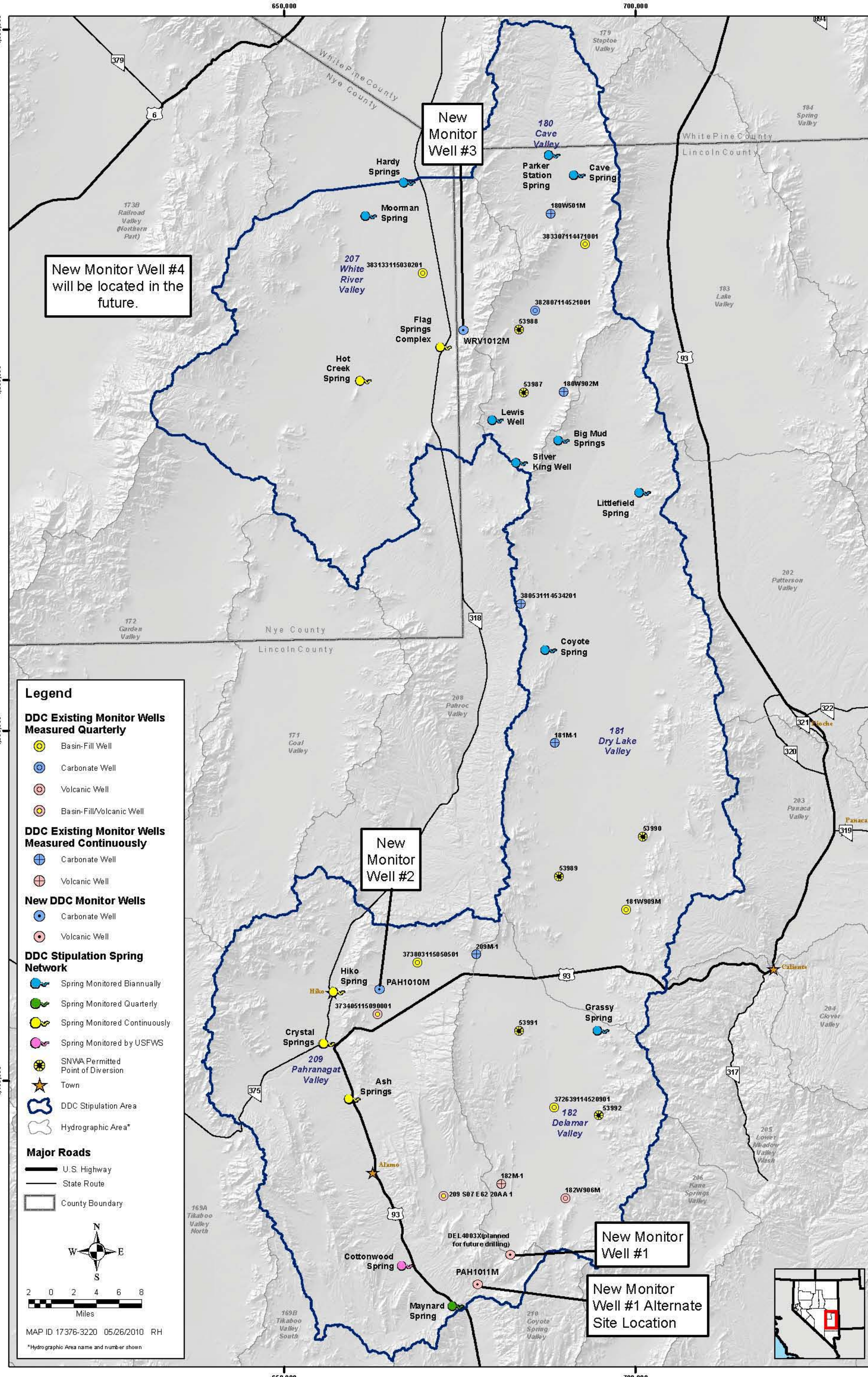

Figure 4-1 TRP Hydrologic Monitoring Spring and Well Sites

4.3.2 BRT Site Selection

To select sites, the BRT first evaluated the springs within DDC. As described in Chapter 3, site selection in DDC was challenging because of the limited surface water resources in these valleys that satisfy the site selection criteria set forth in the Stipulation. The decision for inclusion of DDC water resources for monitoring was made based on whether a given DDC groundwater-influenced ecosystem provided the best available representation of water resources within DDC. Grassy Spring was chosen for biological monitoring in Delamar Valley HB because it is a lower mountain block spring and one of few productive springs known from this valley. Similarly in Dry Lake Valley HB, Coyote Spring was selected as a representative water resource for this valley. Cave Valley HB site selection was more straight-forward because sage grouse habitat areas were specifically referenced in the Stipulation.

To facilitate site selection for Pahranagat and White River HBs, BRT developed a decision-making tree (Figure 4-2) to use in conjunction with specific input from the TRP. The stepwise criteria along the top row of Figure 4-2 were applied to each prospective site. These included an evaluation of 1) whether or not a Special Status Species (as defined by the Stipulation) was present, 2) the likelihood of potential effects from SNWA groundwater withdrawal in DDC, and 3) whether observed effects could potentially be attributed to SNWA groundwater withdrawal from DDC. The BRT relied heavily on guidance from the TRP relative to the second criteria. The TRP advised the BRT on spring types (e.g., local vs. intermediate or regional) and sites with a greater probability of being affected as a result of SNWA's groundwater withdrawals from DDC. Subsequently, BRT considered whether it was reasonable to expect that attributability could be determined. Some sites selected for monitoring did not met these criteria due to limited low-elevation surface water resources in DDC to choose from (as discussed in the paragraph above), and for some sites there was a lack of BRT and TRP consensus regarding the likelihood of effects. Additional factors influencing site selection not shown in Figure 4-2 included proximity to hydrologic monitoring sites, access, level of anthropogenic or natural disturbance, mitigation potential, and possible use as a reference site.

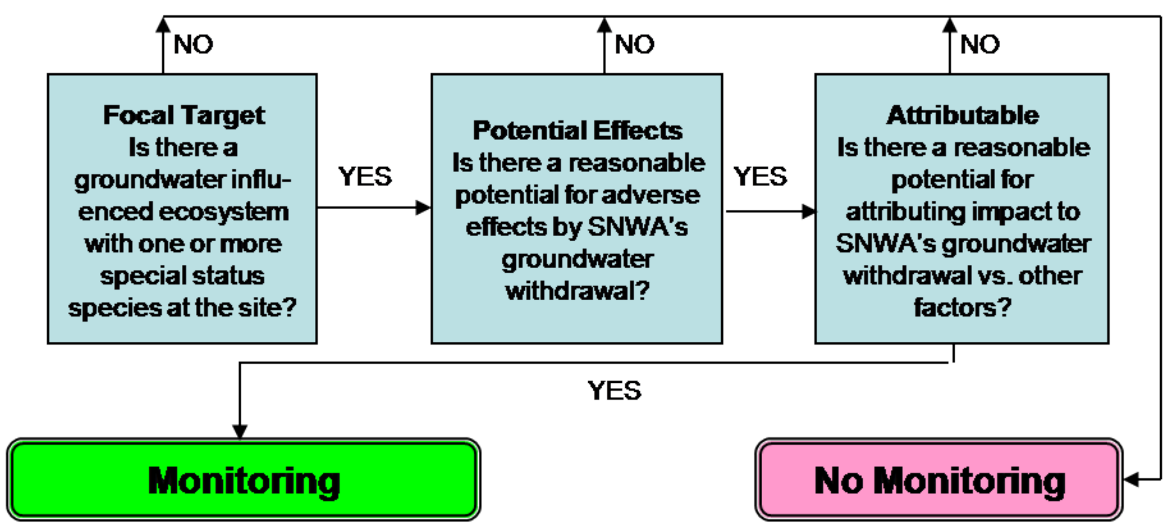

Figure 4-2 Site Selection Decision-Making Tree

4.3.2.1 Areas Managed for Wildlife

Specific reference is made in the Stipulation to Pahranagat NWR, Key Pittman WMA, and Kirch WMA as areas for potential consideration.

No monitoring sites have been selected on Pahranagat NWR at this time for several reasons. First, according to the recently-vacated NSE Ruling 5875, while there is reasonable chance for interbasin flow from Delamar Valley HB to southern Pahranagat Valley HB, various model simulations of SNWA groundwater withdrawal from DDC indicated that spring discharge in Pahranagat Valley HB would likely remain stable for 200 to 500 years. Second, local irrigation practices as they currently operate will likely influence hydrologic conditions at Pahranagat NWR more than distant pumping activities (Rick Felling, NSE, pers. comm.). Third, water and land management between Pahranagat NWR and Ash and Crystal springs will make it difficult to attribute potential impacts on the refuge to SNWA groundwater withdrawal in DDC. Fourth, FWS is currently developing a Pahranagat NWR habitat management plan that may help inform future decisions regarding monitoring on the refuge.

The hydrologic and biological monitoring networks and groundwater flow modeling efforts conducted under the Stipulation should detect propagation of effects from SNWA groundwater withdrawal in DDC toward Pahranagat NWR, providing opportunity for BRT and TRP to reevaluate the need for additional hydrologic and biological monitoring on the refuge. These efforts include continuous and quarterly data collection at groundwater monitoring wells situated between areas of potential groundwater export and Pahranagat Valley HB and Pahranagat NWR; hydrologic and biological monitoring at Ash and Crystal springs, which are major water sources that feed Pahranagat NWR; and periodically-updated groundwater flow model simulations using newly-acquired data. The BRT will also consider conclusions made in future NSE rulings, and will revisit monitoring on the refuge upon completion of a Pahranagat NWR habitat management plan. Should a production well be sited within the Pahranagat Shear Zone, BRT will reinitiate discussions with TRP regarding risk to springs and wetted areas in southern Pahranagat Valley HB, adjusting monitoring levels and locations in this area if appropriate. Additional protection is granted to the Pahranagat NWR in the Stipulation by specifying no injury to Federal Water Rights, which applies to surface water coming into Pahranagat NWR from the outflow of Ash and Crystal springs. If at any point in time effects are predicted on Pahranagat NWR within ten years, BRT will reconvene to select monitoring sites on the refuge and commence monitoring at the Tier 2 level.

No monitoring sites were selected on Key Pittman WMA because it is a highly managed system with artificially-varying water levels and other confounding land management activities. Hydrologic and biological monitoring will be conducted at Hiko Spring, which is a major water source that feeds Key Pittman WMA.

Sites were selected on Kirch WMA, as described in Section 4.3.2.2. These sites meet the site-selection criteria shown in Figure 4-2.

4.3.2.2 Monitoring Sites

Biological monitoring sites are presented in Table 4-2 and locations are shown on Figure 4-3.

Table 4-2 Biological Monitoring Sites and Directly-Monitored Special Status Species

Monitoring Site	Ownership (Public/ Private)	Hydro-graphic Basin	Hydrological Monitoring Location	Springsnails[1]	Fish[2]	Northern Leopard Frog
Cave Valley Ranch Meadow	Private	Cave	No	A	A	--
Parker Station Spring	Private	Cave	Yes	P-pm	--	--
Grassy Spring	Public	Delamar	Yes	A	A	--
Coyote Spring	Public	Dry Lake	Yes	A	A	--
Littlefield Spring	Public	Dry Lake	Yes	--	--	--
Meloy Spring	Private	Dry Lake	No	P-pb	--	--
Butterfield Spring	Private	White River	No	P-pl, pm	P-wd	--
Flag Springs[3]	Public	White River	Yes	P-pb,ps	P-wrs, wd	--
Hardy Springs	Private	White River	Yes	P-pm	P-wd	--
Hot Creek Spring	Public	White River	Yes	P-pme, tc	P-ms	--
Moorman Spring	Private	White River	Yes	P-pme, tc	P-ms	--
Ash Spring	Pub/Pri	Pahranagat	Yes	P-pme, tc	P-ws	--
Crystal Spring	Private	Pahranagat	Yes	P-ph	P-hs	--
Hiko Spring	Private	Pahranagat	Yes	A[4]	P-hs	--
Maynard Spring	Public	Pahranagat	Yes	A[4]	A	P
Pahranagat Ditch	Private	Pahranagat	Yes	A	P-rc, P-pd	--

[1] Springsnails: A = absent; P = present, -- = no data to confirm; *pb = Pyrgulopsis breviloba; ph = Pyrgulopsis hubbsi; pl = Pyrgulopsis lata; pm = Pyrgulopsis marcida; pme = Pyrgulopsis merriami; ps = Pyrgulopsis sathos; tc = Tryonia clathrata*

[2] Fish: A = absent; P = present, -- = no data to confirm; hs = Hiko White River springfish; ms = Moorman White River springfish; wd = White River speckled dace; wrs = White River spinedace; ws = White River springfish, rc = Pahranagat roundtail chub, pd = Pahranagat speckled dace

[3] Includes Sunnyside Creek

[4] Hubbs springsnail historically known for this location but may be extirpated (Hiko Spring: Sada 2005 and BIO-West 2007; Maynard Spring: L. Averill-Murray, FWS, pers. comm..).

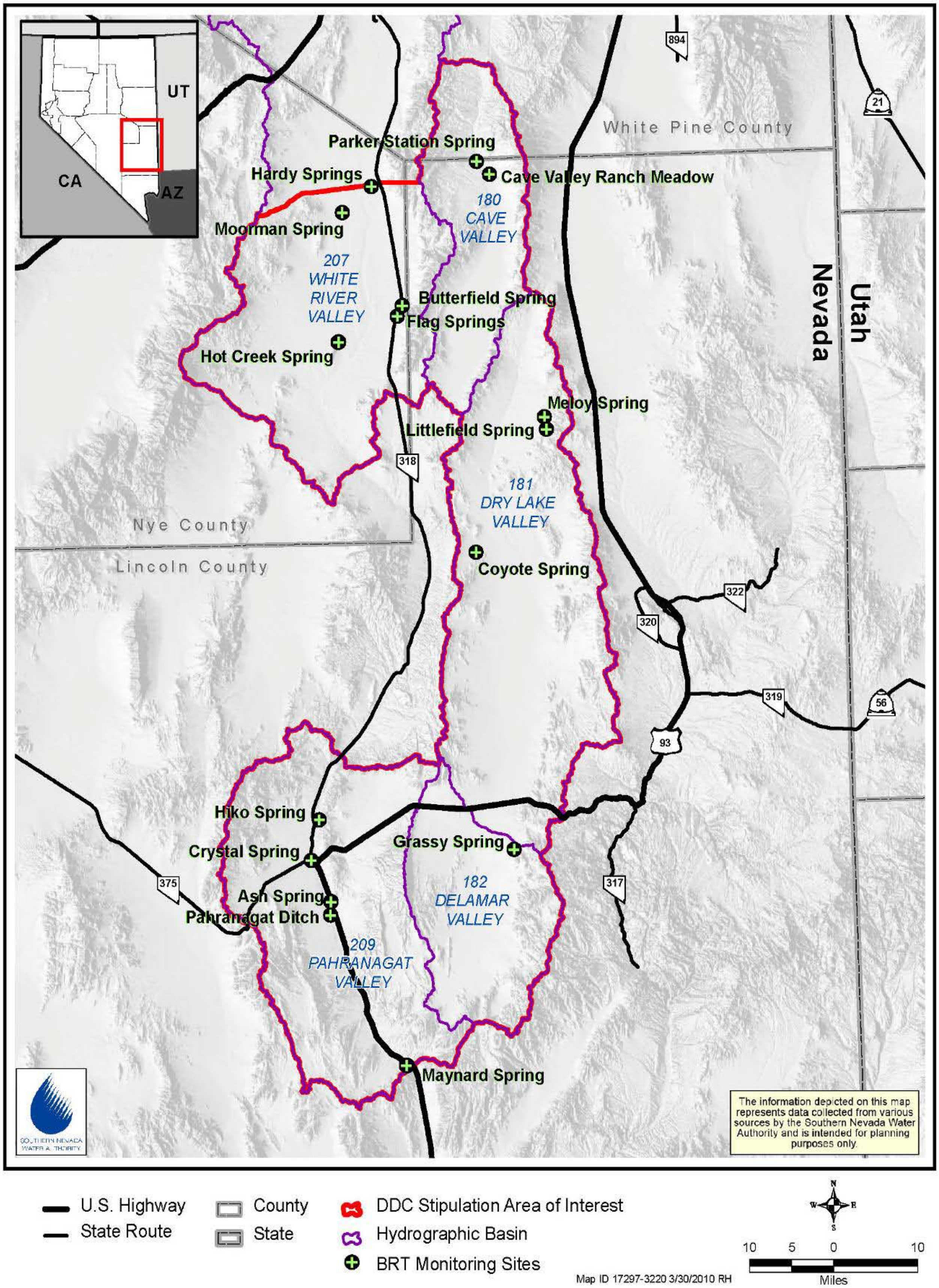

Figure 4-3 BRT Monitoring Sites

Access to the proposed monitoring sites is a key to Plan success. Many of the sites are located on public land managed by BLM and are readily accessible. Access to private land sites is contingent on the permission of the landowners.

In summary, 16 locations were selected by the BRT for monitoring within the Area of Interest: 14 springs site; one perennial stream (Pahranagat Ditch) associated with Ash and Crystal springs and one meadow complex in Cave Valley HB associated with sage grouse habitat. At each site, one or more Special Status Species or habitats will be monitored.

Cave Valley Ranch Meadow

Cave Valley Ranch Meadow is a large high elevation meadow located south of Parker Station in Cave Valley HB. Deep, fertile soils with groundwater near the surface support diverse vegetation communities. This meadow contains vegetation communities of grasses, sedges, and forbs and is very productive. These communities are important summer habitat for the greater sage grouse, which use this area for food, cover, and nesting.

Parker Station

The unnamed spring at Parker Station in Cave Valley HB is approximately 1 meter deep and 15 meters wide. Sada (2005) indicated that this spring was highly disturbed by cattle and may have been excavated at one time. In addition to snails in the subclass Pulmonata, Sada (2005) found Hardy springsnail abundant here.

Grassy Spring

Grassy Spring is currently a small piped springhead in Delamar Valley HB that empties into a circular stock tank and overflows into a pond approximately 19 meters in diameter (BIO-WEST 2007). During a site visit in 2004, the spring appeared to be highly disturbed caused by the piping of water from the springhead. Based on the vegetation around the pond, it appeared that seepage from the tank varied as a result of large, seasonal water fluctuations. This site goes dry at times, as documented in October 2008 (Aaron Ambos, SNWA. pers. comm.). There are no Special Status Species for direct monitoring at Grassy Spring, but numerous bat species have been documented using this water source.

Coyote Spring

Coyote Spring is currently an altered spring system located in Dry Lake Valley HB. During a 2004 site visit, it was noted that the spring was piped into two concrete stock tanks, was impacted by livestock use, and appeared to provide minimal habitat for aquatic organisms since one of the tanks was dry (BIO-WEST 2007). It appeared as though a spring once originated from the hillside to the west (near a dwelling and grove of cottonwood trees) and there was subsurface water flow toward the area where stock tanks were located. During surveys around Coyote Spring in 2005, SNWA personnel observed tiger salamanders in the concrete stock tanks – several approximately 25-cm long adult salamanders and dozens of larvae (approximately 5-10 cm in length) (Aaron Ambos, SNWA. pers. comm.). There are no Special Status Species for direct monitoring at Coyote Spring, but numerous bat species have been documented using this water source.

Littlefield Spring

Littlefield Spring is a mountain block spring system in Dry Lake Valley HB, in close proximity to Meloy Spring. No comprehensive biological survey has been conducted at this site. Littlefield Spring will serve as a monitoring site for the TRP. The BRT chose to monitor

Littlefield Spring to maintain a continuous data set for this area should access to Meloy be granted then revoked at a later date.

Meloy Spring

Meloy Spring is a shallow mountain block spring system located on private land in Dry Lake Valley HB. Meloy Spring has a population of Flag springsnail. Survey results from 1992 listed in Sada (2005) show that Flag springsnail was abundant at this location. Flag springsnail is also known to occur at Flag Springs in White River Valley HB.

Butterfield Spring

Butterfield Spring is on private land in White River Valley HB, in close proximity to the Flag Springs Complex. The Butterfield Spring system historically joined Sunnyside Creek before entering the relic White River, but currently the entire spring outflow is diverted for irrigation several hundred meters below the source. White River speckled dace is currently abundant at this spring system (J. Sjoberg, NDOW, pers. comm.). The spring pool also contains a population of an undescribed sculpin (*Cottus* sp.); it is unclear if the sculpin is endemic to White River Valley HB or has been introduced to the site (J. Sjoberg, NDOW, pers. comm.). Butterfield springsnail is endemic to Butterfield Spring and was abundant in this system during surveys conducted in 1992 (Hershler 1998, Sada 2005). Hardy springsnail is also found in Butterfield Spring.

Flag Springs

The Flag Springs complex consists of: Flag Springs North, Middle, and South in the White River Valley HB. The Flag Springs complex is located at the Headquarters for Wayne Kirch WMA. The three springs discharge from coarse alluvial gravels in an area 275 meters wide to 370 meters long. The discharge of north Flag Spring and south Flag Spring is measured biannually by USGS. The springs discharge into Sunnyside Creek which then flows into the Adams-McGill Reservoir, where it is used by livestock and wildlife.

Flag Springs and Sunnyside Creek currently contain the only population of White River spinedace. Both White River speckled dace and White River desert sucker are abundant in the three spring brook outflows and associated Sunnyside Creek habitats. Flag springsnail is currently only known to occur in the Flag Springs complex in White River Valley HB and Meloy Spring in Dry Lake Valley HB (Hershler 1998, Sada 2005). The Flag Springs complex also supports a narrow riparian corridor adjacent to each of the spring runs. The riparian woodland has several large cottonwood and willow trees. The riparian woodland extends to near the confluence of the three springs and does not extend to the upper portions of Sunnyside Creek.

Hardy Springs

The Hardy Springs Group is comprised of Upper Hardy Springs, which are five individual spring orifices that discharge into a main channel that joins the White River, and Hardy Spring Northwest. Hardy Springs are located in White River Valley HB. A small diversion is present approximately 30 to 50 meters downstream from the confluence of the upper group. Currently, the diversion is in disrepair but could be used again if needed. The entire flow of the upper group can be either diverted into an aqueduct that flows directly west or allowed to flow along its current course. Hardy springsnail is found at Hardy Springs.

Hot Creek Spring

Hot Creek Spring forms a large, irregularly shaped pool and channel approximately 20 meters wide by 700 meters long in White River Valley HB. The lower end of the pool is currently impounded behind a small berm and discharges to Hot Creek, which flows eastward to Adams-McGill Reservoir or to a ditch to Dacey Reservoir, providing water primarily for wildlife habitat maintenance on Kirch WMA. During the 2006 water year, USGS installed a gauging station on Hot Creek Spring. Currently, there is no active diversion on Hot Creek Spring.

Hot Creek Spring was designated as a refuge for Moorman White River springfish in 1966. During 1992 surveys listed in Sada (2005), Pahranagat pebblesnail and grated tryonia were common at Hot Creek. Springsnails were scarce throughout most of a 2004 survey in Hot Creek, but were common in a few areas (BIO-WEST 2007).

Moorman Spring

Moorman Spring is located on the Rocking 13 Ranch in the White River Valley HB. The spring pool has been enhanced through anthropogenic activities. Moorman Spring currently forms a small pool, approximately 10 meters long and 4-6 meters wide, behind an old irrigation diversion structure. The pool is partially encircled by a man-made berm that appears to have been used to contain the spring in a reservoir. A head gate and two aqueducts control Moorman Spring's pool elevation, and all diversion works are in poor condition. From the reservoir, the water discharges into an approximately 1-meter wide channel that continues south for several kilometers.

Moorman Spring is the type location for Moorman White River springfish (Williams and Wilde 1981). Pahranagat pebblesnail and grated tryonia also inhabit Moorman Spring.

Ash Spring

Ash Spring is the largest and warmest spring complex located in Pahranagat Valley HB, with a reported discharge of 440-598 l/s (USFWS 1998). Williams and Wilde (1981) describe White River springfish as occurring in Ash Spring and its outflow, and noted that the rarity of the species was a result of nonnative fish introductions. Periodic monitoring indicates that springfish persist throughout most of the upper spring pool system in low densities (Hobbs et al. 2007). Pahranagat roundtail chub has been reported historically at Ash Spring, but has not been observed in recent surveys and presumably has been extirpated from the upper spring system (Hobbs et al. 2007).

Ash Spring is also the type location for Pahranagat pebblesnail (Hershler 1994). Currently, this snail is found in four systems, of which only Ash Spring is in Pahranagat Valley HB. Sada (2005) listed 1992 Ash Spring survey results showing that Pahranagat pebblesnail was abundant, and grated tryonia was scarce. A survey in 2004 also showed the presence of Pahranagat pebblesnails at two of the springheads and 60 meters downstream of the main pool area at Ash Spring (BIO-WEST 2007). Pahranagat naucorid bug has also been collected at Ash Spring. Additionally, Ash Springs riffle beetle is possibly endemic to Ash Spring (Schmude 1999).

Riparian woodland exists around Ash Spring and extends downstream along the Pahranagat Ditch. The riparian gallery includes large cottonwoods and willows that provide habitat for migratory and breeding birds. Pahranagat Valley montane vole has been historically reported from Ash Spring.

Crystal Spring

Crystal Spring is located on private lands in northern Pahranagat Valley HB, approximately 8.4 km northwest of Ash Spring. The main orifices currently discharge through two spring source pools from bedrock on the east side of a small hill of limestone and sandstone into a channel flowing east approximately 300 meters, then south onto private lands for agricultural uses. Discharge at Crystal Spring is currently measured with a permanently installed 4-ft Parshall flume and a continuous stage recorder operated by USGS. Crystal Spring discharge ranges from 1 to 14 cfs (450 to 6,280 gpm), because the combined discharge from the main orifices is intermittently diverted to an irrigation ditch to the south before it reaches the main channel.

Historical sampling indicated that Pahranagat roundtail chub, Pahranagat speckled dace, and White river desert sucker were found in association with Hiko White River springfish at Crystal Spring, but only Pahranagat speckled dace and Hiko White river springfish remained common throughout the 1960s (Williams and Wilde 1981, Courtenay et al. 1985). Tuttle et al. (1990) found Hiko White River springfish in relatively low numbers at Crystal Spring in the mid 1980s, but Pahranagat speckled dace appeared to be extirpated. Subsequent monitoring indicates that Hiko White River springfish persists in both spring source pools but is highly impacted by nonnative fishes and crayfish; speckled dace and Pahranagat roundtail chub have been extirpated from the spring (Hobbs et al 2007). Crystal Spring contains a population of Hubbs springsnail.

Riparian woodland consisting of cottonwoods and willows occurs around the springs, which provides shelter and refuge for avian species. The overstory of these trees and shrubs provides shade for the springs and habitat for invertebrates. Pahranagat Valley montane vole inhabits the wet meadow communities around the spring pools and along the channel. Tall herbaceous vegetation and moist soils are necessary for persistence of this vole.

Hiko Spring

Hiko Spring is on the Cannon Ranch approximately 1 km northeast of Hiko, Nevada, in the north end of Pahranagat Valley HB. In 1939, a dam was constructed in front of the spring orifice to form a reservoir. The water was diverted using this diversion system until approximately 1980, when a new dam was constructed and the old diversion ditches were converted to pipelines. Historically, this system flowed into the old Pahranagat River channel (USFWS 1998). The most recent discharge value reported for this spring was 151 l/s, with a wide range (34-255 l/s) reported historically (USFWS 1998).

Hiko Spring is the type location for Hiko White River springfish and Pahranagat roundtail chub (Tanner 1950, Williams and Wilde 1981). Springfish persist in the spring pool but chub has been extirpated from this system, presumably because of the loss of lotic habitat in the 1980's when outflow ditches were converted to pipelines. Hiko Spring and Crystal Spring contained the only known populations of Hubbs springsnail (Hershler 1998); however, surveys in 2000 and 2006 revealed no springsnails at Hiko Spring, and it may be extirpated at this location (Sada 2005, BIO-WEST 2007).

Maynard Spring

Maynard Spring is located south of the Pahranagat NWR. NDOW renovated Maynard Spring to remove common carp and western mosquitofish in the mid-1980s, after which Pahranagat speckled dace from the Cottonwood Spring area were introduced (Stein et al. 2000). During surveys conducted in 1999, no Pahranagat speckled dace was found at this location. Little, if any, fish habitat existed at Maynard Spring during a 2004 survey (BIO-WEST 2007). In fall 2010, NDOW engaged in habitat restoration activities and re-introduced approximately 80

Pahranagat speckled dace in the spring. Future surveys will be conducted to determine if the fish population becomes established. Hitchcock (2001) reported northern leopard frog at this spring location.

Pahranagat Ditch

The Ash Spring outflow channel, also known as Pahranagat Ditch, extends downstream from Ash Spring as a semi-natural channel for approximately 2.5 km at which point it enters a lined irrigation ditch. At this time Pahranagat Ditch reach supports the only wild population of Pahranagat roundtail chub; limited recent survey data suggest that adult chub numbers in this reach have declined significantly for unknown reasons but possibly related to the management of agricultural return flows which affect thermal refuges for chub reproduction. Pahranagat Valley specked dace and nonnative fishes including carp and cichlids also currently occur in this stream reach. The Pahranagat Ditch channel also supports extensive riparian woodlands, with large cottonwood and willow trees present. The woodland provides habitat for avian species (e.g., yellow-billed cuckoo) and shade for Pahranagat roundtail chub and invertebrate communities. Pahranagat Valley montane vole has been historically reported from Ash Spring and may extend down into the Pahranagat Ditch area.

4.4 KEY ECOLOGICAL ATTRIBUTES (KEAS) AND INDICATORS

As described in Chapter 3, KEAs are characteristics that describe groundwater-influenced ecosystems and potentially are critical to their long-term viability or integrity, including biological composition, interactions, and processes (Parrish et al. 2003). Indicators are used to assess the KEAs; they are what are actually measured to quantify impacts associated with groundwater withdrawals by SNWA. This section describes the chosen KEAs and indicators, and discusses why they were selected for monitoring for each groundwater-influenced ecosystem. Chapter 5 describes sampling design and protocols for monitoring indicators. For each groundwater-influenced ecosystem, KEAs and indicators are not always monitored at every site because of unique site characteristics or existing monitoring programs.

4.4.1 Overview of Key Ecological Attributes and Indicators

The KEAs identified by the BRT can be summarized by the following three categories:

- **General Site Condition –** provides a qualitative evaluation of site condition over time as captured via fixed station photography and site assessment.
- **Abiotic –** encompasses water availability, water quality, and other physical habitat attributes. Abiotic indicators provide a link between groundwater/surface water conditions and biota, and can serve as an early warning indicator of potential adverse effects.
- **Biotic –** represents both animals and vegetation. Special Status Species strongly tied to aquatic ecosystems provide the best opportunity for correlating species' responses with any ecosystem changes resulting from groundwater withdrawal. Vegetation provides habitat for the Special Status Species. Plant species and plant communities also differ in their sensitivities to groundwater change, making them good indicators of change.

Specific indicators chosen for monitoring provide quantifiable measures of short-term responses to systemic change, as well as long term viability and integrity of the groundwater-influenced ecosystems within the Area of Interest. The indicators provide a means to monitor how each system expands or contracts over time, how water availability and quality changes over time, and how the vegetation and animal communities respond to these changes.

Many of the KEAs and indicators included in this Plan are being monitored under the Biological Monitoring Plan for the Spring Valley Stipulation (BWG 2009). Two years of data have been collected under the Spring Valley Stipulation, and the Biological Work Group (BWG) will be conducting a Plan evaluation and revision in upcoming years. BRT will use the information gained through the BWG's evaluation and revision process and adopt changes as appropriate.

KEAs and indicators for each of the levels of monitoring are summarized in Table 4-3. As discussed in Chapter 3, biological monitoring will consist of a Site Characterization followed by tiered monitoring. Site Characterization will provide a snapshot of ecological conditions at the start of the monitoring program, and will be repeated at intervals (described in Section 4.5) to provide updates of site condition. Tier 1 consists of a basic suite of indicators that will allow for on-going evaluation of conditions, document changes in Special Status Species and/or their habitats prior to any predicted impacts, and help determine the need for Tier 2 monitoring. Tier 2 will consist of an expanded suite of indicators that will include all Tier 1 variables and additional variables, creating a more comprehensive baseline. Tier 2 will accomplish all Tier 1 objectives, as well as facilitate BRT's assessment of biological responses (both species and habitat) to spring flow or groundwater level changes. Tier 2 will also enable the BRT to determine if adverse effects have occurred and, if so, whether they are potentially attributable to SNWA groundwater withdrawal.

Table 4-3 Overview of KEAs and Indicators by Level of Tiered Monitoring

KEA Indicator	**Site Characterization**	**Tier 1**	**Tier 2**
General Site Condition			
Fixed Station Photography		X	X
Site Assessment	X	X	X
Abiotic – TRP[2]			
Depth to groundwater	X	X	X
Discharge[3]	X	X	X
Wetted area[3]	X	X	X
Temperature, pH, Conductivity, Turbidity	X	X	X
Abiotic – BRT			
Dissolved oxygen, Temperature, pH, Conductivity	X	X	X
Nitrogen and Phosphorus	X		X
Aquatic habitat extent	X		X
Water depth, Water velocity, Substrate	X		X
Distance to permanent water, Soil moisture			X
Biotic – Animals			
Macroinvertebrate composition and abundance	X		X
Springsnail presence and/or extent	X	X	X
Springsnail abundance and distribution	X		X
Fish size class structure and distribution	X	X	X
Northern leopard frog (NLF) presence	X	X	X
NLF egg mass abundance and distribution			X
Pahranagat Valley montane vole presence[4]	X		X
Biotic – Vegetation			
Community distribution (mapping)	X		
Cover and composition		X	X
Community extent			
Open water and vegetation cover		X	X
Internal heterogeneity		X	X
Live/dead trees shrubs in gallery (bird habitat)			X
Vegetation height and density (bird and vole habitat)			X

[1] Indicators monitored will vary by site based on resources present, potential for effect, and feasibility.
[2] TRP will be conducting hydrological monitoring as described in the TRP monitoring plan (SNWA 2009b).
[3] If discharge cannot be measured, spring pool elevation or wetted area will be measured and/or general conditions documented via photographs and site assessments.
[4] Presence of Pahranagat Valley montane vole will determine the need for habitat monitoring.

4.4.2 Relevance of Key Ecological Attributes and Indicators

Indicators for the KEAs are listed below.

General Site Condition. *Qualitative data (fixed station photography and site assessment)* are valuable for characterizing overall site condition.

Abiotic

Abiotic measurements will allow the assessment of linkages between changes in groundwater level or spring flow with changes in monitored biota. Understanding these relationships will help determine ecological thresholds and acceptable range of variation for directly-monitored Special Status Species indicators, and help determine cause and effect relationships if changes in biotic indicators are documented. It may become possible to use abiotic habitat indicators as surrogates for plant and animal data, if in fact linkages can be quantified and established. They will also serve as a vehicle to indirectly monitor other Special Status Species via a habitat-based approach. The response time of abiotic habitat indicators is often less than that of animal communities, making them good early warning indicators of potential adverse effects to the Special Status Species.

Abiotic – TRP. Abiotic indicators are direct and effective measures for quantitatively documenting changes over time. Water availability and water quality are major factors influencing biological composition and productivity. Specific indicators include *depth to groundwater*, *discharge*, *wetted area*, and *water quality*.

Abiotic – BRT. Water availability and water quality can reveal changing groundwater and spring flow conditions. *Aquatic habitat extent* documented through physical habitat maps will provide spatial information about standing water availability and coarse-scale habitat delineations for plants and animals within the aquatic systems. These maps will provide coarse-scale descriptions of *water depth* and *water velocity*. Water quality indicators (*temperature, pH, conductivity, dissolved oxygen concentration, turbidity, nitrogen and phosphorus*) are important to plants and animals in these habitats, and can influence the biological integrity of the systems. It will be important to understand how values fluctuate in response to precipitation, weather, and/or other disturbances and to detect meaningful changes that may result from SNWA groundwater withdrawal.

Fine-scale abiotic measurements will also be made associated with Special Status Species sampling to help develop a better understanding of microhabitat needs of the species and potentially develop predictive relationships between abiotic and biotic factors. Water quality (*temperature, pH, conductivity, dissolved oxygen concentration), water depth, water velocity and substrate composition* are thought to be relevant indicators for springsnails (e.g., substrate conditions below spring orifices are thought to influence springsnail distribution. Water quality (*temperature, pH, conductivity, dissolved oxygen concentration)* and *water depth* can affect northern leopard frog egg laying and development.

As part of the habitat-based approach, *distance to permanent water* and *soil moisture* data will also be collected as part of characterizing southwestern willow flycatcher and yellow-billed cuckoo habitat, and *soil moisture* data will be collected within Pahranagat Valley montane vole habitat.

Biotic

Biotic measurements will allow assessment of directly-monitored Special Status Species, and of habitat of directly- and indirectly-monitored Special Status Species.

Biotic - Animals. The animal indicators to be monitored in these aquatic systems are *macroinvertebrate composition and abundance, springsnail abundance and distribution, fish size class structure, distribution, and northern leopard frog presence and egg mass abundance and distribution.* Changes in population dynamics can result from changes in habitat that potentially could be precipitated or augmented by effects from groundwater withdrawal. *Macroinvertebrate composition and abundance* can provide information on changes in water quality and habitat, as well as serve as an index for the quantity and quality of resources available for the other directly-monitored aquatic biota. The indicators for the directly-monitored Special Status Species were chosen because they could provide early indication of potential impacts to the populations. The goal is to detect change early enough to allow BRT time to assess the changes, determine if the changes are caused or augmented by SNWA groundwater withdrawal, and determine if actions are needed to avoid or mitigate potential Unreasonable Adverse Effects.

For the indirectly-monitored species (Pahranagat Valley montane vole, southwestern willow flycatcher, yellow-billed cuckoo, breeding birds and bats), only habitat indicators will be monitored. Presence/absence surveys for Pahranagat Valley montane vole will be conducted only to determine the need for habitat monitoring.

Biotic - Vegetation. Aquatic, riparian (herbaceous and woody) and meadow areas selected for monitoring have been identified by BRT as habitat for directly- and indirectly-monitored Special Status Species. Vegetation measurements will allow the assessment of linkages between changes in groundwater level or spring flow with changes in the directly-monitored Special Status Species. They will also serve as a vehicle to indirectly monitor other Special Status Species via a habitat-based approach. Interpretations of the data will focus not only on vegetative changes, but also how those changes might effect or explain changes in directly- and indirectly-monitored Special Status Species.

Monitoring changes in *vegetation cover and composition* will provide insight into ecological responses to changes in groundwater level and outflow, and provide early indication of potential impacts from SNWA groundwater withdrawal. Measuring cover and composition also provides a non-destructive means of evaluating change in plant communities (e.g., shifts from mesic to xeric species). *Pattern of internal heterogeneity* refers to the distribution patterns of the micro-communities that are included in the meadow, wetland, or aquatic community. The first indicator of depth to groundwater-induced change in the terrestrial vegetation is likely to be manifested in some of these micro-communities, rather than the community as a whole. *Community extent* refers to the extent of micro-communities and macro-communities, and thus the change in the location of ecotones, which can provide early indication of changes in water availability. *Open water and vegetation cover* can also provide early indication of changes in water availability and provide data on the general composition of the physical habitat for Special Status Species in aquatic and terrestrial systems. *Live vs. dead (woody vegetation)* refers to the health of vegetation or plant species. With increasing stress, woody plants often have reduced foliage and branches begin to die (Mooney et al. 1991). Changes in plant species health usually occur before there are changes in cover or composition. Vegetation vigor usually refers to health of major species within a community, and may be indicated by plant size, cover, and live vs. dead branches of the woody community.

Fine-scale vegetative measurements will also be made associated with Special Status Species sampling to help develop a better understanding of microhabitat needs of the species and potentially develop predictive relationships between vegetative habitat and animal indicators. *Algae presence*, *submerged vegetation presence*, and *percent emergent vegetation* are thought to be relevant indicators for springsnails. *Percent emergent vegetation* can affect northern leopard frog egg laying and development.

Vegetation structure indicators have been chosen specifically to address indirectly-monitored Special Status Species. *Woody riparian tree density and canopy height* are indicators relevant to yellow-billed cuckoo (Gaines 1974, Braden et al. 2008), southwestern willow flycatcher (Sedgwick and Knopf 1992, Koronkiewicz et al. 2004, 2006, Broadhead et al. 2007, Ellis et al. 2009), and breeding birds in general (Barry et al. 2006). *Herbaceous riparian plant height* is an indicator relevant to Pahranagat Valley montane vole (C. Tomlinson, NDOW, pers. comm.). Plant density and height are indications of recruitment and the production and expansion of leaves and stems of plants, which could be affected by groundwater drawdown or spring flow reduction. Recruitment and growth result in more food and cover and better habitat for fauna within the ecosystem.

4.5 LEVEL OF MONITORING

As outlined in Chapter 3, the types of water resources present within DDC and the location and timing of potential effects to Pahranagat and White River Valley HBs led the BRT to develop a tiered approach for biological monitoring within the Area of Interest. Each spring location listed in Table 4-2 will receive a Site Characterization at the start of the monitoring program. This initial Site Characterization will offer an initial description of the natural resources and their condition, and will allow for testing and establishing protocols. Following initial Site Characterization, baseline biological sampling will continue at either a Tier 1 or Tier 2 level of monitoring, as described below. Tier 1 or Tier 2 monitoring will be conducted annually throughout SNWA groundwater withdrawal from DDC. For those sites that do not receive Tier 2 monitoring over an extended period of time, Site Characterization will be repeated every 10 years in conjunction with Tier 1 monitoring to provide more comprehensive information on the natural resources and their condition over time.

The BRT developed a decision-making tree to evaluate whether a site would be monitored at the Tier 1 or Tier 2 level, and when a shift from one tier to another would occur (Figure 4-4). Sites were evaluated in coordination with the TRP to determine the potential for effects from SNWA groundwater withdrawal in DDC. Site location (elevation, basin, and proximity to SNWA groundwater withdrawal), source of recharge, and time frame for potential effects were key factors. Using TRP guidance, the BRT based this evaluation on the recently-vacated NSE Ruling 5875 and preliminary groundwater flow modeling results. The TRP and BRT acknowledge levels of uncertainty in these assessments; this was duly considered in development of the Plan, which is designed to adapt to new information and knowledge regarding potential for impacts to Special Status Species and their habitats.

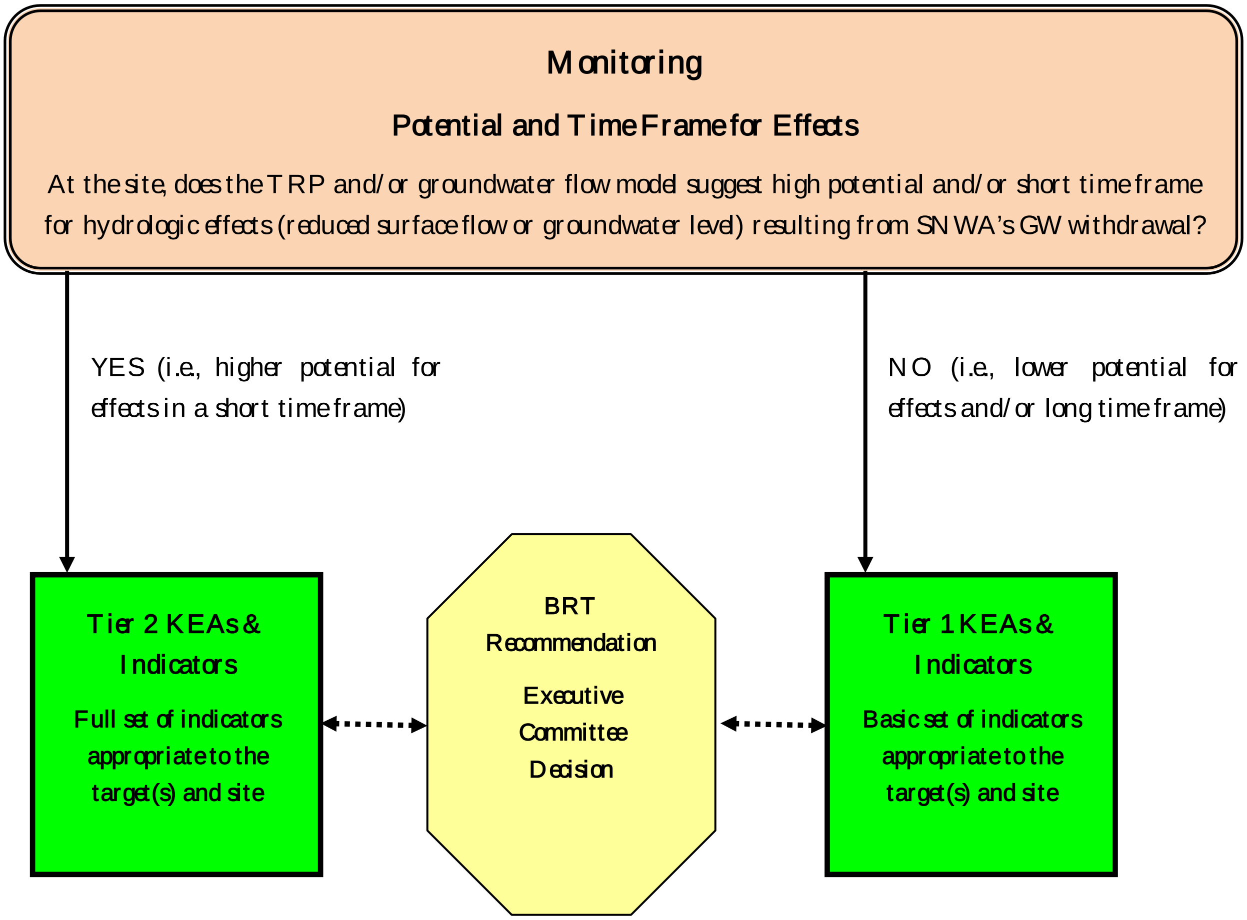

Figure 4-4 Tiered Monitoring Decision-Making Tree

According to the decision-making tree, if a site has no or low potential for effects or effects are not anticipated to be manifested for a long time (i.e., decades or centuries), the site would be monitored at a Tier 1 level; if a site has for effects in a short time frame (i.e., within a decade), the site would be monitored at a Tier 2 level. A shift from Tier 1 to Tier 2, or from Tier 2 to Tier 1, would be determined by the EC decision with recommendations from the BRT and TRP. To allow ample time to develop a comprehensive baseline data set for Tier 2 indicators, a shift from Tier 1 to Tier 2 will be made if evidence suggests that SNWA groundwater withdrawal has the potential to affect Special Status Species or their habitat within 10 years. BRT recommendations to the EC will likely be based on updated groundwater flow modeling results and hydrologic data being collected at springs in DDC, regional springs in the adjacent valleys, and monitoring wells specifically located within the Area of Interest. Modeling results and hydrologic data sets will be routinely evaluated by the TRP and BRT specifically for this purpose. The combination of updated models and hydrological and biological data will be used to evaluate if a shift from one tier to another should be recommended by the BRT to the EC. Finally, the BRT in coordination with the TRP may request a data review or consultation at any time to evaluate the potential for effects and attributability.

With the decision-making tree as a foundation, a charting exercise was undertaken to determine the appropriate level of monitoring intensity for each site at the onset of the monitoring program (Figure 4-5). TRP guidance, the recently-vacated NSE ruling 5875, and preliminary groundwater flow modeling results were used to chart the potential for spring flow reduction.

Risk was categorized as "potential within a decade", "potential within decades", "potential within centuries", and "no to low potential", with the recognition of the uncertainties inherent in modeling and assigning the sites to these categories. Current protection afforded to the Special Status Species, as well as current petitions for federal listing under the ESA, were used to chart species status.

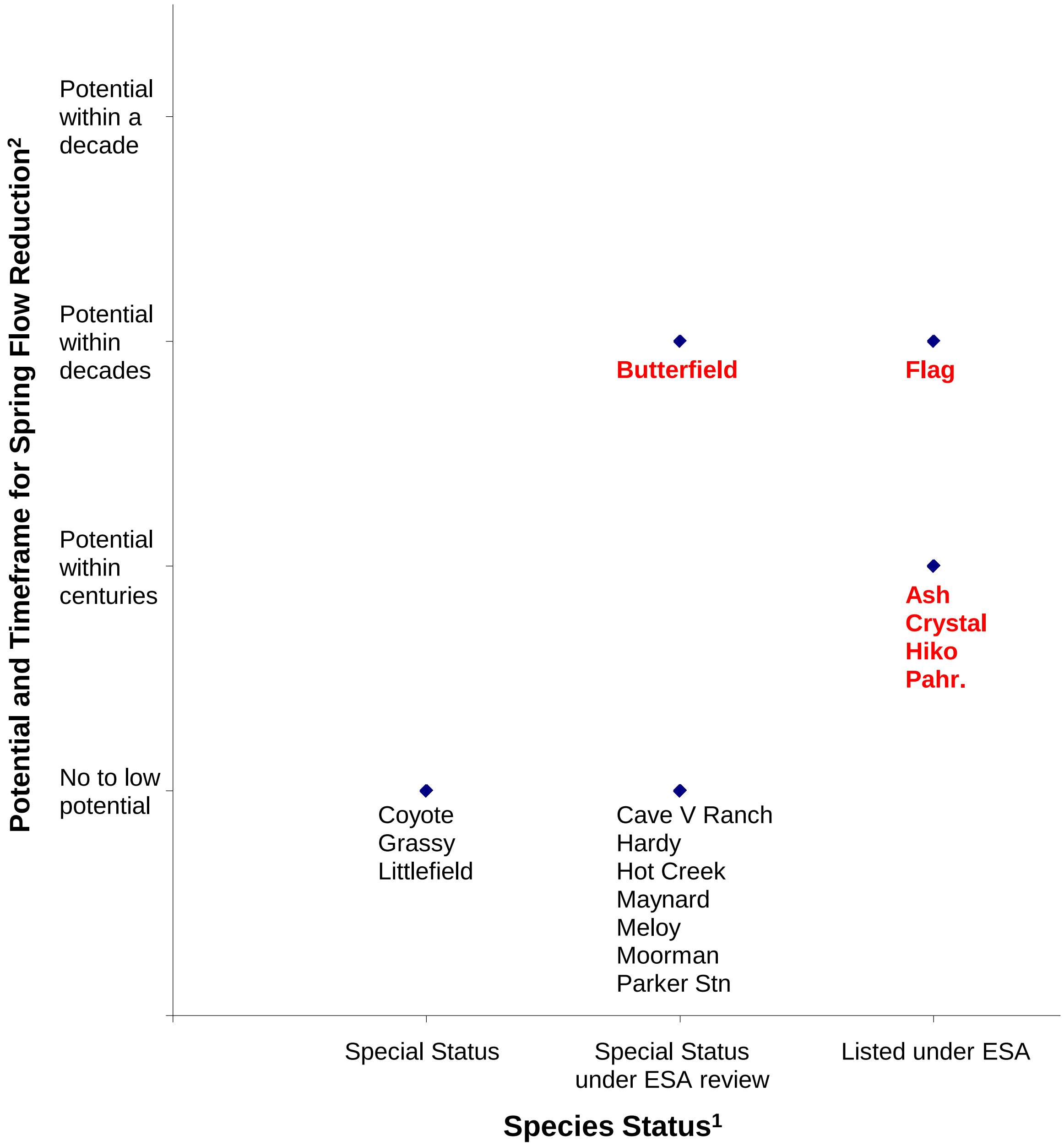

Figure 4-5 Risk-Sensitivity Analysis to Determine Level of Tiered Monitoring

[1] Refer to Stipulation Exhibit A page 14 (Appendix A) for description of Special Status Species
[2] Based on the recently-vacated NSE Ruling 5875. Conclusions made in future NSE rulings will also be considered by the BRT

Based on the results of this risk-sensitivity analysis shown in Figure 4-5, and using the decision-making criteria displayed in Figure 4-4, no sites were categorized as high risk with the potential for short-term impacts (i.e., within a decade). Thus, all sites will be monitored at the Tier 1 level until further evidence that Tier 2 is warranted.

Even though the time line for potential effects as documented in the recently-vacated NSE Ruling is at least multiple decades to centuries, SNWA has agreed to more intensive baseline monitoring on a periodic basis at six sites that harbor specific species of concern (Figure 4-5 upper right corner; Table 4-4). This will be achieved by collecting data consistent with Tier 2 indicators during the first two years of Tier 1 monitoring, and periodically thereafter unless a shift from Tier 1 to Tier 2 monitoring occurs. This more intensive data collection will be conducted at Flag and Butterfield springs every 5 years, and Pahranagat Ditch and Hiko, Crystal and Ash springs every 10 years (in lieu of and on the same schedule as the repeated Site Characterizations). This additional effort will allow BRT to develop a more detailed understating of the ecological systems. Frequency of more intensive monitoring at these six sites may change in the future based on available information.

As mentioned above, the decision-making criteria and BRT's risk-sensitivity analysis relied on the recently\-vacated NSE Ruling 5875, which summarized the results of groundwater flow modeling efforts based on SNWA's applied-for POD and quantities. However, as part of this Plan's adaptive approach, the above risk assessment is subject to modification with new information. The BRT will consider conclusions made in future NSE rulings, which will most likely involve updated groundwater modeling output. Also, while the risk assessment in Figure 4-5 is based on NSE Ruling 5875, the BRT acknowledges that the TRP has not reached complete consensus regarding the probability level for affects to sites in southern Pahranagat Valley and northern Cave Valley HBs, and will continue to consult with the TRP as new information is gained. Because SNWA's proposed action is one of distributed pumping, SNWA will likely seek to change its PODs, which could affect BRT's risk assessment for particular sites. If future production wells are sited farther north in Cave Valley HB or within the Pahranagat Shear Zone, the BRT will consult with TRP regarding risk to springs and wetted areas in northern Cave Valley HB and southern Pahranagat Valley HB, adjusting monitoring levels and locations in these areas if appropriate.

Table 4-4 Level of Tiered Monitoring at Monitoring Sites upon Plan Initiation

Monitoring Site	Hydro-graphic Basin	Monitoring Level	Increased monitoring intensity during Tier 1[1]
Cave Valley Ranch Meadow	Cave	Tier 1	
Parker Station Spring	Cave	Tier 1	
Grassy Spring	Delamar	Tier 1	
Coyote Spring	Dry Lake	Tier 1	
Meloy Spring	Dry Lake	Tier 1	
Littlefield Spring	Dry Lake	Tier 1	
Butterfield Spring	White River	Tier 1	First 2 yrs and every 5 years
Flag Springs	White River	Tier 1	First 2 yrs and every 5 years
Hardy Springs	White River	Tier 1	
Hot Creek Spring	White River	Tier 1	
Moorman Spring	White River	Tier 1	
Ash Spring	Pahranagat	Tier 1	First 2 yrs and every 10 years
Crystal Spring	Pahranagat	Tier 1	First 2 yrs and every 10 years
Hiko Spring	Pahranagat	Tier 1	First 2 yrs and every 10 years
Maynard Spring	Pahranagat	Tier 1	
Pahranagat Ditch	Pahranagat	Tier 1	First 2 yrs and every 10 years

[1] Even though the time line for potential effects as documented in the recently-vacated NSE Ruling is at least multiple decades to centuries, SNWA has agreed to more intensive baseline monitoring on a periodic basis at six sites that harbor specific species of concern. In addition to Tier 1 monitoring, this will be achieved by collecting data consistent with Tier 2 indicators during the first two years of Tier 1 monitoring, and periodically thereafter unless a shift from Tier 1 to Tier 2 monitoring occurs. Frequency of more intensive monitoring at these six sites may change in the future based on available information.

4.6 RESEARCH AND INFORMATION NEEDS

BIO-WEST (2007) indicated that aquatic spring ecosystems without State- or Federal-status species are under-sampled or, in some cases, unsampled. Presence of Special Status Species has been fairly well documented but is not completely known across the Area of Interest. If additional locations harboring Special Status Species are identified in the Area of Interest in the future, surveys to document habitat use may help inform the biological monitoring program.

Although there is considerable information on the ecology and life histories of northern leopard frog and the fish species proposed for monitoring, ecological thresholds at which adverse effects may occur are poorly understood or unknown. Even less is known regarding springsnail life histories. Knowledge of breeding birds and bats dependence on the wetland ecosystems of the Area of Interest is lacking (Rosenberg et al. 2002). In these cases, the linkages of abiotic and biotic habitat to biotic response have not been established or studied to any degree within the Area of Interest.

Springsnails would be ideal candidates for research. Recent work has shown that spring brook length and springsnail distribution and abundance are correlated for springs in Death Valley (Sada and Herbst 2006). Understanding how habitat constricts and expands during dry and wet conditions, and how this affects springsnail populations would provide information to guide decisions relative to adverse effects and threshold conditions.

The natural variability and dynamics of the vegetation communities are not well understood. Plant species composition, depth to groundwater, and precipitation data in these wetland ecosystems will provide information to enhance understanding of the ecological responses of these communities to water availability over time, and reveal whether additional study is warranted. There is a strong relationship between soils and vegetation in many meadow ecosystems and little is known about soil characteristics at meadow and riparian sites to be monitored. Data on the following soil parameters, by horizon, would be helpful in understanding their effects on vegetation at these sites: depth (thickness), texture, bulk density, water-holding capacity, pH, and content of organic matter and major nutrients (e.g., nitrogen, phosphorus, potassium).

Our understanding is complicated further by the level of anthropogenic disturbance within the Area of Interest and thus, monitoring prior to SNWA groundwater withdrawal is necessary to describe ranges of conditions for the various indicators. While data collected during Plan implementation along with existing data from the Great Basin will be used to develop initial estimates for threshold responses, it is likely that several years of data specific to the Area of Interest will be needed to test the appropriateness and completeness of any preliminary estimates. Also, the extent of natural variation has yet to be determined for all of the sites in question and species of interest. This information will only become available through sampling the various components of a given spring ecosystem multiple times in a repeatable manner over time.

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5.0 MONITORING PROTOCOL

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5.5 Summary of Sampling Schedule and Activities

The development of KEAs and indicators for groundwater-influenced ecosystems, as discussed in Chapter 3, was aided by the CAP process. The selection process and rationale for determining sites, KEAs, and indicators are described in Chapter 4. Subsequently, monitoring protocols (protocols) were developed by the BRT to measure each indicator or suite of indicators. Chapter 5 describes the target population (a general term used to describe a plant or animal population of interest or concern), sampling design, monitoring sites, and sampling protocol for data collection for each indicator. Protocols for training, safety, and avoidance of transfer of nuisance species are presented in the Spring Valley Monitoring Plan (BWG 2009).

The goal of protocol development and implementation is to establish a highly repeatable methodology that allows a quantifiable assessment of the indicators. The value of a protocol is largely dependent on repetitive sampling over many sampling events. Repetitive sampling allows for accumulation of data associated with the species and habitat types directly dependent on the target systems from which to identify trends. The accumulated data gives perspective and will assist the BRT to understand and distinguish both natural and anthropogenic changes in groundwater-influenced ecosystems. Therefore, this protocol should facilitate the collection of unbiased information regarding natural fluctuations of the physical, chemical, and biological aspects of selected groundwater-influenced ecosystems in a cost-effective manner and should facilitate ascertainment of future impacts to those ecosystems.

The primary focus during protocol development was building upon the TRP hydrological monitoring network, applying protocols developed for the Biological Monitoring Plan for the Spring Valley Stipulation, and incorporating existing state and federal monitoring programs. Established methods that have been used recently by various BRT entities within the Area of Interest were also evaluated. In each case, presently-employed protocols were evaluated and assessed as to whether or not the type and level of effort associated with existing monitoring programs were sufficient to meet the biological monitoring goals and objectives (Chapter 2) of the Stipulation. State and federal scientific collection permits required for any of the biological collections associated with the Plan will be obtained prior to data collection.

Many of the KEAs and indicators included in this Plan are being monitored under the Biological Monitoring Plan for the Spring Valley Stipulation (BWG 2009). Two years of data have been collected under the Spring Valley Stipulation, and the Biological Work Group (BWG) will be conducting a Plan evaluation and revision in upcoming years. BRT will use the information gained through the BWG's evaluation and revision process and adopt changes as appropriate.

An overview of the KEAs and indicators to be measured at each of the monitoring sites for each respective sampling level (Site Characterization - SC, Tier 1 – T1, and Tier 2 – T2) is presented in Table 5-1. A detailed table of KEAs, indicators broken out by sampling component, sampling schedule, and qualifiers is presented in Appendix B. The tables in Chapter 5 and Appendix B were designed using the following rules concerning Special Status Species occurrence and surveys:

- If a directly- or indirectly-monitored Special Status Species is known to occur at a site, surveys for that species and/or habitat specifically associated with that species are included in the tables for that site.
- If a directly- or indirectly-monitored Special Status Species has been previously documented at a site but current presence is unknown (e.g., possibly extirpated, no recent documentation, or success of recent reintroduction to be determined), surveys for that species and/or habitat specifically associated with that species are included in the tables for that site with footnote "if species present".

- If a directly- or indirectly-monitored Special Status Species has never been documented at a site, surveys for that species and/or habitat specifically associated with that species are omitted from the tables for that site.
- Because occurrence of northern leopard frog within the Area of Interest is less well understood, if northern leopard frogs have been previously documented in a hydrographic basin, surveys for northern leopard frogs and/or habitat specifically associated with northern leopard frogs are included for all sites in that hydrographic basin with footnote "if species present".
- If northern leopard frogs have never been documented in a hydrographic basin, surveys for northern leopard frogs and habitat specifically associated with northern leopard frogs are omitted from all sites in that hydrographic basin.

The tables in Chapter 5 and Appendix B outline sampling to be conducted during Site Characterization, Tier 1 and Tier 2 (SC/T1/T2). The tiered monitoring approach works as follows:

- Site Characterization (SC) will be conducted during a single visit in Year 1.
- Following Site Characterization, Tier 1 monitoring will be conducted each year unless a shift to Tier 2 occurs.
- Site Characterization will be repeated every 10 years in conjunction with Tier 1 monitoring, unless a shift to Tier 2 occurs.
- More intensive baseline monitoring will be conducted at Flag, Butterfield, Ash, Crystal and Hiko springs and Pahranagat Ditch during the first two years of Tier 1 monitoring, and periodically thereafter unless a shift to Tier 2 occurs (Flag and Butterfield springs: every 5 years; Hiko, Crystal, and Ash springs and Pahranagat Ditch: every ten years). This will be achieved by collecting data consistent with Tier 2 indicators.
- If a shift to Tier 2 occurs, Tier 2 monitoring will be conducted each year unless a shift back to Tier 1 occurs.

Table 5-1 Summary of KEAs and Indicators by Site and Level of Tiered Monitoring

[See Appendix B for details]

	Delamar, Dry Lake, and Cave Valley Hydrographic Basins																	
KEA	Cave Valley Ranch Meadow			Coyote Spring			Grassy Spring			Littlefield Spring			Meloy Spring			Parker Station Spring		
Indicator	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2
GENERAL SITE CONDITION																		
Fixed Station Photography		x	x		x	x		x	x		x	x		x	x		x	x
Site Assessment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ABIOTIC																		
Water Availability and Chemistry (TRP)[1]				x	x	x	x	x	x	x	x	x				x	x	x
Dissolved oxygen, Temperature, pH, Conductivity				x		x	x		x	x	x[4]	x	x	x[4]	x	x	x	x
Temperature (logger, continuous)					x	x		x	x		x[4]	x		x[4]	x		x	x
Aquatic habitat extent (w/ depth & velocity categories)				x		x	x		x	x		x	x		x	x		x
Nitrogen and Phosphorus										x[4]		x[4]	x[4]		x[4]	x		x
Water depth, Water velocity, Substrate[2]										x[4]		x[4]	x[4]		x[4]	x		x
Distance to permanent water, Soil moisture																		
BIOTIC – ANIMALS																		
Macroinvertebrate composition and abundance												x[4]			x[4]			x
Springsnail presence and/or extent										x	x[4]	x[4]	x	x[4]	x[4]	x	x	x
Springsnail abundance and distribution										x[4]		x[4]	x[4]		x[4]	x		x
Fish size class structure and distribution																		
Northern leopard frog (NLF) presence																		
NLF egg mass abundance and distribution																		
Pahranagat Valley montane vole presence[3]																		
BIOTIC – VEGETATION																		
Community distribution (mapping)	x			x			x			x			x			x		
Cover and composition		x	x									x[4]			x[4]			x
Community extent		x	x									x[4]			x[4]			x
Open water and vegetation cover		x	x									x[4]			x[4]			x
Internal heterogeneity		x	x									x[4]			x[4]			x
Live/dead trees shrubs in gallery																		
Algae, submerged and emerged vegetation[2]										x[4]		x[4]	x[4]		x[4]	x		x
Vegetation height and density (bird and vole habitat)																		

[1] TRP will be conducting hydrological monitoring as described in the TRP monitoring plan (SNWA 2009b). If discharge cannot be measured, spring pool elevation or wetted area will be measured and/or general conditions documented during site visits via photography and site assessment. At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring and Butterfield Spring), BRT will determine appropriate measurement for water availability.
[2] Certain indicators to be collected in association with data collection on directly-monitored Special Status Species.
[3] To be conducted every 3-5 years at those sites with documented Pahranagat Valley montane vole presence for the purpose of confirming continued occupancy.
[4-7] If the Special Status Species associated with the indicator is present. 4=springsnails, 5=fish, 6=northern leopard frog, 7= Pahranagat V. montane vole or SW willow flycatcher.

Table 5-1 Summary of KEAs and Indicators by Site and Level of Tiered Monitoring

[See Appendix B for details]

	White River Valley Hydrographic Basin														
KEA Indicator	**Butterfield Spring**			**Flag Springs**			**Hardy Springs**			**Hot Creek Spring**			**Moorman Spring**		
	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2
GENERAL SITE CONDITION															
Fixed Station Photography		x	x		x	x		x	x		x	x		x	x
Site Assessment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ABIOTIC															
Water Availability and Chemistry (TRP)[2]				x	x	x	x	x	x	x	x	x	x	x	x
Dissolved oxygen, Temperature, pH, Conductivity	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Temperature (logger, continuous)		x	x		x	x		x	x		x	x		x	x
Aquatic habitat extent (w/ depth & velocity categories)	x		x	x		x	x		x	x		x	x		x
Nitrogen and Phosphorus	x		x	x		x	x		x	x		x	x		x
Water depth, Water velocity, Substrate[2]	x		x	x		x	x		x	x		x	x		x
Distance to permanent water, Soil moisture															
BIOTIC – ANIMALS															
Macroinvertebrate composition and abundance	x		x	x		x	x		x	x		x	x		x
Springsnail presence and/or extent	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Springsnail abundance and distribution	x		x	x		x	x		x	x		x	x		x
Fish size class structure and distribution	x	x	x	x	x	x				x	x	x	x	x	x
Northern leopard frog (NLF) presence	x	x	x[6]	x	x	x[6]	x	x	x[6]	x	x	x[6]	x	x	x[6]
NLF egg mass abundance and distribution			x[6]			x[6]			x[6]			x[6]			x[6]
Pahranagat Valley montane vole presence[3]															
BIOTIC – VEGETATION															
Community distribution (mapping)	x			x			x			x			x		
Cover and composition			x			x			x			x			x
Community extent			x			x			x			x			x
Open water and vegetation cover			x			x			x			x			x
Internal heterogeneity			x			x			x			x			x
Live/dead trees shrubs in gallery			x			x			x						
Algae, submerged and emerged vegetation[2]	x		x	x		x	x		x	x		x	x		x
Vegetation height and density (bird and vole habitat)															

[1] TRP will be conducting hydrological monitoring as described in the TRP monitoring plan (SNWA 2009b). If discharge cannot be measured, spring pool elevation or wetted area will be measured and/or general conditions documented during site visits via photography and site assessment. At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring and Butterfield Spring), BRT will determine appropriate measurement for water availability.

[2] Certain indicators to be collected in association with data collection on directly-monitored Special Status Species.

[3] To be conducted every 3-5 years at those sites with documented Pahranagat Valley montane vole presence for the purpose of confirming continued occupancy.

[4-7] If the Special Status Species associated with the indicator is present. 4=springsnails, 5=fish, 6=northern leopard frog, 7= Pahranagat V. montane vole or SW willow flycatcher.

Table 5-1 Summary of KEAs and Indicators by Site and Level of Tiered Monitoring

[See Appendix B for details]

	Pahranagat Valley Hydrographic Basin														
KEA Indicator	**Ash Spring**			**Crystal Spring**			**Hiko Spring**			**Maynard Spring**			**Pahranagat Ditch**		
	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2	SC	T1	T2
GENERAL SITE CONDITION															
Fixed Station Photography		x	x		x	x		x	x		x	x		x	x
Site Assessment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ABIOTIC															
Water Availability and Chemistry (TRP)[2]	x	x	x	x	x	x	x	x	x	x	x	x			
Dissolved oxygen, Temperature, pH, Conductivity	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Temperature (logger, continuous)		x	x		x	x		x	x		x^{4-6}	x		x	x
Aquatic habitat extent (w/ depth & velocity categories)	x		x	x		x	x		x	x		x			
Nitrogen and Phosphorus	x		x	x		x	x		x	x^{4-6}		x^{4-6}	x		x
Water depth, Water velocity, Substrate[2]	x		x	x		x	$x^{4,6}$		$x^{4,6}$	$x^{4,6}$		$x^{4,6}$	x^{6}		x^{6}
Distance to permanent water, Soil moisture			x			x									x
BIOTIC – ANIMALS															
Macroinvertebrate composition and abundance	x		x	x		x	x		x	x^{4-6}		x^{4-6}	x		x
Springsnail presence and/or extent	x	x	x	x	x	x	x	x^{4}	x^{4}	x	x^{4}	x^{4}			
Springsnail abundance and distribution	x		x	x		x	x^{4}		x^{4}	x^{4}		x^{4}			
Fish size class structure and distribution	x	x	x	x	x	x	x	x	x	x^{5}	x^{5}	x^{5}	x	x	x
Northern leopard frog (NLF) presence	x	x	x^{6}	x	x	x^{6}	x	x	x^{6}	x	x	x^{6}	x	x	x^{6}
NLF egg mass abundance and distribution			x^{6}			x^{6}			x^{6}			x^{6}			x^{6}
Pahranagat Valley montane vole presence[3]	x		x^{7}	x		x							x		x^{7}
BIOTIC – VEGETATION															
Community distribution (mapping)	x			x						x			x		
Cover and composition			x			x						x^{4-6}			x
Community extent			x			x						x^{4-6}			x
Open water and vegetation cover			x			x						x^{4-6}			x
Internal heterogeneity			x			x						x^{4-6}			x
Live/dead trees shrubs in gallery			x			x									x
Algae, submerged and emerged vegetation[2]	x		x	x		x	$x^{4,6}$		$x^{4,6}$	$x^{4,6}$		$x^{4,6}$	x^{6}		x^{6}
Vegetation height and density (bird and vole habitat)			x^{7}			x									x^{7}

[1] TRP will be conducting hydrological monitoring as described in the TRP monitoring plan (SNWA 2009b). If discharge cannot be measured, spring pool elevation or wetted area will be measured and/or general conditions documented during site visits via photography and site assessment. At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring and Butterfield Spring), BRT will determine appropriate measurement for water availability.
[2] Certain indicators to be collected in association with data collection on directly-monitored Special Status Species.
[3] To be conducted every 3-5 years at those sites with documented Pahranagat Valley montane vole presence for the purpose of confirming continued occupancy.
[4-7] If the Special Status Species associated with the indicator is present. 4=springsnails, 5=fish, 6=northern leopard frog, 7= Pahranagat V. montane vole or SW willow flycatcher.

The following sections describe the components listed below for each indicator proposed in Table 5-1 and Appendix B for monitoring within the Area of Interest:

- sampling objectives
- sample design
- monitoring sites
- sampling protocol

Sample areas for Tier 1 and Tier 2 activities will be determined during the initial Site Characterization at each site.

All data for the Plan will be recorded in an effective manner. Project-specific data sheets, calibration logs, and chain-of-custody forms will be prepared prior to the first sampling event. Coordination with the data management team (Chapter 6) will be conducted to ensure that these forms correspond to the extent possible and practical with the data entry format developed for the project database. Digital datasheets may be used for certain or all sampling components of the Plan. When hard copies are used, datasheets will be printed on waterproof paper and designed in a user-friendly manner with a designated space for all necessary information. To ensure completeness, once all necessary information has been recorded on the proper data sheet (or digital file) for each site, the person recording the data must initial and date the data sheet in a specified field. Prior to leaving the site, the data sheet is then reviewed by the designated crew leader to assure completeness, and signed and dated by that reviewer in a separate field.

Access to private property will be coordinated with the property owner. Sampling on private property will be dependent on the granting of access by the property owner.

5.1 GENERAL SITE CONDITION

General site condition measurements will include site assessment and fixed station photography.

5.1.1 Sampling Objectives

The sampling objective for the general site condition measurements is to describe the general habitat conditions during each biological sampling event.

5.1.2 Sampling Design

General site condition will be assessed annually at all sites. Site assessments will be conducted once during the initial Site Characterization, and annually thereafter during spring and fall. One site assessment will represent the entire sampling area of each site each visit. Photographs of aquatic areas will be taken during spring and fall visits, and photographs of vegetation transects will be taken during summer vegetation sampling.

Site Assessment

- Aquatic (spring and stream) sites: Site Characterization, Tier 1 and Tier 2.
- Cave Valley Ranch Meadow: Tier 1 and Tier 2 (once vegetation transects have been established using information collected during the initial Site Characterization).

Fixed Station Photography

- Aquatic Area Photographs
  - Aquatic (spring and stream) sites: Tier 1 and Tier 2. Photograph stations will be established using information collected during the initial Site Characterization.
  - Cave Valley Ranch Meadow: no aquatic area photographs.

- Vegetation Transect Photographs
    - Aquatic (spring and stream) sites with directly-monitored Special Status Species: Tier 2. Vegetation transects and associated vegetation transect photograph stations will be established prior to shifting to Tier 2.
    - Aquatic (spring and stream) sites with no directly-monitored Special Status Species: no vegetation transects or vegetation transect photographs.
    - Cave Valley Ranch Meadow: Tier 1 and Tier 2. Vegetation transects and associated vegetation transect photograph stations will be established using information collected during the initial Site Characterization.

5.1.3 Monitoring Sites

General site condition will be assessed at all sites as shown in Table 5-2:

Table 5-2 General Site Condition Monitoring Sites and Overview of Surveys

Monitoring Site	**Site Assessment (SC, T1, T2)**	**Fixed-Station Photography**	
		Aquatic Areas (T1/T2)[1]	**Vegetation Transects (T1 and/or T2)[2]**
Cave Valley Ranch Meadow	x		x
Grassy Spring	x	x	
Coyote Spring	x	x	
Meloy Spring	x	x	x[3]
Littlefield Spring	x	x	x[3]
Parker Station Spring	x	x	x
Butterfield Spring	x	x	x
Flag Springs	x	x	x
Hardy Springs	x	x	x
Hot Creek Spring	x	x	x
Moorman Spring	x	x	x
Ash Spring	x	x	x
Crystal Spring	x	x	x
Hiko Spring	x	x	x
Maynard Spring	x	x	x[4]
Pahranagat Ditch	x	x	x

[1] For sites with directly-monitored Special Status Species, photography stations will target specific locations where the species occur. For sites without directly-monitored Special Status Species, general stations will be established to depict aquatic site conditions.
[2] Photography at vegetation transects will be conducted during vegetation transect sampling. Cave Valley Ranch Meadow: Tier 1 and Tier 2. All other sites: Tier 2.
[3] If springsnails present.
[4] If springsnails, fish or northern leopard frogs present.

5.1.4 Protocols

Site Assessment

Site assessments will be conducted at springs to qualitatively identify disturbance factors stressing a spring, and the amount of stress of each factor on the aquatic environment. The protocol for site assessments will follow the *U.S. National Park Service Mojave Inventory and Monitoring Network Spring Survey Protocols: Level I and Level II* (Sada and Pohlmann 2006). At each visit, springs will be assigned one of four disturbance levels: (1) undisturbed, (2) slightly disturbed, (3) moderately disturbed or (4) highly disturbed. Brief notes about disturbance factors will also be recorded. Disturbance factors will be divided into three main groups: modifications for diversion; ungulate use of a spring; and recreation disturbance. Disturbances that would be considered a modification for diversion include pipes, dikes, or spring boxes. Hoof prints, droppings, or evidence of grazing are examples of disturbance that could be caused by ungulate use of a spring. Evidence of recreational disturbance to a site could include the presence of campsites, trash or vehicle disturbance.

A site assessment will also be conducted at Cave Valley Ranch Meadow by adapting the above-mentioned NPS protocol as needed. Disturbance will be evaluated at the vegetation transects during vegetation sampling visits, and will be summarized in one assessment for the site per visit.

Fixed Station Photography

Photographic stations will be established following the initial Site Characterization. For sites with directly-monitored Special Status Species, photography stations will target specific locations where the species occur. For sites without directly-monitored Special Status Species, general stations will be established to depict aquatic site conditions. When establishing photographic stations, permanent GPS locations will be recorded for each station. One or more photographs may be taken at each station with direction and orientation determined and recorded during the first visit. Each frame will be taken in a manner that will include the maximum extent of the spring system as possible. GPS coordinates, compass bearings and hard copies of previous photographs will be used to ensure repeatability across seasons over time. Photographs will be taken at springs twice per year (spring and fall).

For vegetation transects, photography stations will be established at one end of each transect, with the photograph taken in the direction of the opposite endpoint.. Photographs will be taken at vegetation transects during vegetation cover and composition data collection in the summer.

5.2 ABIOTIC

The abiotic habitat will be monitored by the TRP (hydrologic monitoring) and the BRT (hydrologic and other abiotic habitat monitoring in association with biota).

The TRP hydrologic monitoring plan is described in SNWA (2009b). In general, TRP measurements include depth to groundwater, discharge, and water chemistry as specified in the TRP monitoring plan (SNWA 2009b). TRP monitoring sites are depicted in Figure 4-2 (Chapter 4), and TRP monitoring data collection is summarized in Table 5-1 and Appendix B. At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring and Butter-field Spring), BRT will determine appropriate measurement for water availability. Depth to groundwater will be measured regionally at groundwater monitoring wells on a continual or quarterly basis (depending on the site). Spring discharge will be measured with flow meters, flumes, USGS gages, or some other method to be determined on a continual or semi-annual basis (during peak and base flows in May and October/November, depending on the site). For those spring sites where discharge cannot be measured, spring pool elevation or wetted area will be measured and/or general conditions documented during site visits via photography and site assessment. The BRT will coordinate closely with the TRP regarding the use of all pertinent water availability and water quality data during data interpretation.

The BRT will monitor abiotic habitat associated with biological processes during data collection on the biota. The BRT has designed protocols to supplement the information already being collected by the TRP and will coordinate closely with the TRP regarding the use of all pertinent water availability and water quality data during data collection and interpretation.

The following sections describe the objectives and sample design for abiotic habitat monitoring conducted specifically by the BRT. [See SNWA (2009b) for information on TRP data collection.]

5.2.1 Sampling Objectives

The objective of collecting abiotic habitat measurements at biological monitoring sites is to help understand changes in or conditions of the biota within the context of the hydrological and physical environment. Understanding these relationships will help determine ecological thresholds and acceptable range of variation for particular indicators, and help determine cause and effect relationships if changes in biotic indicators are documented.

5.2.2 Sampling Design

Abiotic measurements will be conducted at all aquatic (spring and stream) sites. During Site Characterization, abiotic habitat measurements will be collected during a single site visit. During Tier 1 and/or Tier 2, abiotic habitat measurements will be taken during spring and fall visits, with temperature loggers placed at spring sites year-round for continuous hourly measurement.

Fine-Scale abiotic habitat data associated with directly-monitored Special Status Species will also be collected during Tier 2. Algae standard water quality and water velocity data will be collected at springsnail transects, and water depth and substrate composition data will be collected at springsnail sample points. Water depth data will be collected at northern leopard frog egg masses, and standard water quality (including temperature loggers) will be collected at northern leopard frog breeding areas. Species-specific protocols are described in Section 5.3.2.4 (springsnails) and Section 5.3.4.4 (northern leopard frog).

As part of the habitat-based approach, additional abiotic habitat data will be collected as part of the habitat-based approach for southwestern willow flycatcher, yellow-billed cuckoo and Pahranagat Valley montane vole. Distance to permanent water and soil moisture data will be collected in association with vegetation transect sampling for southwestern willow flycatcher and yellow-billed cuckoo habitat, and soil moisture data will be collected in association with vegetation transect sampling for Pahranagat Valley montane vole. Specific protocols are described in Section 5.4.2.2.

Standard Water Quality (temperature, pH, conductivity, dissolved oxygen)

- Sites with directly-monitored Special Status Species: Site Characterization, Tier 1, and Tier 2.
- Sites with no directly-monitored Special Status Species: Site Characterization and Tier 2.
- Turbidity at Pahranagat Ditch: Site Characterization: Tier 1 and Tier 2.
- Temperature loggers at aquatic (spring and stream) sites

  - Sites with directly-monitored Special Status Species: Tier 1 and Tier 2.
  - Sites with no directly-monitored Special Status Species: Tier 2.
  - Temperature loggers will also be placed at Coyote and Grassy springs during Tier 1 to aid in determining frequency and timing of when the spring pools go dry.

Nitrogen and Phosphorus

- Sites with directly-monitored Special Status Species: Site Characterization and Tier 2.
- Sites with no directly-monitored Special Status Species: No nitrogen and phosphorus sampling.

Aquatic Habitat Extent (Physical Habitat Maps)

- Sites with directly-monitored Special Status Species: physical habitat map polygons will be delineated with habitat classifications (categorical data regarding water body [pool vs. channel], water depth, water velocity, and percent emergent vegetation) during Site Characterization and Tier 2.
- Sites with no directly-monitored Special Status Species: general physical habitat maps will be created depicting only the outer boundary of the aquatic area during Site Characterization and Tier 2.
- Aquatic habitat extent data will not be collected at Pahranagat Ditch due to the relatively unchanging nature of the ditch structure.

5.2.3 Monitoring Sites

Data collection for abiotic indicators will be conducted at aquatic sites selected for monitoring within the Area of Interest as presented in Table 5-3.

Table 5-3 Abiotic Monitoring Sites and Overview of Surveys

[See Appendix B for details]

Monitoring Site	TRP surveys (SC/T1/T2)[1]	Water Quality (SC; T1 and/or T2)[2]	Temp Loggers (T1 and/or T2)	Aquatic Habitat Extent (SC/T2)[3]	Additional abiotic measurements associated with Special Status Species				
					Springsnails (T2)	Fish (T2)[4]	Northern leopard frogs (T2)	Pahranagat V. montane vole (T2)	Neo-tropical birds (T2)
Grassy Spring	x	x	x	x					
Coyote Spring	x	x	x	x					
Meloy Spring		x	x	x	x[5]				
Littlefield Spring	x	x	x	x	x[5]				
Parker Station Spring	x	x	x	x	x				
Butterfield Spring		x	x	x	x	x	x[7]		
Flag Springs	x	x	x	x	x	x	x[7]		
Hardy Springs	x	x	x	x	x	x	x[7]		
Hot Creek Spring	x	x	x	x	x	x	x[7]		
Moorman Spring	x	x	x	x	x	x	x[7]		
Ash Spring	x	x	x	x	x	x	x[7]	x[8]	x
Crystal Spring	x	x	x	x	x	x	x[7]	x	x
Hiko Spring	x	x	x	x	x[5]	x	x[7]		
Maynard Spring	x	x	x	x	x[5]	x[6]	x[7]		
Pahranagat Ditch		x	x			x	x[7]	x[8]	x

[1] At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring, Butterfield Spring and Pahranagat Ditch), BRT will determine appropriate measurements for water availability as needed. Data collected by TRP at Parker Station Spring may give general indication of conditions at Cave Valley Ranch Meadow.
[2] Can include temperature, DO, pH, conductivity, turbidity, nitrogen and phosphorus (dependent on site).
[3] For sites with directly-monitored Special Status Species, physical habitat map polygons will be delineated by habitat classifications. For sites without directly-monitored Special Status Species, general physical habitat maps will be created to depict only the outer boundary of the aquatic area.
[4] General abiotic habitat data may be collected according to NDOW's long-term fish RIT monitoring efforts for each species and each site.
[5-8] If the directly- or indirectly-monitored Special Status Species associated with the indicator is present. 5=springsnails, 6=fish, 7=northern leopard frog, 8=Pahranagat Valley montane vole.

5.2.4 Protocols

Water Quality

Water quality will be monitored using the following indicators: :

- water temperature, in degrees Celsius (^{o}C)
- dissolved oxygen (DO), in milligrams per liter (mg/l)
- conductivity, in microSiemens per centimeter (µS/cm)
- pH
- nitrogen
- phosphorus
- turbidity

The number and location of standard water quality samples are presented in Table 5-4. Turbidity will be measured at the location of the standard water sample at Pahranagat Ditch. Nitrogen and phosphorus samples will be collected at one springhead per site.

Table 5-4 Number and Location of Standard Water Quality Measurements

Monitoring Site	# of locations	General measurement locations (SC/T1/T2)	Locations associated with directly-monitored species (T2)
Grassy Spring	1	Springhead	
Coyote Spring	1	Springhead	
Meloy Spring	3	Springhead, midpoint, endpoint	Springsnail transects[1]
Littlefield Spring	3	Springhead, midpoint, endpoint	Springsnail transects[1]
Parker Station Spring	3	Springhead, midpoint, endpoint	Springsnail transects
Butterfield Spring	3	Springhead, midpoint, endpoint	Springsnail transects, frog eggs[2], fish[3]
Flag Springs	3 per spring	Springheads, midpoints, endpoints (North, Middle, South springs)	Springsnail transects, frog eggs[2], fish[3]
Hardy Springs	3	Springhead, midpoint, endpoint	Springsnail transects, frog eggs[2]
Hot Creek Spring	3	Springhead, midpoint, endpoint	Springsnail transects, frog eggs[2], fish[3]
Moorman Spring	3	Springhead, midpoint, endpoint	Springsnail transects, frog eggs[2], fish[3]
Ash Spring	3	Springhead, midpoint, endpoint	Springsnail area, frog eggs[2], fish[3]
Crystal Spring	3	Springhead, midpoint, endpoint	Springsnail transects, frog eggs[2], fish[3]
Hiko Spring	1	Springhead	Springsnail area[1], frog eggs[2], fish[1,3]
Maynard Spring	3	Springhead, midpoint, endpoint	Springsnail transects[1], frog eggs[2], fish[1,3]
Pahranagat Ditch	1	Upper portion of stream	Fish[3]

[1] If species present.
[2] If northern leopard frog egg masses are documented.
[3] NDOW standard measurements for long-term monitoring.

A multi-parameter water quality probe (e.g., Hydrolab, YSI or similar device) will be used to measure standard parameters. The probe will be placed below the water surface at each of the locations where water is of sufficient depth. If water depth is too shallow, water will be collected in a small container (being careful not to splash or create bubbles) and the probe will be inserted into the container of water for measurement of parameters.

Calibration of the water quality probe is necessary for accurate collection of water quality parameter data. While multi-probes usually do not require frequent calibration for measuring water temperature, more frequent calibration is required when measuring conductivity, pH, and DO concentration. The multi-parameter water quality probe will be calibrated prior to each sampling trip and then post-calibrated upon completion of the trip. Calibrations will be performed for each parameter according to the manufacturer's guidelines and recorded in a water quality probe calibration log. Each instrument will have its own log with pre- and post-calibration measurements as well as any maintenance and trouble-shooting notes recorded in it. The log will be reviewed periodically to establish instrument accuracy.

In addition to above water quality measurements, one temperature logger will be placed at each monitoring site. At spring sites, a temperature logger will be placed at one monitored springhead, with the exception of Flag Springs where a temperature logger will be placed in each of the North, Middle and South springheads. The loggers will be placed either in the deepest part of the springhead or into the deepest portion of a spring pool (depending on the spring type). At Pahranagat Ditch one temperature logger will be placed in the upper portion of the designated sample area. During Tier 2, temperature loggers will also be placed near clusters of any northern leopard frog eggs.

Typical temperature loggers (e.g. TidbiT v2 Temp Loggers, www.onsetcomp.com) can be set to record at various time intervals allowing for long periods of data collection prior to downloading. This will allow for the collection of continuous hourly temperature information between survey periods. Temperature loggers will be downloaded during each subsequent field sampling event.

Aquatic Habitat Extent (Physical Habitat Maps)

For sites with directly-monitored Special Status Species, the extent of aquatic areas will be based on the following four main categories: (1) hydro morphological unit (HMU); (2) depth; (3) velocity; and (4) percent emergent vegetation. Initially, the mapping will be conducted by identifying the types and numbers of HMUs at each study site. HMUs are broad aquatic habitat categories based on gross visual assessment of depth, velocity, and surface turbulence (Parasiewicz 2001). For spring systems selected in the Area of Interest, two HMUs have been identified: Channel and Pool. Channels are confined areas of flowing water with the potential for surface turbulence depending on water depth, substrate type, and velocity. Pools are identified as areas that are at least twice as wide as the subsequent channel or downstream areas with little velocity or surface turbulence, often being formed by channel constrictions that may be natural or anthropogenic.

After initial determination of HMUs at each site, measurements of depth, velocity, and percent emergent vegetation will be taken to further describe each polygon. The HMUs will be subdivided by ranges of depth (meters), flow (feet/second), and emergent vegetative cover (percentage). The categories for depth, velocity, and vegetative cover will initially be developed by compiling the overall data collected during year one monitoring and identifying breakpoints. Prior to the first monitoring trip, a habitat subclassification template will be created with physical habitat descriptions defined for each system proposed for mapping. The goal of the template is to provide the professional conducting the work with a process for consistently characterizing habitat conditions at all springs. Once descriptions are defined, a data dictionary for each system will be created within the GPS software program to facilitate future mapping efforts and to ensure consistency among sampling events. Upon completion of the first two years of monitoring, the habitat subclassifications template will be assessed and modified, if necessary to provide specific categories for future monitoring.

For sites without directly-monitored Special Status Species, general physical habitat maps will be created to depict only the outer boundary of the aquatic area. Aquatic habitat extent is thought to be an important indicator for bat habitat.

Physical habitat maps will be created with a global positioning system (GPS) unit (or similar device) with real-time differential correction capable of submeter accuracy. Water depths will be collected using a meter stick or staff gage, and the water depth range that generally describes each polygon will be recorded. Velocity will be measured using a Marsh McBirney Flo-Mate Model 2000 velocity meter (or similar device), and the water velocity range that generally describes each polygon will be recorded. Polygons and polygon descriptions recorded during habitat mapping are coarse characterizations that reflect the average values observed and do not attempt to capture small-scale habitat differences.

Table 5-5 presents the level of detail of physical habitat maps by site.

Table 5-5 Level of Detail of Physical Habitat Maps

Monitoring Site	Level of detail (SC/T2)
Grassy Spring	Outer boundary of aquatic area only
Coyote Spring	Outer boundary of aquatic area only
Meloy Spring	Aquatic polygons delineated with habitat classifications[1]
Littlefield Spring	Aquatic polygons delineated with habitat classifications[1]
Parker Station Spring	Aquatic polygons delineated with habitat classifications
Butterfield Spring	Aquatic polygons delineated with habitat classifications
Flag Springs	Aquatic polygons delineated with habitat classifications
Hardy Springs	Aquatic polygons delineated with habitat classifications
Hot Creek Spring	Aquatic polygons delineated with habitat classifications
Moorman Spring	Aquatic polygons delineated with habitat classifications
Ash Spring	Aquatic polygons delineated with habitat classifications
Crystal Spring	Aquatic polygons delineated with habitat classifications
Hiko Spring	Aquatic polygons delineated with habitat classifications
Maynard Spring	Aquatic polygons delineated with habitat classifications[1]
Pahranagat Ditch	Aquatic polygons delineated with habitat classifications

[1] If directly-monitored Special Status Species present. Otherwise, outer boundary of aquatic area only.

5.3 BIOTIC – ANIMALS

Direct monitoring of Special Status Species will involve the collection and identification of aquatic macroinvertebrates, springsnails, fish, and northern leopard frogs. Presence/absence surveys will be conducted for Pahranagat Valley montane vole to confirm presence, but the indicators for this species will be habitat based measurements.

5.3.1 Macroinvertebrate Composition and Abundance

Monitoring the macroinvertebrate community at springs with directly-monitored Special Status Species can provide information on changes in water quality and habitat, as well as serve as an index for the quantity and quality of resources available for other aquatic biota. Such information can then be used to determine if there are any impact-related changes to aquatic ecosystems and can help identify what types of adaptive management and/or mitigation activities are needed to maintain or enhance existing aquatic conditions. Monitoring the health of the macroinvertebrate community can also help ascertain if spring habitat conditions maintain biological integrity over time.

5.3.1.1 Sampling Objectives

The objective for macroinvertebrate monitoring is to ascertain the seasonal and annual variation in macroinvertebrate assemblage composition and abundance over time. More specifically, there exists a need to monitor the assemblages of aquatic macroinvertebrates throughout the various springs' ecosystems within the Area of Interest to determine seasonal baseline taxonomic richness and relative abundance of the aquatic macroinvertebrate communities at each spring. Potential changes in macroinvertebrate abundance and species composition would allow for the assessment of linkages between changes in habitat and water quality conditions.

5.3.1.2 Sampling Design

The sample design for benthic macroinvertebrates will follow the EPA rapid bioassessment approach for multi-habitat assessments (Barbour et al. 1999). The sampling unit is the macroinvertebrate community collected with a small modified aquarium net in small springs or a D-frame net in larger springs or streams. Regardless of the length or complexity of the spring, a single composite sample will be taken from each spring or stream reach selected for monitoring. Therefore, the sample size will consist of one composite sample per spring or stream reach per sampling event.

During Site Characterization sampling there will be one sample event (most likely spring), and during Tier 2 sampling there will be two sample events per year (spring and fall). Within each spring system, all available macroinvertebrate habitats will be sampled using a systematic procedure based on the proportion of available habitat (as determined by the physical habitat mapping effort).

Aquatic macroinvertebrates will be surveyed at springs that maintain directly-monitored Special Status Species. Macroinvertebrate sampling will be conducted in White River and Pahranagat Valley HBs during Site Characterization and Tier 2. In DDC where all sites are mountain block, macroinvertebrates will only be sampled during Tier 2.

- Sites in White River and Pahranagat Valley HBs with directly-monitored Special Status Species: Site Characterization and Tier 2.
- Sites in DDC with directly-monitored Special Status Species: Tier 2.
- Sites with no directly-monitored Special Status Species: no macroinvertebrate sampling.

5.3.1.3 Monitoring Sites

Aquatic macroinvertebrates will be surveyed at springs and streams with directly-monitored Special Status Species as presented in Table 5-6.

Table 5-6 Macroinvertebrate Monitoring Sites

Monitoring Sites	SC	T2
Littlefield Spring		x[1]
Meloy Spring		x[1]
Parker Station Spring		x
Butterfield Spring	x	x
Hardy Springs	x	x
Moorman Spring	x	x
Crystal Spring	x	x
Flag Springs	x	x
Hot Creek Spring	x	x
Ash Spring	x	x
Hiko Spring	x	x
Maynard Spring	x[2]	x[2]
Pahranagat Ditch	x	x

[1] If springsnails present.
[2] If springsnails, fish or northern leopard frogs present.

5.3.1.4 Protocols

Aquatic macroinvertebrates will be collected systematically from all available in-stream habitats using the multi-habitat rapid bioassessment protocol that involves 20 total samples composited into one sample (Barbour et al. 1999):

> A 100-m reach that is representative of the characteristics of the stream should be selected. Draw a map of the sampling reach. This map should include in-stream attributes (e.g., riffles, falls, fallen trees, pools, bends, etc.) and important structures, plants, and attributes of the bank and near stream areas. Use an arrow to indicate the direction of flow. Indicate the areas that were sampled for macroinvertebrates on the map. If available, use hand-held GPS for latitude and longitude determination taken at the furthest downstream point of the sampling reach. Different types of habitat are to be sampled in approximate proportion to their representation of surface area of the total macroinvertebrate habitat in the reach. For example, if snags comprise 50% of the habitat in a reach and riffles comprise 20%, then 10 jabs should be taken in snag material and 4 jabs should be take in riffle areas. The remainder of the jabs (6) would be taken in any remaining habitat type. Habitat types contributing less than 5% of the stable habitat in the stream reach should not be sampled.

Macroinvertebrate collection will begin at the downstream end of the reach and proceed upstream. A total of 20 roils (if using the modified smaller net) or 20 jabs (if using the standard D-frame net) will be taken over the length of the reach. Using the D-frame net with 250-micron mesh in larger springs or streams, a single jab consists of forcefully thrusting the net into a habitat for a linear distance of 0.5 m while a roil is a stationary sampling accomplished by positioning the net and disturbing the substrate for a distance of 0.5 m upstream of the net. In smaller springs, a modified aquarium net (mouth opening of 17cm x 19 cm and a depth of 11 cm) with 250-micron mesh netting will be used and an upstream area of approximately 0.25 m will be jabbed or roiled. Within each individual system, only one net size will be used to be consistent.

In flowing water, samples will be collected by roiling substrates and capturing material that washes downstream into a modified aquarium net (small springs) or D-frame net (larger springs). In lentic waters, jabbing with the modified aquarium net or D-frame dip net will be the method employed. In either case, a total of 20 roils or jabs will be taken from all major habitat types in the reach (Barbour et al. 1999). The jabs or roils collected from the multiple habitats will be composited to obtain a single sample. After every three jabs, more often if necessary, any collected material will be washed down by running clean spring or stream water through the net two to three times. If clogging does occur that may hinder obtaining an appropriate sample, the material in the net will be discarded and a replacement sample will be collected from the same habitat type but in a different location. Large debris will be removed after rinsing and inspecting it for organisms. All organisms present on the debris will be placed into a sample container. Small debris will be placed directly into the same sample container. The sample will be transferred from the net to sample container(s) and preserved in enough 95% ethanol to completely cover the sample. Forceps may be needed to remove organisms from the dip net or modified aquarium net. Sample bottles will be labeled indicating the sample identification code, date, spring or stream name, sampling location, and collector name.

The samples will be transferred to the laboratory using appropriate Chain of Custody procedures. Laboratory procedures will follow the general process as developed for bioassessment studies (Barbour et al. 1999). Grids will be randomly selected and organisms collected until 300 organisms have been picked, or the entire sample has been sorted. Applying counts from the number of grids sorted to the remaining grids will allow for estimates of the total number (abundance) of each taxon collected in each sample. All organisms will be identified by a trained taxonomist to the lowest practical taxon. Quality assurance and control (QA/QC) procedures will include a QA sorting on all samples to ensure 90% sorting efficiency. Also, a reference collection will be created, and checked by a different taxonomist to ensure taxonomic accuracy.

5.3.2 Springsnail Presence, Extent, Abundance and Distribution

Springsnails are found throughout the Area of Interest. They are present in monitoring sites selected in Dry Lake Valley, Cave Valley, White River Valley, and Pahranagat Valley Hydrographic Basins.

5.3.2.1 Sampling Objectives

There are three sampling objectives for springsnails: 1) monitor the seasonal and annual variation in springsnail abundance; 2) monitor the spatial distribution of springsnails within each spring of interest; and 3) describe any habitat associations or variables that may be influencing springsnail abundance and/or distribution within springs.

5.3.2.2 Sampling Design

Tier 1 sampling will involve determining the presence of springsnails and the extent of their distribution downstream. Tier 2 sampling will include surveying springsnails along equally spaced transects (number to be determined that covers the extent of springsnail distribution or designated sample area) that will allow for the estimation of their abundance per unit of area. Equidistant transects will be established for the extent of the springsnail distribution when feasible. Springsnail searches and detailed habitat characterization will be conducted at 3-5 samples across each transect. Springsnail sampling will be conducted twice per year (spring and fall), with an evaluation after two years of sampling to determine if monitoring may be reduced to annual sampling.

Fine-scale abiotic and biotic habitat sampling will be conducted in conjunction with springsnail abundance and distribution surveys. Substrate type, water depth, algae presence, submerged vegetation presence, and percent emergent vegetation will be recorded at each springsnail sampling point, and water quality (temperature, pH, conductivity, dissolved oxygen concentration) and water velocity data will be recorded at each springsnail transect.

- Sites with documentation of springsnail presence:
  - Springsnail presence surveys during Site Characterization, Tier 1, and Tier 2;
  - Springsnail extent surveys during Site Characterization, Tier 1, and Tier 2, if a linear extent exists;
  - Springsnail abundance and distribution surveys during Tier 2.
  - Sites with no previous or current documentation of springsnail presence: no springsnail sampling.

5.3.2.3 Monitoring Sites

Springsnails will be sampled at the monitoring sites as presented in Table 5-7.

Table 5-7 Springsnail Monitoring Sites

Monitoring Site (SC/T1/T2)	Species previously documented	Presence (SC/T1/T2)	Extent (SC/T1/T2)	Abundance, distribution (SC/T2)	Sample Area
Meloy Spring	*P. breviloba*	x[1]	x[1]	x[1]	Extent of springsnails
Littlefield Spring	*Not sampled*	x[1]	x[1]	x[1]	Extent of springsnails
Parker Station Spring	*P. marcida*	x	x	x	Extent of springsnails
Butterfield Spring	*P. lata,* *P. marcida*	x	x	x	Extent of springsnails
Flag Springs	*P. breviloba,* *P. sathos*	x	x	x	Extent of springsnails
Hardy Springs	*P. marcida*	x	x	x	Extent of springsnails
Hot Creek Spring	*P. merriami,* *T. clathrata*	x	x	x	Designated sample area[2]
Moorman Spring	*P. merriami,* *T. clathrata*	x	x	x	Extent of springsnails
Ash Spring	*P. merriami,* *T. clathrata*	x	x	x	Designated sample area[2]
Crystal Spring	*P. hubbsi*	x	x	x	Extent of springsnails
Hiko Spring	*P. hubbsi* – may be extirpated	x[1]		x[1]	Springhead[3]
Maynard Spring	*P. hubbsi* –may be extirpated	x[1]	x[1]	x[1]	Extent of springsnails

[1] If springsnails present.
[2] Springsnails are distributed in various areas of spring (BIO-WEST 2007). Site Characterization surveys will determine if springsnail transects provide an appropriate or feasible survey method.
[3] Springhead dammed, forming a deep circular reservoir; there is no linear extent.

5.3.2.4 Protocols

Tier 1 monitoring protocol for springsnails specifies documentation of presence and then a description of the longitudinal extent of springsnails in the spring brooks, when applicable. The initial survey will consist of thoroughly searching for springsnails within each micro-habitat type present throughout the spring run extent considered as potential springsnail habitat. Sweeps through each micro-habitat type will be made with a modified aquarium net in a manner to limit the impact to aquatic habitat. Additionally, small quantities of vegetation roots will be pulled and other substrates such as rocks and logs/debris will be picked up and examined for springsnail presence.

For Tier 2, once the extent of springsnails is determined, a series of transects (number to be determined prior to Tier 2 implementation) will be placed equidistant from the spring source to the springsnail extent or within the designated sample area. Transects will not be placed closer than 2.5 m apart. Habitat measurements and population estimates will be made within 25 cm^2 (5 cm x 5 cm) quadrats that will be placed at 3-5 evenly-spaced points along each transect, yielding a maximum of 25 habitat and population sample points along any given spring brook. Springsnail density in each 25 cm^2 quadrat will be estimated using a modified surber sampler to collect snails and temporarily remove them from the spring brook. Samples will be conducted from downstream to upstream. The contents will be washed into a white plastic tray (or similar container), and the springsnails counted. The springsnails will be kept wet so as to not desiccate, and then will be returned to the original location.

Prior to counting springsnails in a given quadrat, specific habitat data will be collected. Presence/absence of substrate types, algae, and submerged vegetation will be recorded at each quadrat. Substrate types will include course particulate organic matter (CPOM), fines, sands, gravel, or cobble (using a Wentworth particle scale analysis, which classifies material as: Fines (<1mm), Sand (1mm – 5mm), Gravel (>5 mm – 80 mm), and Cobble (>80 mm – 300 mm). Size will be defined as the minimum particle size of substrate as measured on a two-dimensional axis, as would pass through a substrate sieve. Percent emergent vegetation, water column velocity and water depth will also be recorded at each quadrat. Standard water quality parameters (temperature, DO, conductivity, pH) and wetted width will be measured at each transect. GPS points will be taken to mark transects for comparison with overall physical habitat mapping. Sampling will be conducted no earlier than 1 hour after dawn and no later than 1 hour before dusk to reduce any variability that might be associated with dawn or dusk activities. Because *Pyrgulopsis* species cannot be distinguished in the field, observed specimens will initially be assumed to be the same as those reported in BIO-WEST (2007) unless additional species are documented in the spring-wide aquatic macroinvertebrate samples described in Section 5.3.1. *Pygrulopsis* can be differentiated from *Tryonia* by knowledgeable observers.

The springsnail transect approach will likely require some modification at certain sites. If each site had a well-defined springhead and shallow spring brook, and a distribution of springsnails extending away from the spring orifice, little modification will be necessary. However, this is not the case for a few of the springs that have springsnails in the Area of Interest. Of the springs listed in Table 5.7, Hot Creek Spring may require special modification to the technique because of the depth of the system. The sampling technique for sites will be determined during the initial Site Characterization at these sites. In addition, modification to the sampling plan may be made after analysis of the 2009-2010 Spring Valley Stipulation biological monitoring data.

5.3.3 Fish Size Class Structure, Abundance and Distribution

The target populations for this indicator are 1) White River springfish at Ash Spring, 2) Hiko White River springfish at Hiko and Crystal springs, 3) White River spinedace at Flag Springs, 4) White River speckled dace at Butterfield Spring, 5) Moorman White River springfish at Moorman and Hot Creek springs, 6) Pahranagat roundtail chub in the lower outflow channel of Ash Spring (Pahranagat Ditch), and 7) Pahranagat speckled dace if reintroduced populations establish at Maynard Spring. NDOW conducts regular monitoring of native fish populations at these locations as a program activity of the state's Native Aquatic Species Program. NDOW has confirmed that routine sampling will continue at these locations, with some minor modifications proposed under the Plan. NDOW data will be incorporated in the annual reports.

5.3.3.1 Sampling Objectives

NDOW monitoring emphasizes three primary sampling objectives related to fish size class structure and distribution: 1) to provide information regarding the recruitment patterns of fish within a given spring or stream; 2) to evaluate annual or seasonal changes in population size or trends in abundance of fish populations within a given spring or stream; and 3) to assess the spatial extent and habitat use of fishes present within a given system over time.

Specific measures and protocols vary with location and species. Springfish and speckled dace populations, with the exception of Moorman White River springfish at Hot Creek Spring and White River springfish at Ash Spring, are measured to develop either a relative abundance estimator expressed as catch per unit effort (CPUE) or an estimate of total population size using mark and recapture protocols as described below in sampling design. White River spinedace, Pahranagat roundtail chub, and springfish at Hot Creek and Ash Spring are measured using a total population estimate developed by visual snorkel survey of occupied habitats.

5.3.3.2 Sampling Design

Fish monitoring, led by NDOW in their continuing efforts to monitor fish of special status, will include the following indicators: population size and age structure, distribution, and catch per unit effort. Sampling design varies by site and species. All sampling activities will be conducted according to NDOW's long-term monitoring efforts for each species and each site, which may include general data collection about the abiotic habitat.

5.3.3.3 Monitoring Sites

Fish sampling will be conducted by NDOW twice per year (spring and fall) at Pahranagat Ditch and Crystal, Hiko and Flag springs, and every other year for the remaining monitoring sites (Table 5-8).

Table 5-8 Fish Monitoring Sites and NDOW Sampling Frequency

Monitoring Site	Special Status Species	Sampling Frequency (SC/T1/T2)
Butterfield Spring	White River speckled dace	Every other year, one event
Flag Springs	White River spinedace, White River speckled dace	Spring and Fall
Hot Creek Spring	Moorman White River springfish	Every other year, one event
Moorman Spring	Moorman White River springfish	Every other year, one event
Ash Spring	White River springfish	Every other year, one event
Crystal Spring	Hiko White River springfish	Spring and Fall
Hiko Spring	Hiko White River springfish	Spring and Fall
Maynard Spring	Pahranagat speckled dace	To be determined if recently reintroduced population establishes
Pahranagat Ditch	Pahranagat roundtail chub Pahranagat speckled dace	Spring and Fall

5.3.3.4 Protocols

The sampling gear type chosen for each site is determined based on past experience and current sampling activities at each of the different locations, the ease of use within the available habitat, and reducing disturbance to the available habitat. Standard Gee-Brand minnow traps will be the gear utilized at all locations for springfish and speckled dace monitoring except for Ash and Hot Creek springs. The number of individual fish captured per trap will be recorded. Catch per unit effort (CPUE) will be calculated for sites monitored using minnow traps. Temperature, DO, conductivity, and salinity are recorded using a YSI Model 85 DO meter at one to multiple locations at each sampling site during each sampling visit.

When minnow traps are used, at a minimum coverage will include deeper areas associated with spring heads and terminus ponded areas (depending on spring type); shallower, near-shore areas of the spring head/ponded head; and connector channels between spring heads, or in other interface locations as needed. Fish are captured using cylindrical, wire-mesh, Gee-type minnow traps. “Standard” traps have a 0.64 cm (1/2 inch) mesh and a 2.54 centimeter (cm) opening. Traps with a 0.32 cm (1/4 inch) mesh may be used in combination with the “standard” traps. All traps are baited with 10-15 pieces of “Chef’s Blend” dry cat food. All fish captured are tallied. A subset of all fish captured (generally up to 200) are measured for total length to develop a length-frequency histogram; where 0.32 cm traps are used measured fish are from these traps to develop a more comprehensive length-frequency analysis. Total trap numbers will vary by site. Traps are fished for a minimum of 2 hours up to 8 hours dependent on catch rates and other factors.

For CPUE estimates, a simple CPUE estimate is developed from total fish captured divided by total trap hours. For population estimates, two trap sessions are conducted per site separated by no more than a 10 day period. During the initial session all springfish greater than 30 mm are marked with an oblique clip on the lobe of the caudal fin with surgical scissors before release. Recapture sessions are conducted using the same trap types, number and locations as the initial capture sessions. All captured fish are examined for marks and recorded prior to release.

For visual total population estimate counts using snorkel surveys, protocols vary with site and species. For Pahranagat roundtail chub, transect markers are established on the Pahranagat Ditch every 50 meters starting at the concrete channel to monitor the distribution of chub and habitat, numbered in ascending order from downstream to upstream. There are three reaches based on varying habitat types. The lower reach (1) is the southernmost portion of the river on the ranch and has a slight gradient with large amounts of silt deposition. The middle reach (2) begins at the bridge crossing and has a moderate to steep gradient with only a small amount of silt deposition. The upper reach (3) starts at the upper bridge and continues to just upstream of the Ash Spring inflow. The upper reach has a low gradient with moderate silt deposition and receives return flow from the Crystal Ditch.

The survey method consists of a single swimmer conducting snorkel surveys in the Pahranagat Ditch. The surveys are conducted moving upstream. During the surveys the counter calls out the size class and number of fish observed while a data recorder logs locations using a Trimble GeoExplorer 3 GPS unit and noting the transect number. When Pahranagat roundtail chub are found, they are grouped into one of the following four length classes: <50 mm (class A); 50 mm to 99 mm (class B); 100 mm to 149 mm (class C); and 150 mm + (class D). Chub less than 100 mm are considered juvenile and 100 mm and larger are considered adults (Tuttle et al. 1990).

White River spinedace are counted by snorkel survey, by a single biologist, in Sunnyside Creek and the Flag Springs outflows. The survey of the Sunnyside Creek portion begins 10 meters downstream of the 40’ culvert and concludes at the confluence of the North and South Flag Spring outflows. Flag Springs (North, South and Middle) outflows are surveyed and enumerated separately, and a combined count is developed for the entire system. The surveyors exit the water and re-enter upstream of large schools of fish to avoid double counting fish moving upstream for all surveys. Each fish counted is categorized into one of four size classes: A-≤30 millimeters (mm), B-31-60 mm, C-61-90 mm, and D-≥90 mm. This information is then relayed to the person on shore, who then enters the count and collected points for the general locations using a Trimble GeoExplorer 3 GPS unit. Water velocity along with stream depth and width are measured at multiple locations along the creek using a Swoffer water current meter and an expandable meter stick. Water velocity is measured at approximately one-third of the total depth from the bottom.

Protocols for visual snorkel counts of Moorman White River springfish at Hot Creek Spring and White River springfish at Ash Spring are similar to those used for White River spinedace. Hot Creek Spring visual counts are initiated at the upper spring source area and proceed downstream to the lower spring diversion dike. Ash Spring visual counts incorporate the entire spring complex on private land, and on areas of BLM lands that have adequate width and depth to allow snorkel surveys.

5.3.4 Northern Leopard Frog Presence and Egg Mass Counts

Egg masses were specifically chosen for monitoring because egg masses are stationary versus the other life stages of the northern leopard frog. These frogs are often difficult to observe because of their secretive behavior. At this time, northern leopard frog has been documented at only a few sites within the Area of Interest.

5.3.4.1 Sampling Objectives

There are two sampling objectives related to northern leopard frogs within the Area of Interest: 1) monitor the spatial distribution of northern leopard frogs and 2) monitor breeding activity at representative springs.

5.3.4.2 Sampling Design

Northern leopard frog presence surveys will be conducted at select aquatic (spring and stream) sites during Site Characterization and Tier 1 (spring breeding season). Confirmation of an adult, juvenile, tadpole, or egg mass will serve to document use at each site. A single confirmation is sufficient to document the presence of northern leopard frog for continued sampling. After two consecutive years of no presence, a site will be classified as not occupied by northern leopard frog. Presence surveys will occur once during the spring (after egg masses have been documented at adjacent sites with known populations) for adult frogs and egg masses, and briefly during the scheduled site visits during the fall. Limited effort will be expended in the fall on visual encounter surveys for adults, as they can be difficult to locate during this time. However, since field crews will be conducting biological sampling in the fall, they will be observant of any adult frog activity. If at any time northern leopard frog activity is incidentally documented at a previously undocumented spring site, that site will be monitored for frogs starting the following spring.

At those sites where northern leopard frogs occur, egg mass and breeding habitat surveys will be conducted during Tier 2 sampling. Sites will be visited every other week for a total of up to three visits per spring breeding season, which is expected to capture the beginning, peak and lagging portion of the main breeding season. Timing and frequency of visits are subject to change if breeding activity differs from what is currently expected.

Fine-scale abiotic and biotic habitat sampling will be conducted in conjunction with northern leopard frog egg mass surveys. Water depth and percent emergent vegetation will be recorded at northern leopard frog egg masses, and water quality measurements (temperature [including temperature loggers], pH, conductivity, and DO) will be collected in breeding areas.

- Sites in hydrographic basins with previous or current documentation of northern leopard frog presence (White River and Pahranagat Valley HBs):
    - Presence surveys: Site Characterization, Tier 1 and/or Tier 2.
        - Discontinue if two consecutive years of no documented presence during presence surveys; reinitiate if presence documented during subsequent site visits.
        - If northern leopard frogs are breeding, egg mass surveys will be conducted during Tier 2.
- Sites in hydrographic basins with no previous or current documentation of northern leopard frog presence (DDC): no northern leopard frog sampling.
    - If northern leopard frogs are observed during other monitoring activities in the DDC valleys, presence and egg mass surveys will commence.

5.3.4.3 Monitoring Sites

Northern leopard frog presence surveys will be conducted during Site Characterization and Tier 1 sampling at all aquatic (spring and stream) sites in White River and Pahranagat Valley HBs. The sampling effort will also include areas of wetlands that have standing water immediately adjacent to the spring survey sites (within the sampling area). Tier 1 monitoring is an attempt to document the use of a site by northern leopard frog. Tier 2 monitoring relative to egg masses and breeding habitat data collection will only be conducted if northern leopard frogs are present at the site and Tier 2 monitoring is implemented. Northern leopard frog presence surveys will not be conducted at DDC sites because the species has never been documented in the hydrographic basins. If northern leopard frogs are observed during other monitoring activities in the DDC valleys, presence surveys (Site Characterization, Tier 1 and Tier 2) and egg mass surveys (Tier 2) will commence.

Northern leopard frog will be sampled at the monitoring sites as presented in Table 5-9.

Table 5-9 Northern Leopard Frog Monitoring Sites

Monitoring Site (SC/T1/T2)	Northern leopard frog presence (SC/T1/T2)	Northern leopard frog egg mass abundance, distribution (T2)
Butterfield Spring	x[1]	x[2]
Flag Springs	x[1]	x[2]
Hardy Springs	x[1]	x[2]
Hot Creek Spring	x[1]	x[2]
Moorman Spring	x[1]	x[2]
Ash Spring	x[1]	x[2]
Crystal Spring	x[1]	x[2]
Hiko Spring	x[1]	x[2]
Maynard Spring	x[1]	x[2]
Pahranagat Ditch	x[1]	x[2]

[1] Presence surveys will be conducted during the initial Site Characterization and the first year of Tier 1. Presence surveys will continue during Tier 1 and Tier 2 only if northern leopard frogs are determined to occur at the site.

[2] Egg mass surveys will be conducted during Tier 2 if northern leopard frogs have been determined to occur at the site.

5.3.4.4 Protocols

During the Site Characterization and Tier 1 monitoring, visual encounter surveys will be used to address the question of whether northern leopard frog is using a given spring site. These surveys will be conducted during the Spring and will be done by trained biologists walking the perimeter of the spring and looking for adult frogs, egg masses, tadpoles, or juveniles. The goal of this phase is to identify whether or not northern leopard frogs are using the springs or adjacent wetland areas. A comprehensive search of the entire wetted area will be conducted without time constraint or time of day restriction. Time spent looking will be recorded as an indication of effort. During fall biological monitoring, only a cursory look (e.g., being visually observant while performing other biological sampling) will be conducted for northern leopard frogs. If after a second consecutive year of visual encounter survey, no northern leopard frog is detected at a site, frog sampling will be removed from Tier 1 monitoring at that site. However, if northern leopard frogs are observed at a future date at a particular spring location, presence surveys will resume.

For the first two years of Tier 2 egg mass counts, surveys will entail trips every other week for up to three visits (as necessary) starting in mid-April and extending into May. The surveys are nearly identical to the confirmation visual encounter efforts except trained biologists will walk the entire perimeter of the wetted area and with the focus on locating egg masses and survey time recorded as a measure of survey effort. To ensure consistency of data collected by different personnel, different sites, and different years, efforts will be made to ensure that all sites receive a relatively consistent level of visual scrutiny during egg mass searches. To standardize survey efforts, a maximum travel speed when surveying for egg masses of approximately 20 meters per minute will not be exceeded. Abundant egg masses, dense emergent vegetation, and other factors may, however, reduce travel speed. Upon completion of the first two years of Tier 2 monitoring, it is anticipated that the information acquired will allow the egg mass search area to be reduced to specific habitats where egg masses are likely to occur.

As described in Chapter 4, northern leopard frog eggs are typically laid in clumps (i.e., egg masses) on submerged vegetation slightly below the water surface. Egg masses themselves may also be deposited in clusters (i.e., females sometimes egg masses in proximity to one another). Once located, each new egg mass will be flagged; GPS coordinates, date and time will be recorded; percent submergent and emergent vegetation will be documented for an area 1 meter in diameter surrounding the egg mass; and water depth and distance to water's edge will be measured. Standard water quality parameters will be recorded once during the breeding season in breeding areas (e.g., in the vicinity of egg mass clusters). After determining where breeding tends to occur at each site, a temperature logger will be placed at those areas prior to the breeding season and downloaded after the eggs hatch.

5.3.5 Pahranagat Valley Montane Vole Presence (To Determine Need for Habitat Monitoring)

Habitat monitoring has been designed specifically for the Pahranagat Valley montane vole. The purpose of Pahranagat Valley montane vole presence surveys is solely to document continued usage at Crystal Spring and occurrence at Ash Spring and Pahranagat Ditch, to determine if habitat-based sampling should be conducted. At this time, montane vole has been documented at only a few sites within the Area of Interest: Crystal Spring, Key Pittman WMA, and Pahranagat NWR (D. Crawford, University of North Carolina at Chapel Hill, pers. comm.). Historical locations of Pahranagat Valley montane vole include Ash Spring (Hall 1946).

Pahranagat Valley montane voles are mobile and difficult to observe but can be trapped with intensive effort. As part of this Plan, an effort will be made to detect presence as described below. However, as discussed in Chapter 4, these presence surveys are not considered as direct species monitoring. Measures of habitat will serve as a surrogate for Pahranagat Valley montane vole using the habitat-based approach. Habitat monitoring includes establishment of permanent line transects and measures of vegetation species cover and composition, vegetation height, and soil moisture. High, dense vegetation and moist soils are essential in characterizing Pahranagat Valley montane vole habitat needed for construction of tunnels and burrows. Habitat-based vegetation monitoring is described in section 5.4.

5.3.5.1 Sampling Objectives

The objective of conducting Pahranagat Valley montane vole presence/absence surveys is to determine the need to conduct habitat monitoring. Pahranagat Valley montane vole will be indirectly monitored through the habitat-based approach.

5.3.5.2 Sampling Design

Pahranagat Valley montane vole presence surveys will be conducted at spring and stream sites where the species is thought to possibly occur. The surveys will take place in the late summer/fall during Site Characterization and Tier 2 monitoring. If documented at a site, Tier 2 monitoring for presence of the montane vole will occur every 3 to 5 years for confirmation of continued occupancy at that location. To detect presence, traps placed intermittently along transects in their meadow habitat will be checked periodically each day for three consecutive days.

- Pahranagat Valley montane vole is a Special Status Species that will be indirectly-monitored using the habitat-based approach. The purpose of presence surveys is to determine the need for habitat monitoring.
- Sites with previous or current documentation of Pahranagat Valley montane vole occurrence: Site Characterization, and every 3-5 years during Tier 2 if determined to be present.
- Sites with no previous or current documentation of Pahranagat Valley montane vole presence: no Pahranagat Valley montane vole survey.

5.3.5.3 Monitoring Sites

Pahranagat Valley montane vole presence surveys will be conducted in the meadows adjacent to springs and outflows at Ash Spring, Crystal Spring, and Pahranagat Ditch.

5.3.5.4 Protocols

Pahranagat Valley montane vole presence surveys will be conducted in the meadows adjacent to the springs and spring outflows. Traps will be placed at 5-10 meter intervals along transects of varying length, depending on available wet and dry meadow habitats. Both high-quality (dense green grasses near water or moist soils) and sub-optimal habitat (drier grasses and dry soils) will be sampled. Traps will remain open for three full 24-hour periods and checked two to three times per day to limit time spent in the traps by the animals and minimize mortalities. The 24-hour sets will optimize sampling opportunities, as montane voles may be active both during the day and night. All captures will be recorded from trapping. Parameters recorded for species will include sex, age, weight and reproductive condition. To optimize trap success with young of the year and to avoid high temperatures, late summer/fall trapping will be conducted. All trapping locality data will be correlated with vegetative transect surveys.

5.4 BIOTIC – VEGETATION

During the initial Site Characterization, vegetation communities will be mapped within a designated area of each monitoring site (Section 5.4.1). Vegetation monitoring will be conducted at sites with Special Status Species at the Tier 2 level (Section 5.4.2).

Fine-Scale vegetative habitat measurements associated with directly-monitored Special Status Species will also be collected during Tier 2. Algae presence, submerged vegetation presence, and percent emergent vegetation data will be collected at springsnail sample points, and percent emergent vegetation data will be collected at northern leopard frog egg masses. Species-specific protocols are described in Section 5.3.2.4 (springsnails) and Section 5.3.4.4 (northern leopard frog).

5.4.1 Community Vegetation Mapping

Vegetation communities will be mapped within aquatic, riparian and meadow systems during the initial Site Characterization. Aquatic systems are those where standing water exists throughout the growing season in all years (i.e., spring and streams). Riparian systems will include herbaceous and woody vegetation immediately adjacent to the aquatic systems. These systems tend to have standing water at least part of the year and saturated or wet soils much of the growing season. Special attention will be given to herbaceous riparian systems used by Pahranagat Valley montane vole, and woody riparian galleries that are used by southwestern willow flycatcher and yellow-billed cuckoo. Cave Valley Ranch Meadow represents the only meadow system in the monitoring plan.

5.4.1.1 Sampling Objectives

The sampling objectives for community vegetation mapping are: 1) provide initial spatial digital maps of aquatic, riparian and meadow plant communities; and 2) assist in defining sampling areas and designing vegetation transects.

5.4.1.2 Sampling Design

Vegetation communities will be mapped within designated areas at all sites once during the initial Site Characterization. The designated area will include portions of the aquatic, riparian and meadow systems that appear to be most appropriate for designating as future sampling areas (e.g., springheads, limited portions of spring outflows, and areas used by directly- and indirectly-monitored Special Status Species). Mapping will be conducted at a peak time to enable species identification. Community vegetation mapping may be repeated on a site-by-site basis immediately prior to shifting to Tier 2 to assist with transect design.

5.4.1.3 Monitoring Sites

Vegetation communities will be mapped within designated areas at all sites once during the initial Site Characterization. Community vegetation mapping may be repeated on a site-by-site basis immediately prior to shifting to Tier 2 to assist with transect design.

5.4.1.4 Protocols

Community vegetation mapping during the initial Site Characterization will establish a baseline delineation of vegetation community locations and extents. The boundaries of aquatic vegetation communities will be mapped where changes in dominant plant species occur. Dominant species composition provides information on habitat for sensitive animal species and the overall health and vigor of these aquatic ecosystems. A plant community for mapping purposes can feasibly be defined as the two to three most abundant species in the order of relative abundance. Two areas with the same species in different orders of dominance will be considered different plant communities (e.g., cattail-green algae-water parsnip is a different community than water parsnip-green algae-cattail). The target population is plant community.

Designated areas at each site will be selected for mapping. The designated areas will be selected to include portions of the aquatic, riparian and meadow systems that appear to be most appropriate for designating as future sampling areas (e.g., springheads, limited portions of spring outflows, and areas used by directly- and indirectly-monitored Special Status Species). Mapping will be conducted at a peak time to enable species identification.

Community vegetation mapping will be conducted in the field using best available aerial or satellite imagery. At aquatic sites, field crews will map vegetation communities (emergent and submergent, if possible) onto these images from locations along the spring bank or from an inflatable boat at larger spring sites. These maps will later be digitized using ESRI mapping software (or equivalent). For verification of the digitization process at the larger sites, GPS data will be collected at the boundaries of several vegetation communities and matched to the digitized map boundaries.

Level of resolution (i.e., size of polygons) will be limited by a rule that for an area to be mapped as a separate plant community, it must cover at least 5% of the entire sampling area and must be sufficiently different from the other plant communities to justify separation. Vegetation community composition will be mapped based on species that comprise 20% or more of the community, with two or three dominant species recorded per polygon. Each polygon mapped will be classified as either a vegetation community or other cover type (e.g., open water, bare ground). The vegetation community classifications will follow the National Vegetation Classifications for Nevada, which is based on the National Vegetation Classification Standard and Standardized National Vegetation Classification System (SNVCS) (TNC 1994).

Remote sensing will be evaluated as a possible tool for documenting broader-scale changes in vegetation over time.

5.4.2 Vegetation Cover and Composition and Associated Indicators

Vegetation transect surveys will provide data on species cover and composition, pattern of internal heterogeneity, community extent, open water vs. vegetation, live vs. dead woody vegetation, and vegetation structure (woody riparian tree density and canopy height, and herbaceous riparian plant height).

Vegetation cover and composition surveys will be conducted within aquatic, riparian and meadow systems. Aquatic systems are those where standing water exists throughout the growing season in all years (i.e., spring and streams). Riparian systems will include herbaceous and woody vegetation immediately adjacent to the aquatic systems. These systems tend to have standing water at least part of the year and saturated or wet soils much of the growing season. Special attention will be given to herbaceous riparian systems used by Pahranagat Valley montane vole, and woody riparian galleries that are used by southwestern willow flycatcher and yellow-billed cuckoo. Cave Valley Ranch Meadow represents the only meadow system in the monitoring plan.

5.4.2.1 Sampling Objectives

The objectives for conducting detailed sampling of vegetation along transects are: 1) detect change in plant species composition and cover associated with water availability; 2) detect change in open water vs. vegetation cover associated with water availability and condition of the vegetative habitat; 3) detect change in dominant species cover and pattern of internal heterogeneity (i.e., spatial integrity); and 4) detect change in the extent and of plant communities, and thus the change in the location of ecotones; and 5) detect change in vegetative structure associated with indirectly-monitored species (southwestern willow flycatcher and yellow-billed cuckoo: woody riparian tree density and canopy height; Pahranagat Valley montane vole: herbaceous riparian plant height).

5.4.2.2 Sampling Design

Vegetation transect sampling will be conducted as a Tier 1 and Tier 2 monitoring effort at Cave Valley Ranch Meadow, and as a Tier 2 monitoring effort at all aquatic (spring and stream) sites with directly-monitored Special Status Species.

Tier 2 vegetation transect sampling will also be focused on habitat for greater sage grouse, Pahranagat Valley montane vole, southwestern willow flycatcher, and yellow-billed cuckoo. Vegetation indicators considered to be relevant to these species were purposely included in the vegetation transect sampling plan. Cave Valley Ranch Meadow was chosen as a monitoring site particularly because it is used by the greater sage grouse. To monitor Pahranagat Valley montane vole habitat, herbaceous riparian transects will be sampled at Crystal Spring and possibly at Ash Spring and Pahranagat Ditch (based on vole occurrence). To monitor southwestern willow flycatcher, and yellow-billed cuckoo habitat, belt transects will be sampled in the woody riparian gallery at the outfall of Ash Spring, along Pahranagat Ditch, and surrounding Crystal Spring.

Transects will be established immediately prior to the onset of transect sampling. Data will be collected along aquatic, riparian (herbaceous and woody) and meadow line-point transects and within woody riparian gallery belt transects. The number and length of transects will depend on the spatial extent and heterogeneity of each habitat. Sampling will be conducted during the height of the growing season (summer) to enable species identification. Data will be collected at 1-cm intervals in aquatic systems, and at 10-cm intervals in riparian and meadow systems, and will be analyzed at 1-m intervals.

Vegetation transects will be conducted at sites as follows:

- Cave Valley Ranch Meadow: Tier 1 and Tier 2
  - Line transects in the meadow
  - Indicators: cover and composition, pattern of internal heterogeneity, community extent, and open water vs. vegetation.
- Aquatic (spring and stream) sites with directly-monitored Special Status Species: Tier 2
  - Line transects in aquatic areas;
  - Line transects in riparian (herbaceous and woody) areas immediately adjacent to the aquatic areas;
  - Indicators: cover and composition, pattern of internal heterogeneity, community extent, and open water vs. vegetation.
  - Due to spring modifications, vegetation transects will not be established at Hiko Spring.
- Aquatic (spring and stream) sites used by southwestern willow flycatcher and/or yellow billed cuckoo: Tier 2
  - Belt transects in woody riparian gallery immediately adjacent to the aquatic areas
  - Indicators: Woody riparian tree density and canopy height
- Aquatic (spring and stream) sites used by Pahranagat Valley montane vole: Tier 2
  - Line transects designed to capture Pahranagat Valley montane vole habitat in herbaceous riparian areas immediately adjacent to aquatic areas (in addition to or in conjunction with the above-mentioned line transects)
  - Indicators: Herbaceous riparian plant height
- Aquatic (spring and stream) sites with no directly-monitored Special Status Species: no vegetation transects

5.4.2.3 Monitoring Sites

Vegetation transect surveys will be conducted at monitoring sites as presented in Table 5-10:

Table 5-10 Vegetation Transect Monitoring Sites

Monitoring Site	Meadow line transects (T1/T2)	Aquatic line transects (T2)	Riparian line transects (T2)	Riparian line transects associated with voles (T2)	Woody riparian belt transects associated with birds (T2)
Cave Valley Ranch Meadow	x				
Meloy Spring		x[1]	x[1]		
Littlefield Spring		x[1]	x[1]		
Parker Station Spring		x	x		
Butterfield Spring		x	x		
Flag Springs		x	x		
Hardy Springs		x	x		
Hot Creek Spring		x	x		
Moorman Spring		x	x		
Ash Spring		x	x	x[3]	x
Crystal Spring		x	x	x	x
Maynard Spring		x[2]	x[2]		
Pahranagat Ditch		x	x	x[3]	x

[1] If springsnails present.
[2] If springsnails, fish or northern leopard frogs present.
[3] If Pahranagat Valley montane vole present.

5.4.2.4 Protocols

Permanent vegetation transects will be established for biological monitoring under the DDC Stipulation. Immediately prior to the onset of vegetation transect surveys, transects will be permanently marked in the field by placing metal monuments at both ends of each transect. Each endpoint will be geo-referenced with a sub-meter accuracy GPS unit and maintained in the database as a permanent vegetation endpoint.

Line Transects

Line transects will be designed to capture areas used by directly- and indirectly-monitored Special Status Species, and to capture ecotones that appear to cross a gradient of groundwater and surface water availability. A hypothetical example of transect locations is presented in Figure 5-1 to illustrate the concept. If available at the time of transect establishment, community vegetation maps will be used to determine transect design. If possible, line transects will be designed so that plant communities that occur along the transects are represented a minimum of five times per site.

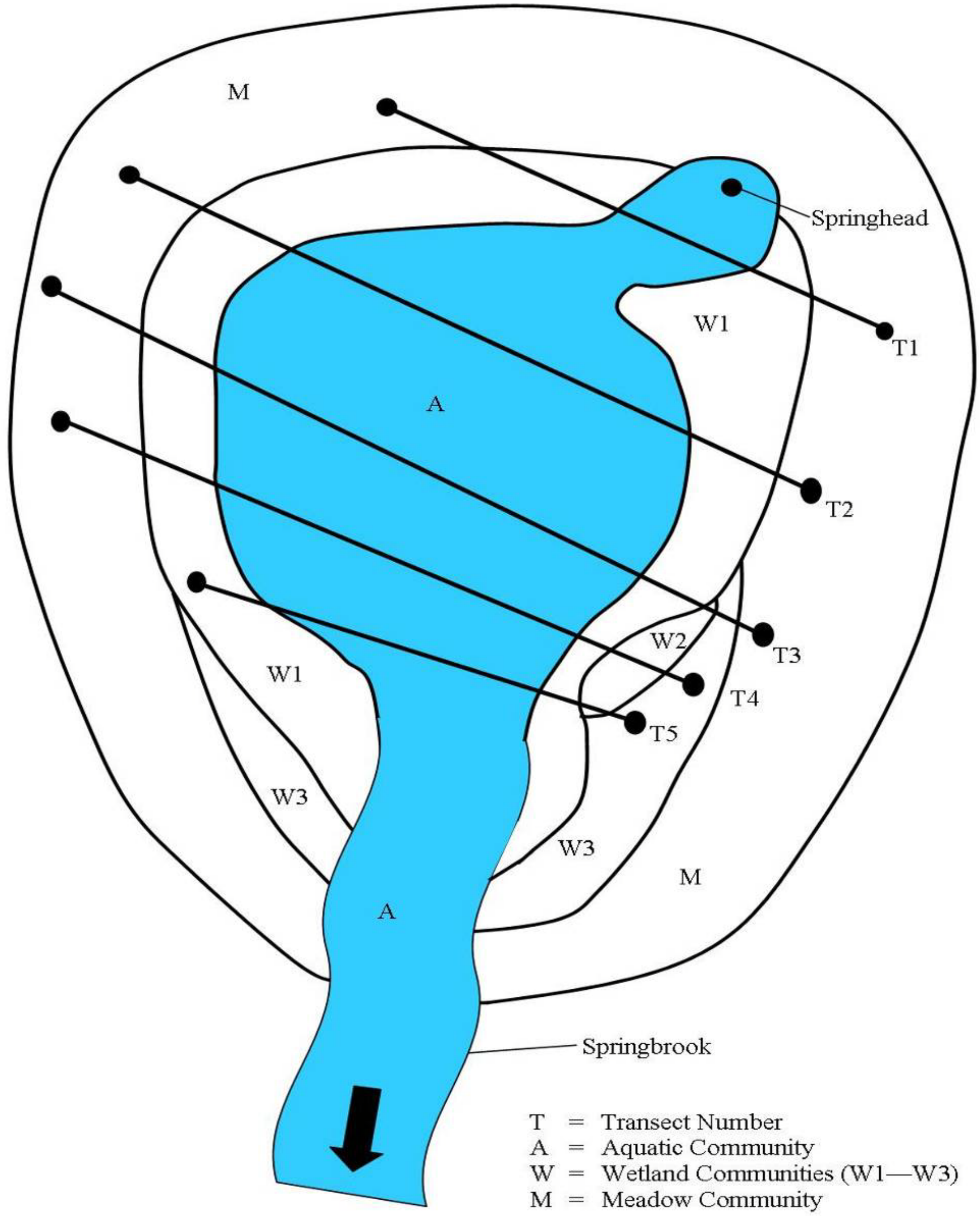

Figure 5-1 Illustration of Transect Design in Aquatic and Riparian Areas at a Hypothetical Site

General transect sampling designs are described below:

- At aquatic (spring and stream) sites, five line transects will be established. The transects will be sufficiently long to extend across the aquatic area plus at least 2 meters past the water edge at both ends of the transects. [Should the aquatic system expand past the 2-m extensions during the monitoring period, the affected transects will be extended to a point at least 2 meters past the new high-water mark.]
- If possible and appropriate, transects within riparian areas will be continuous with those used to measure aquatic vegetation. Additional riparian transects may be established to capture Special Status Species habitat.
- To monitor southwestern willow flycatcher and yellow-billed cuckoo habitat, belt transects composed of three line transects (two outer and one center line) will be established – see Belt Transects section below. These transects represent the riparian transects for Crystal, Ash and Pahranagat Ditch.
- To monitor Pahranagat Valley montane vole habitat, a minimum of five line-point transects will be established in the herbaceous riparian area at the outfall of Crystal Spring (where Pahranagat Valley montane vole has been reported; C. Tomlinson, NDOW, pers. comm.), and possibly in the herbaceous riparian areas adjacent to Ash Spring and Pahranagat Ditch (if the vole is determined to occur at those sites). If possible, these will coincide with the general riparian vegetation transects. Each line-point transect will consist of a 100-m long line transect; if the habitat is less than 100-m wide, the line transect will be the width of the habitat.
- At Cave Valley Ranch Meadow, at least five 100-m long line transects will be established in greater sage grouse habitat.

Along the line transects, data will be collected at 1-cm intervals within aquatic areas (i.e., springs and streams), and at 10-cm intervals within riparian areas immediately adjacent to the aquatic areas. A 100-m tape, marked at 1-cm intervals, will be placed between the starting and ending monument, as close to the ground or water surface as possible. Along each transect, ocular counts will be made at each 1-cm or 10-cm mark for each species that has vegetative material intersecting the transect at that mark. Data collected at each 1 mark will be recorded for each 1-m interval or the length of the aquatic plant community, whichever is shorter.

First and select multiple hit data will be collected along the line transects. In aquatic areas, first-hit (first emergent species encountered at each mark) and multiple-hit (first submergent species or open water encountered at each mark) data will be collected. To reduce disturbance to fauna and flora, multiple-hit data will only be collected when emergent species in aquatic communities are present. In riparian areas, single hits will be recorded if only herbaceous vegetation occurs, and multiple hits will be recorded if woody vegetation occurs. Specifically, data will be collected on the first tree, first shrub and first herbaceous species (or litter, rock or bare ground) encountered.

Within Pahranagat Valley montane vole habitat, at each meter interval maximum herbaceous vegetation height and soil moisture categorical data (standing water, saturated soil, wet soil, moist soil or dry soil) will also be collected. These habitat indicators are considered relevant to the Pahranagat Valley montane vole.

Within greater sage grouse habitat at Cave Valley Ranch Meadow, first-hit (first species encountered at each mark) and potentially multiple-hit (understory species encountered at each mark) data will be collected (Bonham 1989). Specifically, data will be collected on the first shrub and first herbaceous species (or litter, rock or bare ground) encountered. If it is determined that forbs are not well represented using these methods, data on the first forb species may also be collected, as forbs appear to be an important forage type for greater sage grouse.

From these data, percent cover will be calculated by species for each community along each transect, on a first-hit and on a multiple-hit basis. Percent canopy cover per species will be calculated by dividing the number of hits (1-cm or 10-cm marks) recorded for that species within a specific transect by the width of the transect. These data may also be summarized for sections of the transect crossing aquatic areas, riparian areas, or specific plant communities.

At the end of the second year of sampling, the number of transects necessary to achieve a sampling accuracy of 20% of the sample mean at an 80-90% probability level will be calculated, averaged over the two years. If the number of transects necessary to achieve this accuracy, or another accuracy determined by the BRT, is different than the number used in the first two years of sampling, transects may be added or eliminated.

Belt Transects

To monitor southwestern willow flycatcher and yellow-billed cuckoo habitat, five belt transects will be established in woody riparian galleries at the outfall of Ash Spring, along Pahranagat Ditch, and surrounding Crystal Spring. A belt transect is a rectangular shaped strip quadrat that has one long dimension, length, which is greater than its width (Bonham 1989). These long quadrats can be subdivided into smaller units that can then be used to sample such variables as density and frequency of plant species. Individual samples of shrub or tree size, vigor, soil moisture, or other characteristics of the habitat or species can then be measured within portions of the belt transect to characterize the condition of the habitat and species. If shrub and trees are categorized by relative age (seedling, juvenile, and mature) this can yield information on recruitment and age structure of the stand. Therefore, belt transects are useful when more information is desired than only cover and composition of species.

Five belt transects (20 x 5 meters in dimension) will be established at Ash Spring, Pahranagat Ditch, and Crystal Spring each (five belt transects per site). The belt transects will be composed of three permanent 20-m line transects (two outer lines and a center line), which will be surveyed using the line-point intercept method. The rectangular area within each belt transect will also be used to collect additional tree data.

The outer and center line transects will be sampled at 10-cm intervals for point hits (single hits) on herbaceous vegetation, bare ground, rock and litter to determine species composition and spatial heterogeneity. Line point hits on canopy cover of shrub and tree species (multiple hits) will also be recorded. The hits on live and dead branches of shrub and tree species will be visually estimated and recorded along each line transect to determine shrub and tree cover, vigor and perch habitat for birds. In addition, canopy cover of large shrubs and trees will be sampled using a spherical densitometer (Lemmon 1956). Only the central portion of the convex mirror grid will be used to reduce the canopy sampling area to encompass the 20 x 5 m belt transect area and immediate periphery (Fiala et al. 2006, Korhonen et al. 2006, Paletto and Tossi 2009). Data for canopy coverage by live and dead branches for each species will be collected with the densitometer at 5-m intervals along each of the three line transects for each belt transect to give a total of nine densitometer readings per belt transect.

Shrub and tree density within each belt transect will be determined by counting the number of individuals of each species in the 100-meter square area formed by the belt transect, or in sub-plots within the belt transect. Data for tree and shrub density will be categorized as seedling, juvenile or mature individuals. Three mature individuals of each species will then be tagged for permanent monitoring, and height of these individual trees and shrubs will be measured with a range pole or inclinometer to the nearest decimeter. Density and height data for these individual shrubs and trees will be recorded and data will be analyzed by species for the 10 plots within the woody riparian gallery. If Pahranagat Valley montane vole is noted at any of the belt transects, then maximum height of herbaceous vegetation at meter intervals along the three line transects will also be measured and recorded.

Distance to permanent water and soil moisture data will also be collected as part of the habitat-based approach for southwestern willow flycatcher and yellow-billed cuckoo habitat, and soil moisture data will be collected for Pahranagat Valley montane vole habitat. Distance to closest permanent water will be measured from the center point of each belt transect. Soil moisture conditions will be recorded for each belt transect using categorical data (standing water, saturated soil, wet soil, moist soil, or dry soil).

5.5 SUMMARY OF SAMPLING ACTIVITIES

In summary, the protocols employed within the Area of Interest focus on facilitating the collection of objective information regarding the physical, chemical, and biological aspects of the groundwater-influenced ecosystems and the Special Status Species of concern that they support. Over time, these data should serve to ascertain the effects of future perturbations to these areas and the responses of Special Status Species that they support. Table 5-11 provides an overview of the monitoring activities proposed for habitat variables and Special Status Species within the Area of Interest.

Table 5-11 Summary of Activities at Monitoring Sites

Monitoring Site	General Site Conditions (5.1)	ABIOTIC Measurements (5.2)	BIOTIC – ANIMALS (5.3)					BIOTIC – VEGETATION (5.4)	
			Macro-invertebrates (5.3.1)	Springsnails (5.3.2)	Fishes (5.3.3)	Northern Leopard Frog (5.3.4)	Pahranagat Valley Montane Vole (5.3.5)	Community Mapping (5.4.1)	Transect sampling (5.4.2)
Grassy Spring	X	X						X	
Coyote Spring	X	X						X	
Meloy Spring	X	X	X[1]	X[1]				X	X[1]
Littlefield Spring	X	X	X[1]	X[1]				X	X[1]
Parker Station Spring	X	X	X	X				X	X
Cave Valley Ranch Meadow	X							X	X
Butterfield Spring	X	X	X	X	X	X[1]		X	X
Flag Springs	X	X	X	X	X	X[1]		X	X
Hardy Springs	X	X	X	X	X	X[1]		X	X
Hot Creek Spring	X	X	X	X	X	X[1]		X	X
Moorman Spring	X	X	X	X	X	X[1]		X	X
Ash Spring	X	X	X	X	X	X[1]	X[1]	X	X
Crystal Spring	X	X	X	X	X	X[1]	X	X	X
Hiko Spring	X	X	X	X	X	X[1]		X	X
Maynard Spring	X	X	X	X[1]	X[1]	X[1]		X	X[1]
Pahranagat Ditch	X	X	X		X	X[1]	X[1]	X	X

[1] If Special Status Species present

6.0 DATA MANAGEMENT, ANALYSIS AND REPORTING

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6.1 GOALS AND OBJECTIVES OF DATA MANAGEMENT

A Data Management Plan will be prepared by SNWA and provided to the BRT in the initial stages of data collection. The goal of data management is to assemble and maintain the data collected under the Plan in a high quality and secure manner and to provide efficient access to these data by appropriate parties for the duration of the monitoring program. Attainment of this goal will be accomplished by meeting the five objectives outlined in Sections 6.1.1-6.1.5.

6.1.1 Data Quality Maintenance

The DMP must maintain the original quality of the data. Data quality refers to the identity and integrity of each data entry, whether the entry is numeric, non-numeric, or a combination. Once entered into the database, each entry must be maintained and protected. Corrections, summations, deletions, and other types of operations on the data must be clearly noted.

6.1.2 Data Interpretability

The interpretability of the data must be maintained. Interpretability of the data means that the data must be clear and understandable by potential users. The relationship between each data entry and its respective descriptive and organizational categories in the database must be maintained. Descriptive and organizational categories refer to information such as date, spatial location, type of data, and data collector.

6.1.3 Data Security

To ensure data protection and retention, all data will be maintained in a secure environment. Original paper data sheets will be archived in a fire-proof area, and will be scanned to electronic files that will be secured in a protected SNWA database. Original and final electronic files also will be secured in a read-only protected SNWA database. All reasonable precautions will be taken to prevent unauthorized access to the database.

6.1.4 Data Longevity

The database will be actively maintained for the duration of the monitoring program. At the termination of the period of active maintenance, an electronic version of the database will be stored on the most permanent materials available at that time.

6.1.5 Data Availability

BRT Party members and the NSE will have access to copies of all original and provisional data upon request. As instructed in the Stipulation, BRT Party members will have access to all final data via a shared data-repository website administered by SNWA. The public will have access to all final data upon request to SNWA.

6.2 DATA STEWARDSHIP ROLES AND RESPONSIBILITIES OF PARTIES

SNWA will be the party responsible for maintenance and archival of the raw data and QA/QC'd data, as well as establishment and maintenance of the database. SNWA shall make biological monitoring data available to the other Parties within 90 calendar days of each sampling period using a shared data-repository website administered by SNWA. It is the responsibility of the Parties to review this data in a timely fashion.

6.3 DATA MANAGEMENT

Care must be taken to implement responsible data management practices throughout the lifetime of the DMP. Each type of data has its own particular use and management requirements. If data are not properly documented and managed, their use and interpretation will be limited. To maximize future use of the data for comparative purposes, all data must be thorough, accurate, and well documented.

6.3.1 Data Acquisition and Processing

All data collected under the Plan will be archived in raw form (i.e., the form in which the data were collected in the field). If data are collected on data sheets, field maps, or similar paper formats, hard copies of these data will be archived. If data are collected in electronic format, electronic copies of these data will be archived. Data collected by contractors or agencies outside of SNWA will be submitted to SNWA in their entirety in raw form and, if possible, in QA/QC'd electronic form. SNWA will review all data for completeness and quality. If any problems exist with data, SNWA will work with the data collector to resolve these problems. After problems have been resolved and modifications logged, the data will be placed into the database maintained by SNWA. In addition to standard data entry and management, any data collected under a collection permit will also be provided to the respective agency.

Existing data sources may be needed to support the Plan. In some cases, it may be expedient to purchase supporting data (e.g., geospatial, climate, soil survey). Purchased data must be properly archived to protect the investment and preserve its integrity. If purchased data have licensing restrictions preventing outside distribution, they must be properly protected.

A long period of continuous data with consistent structure will maximize its usefulness for analysis and interpretation. Standardized input formats will be developed by SNWA during the initial stages of data collection.

6.3.2 Data Quality Assurance/Quality Control

Procedures will be established to assure data quality. These include how data are collected, transcribed, corrected, updated, stored, backed up, and archived. These procedures will be established and documented by SNWA during the initial stages of data collection. All primary source and field data must be preserved in their initial state as a permanent record. Corrections or adjustments must be annotated and logged. It may be necessary to review the appropriateness of any modification in the future, with the possibility of reversing the change. Data to be analyzed frequently should be stored in a relational database management system for easy maintenance, retrieval and reporting. Standard relational database management practices should be used for maintaining its quality and availability.

The QA/QC efforts for all data must be thorough so that future comparative analyses have a solid basis. For this reason, all data transcription work should be reviewed and corrected as a matter of procedure, not just a random sampling.

Scientific nomenclature frequently changes. The data should be structured in such a way that the original species identification is preserved but can be transformed to current nomenclature for reporting or comparison with subsequent data. Evolving nomenclature should be distinguished from re-identification based on data review.

6.3.3 Data Documentation (Metadata)

Each data source should be thoroughly documented to enable future users of the data to understand the source of the data along with its content, accuracy, and suitable uses. Metadata is particularly important for geospatial data, where it is critical to know the exact projection, coordinate system, zone, and scale, as well as definition of each attribute. The standards established by the Federal Geographic Data Committee (FGDC) for spatial data should be followed whenever possible. For all data sources, it is important to record the source of the data and when and where they were collected, along with any known quality parameters.

6.3.4 Data Dissemination

SNWA will supply the BRT with electronic copies of these provisional data for review within 90 days of completion of data collection for each sampling period.

SNWA will ensure that the provisional data are subjected to final QA/QC procedures (Section 6.3.2). Once all appropriate QA/QC procedures have been completed, the data are stored within the database, and the annual report is finalized, the data will be considered to be correct and in final form.

Copies of final data will be made available to the general public by SNWA by request. All data collected as part of the Plan, not protected by regulatory agencies, will be available. Spatial coordinates may be withheld to protect sensitive species.

6.3.5 Data Maintenance, Storage and Archiving

A relational database management system (RDBMS) will be used to file and retrieve data within a hierarchical data storage scheme where data can be located and displayed. These systems can be housed at SNWA or outsourced, as appropriate. Initial estimates should be made for resource requirements along with growth projections. Geospatial, image, and document data can be very large and require planning for adequate storage and backup capacity.

Systems security and backup/restore procedures are critical to assure protection from misuse, loss, or corruption of the data. Procedures for capturing data snapshots and archiving/retrieval will be established by SNWA. The procedures will be tested periodically to ensure data can be properly retrieved from backup systems and archives.

A shared data-repository website administered by SNWA will be used for data dissemination. Appropriate firewalls to protect secure data resources against intrusion through web access will be established, implemented, and maintained by SNWA.

6.3.6 Data Ownership

Ownership of all data collected by SNWA or its contractors will reside with SNWA. BRT Parties will have full access to these data. Data collected as part of non-SNWA funded projects, but made available to the BRT, will remain under the ownership of the funding agency.

6.4 STATISTICAL ANALYSIS

Suggested statistical protocols will be developed by qualified SNWA staff and/or consultants, in collaboration with the DOI BRT members, prior to and during the initial stages of data collection. These suggested protocols will provide BRT with statistical tests appropriate for the data collection presented in this Plan, and may be utilized and revised as needed. While SNWA has responsibility to produce annual reports, the BRT will have access to the data for making additional collaborative (e.g., 5-year comprehensive reports) and independent analyses. The BRT will meet at least annually following each year of data collection to discuss the data, analyses and interpretations.

6.5 REPORTS

6.5.1 Expected Products

Biological data collected through the Plan shall be made available to the Parties within 90 calendar days of the end of each sampling period using a shared data repository website administered by SNWA (Stipulation Exhibit A page 10 Paragraph IV; Appendix A). Following each year of data collection, SNWA shall report the results of all monitoring and sampling pursuant to the Plan in an annual report, which shall be submitted to the EC and the NSE by March 31. SNWA will provide a draft annual report to the BRT in late-February, followed by a BRT annual meeting in mid-March when other Parties may provide comments. A meeting between the BRT, TRP and the EC will be conducted in late-March. SNWA will consider BRT comments and submit the final report to the EC and NSE by March 31. The Parties can submit comments on the annual report to the NSE, at their discretion. These reporting processes and target dates are subject to revision, if mutually agreed upon by the Parties (Stipulation Exhibit A page 15 Paragraph VII; Appendix A).

The annual reports will not be overly complex due to the tight timeframe for production. The annual reports may include brief descriptions of the sites, indicators being monitored, methodologies of data collection and data analyses, summaries of the data, and results of limited data analyses (e.g., summary statistics, range of variation).

To meet the common goal of the Stipulation, the BRT will conduct further analyses and interpretation outside of the annual reports. A comprehensive report will be prepared every five years during Plan implementation as a collaborative BRT effort. These five-year reports will summarize all available data up to that time, along with analyses of the complete data sets, interpretation of results, recommendations and conclusions. Additional analyses may be documented outside of the annual and five-year reports, such as in recommendations to the EC and internal white papers.

Final annual reports will be distributed to BRT Party members via a shared data-repository website administered by SNWA; provided to landowners participating in the monitoring program if desired; submitted to the NSE; and available to the public upon request to SNWA. Final five-year reports will also be available to the public upon request to SNWA.

6.5.2 Intended Audiences

The annual and the five-year reports are intended for the technical, regulatory, and scientific communities, and therefore will contain large amounts of technical material.

6.6 RESOLVING CONFLICT REGARDING DATA ANALYSIS AND INTERPRETATION

If consensus is not reached on an analysis, interpretation, or recommendation, the BRT will follow the process described in the Stipulation (Stipulation Exhibit A page 19 Paragraph II.2; Appendix A).

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7.0 PLAN IMPLEMENTATION AND SCHEDULE

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7.2 Summary of Sampling Schedule and Frequency
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- **7.3.4 Describing Unreasonable Adverse Effects**
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7.4 Mitigation

7.1 ROLES AND RESPONSIBILITIES OF PARTIES

Per the Stipulation, the BRT shall develop and implement a monitoring plan for detecting Unreasonable Adverse Effects to Special Status Species in the Area of Interest that may result from SNWA groundwater withdrawals in DDC (Stipulation Exhibit A pages 12-14 Paragraph F; Appendix A). Specific SNWA and DOI Bureau responsibilities are defined in the Stipulation (Stipulation Exhibit A pages 4 and 10; Appendix A). The Parties shall collaborate on data collection and technical analysis to ensure decisions are consistent with the common goal of the Stipulation (Stipulation Exhibit A page 10 Paragraph V.A; Appendix A). Monitoring and statistical analysis will be conducted by persons with appropriate qualifications so that all Parties are comfortable with the quality of the data being collected and the validity of the statistical analyses. BRT will also be responsible for overseeing development of statistical protocols, conducting and/or overseeing statistical analyses that will inform five-year comprehensive reports and other BRT reports; and overseeing development of conceptual ecological models or computational models, if the latter is approved by EC.

In order to meet the common goal of the Stipulation, BRT will:

- Meet at least annually to evaluate and discuss progress of the Plan,
- Develop any necessary modifications to the Plan,
- Meet with TRP regularly to discuss hydrological monitoring and modeling results,
- Coordinate with TRP on data collection and data analysis to ensure that TRP hydrologic data can be used to inform biological data interpretation,
- Review data, data analyses, and summaries and results of the data analyses to satisfy the annual NSE reporting requirement,
- Conduct additional analyses to carry out the common goal of the Stipulation,
- Document analyses and interpretations in five-year comprehensive reports, recommendations to the EC, white papers, and/or comments submitted to NSE,
- Develop a framework for describing and detecting Unreasonable Adverse Effect,
- Provide the EC with annual evaluations of the progress of the monitoring program,
- Evaluate the need to shift monitoring from Tier 1 to Tier 2, or from Tier 2 to Tier 1, and
- Provide recommendations to the EC regarding observed or predicted potential Unreasonable Adverse Effects and potential actions to take to avoid or mitigate such effects.

7.2 SUMMARY OF SAMPLING SCHEDULE AND FREQUENCY

Details of the sampling schedules and frequency of sampling are provided in Chapter 5 (Monitoring Protocol). A summary of these schedules and frequencies is presented in Table 7-1.

Indicators associated with aquatic ecosystems will generally be sampled twice per year, once in the spring and once in the fall. Sampling dates each year will depend on climatic conditions but in general, spring samples will be collected during April-May and fall samples during September-October. Vegetation and open water measurement variables will be sampled once per year during the summer (June-August). Each sampling location will be sampled in approximately the same month as the previous year to minimize seasonal variability.

Table 7-1 Data Collection Schedule

Activity	Initial Site Characterization[1]	Frequency (T1/T2)[2]	Sampling Period (T1.T2)[3]
GENERAL SITE CONDITION			
Site Assessment	Single site visit	Biannual	Spring & Fall
Fixed-station photography - Springs		Biannual	Spring & Fall
Fixed-station photography - Vegetation transects		Annual	Summer
ABIOTIC			
TRP			
Depth to groundwater[4]		Continuous or Quarterly	
Discharge[5]		Continuous or Biannual	
BRT			
DO, Temperature, pH, Conductivity	Single site visit	Biannual	Spring & Fall
Temperature logger		Continuous	
Aquatic habitat extent	Single site visit	Biannual	Spring & Fall
Depth, velocity, substrate (springsnail and frog sampling)	Single site visit	Biannual	Spring & Fall
Distance to permanent water, soil moisture (bird and vole habitat)		Annual	Summer
BIOTIC - ANIMALS			
Macroinvertebrate composition, abundance	Single site visit	Biannual	Spring & Fall
Springsnail, presence, abundance, distribution	Single site visit	Biannual	Spring & Fall
Fish size class structure, distribution		Variable[6]	Variable[6]
Northern leopard frog presence	Single site visit	Annual	Spring
Northern leopard frog egg masses		Alternate wks (up to 3 visits) [7]	Spring
Pahranagat Valley montane vole presence[8]	Single site visit	Annual	Fall
BIOTIC - VEGETATION			
Community vegetation mapping	Single site visit		Summer
Cover, composition, and extent of communities		Annual	Summer
Open water and vegetation cover		Annual	Summer
Internal heterogeneity		Annual	Summer
Live/dead trees shrubs in gallery		Annual	Summer
Herbaceous riparian plant height (vole habitat)		Annual	Summer
Tree height, density in gallery (bird habitat)		Annual	Summer

[1]Site Characterization will be repeated every 10 years in conjunction with Tier 1 monitoring. Community vegetation mapping will not be conducted during the repeated Site Characterizations.
[2] The Plan will be reevaluated after 3 years of baseline data collection (1 year of Site Characterization followed by 2 years of tiered monitoring), at which point sampling frequency and schedule may change.
[3]Spring = April-May, Summer = June-August, and Fall = September-October.
[4]Regional monitoring well network
[5]If discharge cannot be measured, spring pool elevation or wetted area will be measured and/or general conditions documented during site visits via photographs and site assessments.
[6]Sampling will be conducted at various times by NDOW (Chapter 5).
[7]Initially, surveys will entail weekly trips for a period not to exceed four weeks; once egg masses are located at a given spring, the site will be visited up to three times at two-week intervals to count additional egg masses.
[8]Montane vole presence surveys will be conducted to determine the need for habitat monitoring.

7.3 PLAN IMPLEMENTATION

Data collection will begin three years prior to projected SNWA groundwater withdrawal in DDC. As such, it is likely that there may be an interim period following Plan finalization without full implementation of the Plan. However, components of the Plan that are already on-going are expected to continue. For example, the DDC Stipulation hydrologic monitoring program has already been implemented, and it is anticipated that at least certain components will continue during this interim period. Additionally, long-term southwestern willow flycatcher, yellow-billed cuckoo, and fish surveys conducted by NDOW and other entities are currently on-going and expected to continue. A timeline for Plan implementation is presented in Table 7-2.

Table 7-2 Biological Monitoring Plan Development and Implementation Schedule

Activity	Timeline
Develop Data Management Plan	Prior to and during initial stages of data collection.
Develop statistical protocols	Prior to and during initial stages of data collection.
Implementation of Monitoring Plan	3 years prior to projected SNWA groundwater withdrawal in DDC.
Conduct Site Characterizations	Prior to tiered monitoring, and every 10 years in conjunction with Tier 1, unless a shift to Tier 2.
Conduct Tier 1 monitoring	Following the first year of Site Characterization, Tier 1 will be conducted annually unless a shift to Tier 2. More intensive baseline monitoring at Flag, Butterfield, Ash, Crystal and Hiko springs and Pahranagat Ditch during the first two years of Tier 1 monitoring, and periodically thereafter unless a shift to Tier 2. To be repeated every five years at Flag and Butterfield, and every ten years at Pahranagat Ditch and Ash, Crystal and Hiko springs (in lieu of and on schedule with repeated 10-yr Site Characterizations).
Conduct Tier 2 monitoring	After shift from Tier 1, if occurs, conduct annually.
Review Plan and sampling protocols	Full evaluation after first two years of tiered monitoring. Also, during BRT annual meetings and additionally as needed.
Develop framework for describing and detecting Unreasonable Adverse Effects	Prior to groundwater withdrawal from DDC.
Revise monitoring plan	Potentially revise after two years of tiered monitoring. Annual changes to protocols will be reported in annual report and a running log. Major revisions to Plan to be completed as needed.
SNWA draft annual report	Late February.
BRT annual meeting	Mid March. Follow-up meetings may be held.
BRT annual meeting with EC	Late March.
SNWA annual report to NSE and EC	March 31.
BRT 5-year comprehensive report	To be determined
Conduct peer review	The BRT will work with the EC to determine if peer review is appropriate.

7.3.1 Protocol Review

Sampling protocols have been established for all indicators (Chapter 5). These protocols will be reviewed throughout Site Characterization and tiered monitoring, and it is likely that some of the protocols may be modified as a result of experience gained. Any modifications made will be incorporated into the Plan upon approval by the BRT. Change in protocol should have no more than a minimum impact on the usefulness of data collected prior to the modifications. If modification is expected to result in incompatibility of subsequent data with previous data, data may be collected for two years using both sets of protocols (pre-modification and modification). This would allow for the development of correlation equations that can be used to compare both data sets.

7.3.2 Site Characterization and Tiered Monitoring

Site Characterization and tiered monitoring timelines are listed in Table 7-2. The Plan will be implemented approximately 3 years prior to projected SNWA groundwater withdrawal in DDC and changes may be made to sampling schedules and indicators monitored with recommendation by BRT and approval of the EC.

7.3.3 Ecological Modeling

While development of computational ecological models is not being pursued at the present time, conceptual models will be used initially in studies of various sensitive species and habitats. Conceptual models developed for groundwater-influenced ecosystems in Spring Valley may be used or modified for use in the Area of Interest, if appropriate, and/or individual species-specific or site-specific models may be developed in the future. BRT will observe how computational modeling proceeds under the Spring Valley Stipulation, and may seek EC approval to develop or modify Rapid Prototype models to address management and monitoring issues specific to the Area of Interest. Therefore, there should be close communication between the BWG and BRT on models, their uses, and values in ongoing monitoring.

7.3.4 Describing Unreasonable Adverse Effects

BRT will develop a framework for describing and detecting Unreasonable Adverse Effects prior to SNWA groundwater withdrawal in DDC. This framework can be reviewed and revised as needed in keeping with an adaptive monitoring and management approach. This framework should be integrated with the Operation Plan that will be developed by SNWA, in cooperation with the DOI Bureaus.

7.3.5 Data Management

The basic components of the data management are presented in Chapter 6. A description of the data management process will be prepared by SNWA and provided to the BRT in the initial stages of data collection.

7.3.6 Statistical Protocols

Suggested statistical protocols will be developed by qualified SNWA staff and/or consultants, in collaboration with the DOI BRT Parties, prior to and during the initial stages of data collection. These suggested protocols will provide BRT with statistical tests appropriate for the data collection presented in this Plan, and may be utilized and revised as needed. Based on data collected during initial Site Characterization, changes to monitoring design and statistical protocols may be made before further data collection. Additionally, any BRT member has the option to perform additional statistical analyses at their discretion, which can then be shared with the BRT and NSE as appropriate.

7.4 MITIGATION

The common goal of the Stipulation Parties includes taking actions that protect and recover Special Status Species currently listed pursuant to the ESA, and taking actions to avoid additional ESA listings. To achieve this goal, the Parties will strive to improve the condition of Special Status Species habitats that are groundwater-influenced within the Area of Interest, both within the current and historic range of these species. These and other mitigation actions will not be described within this Plan, but rather within a Hydrologic Management and Mitigation Operation Plan (Operation Plan), which is to be developed cooperatively by the Parties prior to DDC groundwater withdrawal for production (Stipulation Exhibit A page 11 Paragraph D; Appendix A).

8.0 LITERATURE CITED

Anderson, S. 1959. Distribution, variation, and relationships of the montane vole, *Microtus montanus*. University of Kansas Publication, Museum of Natural History 9:415-511.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish. Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency. Office of Water. Washington DC, USA.

Barry, D., R.A. Fischer, K.W. Hoffman, T. Barry, E.G. Zimmerman, and K.L. Dickson. 2006. Assessment of habitat values for indicator species and avian communities in a riparian forest. Southeastern Naturalist 5:295-310.

[BWG] Biological Work Group. 2009. Biological Monitoring Plan for the Spring Valley and Stipulation. February 2009.

BIO-WEST. 2007. Ecological Evaluation of Selected Aquatic Ecosystems in the Biological Resource Study Area for the Southern Nevada Water Authority's Proposed Clark, Lincoln, and White Pine Counties Groundwater Development Project. Final Report. Vol. 1, PR 987-1. 255 p. plus Appendices, with accompanying database.

Bishop, C.A. 1992. The effects of pesticides on amphibians and the implications for determining the causes of declines in amphibian populations. In: C.A. Bishop and K.E. Pettit (eds.) Declines in Canadian Amphibian Populations: Designing a National Monitoring Strategy. Occasional Paper Number 76. Canadian Wildlife Service. Ottawa, Ontario, Canada.

Bonham, C.D. 1989. Measurements for Terrestrial Vegetation. John Wiley and Sons. New York, New York, USA. 338 p.

Braden, G.T., A. Miller, and L. Crew. 2008. Status of the Yuma Clapper Rail and Yellow-billed Cuckoo along portions of the Virgin and Muddy Rivers in Southern Nevada, 2007 Final Report prepared for the Southern Nevada Water Authority.

Broadhead, K.M., S.H. Stoleson, and D.M. Finch. 2007. Southwestern willow flycatchers (*Empidonax trailli extimus*) in a grazed landscape: Factors influencing brood parasitism. The Auk 124:1213-1228.

Conant, R. and J.T. Collins. 1991. A Field Guide to Reptiles and Amphibians: Eastern and Central North America. Third Edition. Houghton Mifflin. Boston, Massachusetts, USA. 450 p.

Connelly, J.W., E.T. Rinkes, and C.E. Braun. 2010. Characteristics of greater sage grouse habitats: A landscape species at micro and macro scales. Studies in Avian Biology. Cooper Ornithology Society, Scientific Series. (*in press*).

Cooke, A.S. 1981. Tadpoles as indicators of harmful levels of pollution in the field. Environmental Pollution Series A 25:123-133.

Courtenay, W.R. Jr., J.E. Deacon, D.W. Sada, R.C. Allan, and G.L. Vinyard. 1985. Comparative status of fishes along the course of the pluvial White River, Nevada. The Southwestern Naturalist 30:503-524.

Daubenmire, R. 1968. Plant Communities. A Textbook of Plant Synecology. Harper and Row. New York. 300 p.

Dettinger, M. D.; J.R. Harril; D.L. Schmidt; and J.W. Hess. 1995. Distribution of carbonate-rock aquifers and the potential for their development, southern Nevada and adjacent parts of California, Arizona, and Utah. US Geological Survey, Water-Resources Investigations Report 91-4146. 100p.

Drut, M.S., W.H. Pyle, and J.A. Crawford. 1994. Technical note: Diets and food selection of sage grouse chicks in Oregon. Journal of Range Management 47: 90-93.

Eakin, T.E. 1966. A regional interbasin groundwater system in the White River area, southeastern Nevada. Water Resources Research 2(2):251-271.

Ellis, L.A., S.D. Stump, D.M. Weddle. 2009. Southwestern willow flycatcher population and habitat responses to reservoir inundation. Journal of Wildlife Management 73:946-954.

Fiala, A.C.S., S.L. Garman, and A.N. Gray. 2006. Comparison of five canopy cover estimation techniques in the western Oregon Cascades. Forest Ecology and Management 232:188-197.

Gaines, D. 1974. Review of the status of the yellow-billed cuckoo in California: Sacramento Valley populations. The Condor 76:204-209.

Garside, L.J. and J.H. Shilling. 1979. Thermal water of Nevada. Nevada Bureau of Mines and Geology Bulletin 91:1-163.

Gilbert, C.H. 1893. Report on the fishes of the Death Valley expedition collected in southern California and Nevada in 1891, with descriptions of new species. U.S. Department of Agriculture, Bureau Biological Survey, North American Fauna 7:229-234.

Goldstein, J., and B. Hobbs. 2008. Hiko White River springfish 2008 population estimates. Field trip report, Nevada Department of Wildlife Southern Region, Las Vegas. 5 p.

Hall, E.R. 1946. Mammals of Nevada. University of California Press, Berkeley, 710 p.

Hall, R.J. and P.F.P. Henry. 1992. Review. Assessing effects of pesticides on amphibians and reptiles: status and needs. Herpetology Journal 2:65-71.

Hardy, T.B. 1982. Ecological interactions of the introduced and native fishes in the outflow of Ash Spring, Lincoln County , Nevada. Master Thesis, University of Nevada, Las Vegas, USA.

Harper, K.T., L.L. St. Claire, K.H. Thorne, and W.M. Hess (eds.), 1998. Natural History of the Colorado Plateau and Great Basin. University Press of Colorado. Niwot, Colorado, USA. pp 163-208.

Hawkins, C.P., J.L. Kershner, P.A. Bisson, M.D. Bryant, L.M. Decker, S.V. Gregory, D.A. McCullough, C.K. Overton, G.H. Reeves, R.J. Steedman, and M.K. Young. 1993. A hierarchical approach to classifying stream habitat features. Fisheries 18:3-12.

Hayford, B.L., J.E. Sublette, and S.J. Hermann. 1995. Distribution of Chironomids (Diptera: Chironomidae) and Ceratopogonids (Diptera: Ceratopogonidae) along a Colorado thermal spring effluent. In: L.C. Ferrington (ed.) Biodiversity of Aquatic Insects and Other Invertebrates in Springs. Journal of the Kansas Entomological Society. Special Publication No. 1, Supplement to Volume 68. pp 77-92.

Hershler, R.H. 1994. A review of the North American freshwater snail genus *Pyrgulopsis* (Hydrobiidae). Smithsonian Contributions to Zoology 554:115 p.

Hershler, R. 1998. A Systematic Review of the Hydrobiid Snails (Gastropoda: Rissooidea) of the Great Basin, Western United States. Part 1. Genus Pyrgulopsis. Veliger 41:1-132.

Hitchcock, C.J. 2001. The status and distribution of northern leopard frog (*Rana pipiens*) in Nevada. MS Thesis. University of Nevada, Reno, USA. 114 p.

Hobbs, B. 2008. White River spinedace 2008 monitoring. Field trip report. Nevada Department of Wildlife Southern Region, Las Vegas. 8 p.

Hobbs, B., J. Heinrich, J. Hutchings, M. Burrell, M. Beckstrand, B. Bauman, and J.C. Sjoberg. 2007. Nevada Department of Wildlife, Native Aquatic Species Program Annual Report, Southern Region, January 1, 2007-December 31, 2007. Nevada Department of Wildlife. Las Vegas. 137 p.

Hubert, W.A. 2004. In: M.C. McKinstry, W.A. Hubbert, and S.H. Anderson (eds.), Wetland and Riparian Areas of the Intermountain West: Ecology and Management. University of Texas Press, Austin, Texas, USA. pp 52-73.

Hunt, C.B. 1967. Physiography of the United States. W.H. Freeman, San Francisco. 480 p.

Johnson, M.J., J.A. Holmes, C. Calvo, I. Samuels, S. Krantz, and M.K. Sogge. 2007. Yellow-billed cuckoo distribution, abundance, and habitat use along the lower Colorado and tributaries, 2006 Annual Report. USDI Southwest Biological Sciences Center, Flagstaff, Arizona, USA.

Kendell, K. 2002. Survey protocol for the northern leopard frog. Alberta Sustainable Resource Development, Fish and Wildlife Division. Alberta Species at Risk Report No. 43. Edmonton. 30 p.

Korhonen, L., K.T. Korhonen, M. Rautiainen and P. Stenberg. 2006. Estimation of forest canopy cover: a comparison of field measurement techniques. Silva Fennica 40:577-588.

Koronkiewicz, T.J., M.K. Sogge, C. Van Riper III, and E.H. Paxton. 2004. Territoriality, site fidelity, and survivorship of willow flycatchers wintering in Costa Rica. The Condor 108:558-570.

La Rivers, I. 1962. Fishes and fisheries of Nevada. Nevada State Fish and Game Commission, Carson City, Nevada, USA. 782 p.

Lemmon, P.E. 1956. A spherical densitometer for estimating forest overstory density. Forest Science 2:314-320.

Lindenmayer, D.B. and G.E. Likens. 2009. Adaptive monitoring: a new paradigm for long-term research and monitoring. Trends in Ecology and Evolution (in press).

[LVVWD] Las Vegas Valley Water District. 2001. Water Resources and Groundwater Modeling in the White River and Meadow Valley Flow Systems, Clark, Lincoln, Nye, and White Pine Counties, Nevada. Final Report, June 2001.

McLendon, T. 2006. Review of depth-to-water and vegetation relationships. Technical Memorandum 1. July 14. Report prepared for the Los Angeles Department of Water and Power. MWH Inc. Fort Collins, Colorado. 131 p.

McLendon, T. 2008. Differential use of precipitation- and groundwater-derived water by vegetation: a review of the literature. Report prepared for the Los Angeles Department of Water and Power. MWH Inc. Fort Collins, Colorado. 61 p.

McLendon, T., P.J. Hubbard, and D.W. Martin. 2008. Partitioning the use of precipitation- and groundwater-derived moisture by vegetation in an arid ecosystem in California. Journal of Arid Environments 72:986-1001.

Miller, R.R. and C.L. Hubbs. 1960. The spiny-rayed Cyprinid fishes (Plagopterini) of the Colorado River System. Miscellaneous Publications, Museum of Zoology, University of Michigan, No. 115. Ann Arbor, Michigan, USA.

Minckley, W.L. and J.E. Deacon. 1968. Southwestern fishes and the ‘enigma’ of endangered species management. Science 159:1424-1432.

Mooney, H.A., W.E. Winner, and E.J. Pell (eds.) 1991. Response of Plants to Multiple Stresses. Academic Press, Inc. San Diego, California, USA. 422 p.

[NDOW] Nevada Department of Wildlife, 2006. Nevada Wildlife Action Plan. Nevada Department of Wildlife, Reno, Nevada, USA. 547 p.

[NDOW] Nevada Department of Wildlife. 2008. Species Investigations. January 1, 2008, through December 31, 2008. Mammal section – Montane Vole Genetic Study, p. 136.

[NDWR] Nevada Division of Water Resources. 2010. Water Use Inventories Internet, accessed March 31, 2010, available from http://images.water.nv.gov/images/Pumpage%20Inventories/default.aspx

Odum, E.P. 1971. Fundamental of Ecology. Third edition. W.B. Saunders. Philadelphia, Pennsylvania, USA. 574 p.

Oostine, H.J. 1956. The Study of Plant Communities: an Introduction to Plant Ecology. W. H. Freeman and Co. San Francisco.

Paletto, A. and V. Tossi. 2009. Forest canopy cover and canopy closure: comparison of assessment techniques. European Journal of Forest Research. 128:265-272.

Parasiewicz, P. 2001. MesoHABSIM: A concept for application of instream flow models in river restoration planning. Fisheries 26:6-13.

Parrish, J.D., D.P. Braun, and R.S. Unnasch. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. BioScience 53:851-860.

Pennak, R. W. 1978. Freshwater invertebrates of the United States. John Wiley & Sons, New York, New York, USA. 803 p.

Polhemus, D. A. 2002. Basins and ranges: the biogeography of aquatic true bugs (Insecta: Heteroptera) in the Great Basin. pp 235–254. *in* Hershler, R., D. B. Madsen, and D. R. Currey, (eds.). Great Basin aquatic systems history. Smithsonian Contributions to the Earth Sciences No. 33. Washington, DC.

Prudic, D.E., J.R. Harrill, and T.J Burbey. 1995. Conceptual evaluation of regional ground-water flow in the carbonate-rock province of the Great Basin, Nevada, Utah, and adjacent states. U.S. Geological Survey Open-File Report 93-170 (revision of Open-File Report 90-560). pp 69-72.

Rorabaugh, J.C. 2005. *Rana pipiens*. In: M. Lannoo (ed.). Amphibian Declines: The Conservation Status of North American Species. University of California Press. Berkeley, California, USA. pp 570-580.

Rosenberg, P.D. Vickery, and T.B. Wigley. 2002. Priority research needs for the conservation in migrant landbirds. Journal of Field Ornithology 73:329-339.

Sada, D.W. 2000. Spatial and temporal variation in aquatic mollusk abundance and habitat as indicators of environmental change, Muddy River Springs, Clark County, Nevada. Report prepared for the Southern Nevada Water Authority. Las Vegas, Nevada, USA.

Sada, D.W. 2001. Demography and habitat use of the Badwater snail (*Assiminea infima*), with observations on its conservation status. Hydrobiologia 466:255-265.

Sada, D.W. 2003. Conservation management plan for springs in Clark County, NV. Preliminary Draft. Desert Research Institute. University of Nevada, Reno. 35 p.

Sada, D.W. 2005. Desert Research Institute Springs Database. Desert Research Institute. University of Nevada, Reno, USA.

Sada, D.W. and D.B. Herbst. 2006. Ecology of aquatic macroinvertebrates in Travertine and Nevares Springs, Death Valley National Park, California, with an examination of water diversion effects on abundance and community structure. Report to the National Park Service. 12 July 2006. 58 p.

Sada, D.W. and K.F. Pohlmann. 2006. U.S. National Park Service Mojave Inventory and Monitoring Network Spring Survey Protocols: Level I and Level II. Desert Research Institute, Nevada, USA. Final draft. 96 p.

Sada, D.W. and G.L. Vinyard. 2002. Anthropogenic changes in historical biogeography of Great Basin aquatic biota. In: R. Hershler, D.B. Madsen, and D. Currey (eds.) Great Basin Aquatic Systems History. Smithsonian Contributions to the Earth Sciences No. 33. pp 227-293.

Sage Grouse Conservation Team. 2004. Greater Sage Grouse Conservation Plan for Nevada and Eastern California. 2004 First Edition.

Sedgwick, J.A., and F.L. Knopf. 1992. Describing willow flycatcher habitats: scale perspectives and gender differences. The Condor 94:720-733.

Schmude, K.L. 1999. Riffle beetles in the genus *Stenelmis* (Coleoptera: Elmidae) from warm springs in southern Nevada: new species, new status and a key. Entomological News 110(1): 1-12.

Scoppettone, G.G., J.E. Harvey, S.P. Shea and J. Heinrich. 1992. Relative abundance and distribution of fishes in the White River Valley, Nevada with special emphasis on the White River spinedace (*Lepidomeda albivallis*). Report to Nevada Department of Wildlife Contract #NV E-1-8. USFWS National Fishery Research Center, Seattle, Washington, USA. 163 p.

Sigler, W.F. and J.W. Sigler. 1987. Fishes of the Great Basin. A Natural History. University of Nevada Press. Reno, Nevada, USA. 425 p.

Smith, B.E. 2003. Conservation Assessment of the Northern Leopard Frog in the Black Hills National Forest, South Dakota and Wyoming. U.S.D.A. Forest Service. Black Hills National Forest. 78 p.

Smith, B.E. and D.A. Keinath. 2007. Northern leopard frog (*Rana pipiens*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. October 6, 2008. http://www.fs.fed.us/r2/projects/scp/assessments/northernleopardfrog.pdf.

Smith, R.L. 1992. Elements of Ecology. 3rd Edition. HarperCollins Publishers, New York. 617p.

[SNWA] Southern Nevada Water Authority. 2007a. Water-Resources Assessment and Hydrogeologic Report for Cave, Dry Lake, and Delamar Valleys. Submitted to NSE pertaining to groundwater applications 53987 to 53992. November 2007. Southern Nevada Water Authority. Las Vegas, Nevada, USA.

[SNWA] Southern Nevada Water Authority. 2007b. Clark, Lincoln, and White Pine Counties Groundwater Development Project: Sage Grouse Lek Survey Report 2007. Final Report, December 2007. Southern Nevada Water Authority. Las Vegas, Nevada, USA.

[SNWA] Southern Nevada Water Authority. 2009a. Chapter 1 *in* Clark, Lincoln, and White Pine Counties Groundwater Development Project: 2008 Wildlife Surveys. Final Report August 2009.

[SNWA] Southern Nevada Water Authority. 2009b. Delamar, Dry Lake, and Cave Valleys Stipulation Agreement Hydrologic Monitoring Plan Status and Historical Data Report. Doc. No. WRD-ED-0005. Southern Nevada Water Authority, Las Vegas, Nevada, USA. 162 p.

Stauffer, D.F. and L.B. Best. 1980. Habitat selection by birds of riparian communities: Evaluating effects of habitat alterations. Journal of Wildlife Management 44:1-15.
Stebbins, R.C. 1985. A Field Guide to Western Reptiles and Amphibians. Second Edition. Houghton Mifflin. Boston, Massachusetts, USA. 337 p.

Stebbins, R.C. 1985. A Field Guide to Western Reptiles and Amphibians. Second Edition. Houghton Mifflin. Boston. 337 p.

Stein, J., J. Heinrich, and J. Sjoberg. 2000. Section 6 Project Progress Summary Report, Southern Region. Nevada Division of Wildlife, Nevada, USA. 18 pg.

[SWCA] McLeod, M.A. and T.J. Koronkiewicz. 2009. Southwestern Willow Flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2005. Annual Report submitted to U.S. Bureau of Reclamation, Boulder City, NV by SWCA Environmental Consultants, Flagstaff, Arizona, USA. 176 p.

[SWCA] Koronkiewicz, T.J., M.A. McLeod, B.T. Brown, and S.W. Carothers. 2006. Southwestern Willow Flycatcher surveys, demography, and ecology along the lower Colorado River and tributaries, 2005. Annual Report submitted to U.S. Bureau of Reclamation, Boulder City, NV by SWCA Environmental Consultants, Flagstaff, AZ. 176 pp

Tanner, V. 1950. A new species of Gila from Nevada (Cyprinidae). Great Basin Naturalist 10:31-36.

[TNC] The Nature Conservancy. 1994. Standardized national vegetation classification system: USGS/NPS Vegetation Mapping Program. November 2004 Final Draft prepared for the US Department of Interior, US Geological Survey and National Park Service. http://biology.usgs.gov/npsveg/nvcs.html.

Tomlinson, C. and Shoneman C. 1993. Letter to Ken Voget of USFWS regarding trapping efforts in Pahranagat Valley for the Pahranagat Valley montane vole.

Tuttle, P., G. Scoppettone, and D. Withers. 1990. Status and life history of Pahranagat River fishes completion report. U.S. Fish and Wildlife Service, National Fisheries Research Center, Seattle, WA and Nevada Department of Wildlife, Reno, Nevada, USA.

[USFWS] U.S. Fish and Wildlife Service. 1994. White River spinedace, *Lepidomeda albivalis*, recovery plan. Portland, Oregon, USA. 45 p.

[USFWS] U.S. Fish and Wildlife Service. 1998. Recovery Plan for the Aquatic and Riparian Species of Pahranagat Valley. Portland, Oregon, USA. 82 p.

Van der Kamp, G. 1995. The hydrology of springs in relation to the biodiversity of spring fauna. In: L.C. Ferrington, Jr. (ed.). Biodiversity of aquatic insects and other invertebrates in springs. Journal of the Kansas Entomological Society 68(Supplement):4-17.

Varza, D. and A.P. Covich. 1995. Population fluctuations within a spring community. In: L.C. Ferrington (ed.). Biodiversity of aquatic insects and other invertebrates in springs. Journal of the Kansas Entomological Society 68(Supplement):42-49.

White, G.C., D.R. Anderson, K.P. Burnham, and D.L. Otis. 1972. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory Report No. LA-8787-NERP, UC-11.

Williams, J.E., and G.R. Wilde. 1981. Taxonomic status and morphology of isolated populations of the White River springfish, *Crenichthys baileyi* (Cyprinodontidae). The Southwestern Naturalist 25:485-503.

Electronic Databases and Information:

http://heritage.nv.gov/animaldat.htm

http://www.nv.blm.gov/wildlife/documents/sensitivespecies.pdf

http://www.raws.dri.edu/

http://conserveonline.org/workspace/cbdgateway/cap

http://www.wrcc.dri.edu/

http://images.water.nv.gov/images/Pumpage%20Inventories/default.aspx

9.0 GLOSSARY

Abiotic The non-living portions of an ecosystem; includes climatic, edaphic, geologic, hydrologic, pyric, and topographic factors.

Acceptable Range in Variation The range in values of an ecological variable that provides conditions for long-term viability for an ecological entity; that range in values, rates of change, and frequency of change associated with ecosystem integrity and long-term viability (Parrish et al. 2003).

Adverse Effect An adverse effect will be considered to occur if an indicator or suite of indicators falls outside the acceptable range of variation.

Animal Community The animal components characteristic of an ecological community.

Anthropogenic Relating to human activities.

Area of Interest The study area within Delamar Valley, Dry Lake Valley, Cave Valley, Pahranagat Valley, and southern White River Valley Hydrographic Basins.

Baseline Conditions that exist prior to the beginning of implementation of a specified change or set of changes to an ecosystem.

Belt Transect A rectangular area, generally much longer than wide, used to sample vegetation, especially woody vegetation.

Benthic Relating to the bottom of body of water.

Biotic The living portions of an ecosystem; includes microbes, plants, and animals.

Bulk Density The physical property of a soil associated with the weight of one cubic centimeter of the soil, expressed in grams.

Canopy Cover The ground or water surface area covered by a vertical projection of the leaves and stems of the overlying vegetation.

Capillarity Upward movement of a liquid in a thin-diameter cylinder, tube, or similar structure (e.g., pore spaces in a soil).

Capillary Fringe The moist zone in a soil directly above a saturated layer, resulting from upward movement of water by capillarity.

Coarse-Textured Soil Soil consisting of a relatively high percentage of sand or gravel.

Computational Model A mathematical model to study the behavior of a complex system by computer simulation. The system under study is often a complex nonlinear system for which simple, intuitive analytical solutions are not readily available.

Conceptual Model A short-hand method of presenting the state of understanding of a system; a means of focusing the thought processes of those working on the system and of communicating the status of understanding, or perceived understanding, to others.

Diapause A period of dormancy, usually seasonal, in the life cycle of an insect in which growth and development cease and metabolism is greatly decreased (Smith 1992).

Discharge Quantifies the actual amount or volume of water issuing from a source (i.e., spring, well, or stream).

Disturbance Any impact, natural or anthropogenic, to an ecological community that results in a change in composition, structure, or function of the community beyond its usual range of variability.

Early-Successional Relating to the first few stages of an ecological succession where the plant communities are typically dominated by fast-growing and short-lived species.

Ecological Community An assemblage of populations living in a prescribed area or physical habitat (Odum 1971); used in a broad sense to refer to ecological units of various sizes and degrees of integration (Stiling 1992); used in a narrow sense to refer to an ecological unit characterized by the same dominant plant or animal species (Oosting 1956).

Ecological Threshold The level of an indicator or suite of indicators corresponding to the shift from one condition level to another for a species or their habitat.

Ecosystem An ecological community and its associated abiotic factors treated as a functional unit (Odum 1971, Smith 1992, Stiling 1992).

Ecotone A zone of intergradations or interfingering, narrow or broad, between contiguous types of vegetation (Daubenmire 1968).

Edaphic Pertaining to soils.

Emergent Vegetation Rooted aquatic plants with substantial portions of their photosynthetic tissue above the water surface.

Endemic Restricted to a given region (Smith 1992).

Ephemeral Temporary, often in response to seasonal or episodic events.

Estivate To become dormant (i.e., animals) in response to drought or a dry season.

Evapotranspiration The combined water loss from evaporation from the soil or water surface and transpiration through plants.

Federal Reserved Water Rights Water rights created when federal lands are withdrawn from the public domain (e.g. national parks, wildlife refuges, forests); these are distinct from state appropriated water rights. These rights: 1) may apply to both in- and out-of-stream water uses; 2) may be created without actual diversion or beneficial use; 3) are not lost by non-use; 4) have priority date established as the date the land was withdrawn; and 5) are for the minimum amount of water necessary to satisfy both existing and foreseeable future uses of water for the primary purposes for which the land is withdrawn.

Federal Resources Natural resources that fall under DOI jurisdiction, as recognized in the Stipulation (Stipulation pages 1-2 Recital B; Appendix A). These resources include groundwater-influenced ecosystems on federal land, federally-protected species that use those ecosystems, and migratory birds in the Area of Interest.

Fine-Textured Soil Soil consisting of a relatively high percentage of silt or clay particles.

Flow Meter An instrument for monitoring, measuring, or recording the rate of flow of a fluid, such as water.

Gallery Forest A forest of trees occurring on the banks of a stream in a region that otherwise would be treeless.

Great Basin The ecological region in the western United States broadly located between the Sierra Nevada Mountains and Rocky Mountains and north of the Mojave, Sonoran, and Chihuahuan Deserts.

Groundwater-influenced ecosystem An ecosystem that is substantially affected by groundwater at least most of the year; includes aquatic ecosystems and wetlands, and those meadows, shrublands, and woodlands where the vegetation utilizes substantial amounts of groundwater on an annual basis and where the composition, structure, or productivity is dependent on this groundwater utilization.

Groundwater Withdrawal The removal of water that is below the soil surface.

Hardpan A soil layer with high bulk density, generally resulting from compaction or the accumulation of translocated silt or clay particles.

Helocrene A spring that discharges into a marshy and comparatively shallow wetland.

Herbivory Consumption of plant tissue by animals.

Late-Successional Relating to the later stages of an ecological succession where the plant communities are typically dominated by relatively slow-growing and long-lived species and relatively well-developed vegetation structure.

Lentic Of or pertaining to still waters such as lakes, reservoirs, ponds, and bogs.

Limnocrene A spring that discharges into a ponded or pooled habitat before flowing into a defined channel.

Line Transect A one-dimensional extension of a tape measure or similar device, used to sample vegetation.

Macrophyte A relatively large aquatic plant.

Meadow A plant community dominated by grasses or grass-like plants and that generally has relatively wet soil for at least part of the growing season; when standing water is present, it is for less than the entire growing season.

Metadata Information about data that facilitates the understanding, usage, and management of data.

Micro-topography The small-scale differences in surface elevation across a landscape.

Monitoring To observe, measure, and record conditions through time.

Mountain Block Spring A spring located on the side of a mountain and usually not connected to a regional aquifer.

NatureServe An online database that is an authoritative source of information on more than 70,000 plants, animals, and ecosystems of the United States and Canada.

Peer Review The process whereby qualified scientists in the appropriate disciplines who are not directly involved in a program have the opportunity to critically review work plans and products.

pH A measure of hydrogen ion concentration used to evaluate whether a water or soil sample is acidic (low value) or basic (high value).

Photoperiod Relating to the relative amounts of light and dark during a 24-hour period.

Piezometer A small-diameter observation well used to measure the hydraulic head of groundwater in an aquifer.

Plant Community The plant components of an ecological community.

Phreatophytic Relating to the use of subsurface groundwater by plants.

Phytoplankton Small, free-floating plants in the water column of an aquatic ecosystem.

Range Front Spring A spring located at an elevation higher than the valley floor and in proximity to the slope or bench that precedes the mountain block.

Range of Variation Range of variation consists of maximum and minimum values and related descriptive statistics for an indicator, encompassing natural and anthropogenic influences (e.g., grazing, water diversions, roads, etc.). Range of variation can be based on monitoring data prior to and during groundwater withdrawal, historical data, expert opinion, and inferences from other species and locations.

Recruitment The increase in a species or ecological community resulting from addition of new individuals, either from reproduction or migration.

Relational Database Management System (RDBMS) System for storing data in related tables, providing quick search and retrieval of data or information from a database.

Rheocrene A spring that discharges into a defined channel.

Riparian The ecological zone along the banks of a stream, river or body of water.

Saline Relating to a high concentration of soluble salts.

Sample Size The number of observations in a given sample.

Scientific Credibility The general acceptance by the scientific community of the approach used in an investigation or study, data collected, and the interpretation of these data.

Shrubland An area on which the vegetation is dominated by woody plants generally less than 4 meters tall, and often multi-stemmed.

Site Characterization Description of the abiotic and biotic components and conditions within a particular area.

Soil Texture The physical property of a soil associated with the relative amounts of the three soil particle classes (sand, silt, clay).

Sodic Relating to a high concentration of sodium.

Spatial Extent The area covered by an ecological unit.

Special Status Species As defined in the Stipulation, those species that are groundwater dependant and any of the following: 1) listed as threatened or endangered by FWS under the Endangered Species Act (ESA), or a proposed or candidate species for ESA listing; 2) listed as a Sensitive Species by Nevada BLM State Director; 3) listed by the State of Nevada in a category implying but not limited to potential endangerment or extinction; or 4) designated as critically imperiled or imperiled across its entire range (G1 or G2 rank) by the Nevada Natural Heritage Program (NNHP) (Stipulation Exhibit A page 14; Appendix A). This Plan focuses on Special Status Species that are dependent on groundwater-influenced ecosystems for all or part of their life cycles.

Species Composition The proportion of a vegetation metric (e.g., cover or biomass) contributed by a particular plant species.

Species Cover The ground or water surface area covered by a vertical projection of plant tissue.

Stipulation A condition or requirement specified in a legal agreement among participating parties. The purpose of this biological monitoring plan is to meet the requirements of the Stipulation for the Withdrawal of Protests between SNWA and Department of the Interior agencies regarding groundwater applications 53987-53992 in DDC (Stipulation). Also discuss in this document is the Stipulation for the Withdrawal of Protests between SNWA and Department of the Interior agencies regarding groundwater applications 54003-54021 in Spring Valley Hydrographic Basin (Spring Valley Stipulation)

Stratified Random A sampling technique in which the area or population to be sampled is first divided into units based on defined criteria and then samples are randomly selected from each of the units.

Stressor Any factor that shifts conditions away from optimum for a species; a stimulus that causes stress.

Submergent Vegetation Rooted aquatic plants with their tissue below the water surface.

Succession The ecological process of the natural replacement of one plant community by another at a given location over time, progressing in the direction of a relatively stable plant community that is in balance with the environmental factors at the site.

Target Population A general term used to describe a population of interest or concern.

Taxon (Taxa, pl.) A taxonomic category or group, such as family, genus, or species.

Temperature Loggers Instruments designed and programmed to measure and record temperatures at certain time intervals.

Transect An extension, either single- (line) or two-dimensional, of some defined distance or length and width, through an area to be sampled and used to collect data.

Unreasonable Adverse Effect A term specific to the Stipulation. The common goal of the Parties to the Stipulation is to manage the development of groundwater by SNWA in DDC without causing injury to Federal Water Rights and/or Unreasonable Adverse Effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in DDC (Stipulation page 4 Recital H; Appendix A). What constitutes an Unreasonable Adverse Effect will be determined by the EC, with input from the BRT and TRP. To assist in accomplishing this goal, the BRT plans to develop a framework for describing and detecting Unreasonable Adverse Effects.

USGS Gage A permanent instrument installed in certain streams to measure streamflow or annual discharge.

Valley Floor Spring A spring located on the valley floor.

Vegetation Composition The relative amounts of the plant species of the vegetation.

Vegetation Structure Relating to the spatial arrangement of vegetation, including height, stratification, cover, and spatial pattern.

Water-Dependent Ecosystem As defined in the Stipulation, those Special Status Species habitat areas in the Area of Interest that are dependent upon groundwater levels and/or local and regional spring flows (Stipulation Exhibit A page 12 Paragraph F; Appendix A).

Weir A small overflow-type dam used to raise the level of water in a stream so that the rate of water flow can be measured.

Wetland An area with soils which are saturated to the surface most of the time.

Woodland An area on which the vegetation is dominated by woody plants generally more than 4 meters tall and usually single-stemmed, and where canopy cover of the woody plants is not continuous.

Woody Vegetation Plants which have concentrations of lignin in cells of stems and branches. Examples include species of shrubs and trees.

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Appendix A Stipulation for Withdrawal of Protests

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STIPULATION FOR WITHDRAWAL OF PROTESTS

This Stipulation is made and entered into on this 7th day of January, 2008 between the Southern Nevada Water Authority ("SNWA") and the United States Department of the Interior on behalf of the Bureau of Indian Affairs, the Bureau of Land Management, the National Park Service, and the Fish and Wildlife Service (collectively the "DOI Bureaus"). Collectively, SNWA and each of the DOI Bureaus are referred to as the "Parties."

RECITALS

A. In October 1989, the Las Vegas Valley Water District (SNWA's predecessor-in-interest) filed Applications 53987 through 53992, inclusive, (hereinafter referred to as the "SNWA Applications") for a combined 48 cubic feet per second ("cfs") of groundwater withdrawals in the Delamar, Dry Lake and Cave Valley Hydrographic Basins ("the Hydrographic Basins"). SNWA intends to pump up to 34,752 acre-feet of groundwater annually from the Hydrographic Basins for municipal purposes with concurrent monitoring, management, and mitigation as specified in Exhibit A to this Stipulation. In the future, SNWA may seek to change the points of diversion within the Hydrographic Basins for any quantities of groundwater permitted pursuant to the SNWA Applications.

B. The DOI Bureaus filed timely protests to the granting of the SNWA Applications pursuant to the DOI Bureaus' responsibilities to protect their state and federal water rights ("Federal Water Rights") and other water-dependent resources ("Federal Resources") of the DOI Bureaus in 1) the Hydrographic Basins; 2) that portion of the Whiter River Valley Hydrographic Basin that is south of Hardy Springs; and 3) the Pahranagat Valley Hydrographic Basin, including the Pahranagat National Wildlife Refuge ("Area of Interest") (depicted in Figure 1). The DOI Bureaus are required by law to manage, protect, and preserve all Federal Water Rights and Federal Resources that fall under their jurisdiction. A number of these Federal Water Rights and Federal Resources occur within the Area of Interest. As of the date of this Stipulation, those Federal Water Rights that are based upon the application of federal law have not been quantified pursuant to an adjudication that complies with the requirements of the McCarran Amendment, 43 U.S.C. § 666. SNWA expressly reserves the right to contest any and all claims of the DOI Bureaus to such Federal Water Rights as are based upon the application of federal law in any proceeding that conforms to the requirements of the McCarran Amendment, 43 U.S.C. § 666.

C. The DOI Bureaus are concerned that the proposed groundwater withdrawals from the Hydrographic Basins may injure Federal Water Rights and/or affect Federal Resources in the Area of Interest and certain other areas outside the Area of Interest, and are desirous of working in a cooperative manner with the SNWA to protect these Federal Water Rights and Federal Resources.

D. On September 8, 2006, the Parties entered into a Stipulation for the Withdrawal of Protests related to Applications 54003 through 54021 for the appropriation of Nevada state groundwater from the Spring Valley Hydrographic Basin ("Spring Valley Stipulation"). The Spring Valley Stipulation established a number of cooperative processes among the Parties for the management of SNWA's groundwater development project in Spring Valley. Rather than duplicate the processes established by the Spring Valley Stipulation, the Parties desire to expand certain of the processes, as contained in Exhibit A to this Stipulation, to efficiently accommodate an agreed upon Hydrologic Monitoring, Management and Mitigation Plan for SNWA groundwater development within the Delamar, Dry Lake and Cave Valleys Hydrographic Basins.

E. The Parties acknowledge that pursuant to Nevada Revised Statutes (NRS) 534.110(4), Nevada Water Law provides that "[i]t is a condition of each appropriation of groundwater acquired under this chapter [534] that the right of the appropriator relates to a specific quantity of water and that the right must allow for a reasonable lowering of the static water level at the appropriator's point of diversion." Further, pursuant to NRS 534.110(5), Nevada Water Law "does not prevent the granting of permits to applicants later in time on the ground that the diversions under the proposed later appropriations may cause the water level to be lowered at the point of diversion of a prior appropriator, so long as the rights of holders of existing appropriations can be satisfied under such express conditions." It is the intent of the Parties that this Stipulation provides the initial "express conditions" to allow development of the SNWA Applications to proceed; however, such future conditions may be adjusted based on implementation of the monitoring, management, and mitigation plans specified in Exhibit A, which are attached to this Stipulation and made a part hereof.

F. The State Engineer has set an administrative hearing on the protests of the DOI Bureaus and other protestants to the SNWA Applications commencing February 4, 2008.

G. The Parties acknowledge that other entities and individuals have lodged protests to the SNWA Applications, but such additional protestants are not Parties to or in any way bound or prejudiced by this Stipulation. Further, these protestants may enter into stipulations with SNWA concerning the SNWA Applications. Such stipulations shall not require the participation of the DOI Bureaus nor modify in any way the intent or content of this Stipulation, nor shall the DOI Bureaus be bound or prejudiced by such stipulations.

H. The Common Goal of the Parties, as expressed in Exhibit A to this Stipulation, is to manage the development of groundwater by SNWA in the Hydrographic Basins without causing injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in the Hydrographic Basins. The Parties agree that the preferred conceptual approach for protecting Federal Water Rights from injury and Federal Resources and Special Status Species from unreasonable adverse effects within the Area of Interest that may be caused by groundwater withdrawals by SNWA in the Hydrographic Basins is through the development of such groundwater in conjunction with the implementation of the monitoring, management, and mitigation plans described in Exhibit A. The effects of groundwater withdrawals pursuant to the development of any or all of the SNWA Applications and any future changes in points of diversion and/or rates of withdrawal need to be properly monitored and managed to avoid any injury to Federal Water Rights and unreasonable adverse effects to Federal Resources and Special Status Species within the Area of Interest. There is a need to better understand the response of the aquifers and associated discharge points, such as artesian wells, springs, streams, wetlands, and playas, to pumping stresses from development of permitted quantities of groundwater in accordance with the monitoring, management, and mitigation plans set forth in Exhibit A to this Stipulation.

I. The Parties have determined that it is in their best interests to cooperate in the collection and analysis of additional hydrologic, hydrogeologic, water chemistry, and biological information.

J. The Parties desire to resolve the issues raised by the DOI Bureaus' protests according to the terms and conditions contained herein.

NOW, THEREFORE, in consideration of the mutual promises and covenants contained herein, the Parties do agree as follows:

1. **Intent of the Parties.** SNWA and the DOI Bureaus have entered into various stipulations and memorandums of agreement, and anticipate similar future agreements that outline activities to cooperate and collaborate to monitor, manage, and mitigate potential impacts from SNWA's development of various permits to appropriate groundwater in eastern and central Nevada. It is the intent of the Parties to integrate the various activities outlined in these existing and future stipulations and agreements into an overall process that will evaluate the cumulative effects of SNWA's groundwater development projects utilizing technical tools such as a transient groundwater flow model that has been calibrated and validated as a tool to predict future impacts. This process will outline how the Parties incorporate ongoing and future data collected into the transient groundwater flow model and use this tool and process to help SNWA make management decisions regarding the operation of the groundwater development projects based on the projected potential impacts to the groundwater and surface water systems. The process will also allow the Parties to refine the ongoing monitoring, management and mitigation plans. Therefore, no later than March 31, 2009, the Parties agree to negotiate a separate memorandum of understanding that will provide for such a process.

2. The DOI Bureaus hereby expressly agree to withdraw their protests to the SNWA Applications and agree that the Nevada State Engineer may rule on the SNWA Applications based upon the terms and conditions set forth herein. It is expressly understood that this Stipulation is binding only upon the Parties hereto and their successors, transferees and assignees, and shall not bind or seek to bind or prejudice any other parties or protestants, including any Indian Tribe.

3. Other entities with groundwater applications in and around the Hydrographic Basins may be invited to participate in the cooperative processes described in Exhibit A upon mutual written agreement between the Parties.

4. SNWA may seek to change the points of diversion and rates of withdrawal within the Hydrographic Basins for any quantities of groundwater permitted pursuant to the SNWA Applications. Prior to filing such change applications, SNWA shall consult with the TRP and the BRT about the potential effects of any proposed changes on Federal Water Rights, Federal Resources, and Special Status Species. If the consensus of the TRP and the BRT is that the proposed change(s) will not increase the risk of injury to Federal Water Rights and/or increase the risk of unreasonable adverse effects to Federal Resources and/or Special Status Species, then the TRP and the BRT will recommend to the Executive Committee that protests not be filed by the DOI Bureaus to the proposed change(s). If there is no such consensus between the TRP and the BRT, or within the Executive Committee, then the DOI Bureaus shall be free to file such protests as they deem necessary.

5. This Stipulation does not waive any authorities of the DOI Bureaus or the United States, including any other agency or bureau not specified in this Stipulation. Further, this Stipulation does not override or relieve the Parties from complying with applicable federal laws, including, but not limited to, the National Environmental Policy Act, the Endangered Species Act, the Federal Land Policy and Management Act, and any and all rules and regulations thereunder.

6. It is the expressed intention of the Parties that by entering into this Stipulation, the DOI Bureaus, the United States, and SNWA are not waiving legal rights of any kind, except as

expressly provided herein. Nor is this Stipulation intended to modify any legal standard by which Federal Water Rights or Federal Resources are protected.

7. The Parties expressly acknowledge that the Nevada State Engineer has, pursuant to both statutory and case law, broad authority to administer groundwater resources in the State of Nevada and, furthermore, that nothing contained in this Stipulation shall be construed as waiving or in any manner diminishing such authority.

8. The DOI Bureaus agree not to file rebuttal evidence with the State Engineer in response to the first evidentiary exchange for the hearings scheduled to begin February 4, 2008. The Parties agree that a copy of this Stipulation shall be submitted to the Nevada State Engineer at the commencement of the administrative proceedings scheduled to begin on February 4, 2008. At that time, the Parties shall request on the record at the beginning of the scheduled proceeding that the State Engineer include this Stipulation and Exhibit A as part of the permit terms and conditions in the event that he grants any of the SNWA Applications in total or in part. Following the submission of this Stipulation and Exhibit A to the State Engineer, then the DOI Bureaus, at their option, may attend the hearing, but shall not present a case, witnesses, exhibits, or statements, nor cross-examine any witnesses, nor assist any other party or protestant in presenting a case, witnesses, exhibits, statements, or cross examination.

9. SNWA shall submit a copy of this Stipulation and Exhibit A to the Bureau of Land Management and request that it be included in any Environmental Impact Statement prepared for the "Clark/Lincoln/White Pine Counties Groundwater Development Project," or any other project related to the development of the SNWA Applications.

10. Any notice given under this Stipulation shall be deemed properly given when actually received or three (3) days after such notice was deposited in the United States Mail, certified or registered, return receipt requested, postage prepaid, addressed as follows:

If to DOI Bureaus:

Regional Director
Western Regional Office
Bureau of Indian Affairs
400 North 5th Street
Phoenix, AZ 85004

State Director
Nevada State Office
Bureau of Land Management
1340 Financial Blvd.
Reno, NV 89502

Field Supervisor
Nevada Field Office
Fish and Wildlife Service
1340 Financial Blvd., #234
Reno, NV 89502

Branch Chief
Water Rights Branch
National Park Service
1201 Oak Ridge Drive, Suite 250
Fort Collins, CO 80525

If to SNWA:

General Manager
Southern Nevada Water Authority
1001 S. Valley View Blvd
Las Vegas, NV 89153

11. Any Party hereto may transfer or assign its interest, if any, in the water rights here involved, without prior notice or permission from any of the other Parties. Any and all transferees and assignees shall be bound by the terms and conditions of this Stipulation. As a condition to any such transfer or assignment, the transferee and/or assignee shall

execute a stipulation expressly stating it is bound to all of the terms and conditions of this Stipulation.

12. This Stipulation shall be governed in accordance with the laws of the State of Nevada to the extent not inconsistent with federal law.

13. It is the intent of the Parties hereto that the Nevada State Engineer shall be kept informed of all activities and data gathered pursuant to this Stipulation in the same fashion as are the Parties hereto; however, the Executive Committee (described in Exhibit A), in consultation with the Nevada State Engineer, may specify the types of data and documents that shall be submitted to the Nevada State Engineer.

14. By entering into this Stipulation, the DOI Bureaus do not become a party to any proceeding other than the protest proceeding referenced above nor waive their immunity from suit nor consent to or acknowledge the jurisdiction of any court or tribunal. Nothing in the Stipulation shall affect any federal reserved water rights of the DOI Bureaus or the United States on behalf of any Indian Tribe and the DOI Bureaus by entering into this Stipulation do not waive or prejudice any such rights. The DOI Bureaus reserve all legal rights, of any kind, they possess pursuant to or derived from Executive Orders, acts of Congress, judicial decisions, or regulations promulgated pursuant thereto. The Parties do not waive their rights to seek relief in any appropriate forum not expressly prohibited by this Stipulation.

15. Any commitment of funding by the DOI Bureaus or the SNWA in this Stipulation, including specifically any monitoring, management, and mitigation actions provided for in Exhibit A is subject to appropriations by Congress or the governing body of the SNWA as appropriate.

16. No Party shall be considered to be in default in the performance of any of its obligations under this Stipulation when a failure of performance shall be due to an uncontrollable force, including but not limited to, denial of access to private property, denial of right-of-way permits, facilities failure, flood, earthquake, storm, lightning, fire, labor disturbance, sabotage and/or restraint by court or public authority. A Party rendered unable to fulfill any of its obligations under this Stipulation by reason of an uncontrollable force shall give prompt written notice of such act to the other Parties. The Parties shall meet and confer to determine if the affected performance can be completed by other means and to address future performance under this Stipulation that may be affected by such uncontrollable force in an attempt to obtain the Parties' full performance under this Stipulation.

17. This Stipulation may only be amended by mutual written agreement of the Parties. Other entities may become parties to this Stipulation by amending this Stipulation in writing.

18. This Stipulation sets forth the entire agreement of the Parties and supercedes all prior discussions, negotiations, understandings or agreements regarding the subject matter of this Stipulation. No alteration or variation of this Stipulation shall be valid or binding unless contained in a written amendment in accordance with Paragraph 17 of this Stipulation.

19. This Stipulation is entered into for the purpose of resolving a disputed claim and establishing the monitoring, management, and mitigation plans contained in Exhibit A. Except as expressly provided herein, the Parties agree that the Stipulation shall not be offered as evidence or treated as an admission regarding any matter herein and may not be used in proceedings on any other application or protest whatsoever, except that the Stipulation may be used in any future proceeding to interpret and/or enforce its terms.

Further, the Parties agree that neither the Stipulation nor any of its terms shall be used to establish precedent with respect to any other application or protest in any water rights adjudication or water rights permitting proceeding, including but not limited to any hearing regarding the SNWA applications to appropriate groundwater in the Snake Valley Hydrographic Basin, before the Nevada State Engineer or in any other administrative or judicial proceeding.

20. The terms and conditions of this Stipulation shall be binding upon and inure to the benefit of the Parties hereto and their respective agents, officers, employees, personal representatives, successors, transferees and assigns. This Agreement is for the sole benefit of the Parties and does not create any right or benefit, substantive or procedural, enforceable by any third parties.

21. Each Party agrees to bear its own costs and attorney fees.

22. This Stipulation shall become effective as between the Parties upon all Parties signing this Stipulation. The Parties may execute this Stipulation in two or more counterparts, which shall, in the aggregate, be signed by all Parties; each counterpart shall be deemed an original as against any Party who has signed it.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement which is effective as of the date first written above.

Date: JAN 07 2008

UNITED STATES DEPARTMENT OF THE INTERIOR

Bureau of Indian Affairs

By: ______________________
Regional Director

Title: ______________________

Date: January 3, 2008

UNITED STATES DEPARTMENT OF THE INTERIOR

Bureau of Land Management

By Ron Wenker

Title: Nevada State Director

Date: JAN 0 2 2007

UNITED STATES DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

By [signature]

Title: Regional Director, Region 8

Date: 1/07/2008

UNITED STATES DEPARTMENT OF THE INTERIOR

National Park Service

By [signature]

Title: Regional Director, PWR

Date: 12-21-07

SOUTHERN NEVADA WATER AUTHORITY

P Mulroy

Patricia Mulroy, General Manager

Approved as to form:

Dana Smith

Dana R. Smith, Deputy Counsel

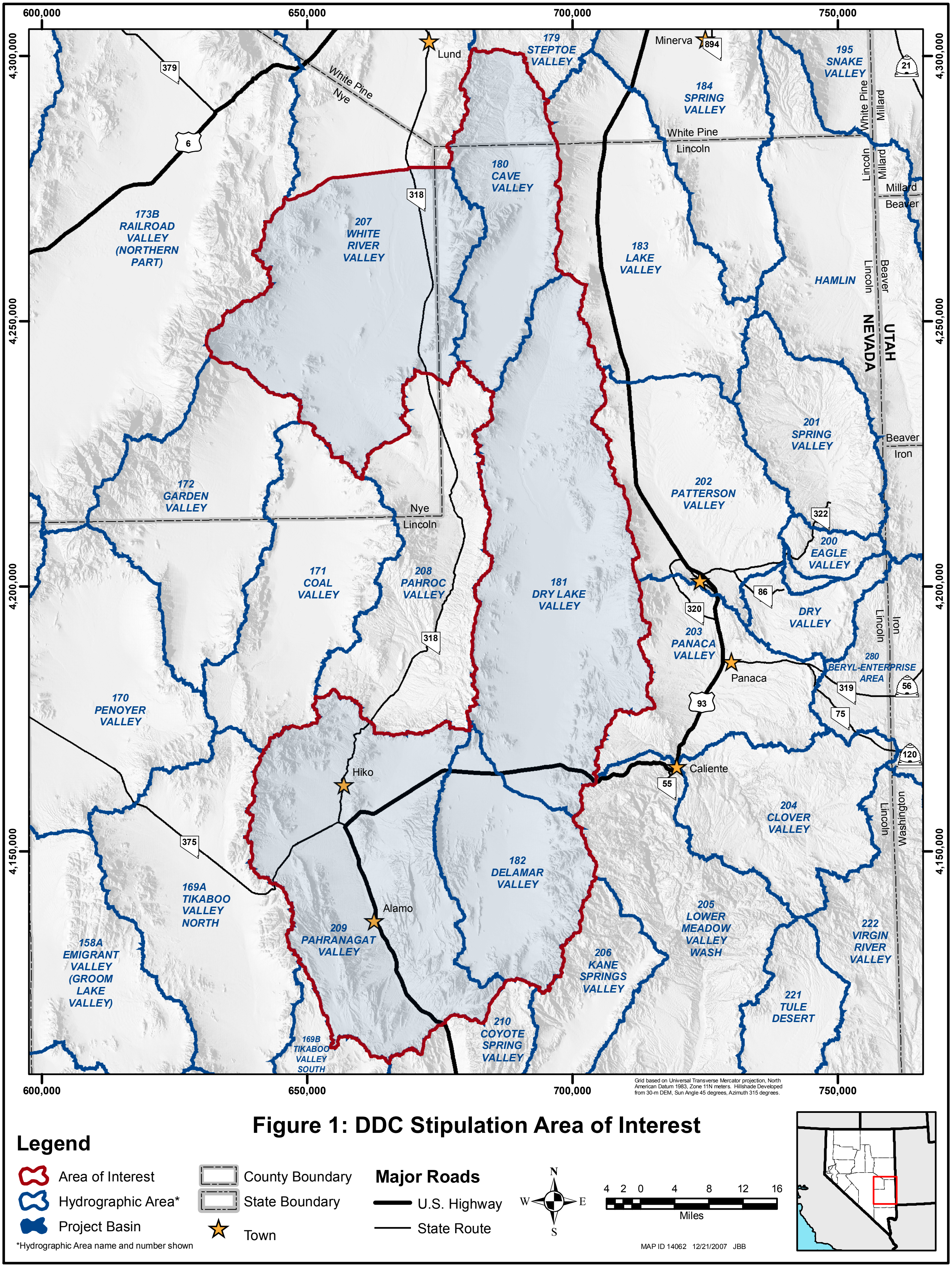

Figure 1: DDC Stipulation Area of Interest

EXHIBIT A

HYDROLOGIC AND BIOLOGICAL MONITORING, MANAGEMENT AND MITIGATION PLAN FOR DEVELOPMENT OF GROUNDWATER IN THE DELAMAR, DRY LAKE AND CAVE VALLEY HYDROGRAPHIC BASINS PURSUANT TO APPLICATION NOS. 53987 THROUGH 53992 BY THE SOUTHERN NEVADA WATER AUTHORITY

1. Introduction

This hydrologic monitoring, management and mitigation plan ("Plan") is a component of a Stipulation between the Southern Nevada Water Authority (hereinafter referred to as "SNWA") and the U.S. Department of the Interior bureaus, including the Bureau of Indian Affairs, the Bureau of Land Management, the Fish and Wildlife Service, and the National Park Service (hereinafter referred to as the "DOI Bureaus"). Collectively, SNWA and each of the DOI Bureaus are hereinafter referred to as the "Parties." Unless otherwise specifically defined in this Exhibit A, all defined terms used in this Exhibit A shall have the same definition that appears in the Stipulation to which this Exhibit A is attached.

This Plan describes the Parties' obligations regarding the development, monitoring, management, and mitigation related to SNWA's applications 53987 through 53992 to withdraw groundwater from points of diversion in the Delamar, Dry Lake, and Cave Valley Hydrographic Basins (hereinafter referred to as the "Hydrographic Basins"). The Plan consists of three principal components:

> *Monitoring Requirements* - including, but not limited to, existing wells, new monitoring wells, water chemistry analyses, spring discharge measurements, quality control procedures, and reporting requirements;
>
> *Management Requirements* – including, but not limited to, creation of a Biologic Resources Team ("BRT") to review biological information collected pursuant to this Plan and advise the Executive Committee (established pursuant to Paragraph 3(B) of Exhibit A of the Spring Valley Stipulation); the expansion of the duties of the Technical Review Panel ("TRP") (established pursuant to Paragraph 3(C) of Exhibit A of the Spring Valley Stipulation) to review information collected under this Plan and advise the Executive Committee; the use of an agreed upon transient groundwater flow system numerical model to help predict effects of groundwater withdrawals by SNWA in the Hydrographic Basins; and the use of the consensus-based decision making process established in the Spring Valley Stipulation as set forth in Appendix A to this Exhibit A; and,
>
> *Mitigation Requirements* – including, but not limited to the: (1) modification**,** relocation or reduction in points of diversion and/or rates and quantities of groundwater withdrawals, the augmentation of Federal Water Rights, Federal

Resources, and/or Water Dependent Ecosystems; (2) acquisition of real property and/or water rights dedicated to the protection of Special Status Species; and (3) measures designed and calculated to rehabilitate, repair or replace any and all Federal Water Rights, Federal Resources and Water Dependent Ecosystems if necessary to achieve the Common Goals set forth in Paragraph 1.A. of this Exhibit A.

For purposes of this Exhibit A, "Area of Interest" shall consist of 1) the Hydrographic Basins, 2) that portion of the White River Valley Hydrographic Basin that is south of Hardy Springs, and 3) the Pahranagat Valley Hydrographic Basin, including the Pahranagat National Wildlife Refuge. The term "Special Status Species" is defined in Paragraph V.F. of this Exhibit A. The terms "Federal Water Rights" and "Federal Resources" as used in this Exhibit A shall have the same definition as in the Stipulation to which this Exhibit A is attached. The term "Water Dependent Ecosystem" is defined in Paragraph V.F. of this Exhibit A.

A. Common Goals

The Common Goals of the Parties are to manage the development of any water rights permitted to SNWA by the Nevada State Engineer in the Hydrographic Basins without causing: 1) any injury to the Federal Water Rights; and 2) any unreasonable adverse effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in the Hydrographic Basins ("Common Goals"). These Common Goals include taking actions that protect and recover those Special Status Species that are currently listed pursuant to the Endangered Species Act and avoid listing of currently non-listed Special Status Species. To accomplish these goals, the Parties will strive to improve existing Water Dependent Ecosystems within the Area of Interest for habitat areas that are within the current and historic habitat range of each of the Special Status Species. Such actions should be focused on habitat within the hydrographic basin(s) that is most likely to be affected by hydrologic changes that may result from SNWA groundwater withdrawals in the Hydrographic Basins.

To accomplish the Common Goals, the Parties agree that once the TRP has determined that an agreed-upon transient regional groundwater flow model has been adequately calibrated and validated by actual field measurements, it will be used as one tool to give an early warning of possible injury to Federal Water Rights or unreasonable adverse effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in the Hydrographic Basins. It is the intent of the Parties to take actions as provided for in this Exhibit A to the extent possible to prevent injury to Federal Water Rights or unreasonable adverse effects to Federal Resources and Special Status Species within the Area of Interest as a result of groundwater withdrawals by SNWA in the Hydrographic Basins.

Actions that SNWA may take in order to offset any unreasonable adverse effect to Federal Resources and/or Special Status Species within the Area of Interest or any injury to Federal Water Rights include, but are not necessarily limited to:

1. Reduction or cessation of groundwater withdrawals within the Hydrographic Basins;

2. Geographic redistribution of pumping within the Hydrographic Basins;

3. Acquisition of real property and/or water rights dedicated to the recovery of Special Status Species within the current and historic habitat range of each of the Special Status Species. The Parties anticipate that such acquisition of real property and/or water rights may be accomplished prospectively in order to offset future impacts, also known as mitigation banking. Such mitigation banking measures will be recommended by the BRT in advance of actual acquisition and/or dedication of real property and/or water rights and will be measured against existing baseline habitat conditions;

4. Augmentation of Federal Water Rights, Federal Resources, and/or Water Dependent Ecosystems;

5. Provision of resources to restore and enhance habitat on the Pahranagat National Wildlife Refuge; and

6. Other measures as agreed to by the Parties and/or required by the State Engineer that are consistent with this Stipulation.

The actions taken will be those which will best accomplish the Common Goals. Other Parties may also take actions, including but not limited to those listed above, to offset unreasonable adverse effects either individually or in coordination with SNWA.

2. <u>Monitoring Requirements</u>

I. GENERAL

The parties recognize that the establishment of accurate early-warning indicators and specific mitigation actions that are necessary to meet the Common Goals is difficult until monitoring data are developed prior to groundwater withdrawals by SNWA in the Hydrographic Basins. Additionally, the Parties recognize that additional monitoring data developed during groundwater withdrawals by SNWA in the Hydrographic Basins will further inform the development of early-warning indicators and specific mitigation actions. Data collected pre- and post- groundwater withdrawals shall be used to design and calibrate an agreed upon transient regional groundwater flow model that may assist in predicting actual pumping effects and changes caused by groundwater withdrawals by SNWA in the Hydrographic Basins.

The Parties agree that monitoring is necessary to accomplish the Common Goals and agree to cooperatively implement a monitoring plan sufficient to collect and analyze data to assess the effects, if any, from SNWA's proposed groundwater withdrawals in the Hydrographic Basins on Federal Water Rights, Federal Resources and Special Status Species in the Area of Interest. The monitoring network shall be comprised of existing SNWA wells, SNWA exploratory wells, SNWA production wells, new monitoring wells, existing monitoring wells, and spring discharge sites. These monitoring sites shall be selected by the TRP ("Monitoring Network").

Some wells in the Monitoring Network will be selected by the TRP to help characterize the movement of groundwater from the Hydrographic Basins to the White River, Pahroc, and

Pahranagat Valley Hydrographic Basins to the west ("Adjacent Hydrographic Basins"). Other wells in the Monitoring Network shall be located throughout the Hydrographic Basins and Adjacent Hydrographic Basins to provide early warning of the spread, if any, of drawdown toward Federal Water Rights and Federal Resources as well as data for future groundwater model calibration. Shallow piezometers and wells may be used to evaluate the effects of groundwater withdrawals near discharge areas as listed below in Paragraph 2.II.C.

To ensure baseline aquifer conditions are established, SNWA shall ensure that at least five (5) years of monitoring data exists for wells or spring discharge sites that are currently being monitored within the Monitoring Network as of the date of execution of this Stipulation prior to any groundwater withdrawals, other than for aquifer tests and construction. Pursuant to funding agreements with non-Parties, SNWA has already collected extensive monitoring data from existing monitoring wells. The Parties agree that this data shall be used by the TRP as part of baseline data collection.

The Parties recognize that substantial baseline hydrologic data for the Hydrographic Basins and Adjacent Hydrographic Basins is being collected as part of the BLM's ongoing compliance with the National Environmental Policy Act for SNWA's Clark, Lincoln, and White Pine County Groundwater Development Project ("EIS Process"). Each Party agrees to submit baseline hydrologic data collected by that Party in the Hydrographic Basins and Adjacent Hydrographic Basins for inclusion in the EIS Process. The Parties also recognize the need for continued baseline hydrologic data collection between issuance of the Final Environmental Impact Statement and the commencement of groundwater withdrawals by SNWA in the Hydrographic Basins. Therefore, baseline data will continue to be collected in the Hydrographic Basins and the Adjacent Hydrographic Basins in order to keep the data compiled in the Final Environmental Impact Statement current up to the commencement of groundwater withdrawals by SNWA in the Hydrographic Basins.

SNWA shall monitor all new wells in the Monitoring Network at least two (2) years prior to any groundwater withdrawals, other than for aquifer tests and construction. SNWA shall ensure that at least two (2) years of monitoring is done for the new spring discharge sites in the Monitoring Network before SNWA groundwater withdrawals, other than for aquifer tests and construction.

Notwithstanding anything to the contrary contained in this Stipulation or this Exhibit A, SNWA shall use its best efforts to complete baseline monitoring within these time frames. However, in the event SNWA is unable to perform the monitoring requirements set forth in this Exhibit A due to circumstances beyond SNWA's control, including but not limited to delays related to construction, private property access issues or other delays, then SNWA reserves the right to develop any water rights granted to SNWA by the Nevada State Engineer in accordance with Nevada water law and this Exhibit A.

The cost of the monitoring plan shall be borne primarily by SNWA. The DOI Bureaus shall provide staffing to the TRP and shall jointly seek funding through the TRP to contribute to monitoring efforts. Any funding requests for studies within the Area of Interest submitted through the Southern Nevada Public Lands Management Act shall be coordinated through the TRP, or BRT as appropriate. Except as otherwise provided in this Plan, each DOI Bureau is responsible for monitoring its own Federal Water Rights and Federal Resources, and for sharing this information with the other Parties within 90 days of its collection.

Any requirement for SNWA to continuously monitor wells, piezometers, and surface water sites pursuant to the Plan shall require SNWA to install all equipment necessary to continuously record discharge and/or water levels at all monitoring sites and shall, unless prevented by circumstances beyond its control, ensure that all such discharge and/or water level data is recorded on a continuous basis.

SNWA shall record discharge and water levels in all SNWA production wells within the Hydrographic Basins on a continuous basis.

Modification of the monitoring requirements in this Plan, including any addition, subtraction or replacement of the wells initially selected by the TRP or the frequency of monitoring for these wells may be made through consensus recommendations from the TRP as set forth in Appendix A of this Exhibit A.

II. HYDROLOGIC MONITORING

A. Existing Monitoring Wells

Pursuant to funding agreements with non-Parties, SNWA has collected extensive monitoring data from existing monitoring wells. The Parties agree that this data shall be used by the TRP as part of baseline data collection. Because the list of wells monitored under these funding agreements has changed over time, SNWA agrees to ensure continued monitoring of certain existing wells selected by the TRP pursuant to this Paragraph. SNWA shall monitor groundwater levels quarterly in a total of nine (9) existing monitoring wells and continuously in a total of six (6) existing monitoring wells in the Hydrographic Basins and Adjacent Hydrographic Basins, for a total of fifteen (15) existing wells to be monitored. These wells shall be selected by the TRP. The wells may be selected to provide early warning of the spread of drawdown toward Federal Water Rights and Federal Resources and obtain hydrologic information throughout the Hydrographic Basins and Adjacent Hydrographic Basins in order to produce annual groundwater level contour and water level change maps, calibrate the transient groundwater flow model, and evaluate the effects, if any, of SNWA's groundwater withdrawals within the Hydrographic Basins.

B. New Monitoring Wells

The DOI Bureaus agree to expedite NEPA and other permitting clearances, within the limits of applicable laws, to help meet the monitoring requirements of this Plan. The construction of the new monitoring wells is contingent upon accessibility and issuance of appropriate rights-of-way by various Federal and State agencies.

SNWA shall record water level data continuously at all new monitoring wells upon their completion, contingent upon accessibility and issuance of appropriate rights-of-way by various Federal and State agencies. SNWA shall purchase and install all necessary water-level measuring equipment.

SNWA shall make the new monitoring wells available to the DOI Bureaus for additional data collection.

SNWA shall construct and equip four (4) new monitoring wells in or around the Hydrographic Basins and Adjacent Hydrographic Basins that must be dedicated to long-term monitoring. The location of these new monitoring wells shall be selected in order to provide early warning of the spread of drawdown toward Federal Water Rights and Federal Resources; to help characterize interbasin groundwater flow between the Hydrographic Basins and the Adjacent Hydrographic Basins; and/or to help further the understanding of the relationship between the alluvial and bedrock aquifers. SNWA may substitute existing monitoring wells for some or all of the monitoring wells required to be constructed pursuant to this Paragraph, if agreed upon by the TRP. In order to install these new wells in a timely manner, within one (1) year after execution of this Stipulation the TRP shall select the location for these new wells. If the TRP has not selected the location for the new monitoring wells within one (1) year after execution of this Stipulation, SNWA shall select the location of these new wells and shall provide notice to the TRP of its selections.

C. Spring Discharge Measurements

Pursuant to a funding agreement with non-Parties, SNWA has collected extensive monitoring data from the existing spring discharge monitoring sites listed in Subsection (i) below. The Parties agree that this data shall be used by the TRP as part of baseline data collection. Because the list of spring discharge sites that are monitored under this funding agreement has changed over time, in the event that this funding agreement changes, terminates or expires, SNWA agrees to ensure continued monitoring of certain existing spring discharge sites selected by the TRP pursuant to this Paragraph.

The springs listed in Subsection (*i*) below are currently monitored through a funding agreement between SNWA, the Nevada Division of Water Resources, and the U.S. Geological Survey (USGS). SNWA shall make all data gathered pursuant to this funding agreement available to all Parties and shall include this data in baseline conditions. In the event this funding agreement changes, terminates or expires, the TRP, in coordination with the BRT, shall determine which sites are to be included in the Monitoring Network. The basis for the selection of any site and the total number of sites selected shall be to meet the Common Goals of this Plan. The TRP shall determine the method of spring discharge measurement and shall carefully consider the use of shallow wells to avoid damage to sensitive areas. In the event the funding agreement changes, terminates or expires, SNWA agrees to continue monitoring the springs selected by the TRP either directly or through funding of a third party. For those springs located on private land, SNWA shall use its best efforts to gain access for monitoring, but SNWA shall not be responsible for monitoring on private land to which it cannot gain access.

(i). Spring Discharge Measurements within Adjacent Hydrographic Basins that are Currently Being Monitored

Spring	*Owner*	*Measured By*	*Frequency*	*Location*
Flag Springs (3) Complex	NDOW	USGS	Biannual	WR
Hot Creek Spring	NDOW	USGS	Continuous	WR
Moorman Spring	Private	USGS	Biannual	WR
Ash Springs	BLM/Private	USGS	Continuous	Pah
Crystal Spring	Private	USGS	Continuous	Pah

*NDOW= Nevada Department of Wildlife; WR= White River Valley Hydrographic Basin; Pah= Pahranagat Valley Hydrographic Basin

Due to the modified nature of the spring discharge sites listed in Subsection (*ii*) below, the TRP shall determine whether monitoring of these springs can be accomplished in a manner such that the data collected is representative of actual hydrologic conditions, and if so, the TRP shall select which sites in Subsection (*ii*) to include in the Monitoring Network. SNWA shall ensure biannual monitoring of the sites in Subsection (*ii*) selected by the TRP either directly or through funding of a third party, but SNWA shall not be responsible for monitoring on private land to which it cannot gain access.

(ii). Spring Discharge Sites to be Evaluated for Monitoring by TRP

Spring	*Owner*	*Measured By*	*Frequency*	*Location*
Hiko Spring	Private	--	--	Pah
Maynard Spring	BLM	--	--	Pah
Hardy Springs (5) Complex	Private		--	WR

(iii). Cottonwood Spring

The U.S. Fish and Wildlife Service (USFWS) currently measures spring discharge at Cottonwood Spring on the Pahranagat National Wildlife Refuge and agrees to provide data from this site to all Parties.

(iv). Spring Discharge Measurements within the Hydrographic Basins

In addition, the TRP may identify a total of up to 8 springs to be monitored biannually within the Hydrographic Basins in which SNWA production wells are to be located, but SNWA shall not be responsible for monitoring on private land to which it cannot gain access. The springs selected by the TRP pursuant to this Subsection (*iv*) need not be evenly distributed throughout each of the Hydrographic Basins.

D. Aquifer Tests

An understanding of aquifer properties is necessary in order to make predictions regarding changes in groundwater levels and flows and facilitate the modeling of the groundwater flow systems. Furthermore, aquifer tests are needed to help determine such aquifer properties. As such, aquifer tests shall be performed. A well step drawdown test and 72 hour constant rate aquifer test shall be performed on all test wells and SNWA shall share the data from these tests with the TRP.

E. Water Chemistry Sampling Program

SNWA has extensive water chemistry data collected from existing monitoring wells and spring discharge sites. The Parties agree that this existing water chemistry data shall be included in baseline data and may be substituted for the sampling required pursuant to this Paragraph where such data exists. The TRP shall select 10 sites from the Monitoring Network for water chemistry sampling, excluding SNWA exploratory and production wells. These sites shall be sampled two (2) times at six (6)-month intervals pursuant to a schedule determined by the TRP, but completed by no later than three (3) years from the date of the execution of the Stipulation, unless prevented by circumstances beyond SNWA’s control. After this first round of sampling the TRP shall review these data to determine if water chemistry parameters in Table 1 need to be modified. Future sampling will use the TRP-revised list of water chemistry parameters. Thereafter, sampling of the selected sites identified in the Monitoring Network shall be conducted once every five (5) years following the start of groundwater withdrawals by SNWA, other than for aquifer tests and construction, unless prevented by circumstances beyond SNWA's control. The TRP, in consultation with the BRT, may change any aspect of this water chemistry sampling program, including but not limited to the addition and/or deletion of sampling sites, the addition and/or deletion of water chemistry parameters, and an increase or decrease in sampling frequency, if deemed appropriate by the TRP. SNWA may subcontract this obligation to a third party.

Table 1 - Water Chemistry Parameters

Field Parameters	**Major Ions**	**Isotopes**	**Minor and Trace Elements**
Water temperature	TDS	Oxygen-18	Arsenic
Air temperature	Calcium	Deuterium	Barium
pH	Sodium	Tritium	Cadmium
Electrical conductivity	Potassium	Chlorine-36*	Chromium
Dissolved oxygen	Chloride	Carbon-14*	Lead
	Bromide	Carbon-13*	Mercury
	Fluoride	Strontium-87*	Selenium
	Nitrate	Uranium-238*	Silver
	Phosphate		Manganese
	Sulfate		Aluminum
	Alkalinity		Iron
	Silica		Bromide
	Magnesium		Fluoride

*These parameters shall be included only in the first sampling event, and shall not be included in any further water chemistry sampling performed pursuant to this Exhibit.

All analyses shall be conducted and reported in accordance with standard Environmental Protection Agency (EPA) listed methods.

F. Precipitation Stations

The coverage of existing precipitation stations shall be reviewed by the TRP, and, if necessary, the TRP may recommend that additional precipitation stations be established. SNWA shall fund the construction, operation, and maintenance of any such additional stations.

G. Elevation Control

SNWA shall conduct a detailed elevation survey of all production wells and wells within the Monitoring Network.

H. Quality of Data

SNWA and the DOI Bureaus shall ensure that all measurement and data collection is done based on USGS established protocols, unless otherwise agreed upon by the TRP.

III. BIOLOGICAL MONITORING

A. General

Biological monitoring shall be conducted only to further the Common Goals and shall be focused on Special Status Species and their habitats within the Area of Interest that are most likely to be affected by any hydrologic changes that may result from SNWA's groundwater withdrawals in the Hydrographic Basins. The areas that are most likely to be affected by any hydrologic changes that may result from SNWA's groundwater withdrawals in the Hydrographic Basins shall be determined by the TRP. Biological monitoring will be developed and implemented by the Biologic Resources Team (defined in Paragraph V.F, "BRT") in coordination with the Nevada Department of Wildlife (NDOW). Other technical advisors may be consulted as deemed necessary by the BRT. The BRT will coordinate its monitoring effort with the Recovery Implementation Teams for Pahranagat and White River Valleys.

Biological monitoring may include these areas within the Hydrographic Basins, but only to the extent that access can be obtained:

1. Biological monitoring of valley floor and range-front springs where Special Status Species occur, to the extent that access can be obtained. The Parties will work to gain access to these areas to the maximum extent possible;
2. Monitoring of Water Dependent Ecosystems on the valley floors, to the extent that these exist;
3. Monitoring of sage grouse breeding/late brood-rearing habitat that is groundwater dependent.

Biological monitoring may include these areas within the Adjacent Hydrographic Basins, but only to the extent that access can be obtained:

4. Monitoring of selected areas to be determined by the BRT in consultation with the TRP, for those Special Status Species and their habitats that are most likely to be affected as a result of SNWA's groundwater withdrawals in the Hydrographic Basins. Monitoring locations will be determined by the BRT and may include the following areas:

   a. Pahranagat Valley: Pahranagat National Wildlife Refuge, Key Pittman Wildlife Management Area, and Ash, Crystal, and Hiko Springs;
   b. White River Valley: Hot Creek, Flag, Moorman, and Hardy Springs and phreatophytic habitats that support Special Status Species in Middle and Lower White River Valley, including the Kirch Wildlife Management Area.

IV. REPORTING

All data collected pursuant to this Plan shall be fully and cooperatively shared among the Parties.

Using data derived from groundwater level measurements of all production and Monitoring Network wells in this Plan, SNWA shall produce groundwater contour maps and water-level change maps at the end of baseline data collection, and annually thereafter at the end of each year of groundwater withdrawals by SNWA, or at a frequency agreed upon by the TRP.

Water level and water production data shall be made available to the Parties within 90 calendar days of collection using a shared data-repository website administered by SNWA. Water chemistry sampling reports shall be made available to the Parties within 90 calendar days of receipt using a shared data-repository website administered by SNWA.

SNWA shall report the results of all monitoring and sampling pursuant to this Plan in an annual monitoring report that shall be submitted to the TRP and the Nevada State Engineer's Office by no later than March 31 of each year that this Plan is in effect. The DOI Bureaus may, at their option, provide comments to the Nevada State Engineer's Office on the annual report.

V. MANAGEMENT REQUIREMENTS

A. General

Through the TRP and BRT the Parties shall collaborate on data collection and technical analysis to ensure decisions are consistent with the Common Goals. Decisions must be based on the best scientific information available and the Parties shall collaborate on technical data collection and analysis. The Parties shall use existing data, data collected under this Plan, and the agreed upon transient regional groundwater flow system model as tools to evaluate the effects, if any, of groundwater development on Federal Water Rights, Federal Resources, and Special Status Species in the Area of Interest. The Parties agree that the transient regional groundwater flow system model is one tool that shall be used to inform the Executive Committee about the potential for effects of groundwater withdrawals to spread through the basin-fill and the regional carbonate-rock aquifers, as well as the effectiveness of the potential mitigation actions.

B. Executive Committee

The Parties agree that the Executive Committee ("EC") created pursuant to the Spring Valley Stipulation shall also perform the functions related to the Hydrographic Basins that are the subject of this Stipulation and this monitoring, management and mitigation Plan as set forth in Appendix A to this Exhibit A. In addition to its duties specified in Appendix A, the EC shall 1) review agreed-upon TRP and/or BRT recommendations for actions to reduce or eliminate an injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources or Special Status Species in the Area of Interest from groundwater withdrawals by SNWA in the

Hydrographic Basins, and 2) negotiate a resolution in the event that the TRP and/or BRT cannot reach consensus on monitoring requirements/research needs, technical aspects of study design, interpretation of results, and/or appropriate actions to minimize or mitigate unreasonable adverse effects to Federal Resources or Special Status Species within the Area of Interest or injury to Federal Water Rights from groundwater withdrawals by SNWA in the Hydrographic Basins.

C. Technical Review Panel

The Parties agree that the TRP created pursuant to the Spring Valley Stipulation shall also perform the functions related to the Hydrographic Basins that are the subject of this Stipulation and this monitoring, management and mitigation Plan, as set forth in Appendix A to this Exhibit A.

The Parties agree that data and information gathered pursuant to other stipulations with the DOI Bureaus in the White River Flow System will be presented for review and analysis by the TRP. At a minimum, the TRP shall review, analyze and integrate the data and information gathered pursuant to the July 19, 2001 Stipulation for Dismissal of Protests to SNWA applications in Coyote Spring Valley; and the April 20, 2006 Memorandum of Agreement between SNWA, the U.S. Fish and Wildlife Service, Coyote Springs Investment LLC, the Moapa Band of Paiute Indians, and the Moapa Valley Water District. Additionally, data, reports and other analyses related to the Hydrographic Basins that is performed by the TRP shall be shared with the Moapa Band of Paiute Indians ("Tribe"), provided however, that the Tribe shall not be a voting member of the TRP unless otherwise agreed to by the Executive Committee.

D. Hydrologic Management and Mitigation Operation Plan

Prior to groundwater pumping for production from the Hydrographic Basins, SNWA, in cooperation with the DOI Bureaus, shall prepare a written Hydrologic Management and Mitigation Operation Plan ("Operation Plan"). The Operation Plan shall: 1) identify and define early warning indicators for injury to Federal Water Rights and unreasonable adverse effects to Federal Resources and Special Status Species; 2) define a range of specific mitigation actions that may be carried out if early warning indicators are reached; and 3) use collected baseline data to develop a plan to optimize groundwater development to allow for development of any water rights permitted to SNWA by the Nevada State Engineer in the Hydrographic Basins without causing injury to Federal Water Rights and unreasonable adverse effects to Federal Resources and Special Status Species, consistent with the Common Goals. Early warning indicators and the range of specific mitigation and conservation measures identified in the Operation Plan will be based on all relevant and available data. This Operation Plan shall be used by the Executive Committee during its decision-making process as outlined in Appendix A. The TRP, in coordination with the BRT, shall update the Operation Plan as necessary to ensure the early warning indicators and mitigation actions are consistent with the Common Goals. The Operation Plan, or any mitigation or conservation measures described in the Operation Plan, may also be submitted by SNWA to the Bureau of Land Management, the lead agency for the Clark, Lincoln, and White Pine Counties Groundwater Development Project EIS and the action agency for Endangered Species Act consultation, for consideration as part of the proposed action or alternatives in the EIS process and as part of the proposed action for the Endangered Species Act consultation process for that Project.

E. Transient Regional Groundwater Flow System Modeling

Once groundwater pumping for production has begun, SNWA shall update and calibrate the steady-state regional groundwater flow model with the data collected during groundwater production in order to produce a transient regional groundwater flow system model ("Model"). The Parties agree that the Model is one tool that may be used to give an early warning of possible injury to Federal Water Rights or unreasonable adverse effects to Federal Resources or Special Status Species within the Area of Interest. However, the Parties recognize that a regional Model may not be an accurate predictor of site-specific effects and that Model results must be qualified based on a comparison of the accuracy of the Model and the capability of the Model to predict actual conditions.

The Parties shall share all geologic, geophysical, hydrologic, and geochemical information collected in the Area of Interest. All data collected pursuant to this Exhibit and data collected pursuant to the EIS Process that has passed QA/QC, as determined by the TRP, shall be included in the Model. The Parties may use the Model to, among other things, study the long term effects in the Area of Interest of removing water from storage, and to create embedded (child) models focused on the Pahranagat and White River Valley Hydrographic Basins.

SNWA shall maintain, update, calibrate, and operate the Model in cooperation with the TRP to include data collected pursuant to this Exhibit and data collected during groundwater production. SNWA may subcontract this obligation to a third party. The cost of all modeling described herein shall be borne by SNWA.

SNWA shall provide Model output for evaluation by the TRP in the form of input files, output files, drawdown maps, tabular data summaries, and plots of simulated water levels through time for the aquifer system, unless otherwise recommended by the TRP.

F. Biologic Resources Team

The Parties hereby establish a Biologic Resources Team ("BRT") to determine and recommend to the EC the appropriate course of action to avoid and/or mitigate unreasonable adverse effects to Federal Resources and Special Status Species in the Area of Interest resulting from SNWA's withdrawal of groundwater from the Hydrographic Basins, consistent with the Common Goals. However, in determining whether an unreasonable adverse effect has occurred, it is the intent of the Parties to give Special Status Species the same level of protection that would be afforded to them under applicable state and/or federal law, including but not limited to, the Federal Land Policy and Management Act and the Endangered Species Act. The term "Water Dependent Ecosystems" as used in this Exhibit A shall mean those Special Status Species habitat areas in the Area of Interest that are dependent upon groundwater levels and/or local and regional spring flows.

The membership of the BRT shall consist of one representative with biologic expertise of Special Status Species and Water Dependent Ecosystems in the Area of Interest from SNWA and each DOI Bureau that chooses to participate. At the discretion of the BRT, others with specific biologic expertise of the Special Status Species and Water Dependent Ecosystems in the Area of Interest may be invited to consult with the BRT, but shall not be voting members of the BRT. All information considered by the BRT shall be made available to all Parties.

Members of the BRT shall be appointed no later than 30 days after a State Engineer decision granting any of SNWA's Applications in whole or in part. The BRT shall use the consensus-based decision making process as provided in Appendix A.

In furtherance of the Common Goals, the BRT shall strive to identify and monitor responses of Special Status Species within the Area of Interest with respect to changes in biologic resources resulting from SNWA's withdrawal of groundwater from the Hydrographic Basins. The Parties agree that the natural condition of the biologic resources in the Hydrographic Basins and the Adjacent Hydrographic Basins has been highly modified by agricultural practices and other activities, and that because of these existing conditions the BRT may consider whether a minor adverse effect to biologic resources coupled with mitigation measures may be more beneficial for proper ecological functioning than to avoid any adverse effects to biologic resources.

The BRT shall:

1. Work with the TRP to identify Special Status Species and Water Dependent Ecosystems within the Area of Interest and identify those areas that are most likely to be affected by potential hydrologic changes, as determined by the TRP, that may result from SNWA groundwater withdrawals in the Hydrographic Basins;
2. Assemble baseline information using data collected during the EIS Process on those Special Status Species that are most likely to be effected by potential hydrologic changes, as determined by the TRP, that may result from SNWA groundwater withdrawals within the Area of Interest;
3. Develop and implement a baseline monitoring program within the Area of Interest to collect information on those Special Status Species that are most likely to be effected by potential hydrologic changes, as determined by the TRP, that may result from SNWA groundwater withdrawals within the Hydrographic Basins for the time period between issuance of the Final Environmental Impact Statement to the commencement of groundwater withdrawals by SNWA in the Hydrographic Basins. The goal of this baseline monitoring program shall be to help establish natural variability in the Water Dependent Ecosystems;
4. Identify a representative sample of indicators to monitor to establish early warning of unreasonable adverse effects, if any, to Special Status Species in the Area of Interest;
5. Develop and implement a monitoring plan for detecting unreasonable adverse effects to Special Status Species in the Area of Interest that may result from SNWA groundwater withdrawals in the Hydrographic Basins. The BRT shall develop the monitoring plan within 18 months from the date of a State Engineer decision granting the SNWA Applications, in whole or in part;
6. Identify and seek funding to implement research projects, if determined to be necessary by the BRT, to help characterize the relationship between groundwater and Special Status Species habitats, including responses to changing groundwater elevations and spring flows;
7. Specify procedures for data management, sharing, analysis, and reporting;
8. Coordinate with the Pahranagat and White River Valley Recovery Implementation Teams;

9. Develop recommendations to mitigate unreasonable adverse effects to Special Status Species from SNWA groundwater withdrawals in the Hydrographic Basins; and
10. Monitor the success of mitigation actions.

Definition of Special Status Species
As used in this Exhibit, the term "Special Status Species" shall consist of species that are groundwater-dependent and that belong in any of the following categories:

Proposed Species - species that have been officially proposed for listing as threatened or endangered by the Secretary of the Interior under provisions of the Endangered Species Act ("ESA") and for which a proposed rule has been published in the Federal Register.

Listed Species - species officially listed as threatened or endangered by the Secretary of the Interior under ESA and for which a final rule for the listing has been published in the Federal Register.

Endangered Species – under provisions of the ESA, any species which is in danger of extinction throughout all or a significant portion of its range.

Threatened Species – under provisions of the ESA, any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Candidate Species - species designated as candidates for listing as threatened or endangered pursuant to the ESA by the Fish and Wildlife Service ("FWS"), and/or National Marine Fisheries Service ("NMFS").

State Listed Species - species listed by the state of Nevada in a category implying but not limited to potential endangerment or extinction. Listing is either by legislation or regulation.

BLM Sensitive Species - those designated by the Nevada State Director, in cooperation with the Nevada agency responsible for managing the species and Nevada Natural Heritage programs, as sensitive. They are those species that: (1) could easily become endangered or extinct in Nevada, (2) are under status review by the FWS and or NMFS, (3) are undergoing significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution, (4) are undergoing significant current or predicted downward trends in population or density such that Federal listed, proposed, or candidate status may become necessary, (5) typically have small and widely dispersed populations, (6) inhabit ecological refugia or other specialized or unique habitats, (7) are State Listed but which may be better conserved through application of BLM sensitive species status.

TNC G1/G2 Species - <u>G1 Extremely rare</u>**;** usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction. <u>G2 Very rare</u>**;** usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction.

VI. MITIGATION REQUIREMENTS

To further the Common Goals, SNWA shall mitigate any injury to Federal Water Rights, or unreasonable adverse effects to Federal Resources and/or Special Status Species within the Area of Interest agreed upon by the Parties as determined through the processes described in Appendix A, or after the Nevada State Engineer determines whether there are any such effects due to groundwater withdrawals by SNWA in the Hydrographic Basins. Provided, however, that if any member of the TRP or BRT provides data to the Executive Committee identifying an injury to Federal Water Rights related to the Pahranagat National Wildlife Refuge and also presents data that indicates a trend towards reaching an early warning indicator identified in the Operation Plan, then SNWA shall, within 30 days, identify appropriate mitigation action(s) from within the range of mitigation action(s) identified within the Operation Plan and implement such mitigation action(s). The TRP consultation process identified in Appendix A may be commenced upon identification of such injury by any Party, but will automatically begin no later than 30 days after notice of such injury is provided to the Executive Committee. Following completion of the consultation process identified in Appendix A, any mitigation action commenced by SNWA prior to the initiation of the TRP and/or BRT consultation process may be discontinued if the Executive Committee does not agree by consensus that such mitigation shall continue.

The Parties shall take all necessary steps to ensure that mitigation actions are feasible and are timely implemented. Mitigation measures may include, but are not limited to one or more of the following:

- Geographic redistribution of groundwater withdrawals;
- Reduction or cessation in groundwater withdrawals;
- Provision of consumptive water supply requirements using surface and groundwater sources;
- Acquisition of real property and/or water rights dedicated to the recovery of the Special Status Species within the current and historic habitat range within the Area of Interest of each of the Special Status Species.
- Augmentation of water supply and/or acquisition of water rights for Federal Water Rights and/or Federal Resources using surface and groundwater sources; and
- Other measures as agreed to by the Parties and/or required by the State Engineer that are consistent with this Stipulation.

VII. MODIFICATION OF THE PLAN

The Parties may modify this Plan by mutual written agreement.

APPENDIX A

Criteria Initiating TRP/BRT Consultation and Management or Mitigation Actions

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A consultation initiated under this Appendix A shall be completed within 150 days from initiation. The TRP/BRT consultation process shall be completed within 90 days from initiation and the EC process shall be completed within 60 days from completion of the TRP/BRT process. These timelines may be modified or extended by mutual agreement of the EC. The consultation is deemed initiated when a member of the TRP and/or BRT notifies the other members of a concern as described below. Criteria for initiation of consultation, management, and/or mitigation actions are as follows:

I. TRP/BRT Consultation Initiation Criteria

Any party may initiate a TRP or BRT consultation when that Party is concerned that there may be an injury to Federal Water Rights and/or an unreasonable adverse effect to Federal Resources and/or Special Status Species within the Area of Interest as the result of:

a) a change in surface water and/or groundwater level and/or discharge measured by one or more of the monitoring sites included in this Plan, or

b) a change in groundwater level predicted by the agreed-upon transient regional groundwater flow system Model, or

c) a change in a measured biological parameter in a Special Status Species or its Water Dependent Ecosystem,

that is due to, or may be reasonably attributed to, groundwater withdrawals by SNWA in the Hydrographic Basins.

If consultation is initiated pursuant to Section I a) or c) above, the following consultation process shall apply:

1) Parties shall notify each other and the TRP and BRT shall confer by teleconference or in person within 21 calendar days;

2) The TRP and BRT shall evaluate all relevant data including the water level, discharge measurement, and biological data. The objective for the consultation is to determine if the change in water level, discharge and/or biological parameter may be due to groundwater withdrawals by SNWA in the Hydrographic Basins.

   i. The TRP shall compare the observed field data with Model predictions to evaluate how well Model predictions match observed drawdown and shall discuss potential changes to the Model as agreed to by consensus of the TRP.

ii. The BRT shall compare observed changes in biological parameters to changes in hydrologic conditions evaluated by the TRP and/or predicted by the TRP Model.

iii. Based on observed data, the Model shall be recalibrated and sensitivity analysis applied if necessary, and the Model shall be rerun to evaluate the effects of groundwater withdrawals by SNWA in the Hydrographic Basins on Federal Water Rights, Federal Resources and Special Status Species within the Area of Interest and on regional groundwater gradients.

iv. If the TRP and/or BRT agree that the measured change in water level, discharge, and/or biological parameter is not attributable to groundwater withdrawals by SNWA in the Hydrographic Basins, no further management actions shall be taken at that time. The TRP and BRT may conduct further investigations into the cause(s) of such changes.

v. If any member of the TRP or BRT is concerned that the measured change in water level, discharge, and/or biological parameter is attributable to groundwater withdrawals by SNWA in the Hydrographic Basins and is causing or has the potential to cause injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources and/or Special Status Species in the Area of Interest, then the TRP and/or BRT shall work to develop consensus-based courses of action to address the concern and/or that manage or mitigate any injury and/or unreasonable adverse effect(s). The TRP and BRT may use the Model to evaluate the effects of various courses of action outlined in the Paragraph VI of Exhibit A to manage or mitigate such unreasonable adverse effect(s). The TRP and BRT shall convey all recommended courses of action to the Executive Committee, and the Parties shall proceed to Section II.1.

vi. If the water level, discharge measurement, or biological data indicates that there is an injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources and/or Special Status Species within the Area of Interest, and the TRP and/or BRT is unable to develop a consensus-based course of action, the TRP and/or BRT shall notify the Executive Committee, and the Parties shall proceed to Section II.2.

If a consultation is initiated pursuant to Section 1.b) above, the following consultation process shall apply:

1) Parties shall notify each other and the TRP and BRT shall confer by teleconference or in person within 21 calendar days;

2) The TRP shall evaluate the modeling parameters, variances to water level changes relative to modeling predictions, the translation of modeling variances to areas of concern and variables influencing Model results. The TRP objective for the consultation is to determine if the response may be due to groundwater withdrawals by SNWA in the Hydrographic Basins.

i. The TRP shall compare the observed field data with Model predictions to evaluate how well the Model predictions match observed drawdown and shall discuss potential changes to the Model as agreed to by consensus of the TRP. All Parties recognize that future modeling of predicted effects for the verification of the Model shall be a necessary component to determine the validity of the modeling results and any course of action.

ii. Based on observed data, the Model shall be recalibrated as necessary, and shall be rerun to evaluate the effects of groundwater withdrawals by SNWA in the Hydrographic Basins on Federal Water Rights, Federal Resources and/or Special Status Species in the Area of Interest.

iii. If the TRP agrees that the recalibrated Model does not predict a potential injury to Federal Water Rights and/or an unreasonable adverse effect to Federal Resources or Special Status Species in the Area of Interest, no further management actions shall be taken at that time.

iv. If any member of the TRP is concerned that the recalibrated Model predicts a potential injury to Federal Water Rights and/or an unreasonable adverse effect to Federal Resources and/or Special Status Species in the Area of Interest, then the TRP shall develop consensus-based actions to address the concern and/or that manage or mitigate those effect(s). The TRP shall also use the Model to evaluate the effects of different courses of action outlined in Paragraph VI of Exhibit A to manage or mitigate those effects. The TRP shall convey all recommended courses of action to the Executive Committee, and the Parties shall proceed to Section II.1.

v. If the recalibrated Model predicts a potential injury to Federal Water Rights and/or an unreasonable adverse effect to Federal Resources and/or Special Status Species in the Area of Interest, and the TRP is unable to develop a consensus-based course of action, the TRP shall notify the Executive Committee, and the Parties shall proceed to Section II.2.

II. Actions to Manage or Mitigate

1) If the TRP and/or BRT determines, by consensus, that a predicted or measured change in groundwater levels or biological parameter would result in injury to Federal Water Rights and/or an unreasonable adverse effect to Federal Resources and/or Special Status Species in the Area of Interest, the Executive Committee shall consider the TRP and/or BRT's recommended courses of action. Upon receiving any consensus-based TRP and/or BRT recommendations, the Parties, through the Executive Committee (with input from the TRP and BRT as necessary), may seek a negotiated resolution of a course of action to reduce or eliminate the injury to Federal Water Rights and/or the unreasonable adverse effect

to Federal Resources and/or Special Status Species in the Area of Interest, through management of groundwater withdrawals, and/or the mitigation of the injury or effects. If the Executive Committee cannot reach consensus, any Party may refer the issue to the Nevada State Engineer or other agreed-upon third party after notifying all other Parties of its intent to refer the matter to the Nevada State Engineer or other agreed upon third party.

2) If the TRP and/or BRT notifies the Executive Committee that it is unable to make a determination by consensus that a predicted or measured change in groundwater levels, and/or biological parameter would result in injury to Federal Water Rights and/or an unreasonable adverse effect to Federal Resources and/or Special Status Species in the Area of Interest, or that the TRP and/or BRT is unable to obtain consensus on a recommended course of action, the Executive Committee shall attempt to negotiate a mutually acceptable course(s) of action. If that is not successful, any Party may refer the issue to the Nevada State Engineer or other agreed-upon third party after notifying all other Parties of its intent to refer the matter to the Nevada State Engineer or other agreed upon third party.

3) The Executive Committee shall refer to the Operation Plan developed pursuant to Paragraph V.D. of Exhibit A when determining management or mitigation actions.

Appendix B - Detailed Table of KEAs and Indicators by Monitoring Site and Level of Tiered Monitoring

A detailed table of KEAs, indicators broken out by sampling component, sampling schedule, and qualifiers is presented in Appendix B. The tables in Appendix B were designed using the following rules concerning Special Status Species occurrence and surveys:

- If a directly- or indirectly-monitored Special Status Species is known to occur at a site, surveys for that species and/or habitat specifically associated with that species are included in the tables for that site.
- If a directly- or indirectly-monitored Special Status Species has been previously documented at a site but current presence is unknown (e.g., possibly extirpated, no recent documentation, or success of recent reintroduction to be determined), surveys for that species and/or habitat specifically associated with that species are included in the tables for that site with footnote "if species present".
- If a directly- or indirectly-monitored Special Status Species has never been documented at a site, surveys for that species and/or habitat specifically associated with that species are omitted from the tables for that site.
- Because occurrence of northern leopard frog within the Area of Interest is less well understood, if northern leopard frogs have been previously documented in a hydrographic basin, surveys for northern leopard frogs and/or habitat specifically associated with northern leopard frogs are included for all sites in that hydrographic basin with footnote "if species present".
- If northern leopard frogs have never been documented in a hydrographic basin, surveys for northern leopard frogs and habitat specifically associated with northern leopard frogs are omitted from all sites in that hydrographic basin.

The tables outline sampling to be conducted during Site Characterization, Tier 1 and Tier 2 (SC/T1/T2). The tiered monitoring approach works as follows:

- Site Characterization (SC) will be conducted during a single visit in Year 1.
- Following Site Characterization, Tier 1 monitoring will be conducted each year unless a shift to Tier 2 occurs.
- Site Characterization will be repeated every 10 years in conjunction with Tier 1 monitoring, unless a shift to Tier 2 occurs.
- More intensive baseline monitoring will be conducted at Flag, Butterfield, Ash, Crystal and Hiko springs and Pahranagat Ditch during the first two years of Tier 1 monitoring, and periodically thereafter unless a shift to Tier 2 occurs (Flag and Butterfield springs: every 5 years; Hiko, Crystal, and Ash springs and Pahranagat Ditch: every ten years). This will be achieved by collecting data consistent with Tier 2 indicators.
- If a shift to Tier 2 occurs, Tier 2 monitoring will be conducted each year unless a shift back to Tier 1 occurs.

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	Delamar, Dry Lake and Cave Valleys																	
	Cave V Meadow			**Coyote**			**Grassy**			**Littlefield**			**Meloy**			**Parker Stn**		
KEAs and Indicators	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**
GENERAL SITE CONDITION																		
Fixed station photography (aquatic area; spring, fall)					x	x		x	x		x	x		x	x		x	x
Fixed station photography (veg transects; summer)		x	x									1			1			x
Site assessment (spring, fall)	2	2	2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ABIOTIC																		
TRP MONITORING[3]																		
Depth to groundwater (piezometer; spring, fall)																		
Flow (continuous)																		
Flow (spring, fall)				5	5	5				x	x	x				x	x	x
Wetted area (spring, fall)				5	5	5	x	x	x									
Temp, pH, Conductivity, Turbidity (spring, fall)				x	x	x	x	x	x	x	x	x				x	x	x
BRT MONITORING																		
Temp, pH, Conductivity, DO (spring, fall)				x		x	x		x	x	1	x	x	1	x	x	x	x
Temperature (logger; continuous)					9	x		9	x		1	x		1	x		x	x
Nitrogen, Phosphorus (spring, fall)										1		1	1		1	x		x
Turbidity (spring, fall)																		
Aquatic habitat extent (w/ depth & veloc.; spring, fall)[8]				x		x	x		x	x		x	x		x	x		x
Water depth (springsnail & frog sampling; spring, fall)										1		1	1		1	x		x
Water velocity (springsnail sampling; spring, fall)										1		1	1		1	x		x
Substrate (springsnail sampling; spring, fall)										1		1	1		1	x		x
Distance to permanent water (bird habitat; summer)																		
Soil moisture (bird and vole habitat; summer)																		
BIOTIC - ANIMALS																		
MACROINVERTEBRATES																		
Abundance and composition (spring, fall)												1			1			x
SPRINGSNAILS																		
Presence (spring, fall)										x	1	1	x	1	1	x	x	x
Extent (spring, fall)										1	1	1	1	1	1	x	x	x
Abundance, distribution (spring, fall)										1		1	1		1	x		x
FISH																		
Population size and age structure																		
Distribution (spring, fall)																		
Catch per unit effort																		
NORTHERN LEOPARD FROG																		
Presence (spring)[14]																		
Egg masses (spring)																		
PAHRANAGAT VALLEY MONTANE VOLE																		
Presence (fall)[15]																		
BIOTIC - VEGETATION[17]																		
Community distribution (mapping; summer)	x			x			x			x			x			x		
Species cover and composition (transects; summer)		x	x									1			1			x
Internal heterogeneity (transects; summer)		x	x									1			1			x
Open water/veg cover (transects; summer)		x	x									1			1			x
Extent of community types (transects; summer)		x	x									1			1			x
Veg cover (springsnail & frog sampling; spring, fall)												1			1			x
Tree height in riparian gallery (bird habitat; summer)																		
Tree density in riparian gallery (bird habitat; summer)																		
Live/dead trees shrubs in gallery (transects; summer)																		
Herbaceous riparian plant height (vole habitat; summer)																		

1. If springsnails present.
2. Summer monitoring.
3. At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring, Butterfield Spring and Pahranagat Ditch), BRT will determine appropriate measurements for water availability as needed. Data collected by TRP at Parker Station Spring may give general indication of conditions at Cave Valley Ranch Meadow.
4. Flag Middle: continuous flow measurements; Flag North and South - spring and fall measurements.
5. If possible, flow will be measured. If not, wetted area will be monitored.
6. If northern leopard frog present.
7. If Special Status Species fish present.
8. For sites with directly-monitored Special Status Species, physical habitat map polygons will be delineated by habitat classifications. For sites without directly-monitored Special Status Species, general physical habitat maps will be created to depict only the outer boundary of the aquatic area.
9. To determining frequency and timing of when the spring pools go dry.
10. Once every 1-2 years (summer).
11. Once per year.
11. Frequency to be determined.
12. White River spinedace only.
13. Conducted during those summers when population size and age structure are not monitored.
14. Discontinue if two consecutive years of no documented presence during presence surveys; reinitiate if presence documented during subsequent site visits.
15. To be conducted every 2-4 years at those sites with documented Pahranagat Valley montane vole presence for the purpose of confirming continued occupancy.
16. If Pahranagat Valley montane vole present.
17. Belt transects in woody riparian areas: line transects in all other habitats.

	White River Valley														
	Butterfield			Flag			Hardy			Hot Creek			Moorman		
KEAs and Indicators	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**
GENERAL SITE CONDITION															
Fixed station photography (aquatic area; spring, fall)		x	x		x	x		x	x		x	x		x	x
Fixed station photography (veg transects; summer)			x			x			x			x			x
Site assessment (spring, fall)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ABIOTIC															
TRP MONITORING[3]															
Depth to groundwater (piezometer; spring, fall)															
Flow (continuous)				4	4	4				x	x	x			
Flow (spring, fall)				4	4	4	x	x	x				x	x	x
Wetted area (spring, fall)															
Temp, pH, Conductivity, Turbidity (spring, fall)				x	x	x	x	x	x	x	x	x	x	x	x
BRT MONITORING															
Temp, pH, Conductivity, DO (spring, fall)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Temperature (logger; continuous)		x	x		x	x		x	x		x	x		x	x
Nitrogen, Phosphorus (spring, fall)	x		x	x		x	x		x	x		x	x		x
Turbidity (spring, fall)															
Aquatic habitat extent (w/ depth & veloc.; spring, fall)[8]	x		x	x		x	x		x	x		x	x		x
Water depth (springsnail & frog sampling; spring, fall)	x		x	x		x	x		x	x		x	x		x
Water velocity (springsnail sampling; spring, fall)	x		x	x		x	x		x	x		x	x		x
Substrate (springsnail sampling; spring, fall)	x		x	x		x	x		x	x		x	x		x
Distance to permanent water (bird habitat; summer)															
Soil moisture (bird and vole habitat; summer)															
BIOTIC - ANIMALS															
MACROINVERTEBRATES															
Abundance and composition (spring, fall)	x		x	x		x	x		x	x		x	x		x
SPRINGSNAILS															
Presence (spring, fall)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Extent (spring, fall)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Abundance, distribution (spring, fall)	x		x	x		x	x		x	x		x	x		x
FISH															
Population size and age structure					x	x					10	10		10	10
Distribution (spring, fall)					12	x									
Catch per unit effort		10	10								13	13			
NORTHERN LEOPARD FROG															
Presence (spring)[14]	x	x	6	x	x	6	x	x	6	x	x	6	x	x	6
Egg masses (spring)			6			6			6			6			6
PAHRANAGAT VALLEY MONTANE VOLE															
Presence (fall)[15]															
BIOTIC - VEGETATION[17]															
Community distribution (mapping; summer)	x			x			x			x			x		
Species cover and composition (transects; summer)			x			x			x			x			x
Internal heterogeneity (transects; summer)			x			x			x			x			x
Open water/veg cover (transects; summer)			x			x			x			x			x
Extent of community types (transects; summer)			x			x			x			x			x
Veg cover (springsnail & frog sampling; spring, fall)			x			x			x			x			x
Tree height in riparian gallery (bird habitat; summer)															
Tree density in riparian gallery (bird habitat; summer)															
Live/dead trees shrubs in gallery (transects; summer)															
Herbaceous riparian plant height (vole habitat; summer)															

1. If springsnails present.
2. Summer monitoring.
3. At sites not monitored by TRP (Cave Valley Ranch Meadow, Meloy Spring, Butterfield Spring and Pahranagat Ditch), BRT will determine appropriate measurements for water availability as needed. Data collected by TRP at Parker Station Spring may give general indication of conditions at Cave Valley Ranch Meadow.
4. Flag Middle: continuous flow measurements; Flag North and South - spring and fall measurements.
5. If possible, flow will be measured. If not, wetted area will be monitored.
6. If northern leopard frog present.
7. If Special Status Species fish present.
8. For sites with directly-monitored Special Status Species, physical habitat map polygons will be delineated by habitat classifications. For sites without directly-monitored Special Status Species, general physical habitat maps will be created to depict only the outer boundary of the aquatic area.
9. To determining frequency and timing of when the spring pools go dry.
10. Once every 1-2 years (summer).
11. Once per year.
11. Frequency to be determined.
12. White River spinedace only.
13. Conducted during those summers when population size and age structure are not monitored.
14. Discontinue if two consecutive years of no documented presence during presence surveys; reinitiate if presence documented during subsequent site visits.
15. To be conducted every 2-4 years at those sites with documented Pahranagat Valley montane vole presence for the purpose of confirming continued occupancy.
16. If Pahranagat Valley montane vole present.
17. Belt transects in woody riparian areas: line transects in all other habitats.

								Pahranagat Valley							
	Ash			Crystal			Hiko			Maynard			Pahranagat Ditch		
KEAs and Indicators	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**	**SC**	**T1**	**T2**
GENERAL SITE CONDITION															
Fixed station photography (aquatic area; spring, fall)		x	x		x	x		x	x		x	x		x	x
Fixed station photography (veg transects; summer)			x			x			x			1,6,7			x
Site assessment (spring, fall)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ABIOTIC															
TRP MONITORING[3]															
Depth to groundwater (piezometer; spring, fall)										x	x	x			
Flow (continuous)	x	x	x	x	x	x	x	x	x						
Flow (spring, fall)															
Wetted area (spring, fall)										x	x	x			
Temp, pH, Conductivity, Turbidity (spring, fall)	x	x	x	x	x	x	x	x	x	x	x	x			
BRT MONITORING															
Temp, pH, Conductivity, DO (spring, fall)	x	x	x	x	x	x	x	x	x	x	1,6,7	x	x	x	x
Temperature (logger; continuous)		x	x		x	x		x	x		1,6,7	x		x	x
Nitrogen, Phosphorus (spring, fall)	x		x	x		x	x		x	1,6,7		1,6,7	x		x
Turbidity (spring, fall)													x	x	x
Aquatic habitat extent (w/ depth & veloc.; spring, fall)[8]	x		x	x		x	x		x	x		x			
Water depth (springsnail & frog sampling; spring, fall)	x		x	x		x	1		1,6	1		1,6			6
Water velocity (springsnail sampling; spring, fall)	x		x	x		x	1		1	1		1			6
Substrate (springsnail sampling; spring, fall)	x		x	x		x	1		1	1		1			
Distance to permanent water (bird habitat; summer)			x			x									x
Soil moisture (bird and vole habitat; summer)			x			x									x
BIOTIC - ANIMALS															
MACROINVERTEBRATES															
Abundance and composition (spring, fall)	x		x	x		x	x		x	1,6,7		1,6,7	x		x
SPRINGSNAILS															
Presence (spring, fall)	x	x	x	x	x	x	x	1	1	x	1	1			
Extent (spring, fall)				x	x	x				1	1	1			
Abundance, distribution (spring, fall)	x		x	x		x	1		1	1		1			
FISH															
Population size and age structure			x	11	11	x	11	11	x					11	x
Distribution (spring, fall)															
Catch per unit effort	11	11									7	7		11	x
NORTHERN LEOPARD FROG															
Presence (spring)[14]	x	x	6	x	x	6	x	x	6	x	x	6	x	x	6
Egg masses (spring)			6			6			6			6			6
PAHRANAGAT VALLEY MONTANE VOLE															
Presence (fall)[15]	x		16	x		x							x		16
BIOTIC - VEGETATION[17]															
Community distribution (mapping; summer)	x			x						x			x		
Species cover and composition (transects; summer)			x			x						x			x
Internal heterogeneity (transects; summer)			x			x						x			x
Open water/veg cover (transects; summer)			x			x						x			x
Extent of community types (transects; summer)			x			x						x			x
Veg cover (springsnail & frog sampling; spring, fall)			x			x						1,6			6
Tree height in riparian gallery (bird habitat; summer)			x			x									x
Tree density in riparian gallery (bird habitat; summer)			x			x									x
Live/dead trees shrubs in gallery (transects; summer)			x			x									x
Herbaceous riparian plant height (vole habitat; summer)			16			x									16

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Appendix C - List of Scientific and Common Names

Animals

Common Name	Scientific Name
Aquatic Invertebrates	
Ash Springs riffle beetle	*Stenelmis lariversi*
Butterfield springsnail	*Pyrgulopsis lata*
Flag springsnail	*Pyrgulopsis breviloba*
grated tryonia	*Tryonia clathrata*
Hardy springsnail	*Pyrgulopsis marcida*
Hubbs springsnail	*Pyrgulopsis hubbsi*
Pahranagat naucorid bug	*Pelocorus shoshone shoshone*
Pahranagat pebblesnail	*Pyrgulopsis merriami*
White River Valley springsnail	*Pyrgulopsis sathos*
Amphibians	
Great Basin spadefoot toad	*Spea intermontana*
northern leopard frog	*Rana pipiens*
Fish	
Hiko White River springfish	*Crenichthys baileyi grandis*
Moorman White River springfish	*Crenichthys baileyi thermophilus*
mottled sculpin	*Cottus bairdi*
Pahranagat roundtail chub	*Gila robusta jordani*
Pahranagat speckled dace	*Rhinichthys osculus velifer*
White River desert sucker	*Catostomus clarki intermedius*
White River sculpin	*Cottus* sp. 3
White River speckled dace	*Rhinichthys osculus spp.*
White River spinedace	*Lepidomeda albivallis*
White River springfish	*Crenichthys baileyi baileyi*
Reptiles	
common side-blotched lizard	*Uta stansburiana*
Mammals	
Brazilian free-tailed bat	*Tadarida brasiliensis*
deer mice	*Peromyscus* sp.
harvest mice	*Reithrodontomys* sp.
Pahranagat Valley montane vole	*Microtus montanus fucosus*
pronghorn	*Antilocapra americana*
pygmy rabbit	*Brachylagus idahoensis*
Birds	
greater sage grouse	*Centrocercus urophasianus*
northern harrier	*Circus cyanus*
southwestern willow flycatcher	*Empidonax traillii extimus*
yellow-billed cuckoo	*Coccyzus americanus*

Vegetation

Common Name	Scientific Name
Shrubs	
big sagebrush	*Artemisia tridentata*
black sagebrush	*Artemisia nova*
creosote bush	*Larrea tridentata*
greasewood	*Sarcobatus vermiculatus*
indigo bush	*Psorothamnus fremontii*
Joshua tree	*Yucca brevifolia*
rabbitbrush	*Chrysothamnus* spp.
shadscale	*Atriplex confertifolia*
white bursage	*Ambrosia dumosa*
Trees	
ash	*Fraxinus* spp.
cottonwood	*Populus* spp.
Fremont cottonwood	*Populus fremontii*
willow	*Salix* spp.
Goodding's willow	*Salix gooddingii*
Grasses/Grass-likes	
alkali sacaton	*Sporobolus airoides*
baltic rush	*Juncus arcticus*
cattail	*Typha* spp.
common reed	*Phragmites australis*
common spikerush	*Eleocharis palustris*
common threesquare	*Schoenoplectus pungens*
cordgrasses	*Spartina* spp.
Nebraska sedge	*Carex nebraskensis*
saltgrass	*Distichlis spicata*
watercress	*Rorippa nasturtium-aquaticum*
wildrye	*Leymus* spp.