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SOUTHERN NEVADA WATER AUTHORITY

Water Resources Division

Hydrologic Monitoring and Mitigation Plan for Delamar, Dry Lake, and Cave Valleys

December 2009

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ACRONYMS

BLM	Bureau of Land Management
DDC	Delamar, Dry Lake, and Cave valleys
GPS	Global Positioning System
HA	hydrographic area
LVVWD	Las Vegas Valley Water District
NDOW	Nevada Department of Wildlife
NDWR	Nevada Division of Water Resources
NRCS	Natural Resources Conservation Service
NSE	Nevada State Engineer
QA	quality assurance
QC	quality control
SNOTEL	SNOwpack TELemetry
SNWA	Southern Nevada Water Authority
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WRCC	Western Regional Climate Center

ABBREVIATIONS

afy	acre-feet per year
amsl	above mean sea level
bgs	below ground surface
ft	foot
gpm	gallons per minute
in.	inch
m	meter

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1.0 INTRODUCTION

This document presents the Southern Nevada Water Authority (SNWA) Hydrologic Monitoring and Mitigation Plan for Delamar, Dry Lake, and Cave valleys (DDC) hydrographic areas (HA) 182, 181, and 180, respectively (DDCHMM Plan). The locations of the DDC hydrographic areas are presented on Figure 1. SNWA prepared this plan to satisfy permit conditions for SNWA groundwater rights granted under Permits 53987 through 53992 by the Nevada State Engineer (NSE) in Ruling Number 5875 (Ruling) issued on July 9, 2008 (Nevada State Engineer, 2008).

1.1 Background

In 1989, the Las Vegas Valley Water District (LVVWD) filed applications (53987 through 53992) for the appropriation of groundwater resources in DDC. By agreement with LVVWD on December 2, 2003, SNWA assumed full interest in these applications, which are the subject of the above referenced Ruling.

SNWA groundwater rights in DDC are for municipal and domestic purposes. The total combined duty under Permits 53987 and 53988 located in Cave Valley is limited to 4,678 afy. The total combined duty under Permits 53989 and 53990 located in Dry Lake Valley is limited to 11,584 afy. The total combined duty under Permits 53991 and 53992 located in Delamar Valley is limited to 2,493 afy.

The Ruling requires the development and approval of hydrologic and biologic monitoring and mitigation plans prior to exporting any groundwater resources from DDC. The Ruling also requires that a minimum of two years of biologic and hydrologic baseline data be collected in accordance with the plans as approved by the NSE. Data collected prior to approval of the DDCHMM Plan qualify as baseline data, provided the data were collected in accordance with the approved plan.

A DDCHMM Plan status and data report will be prepared each year to meet the annual reporting requirements of the Ruling.

1.2 Purpose and Scope

The objectives of the DDCHMM Plan are to identify and assess potential impacts to existing water-right holders and groundwater-dependent areas sustaining critical habitat for endangered and/or threatened species as a result of the SNWA development of groundwater resources within DDC. This document presents the hydrologic monitoring plan and implementation strategy to satisfy the requirements of the Ruling.

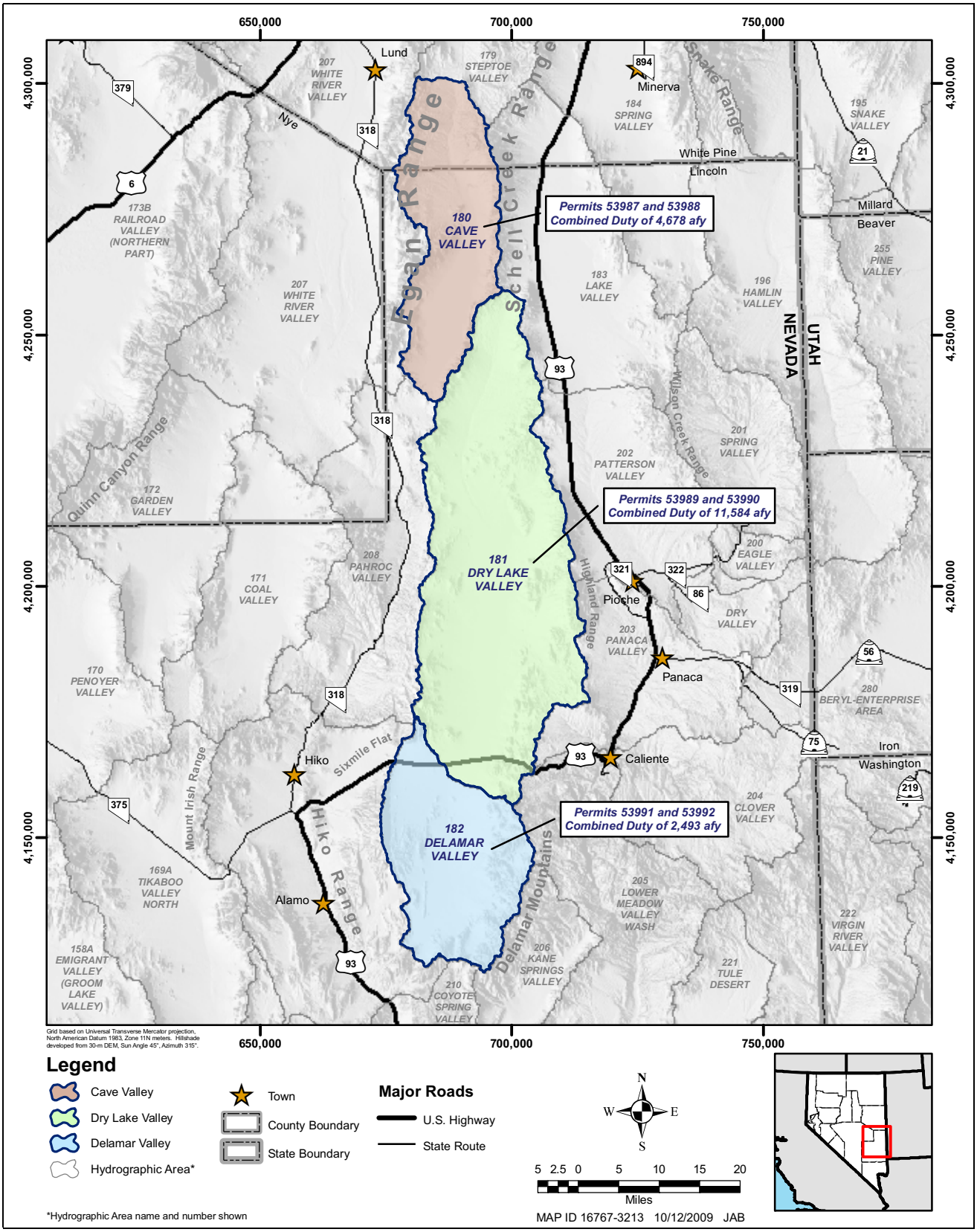

Figure 1
DDC Hydrographic-Area Locations

1.3 Previous DDC Hydrologic Monitoring Data Reports

The monitor network status and data collected as of December 2007 for elements of the DDCHMM Plan, which were in place prior to plan development, were presented in the *Delamar, Dry Lake, and Cave Valley Stipulation Agreement Hydrologic Monitoring Plan Status and Data Report* (SNWA, 2008).

Data from this network collected in 2008, as well as physical descriptions and historical hydrologic and water-chemistry data from springs and monitor wells included in the DDCHMM Plan monitoring network, are presented in the *Delamar, Dry Lake, and Cave Valley Stipulation Agreement Hydrologic Monitoring Plan Status and Historical Data Report* (SNWA, 2009).

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2.0 MONITORING PLAN REQUIREMENTS

The Ruling presents specific objectives and requirements that are incorporated within the DDCHMM Plan. This section summarizes the key requirements. The strategy and task elements for satisfying these requirements are presented in Section 3.0.

2.1 Ruling Requirements

A summary of the hydrologic monitoring requirements specified in the Ruling are presented below.

- Develop a hydrologic monitoring and mitigation program approved by the NSE.
- Collect a minimum of two years of hydrologic baseline data. The baseline monitoring program must be approved by the NSE prior to the export of any groundwater resources from DDC under the permits.
- File an annual data report with the NSE by March 15 of each year detailing the findings of the NSE-approved DDCHMM Plan.
- Update an NSE-approved groundwater flow model every five years after pumping begins and provide predictive results under pumping conditions of 10-, 25-, and 100-year periods.
- Modify or curtail pumping under specific conditions. If pumping effects impact existing rights, conflict with the protectible interests in existing domestic wells, as set forth in NRS §533.024, threaten to prove detrimental to the public interest, or are not environmentally sound, SNWA will be required by the NSE to curtail pumping and/or mitigate the impacts to the satisfaction of the NSE.

2.2 Monitoring Plan Implementation Strategy

A summary of the key requirements of the plan follows:

- General Requirements
  - Design and implement a baseline hydrologic data collection program.
  - Collect at least two years of monitoring data prior to groundwater withdrawals from wells and spring discharge sites that are incorporated into the approved monitoring network.

- Collect at least two years of data prior to groundwater withdrawals from new well and spring discharge sites in the monitoring network contingent upon property access and timely issuance of appropriate rights-of-way by various Federal agencies.

- Monitor Well Data Collection

  - Collect quarterly water-level data at nine existing monitor wells in DDC and adjacent basins.

  - Collect continuous water-level data at six existing monitor wells in DDC and adjacent basins.

  - Construct up to four new monitor wells located in or around DDC and adjacent hydrographic areas that will be dedicated to long-term monitoring. Collect continuous water-level data from the new monitor wells.

  - Collect quarterly water-level data at SNWA exploratory and test wells located in DDC.

  - Monitor the wells selected to be included in the network to help characterize groundwater movement within DDC and the adjacent HAs of White River, Pahroc, and Pahranagat valleys. Monitor wells are located throughout DDC and adjacent hydrographic areas to detect and quantify the propagation, if any, of drawdown toward existing water-right holders and groundwater-dependent areas sustaining critical habitat for endangered and/or threatened species and to provide observations for future groundwater model calibration.

- Future Production Well Monitoring

  - Record groundwater production and continuous water-level data in all future SNWA production wells in DDC when operational.

- Aquifer Testing

  - Perform a constant-rate aquifer test on all SNWA production and test wells located in DDC.

- Spring Discharge Sites

  - Monitor, or fund a mutually agreed-upon third party to monitor, eight spring locations: Flag Springs Complex, Hot Creek, Moorman, Hardy, Hiko, Maynard, Ash, and Crystal springs located in White River and Pahranagat valleys.

  - Report and evaluate spring discharge data from Cottonwood Spring, located in Pahranagat Valley, as provided by the U.S. Fish and Wildlife Service (USFWS).

  - Perform biannual monitoring of up to eight springs in DDC.

- Baseline Water Chemistry

  - Perform chemical analyses of selected parameters for samples collected from well and spring sites determined by SNWA in cooperation with the NSE. The program will consist of two sampling events at 6-month intervals. Samples will be collected at up to 10 locations per event.

  - Perform an additional round of sampling every five years after the commencement of groundwater pumping.

- Modeling

  - Update, calibrate, and maintain as required a numerical flow model of the regional groundwater flow system.

- Reporting

  - Provide collected data associated with the monitoring plan to NSE on a quarterly basis.

  - File an annual data report with the NSE by March 15 of each year reporting the results of monitoring and sampling pursuant to this plan.

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3.0 MONITORING PLAN STRATEGY AND IMPLEMENTATION

The objectives of the DDCHMM Plan encompass those set forth by the Ruling and include any additional objectives determined by the NSE to identify and assess potential impacts to existing water-right holders and groundwater-dependent areas in DDC sustaining critical habitat for endangered and/or threatened species.

3.1 Baseline Hydrologic Monitoring Program

The DDCHMM Plan focuses on establishing a network to collect hydrologic data for the purposes of defining baseline hydrologic conditions prior to SNWA withdrawals in DDC and detecting the effects of these withdrawals as pumping occurs. The network includes the springs and monitor wells within DDC and adjacent hydrographic areas that are presented on Figure 2.

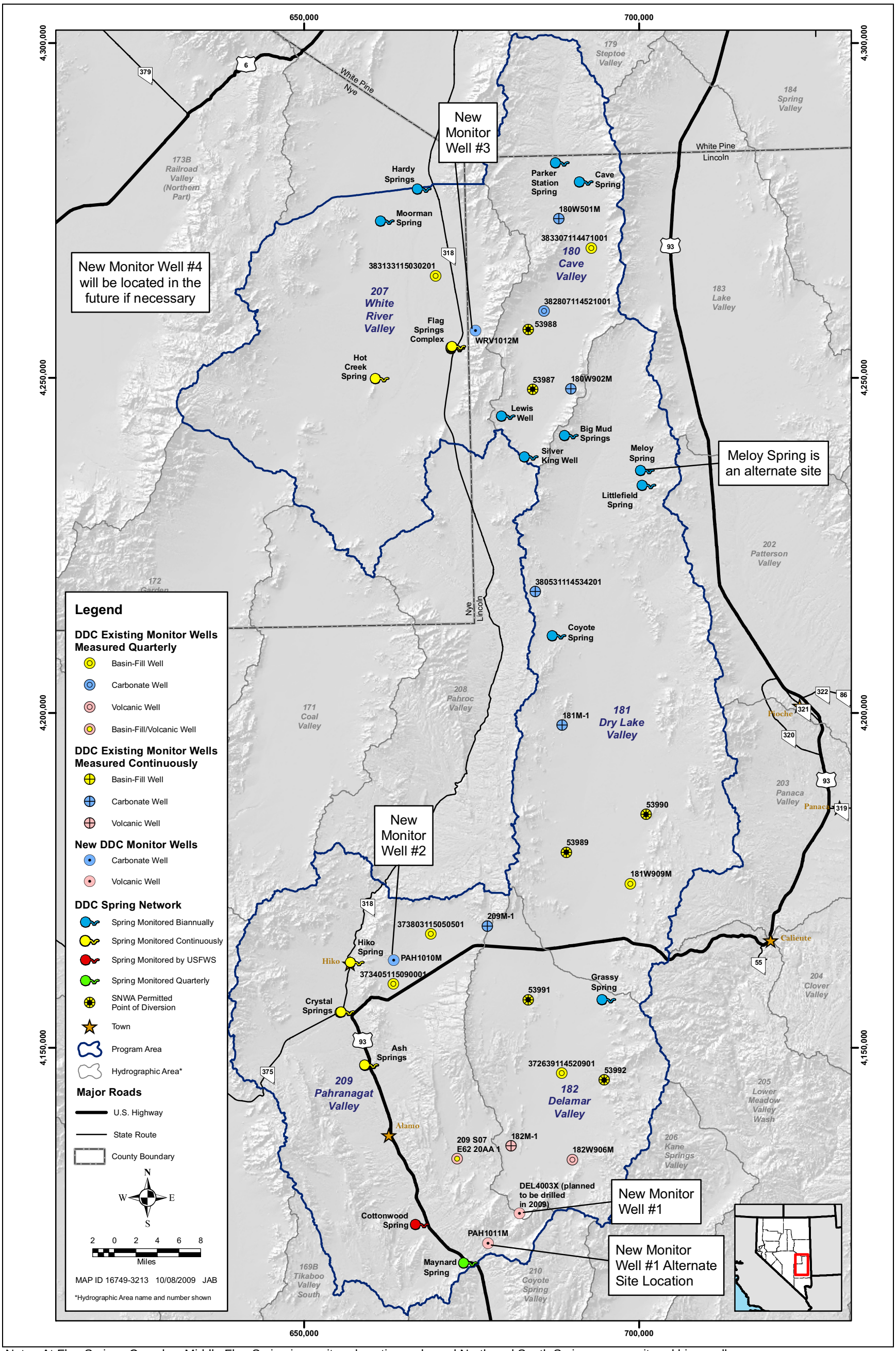
Acquisition of baseline hydrologic and water-chemistry data will follow the program presented in this plan, with any subsequent modifications approved by the NSE.

3.2 Monitor Wells

The DDCHMM Plan includes monitoring of new and existing wells completed in the basin-fill, carbonate-rock, and volcanic-rock aquifers at strategic locations to provide representative data spatially across the program area. Monitor well locations were selected with consideration of the hydrogeologic conditions at each location. Geologic reconnaissance, stratigraphic and structural field mapping, aerial photo analysis, surface geophysics, and a review of existing hydrogeologic data were performed to assist in well site selection. This network will provide long-term monitoring and early warning of drawdown propagation, if any, induced by SNWA groundwater development that might adversely affect existing water-right holders and groundwater-dependent areas sustaining critical habitat for endangered and/or threatened species.

3.2.1 Existing Well Network

Periodic water levels shall be measured quarterly in nine representative monitor wells and continuously in six representative monitor wells located in DDC and the adjacent White River and Pahranagat hydrographic areas. Well construction data, monitoring frequency, and surveyed location and elevation information for each location are presented in Table 1. The wells were selected to (1) serve as long-term monitoring points between SNWA's future production wells and existing water-right holders and environmental resources; (2) provide spatially distributed hydrologic data from aquifers within DDC and adjacent hydrographic areas in order to analyze and produce annual groundwater-level contour and water-level drawdown maps after pumping begins; (3) provide head



Note: At Flag Springs Complex, Middle Flag Spring is monitored continuously, and North and South Springs are monitored biannually.

Figure 2
DDC Monitoring Network

Table 1
DDC Existing Well Monitoring Network

Site Number	Station Local Number	Location[a]		Surface Elevation[b] (ft amsl)	Completion Date	Drill Depth (ft bgs)	Well Depth (ft bgs)	Well Casing Diameter (in.)	Screened Interval (ft bgs)	Open Interval (ft bgs)	Aquifer	Monitor Frequency
		UTM Northing (m)	UTM Easting (m)									
180W902M	180W902M	4,248,355.594	689,816.075	5,984.889	10/18/2005	915	903	12	196-882	77-915	Carbonate	Continuous
382807114521001	180 N07 E63 14BADD 1 USGS-MX	4,259,963.148	685,737.555	6,012.388	9/30/1980	460	460	10	210-250, 375-435	190-460	Carbonate[c]	Quarterly
383307114471001	180 N08 E64 15BCBC1 USBLM (Harris Well)	4,269,378.233	692,859.569	6,162.553	---	---	---	7	---	---	Basin Fill	Quarterly
180W501M	180W501M	4,273,712.794	687,971.032	6,428.634	9/25/2005	1,215	1,212	7	788-1,192	54-1,215	Carbonate	Continuous
182W906M	182W906M	4,133,304.570	690,065.209	4,796.956	9/2/2005	1,735	1,703	6	1,275-1,678	128-1,735	Volcanic	Quarterly
182M-1	182M-1	4,135,293.370	680,867.319	4,597.775	7/10/2005	1,345	1,331	12	1,007-1,290	58-1,345	Volcanic	Continuous
372639114520901	182 S06 E63 12AD 1 USGS-MX	4,146,220.241	688,472.411	4,706.299	5/10/1980	1,215	1,195	10	920-980, 1,040-1,180	10-1,215	Basin Fill	Quarterly[d]
181W909M	181W909M	4,174,462.589	698,676.168	4,799.409	10/17/2007	1,285	1,260	12	637-1,240	183-1,285	Basin Fill	Quarterly
181M-1	181M-1	4,198,199.898	688,534.985	4,963.074	8/30/2005	1,501	1,472	6	765-1,451	59-1,501	Carbonate	Continuous
380531114534201	181 N03 E63 27CAA 1 USGS-MX	4,218,085.093	683,720.322	5,456.348	1/1/1981	2,395	2,395	9	935-2,395	---	Carbonate	Continuous[d]
209 S07 E62 20AA 1[e]	209 S07 E62 20AA 1 (Dean Turley Well)	4,133,610.322	672,648.881	4,082.464	1/10/1981	695	695	8	600-695	55-695	Basin Fill/ Volcanic	Quarterly
373405115090001[e]	209 S04 E61 28CD 1	4,159,504.384	663,314.660	4,230.577	6/22/1965	1,314	980	12	---	52-1,143	Basin Fill/ Volcanic	Quarterly
373803115050501[e]	209 S04 E61 01AACB1	4,166,944.288	668,927.028	4,528.895	---	---	700	8	---	---	Basin Fill	Quarterly
209M-1	209M-1	4,168,065.785	677,323.461	5,097.298	8/4/2005	1,616	1,616	6	1,274-1,595	52-1,616	Carbonate	Continuous
383133115030201	207 N08 E62 30CD 1 USGS-MX	4,265,229.623	669,732.248	5,290.205	---	101	101	2	---	---	Basin Fill	Quarterly

[a]Professional survey complete on location and elevation. All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.
[b]Elevations are North American Vertical Datum of 1988 (NAVD88).
[c]Carbonate bedrock was encountered at 265 ft bgs according to the well log.
[d]Well is monitored continuously by the USGS.
[e]Wells are pending property access approval.
Well-construction data are based upon best available information from well logs, MX Project Reports (Ertec Western Inc., 1981a through e), and direct field measurements.

observations for calibration of the groundwater flow model; and (4) evaluate the effects of SNWA's groundwater withdrawals on local and regional water levels.

The existing well network was selected in consultation with the NSE to include seven SNWA wells, three private wells, one Bureau of Land Management (BLM) well, and four USGS-MX wells. Wells included in the network are completed in carbonate-rock, volcanic-rock, and basin-fill aquifers. Historic water-level data from wells in the network are presented in SNWA (2009).

The data collection interval at the continuously monitored locations is hourly. Site visits will be conducted to obtain periodic water-level measurements and download continuous pressure transducer data for processing and analysis.

Modification of the monitoring program, including the inclusion or exclusion of monitor well locations and/or monitoring frequency, will be made as required by the NSE in consultation with SNWA. Alternate locations may be used if private property access is not granted.

Seven of the existing monitor wells included in the program were constructed by SNWA and are located in DDC and Pahranagat valleys. The SNWA wells were constructed in 2005 and include four 6-in.-diameter and three 12-in.-diameter monitor wells in Delamar, Dry Lake, Cave, and Pahranagat valleys. Geologic analysis reports for the seven wells are presented in Eastman (2007a through g). Five of the SNWA monitor well locations were selected for continuous monitoring along with one USGS MX monitoring well. The continuous recording instrumentation at the SNWA wells was installed between April and June 2007. The period of record for the USGS MX well (380531114534201) dates back to the early 1980s. Continuous monitoring of water levels at that location has been conducted periodically, with the most recent period beginning in late 2007.

A professional survey of location coordinates, ground-surface elevation, and top-of-casing measuring-point elevation of the network wells was completed. Surveys will be performed on any newly constructed wells upon completion or on existing monitor wells added to the network in the future.

3.2.2 New Monitor Well Locations

SNWA will install up to four new monitor wells. In 2009, SNWA and NSE selected three new sites and one contingency site. One additional well is being kept in reserve, if needed, until more information is available on the production network configuration. The coordinates and estimated surface elevations and depth to groundwater for the new monitor wells are presented in Table 2 and are depicted in Figure 2.

The northernmost new monitor well, WRV1012M, is located on the west side of the Egan Range northeast of the Flag Springs Complex in White River Valley. The second new monitor well, PAH1010M, is located on the east side of the Hiko Range in Sixmile Flat in Pahranagat Valley. The site is east of Hiko Spring. These two monitor wells are planned to be completed in the carbonate-rock aquifer and are located on BLM land. The third new monitor well is an SNWA-proposed exploratory well, DEL4003X, which is located near the southern boundary of Delamar Valley. This well is anticipated to be completed in the volcanic-rock aquifer. If the

Table 2
New DDC Monitor Wells

Well Name	Location[a]		Estimated Surface Elevation[b] (ft amsl)	Estimated Depth to Water (ft)
	UTM Northing (m)	UTM Easting (m)		
WRV1012M	4,257,087	675,519	5,794	420
PAH1010M	4,163,098	663,576	4,380	700
DEL4003X	4,125,223	682,153	4,738	1,450
PAH1011M (alternate site)	4,121,019	677,508	3,727	635

[a]All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.
[b]Elevations are North American Vertical Datum of 1988 (NAVD88).

hydrogeologic conditions encountered at this site indicate a future production well would not be viable at this location, this well will become the third DDC new monitor well. However, if the well is viable as a future production site, a contingent site, PAH1011M, located along a major structural feature southwest of Well DEL4003X in the Pahranagat Shear Zone complex will be installed. The fourth new monitor well will be located, if needed, after the production well network configuration is identified, in order to provide additional monitoring coverage to meet the DDCHMM Plan objectives.

3.2.3 Exploratory and Production Well Monitoring

SNWA will record groundwater production and water-level data at all future operational SNWA production wells on a continuous basis. SNWA will record water levels in all existing and future SNWA exploratory and test wells at least quarterly.

Two existing SNWA exploratory wells, one 6-in.-diameter monitor well (CAV6002M2) and one 20-in.-diameter test well (CAV6002X), were installed in southern Cave Valley near Monitor Well 180W902M on October 13 and 28, 2007, respectively. Well-construction attributes of these two wells are presented in Table 3. The periodic water-level measurements at these wells will be performed quarterly.

3.3 Aquifer Characterization

A constant-rate pumping test will be performed on each future production and test well to evaluate aquifer properties. The test results may also identify boundary conditions and provide information on aquifer heterogeneity. Hydraulic-testing data will be evaluated to assess well performance and will be analyzed to provide aquifer-property data to constrain groundwater flow model calibration and to evaluate long-term pumping effects.

Step-drawdown and 72-hour constant-rate tests have been performed on SNWA Test Well CAV6002X and Monitor Well 180W902M located in Cave Valley. A Hydrologic Analysis Report, including hydrologic data, test analysis, and water-chemistry results, is currently being prepared for the site.

Table 3
Existing SNWA DDC Exploratory Wells

Site Number	Station Local Number	Location[a]		Surface Elevation[b] (ft amsl)	Completion Date	Drill Depth (ft bgs)	Well Depth (ft bgs)	Well Casing Diameter (in.)	Screened Interval (ft bgs)	Open Interval (ft bgs)	Aquifer	Monitor Frequency
		UTM Northing (m)	UTM Easting (m)									
CAV6002X	CAV6002X	4,248,307.582	689,819.008	5,987.966	10/28/2007	917	901	20	219-901	50-917	Basin Fill/ Carbonate	Quarterly
CAV6002M2	CAV6002M2	4,248,365.834	689,782.960	5,982.814	10/13/2007	893	885	6	159-882	50-893	Basin Fill/ Carbonate	Quarterly

[a]Professional survey complete on location and elevation. All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.
[b]Elevations are North American Vertical Datum of 1988 (NAVD88).
Note: Well-construction data are based upon best available information from well logs.

3.4 Spring Discharge Monitoring Network

The hydrologic monitoring program has two components of spring discharge monitoring. The first component consists of eight springs within DDC that will be monitored biannually for discharge (if measurable), field chemistry, and general conditions. The second component consists of nine springs in White River and Pahranagat valleys that will be monitored for discharge. The spring locations and monitoring frequency are presented in Table 4. Available historical data and descriptions of selected springs are presented in *Delamar, Dry Lake, and Cave Valley Stipulation Agreement Hydrologic Monitoring Plan Status and Data Report* (SNWA, 2009).

Table 4
DDC Springs Monitoring Locations and Monitoring Frequency

Basin Number	Station Number	Station Name	Elevation[a]	Location[b]		Monitoring Frequency
				UTM Northing (m)	UTM Easting (m)	
180	1800101	Cave Spring	6,490	4,279,249	691,760	Biannual
	1800301	Parker Station Spring	6,490	4,282,096	688,179	
	381624114540302	USBLM Silver King Well	6,230	4,238,220	683,551	
	381943114562201	Lewis Well	6,260	4,244,297	680,106	
181	1810101	Meloy Spring[c]	6,180	4,236,201	700,888	Alternate
	1810301	Littlefield Spring	6,150	4,233,949	701,112	Biannual
	1810401	Coyote Spring	5,220	4,211,513	687,693	
	1810501	Big Mud Springs	6,430	4,241,387	689,547	
182	1820101	Grassy Spring	5,790	4,157,193	695,124	
207	2070501	Hot Creek Spring near Sunnyside, NV	5,230	4,249,926	661,290	Continuous
	2071101	Moorman Spring	5,300	4,273,440	662,053	Biannual
	2071501	Hardy Springs	5,350	4,278,196	667,553	
209	2090101	Hiko Spring	3,880	4,162,744	657,549	Continuous
	2090201	Cottonwood Spring	3,240	4,123,643	667,261	Quarterly[d]
	2090801	Maynard Spring	3,110	4,117,909	674,444	Quarterly
Flag Springs Complex						
207	2071301	Flag Spring 3 (South)	5,290	4,254,416	672,579	Biannual
	2071302	Flag Spring 2 (Middle)	5,280	4,254,570	672,576	Continuous
	2071303	Flag Spring 1 (North)	5,290	4,254,696	672,719	Biannual
Crystal Springs						
209	09415589	Crystal Springs Diversion near Hiko, NV	3,820	4,155,336	656,011	Continuous
	2090401	Crystal Springs near Hiko, NV	3,800	4,155,348	656,165	
Ash Springs						
209	09415639	Ash Springs Diversion at Ash Springs, NV	3,600	4,147,415	659,716	Continuous
	2090501	Ash Springs	3,600	4,147,460	659,684	

[a]All elevations are rounded to the nearest 10 ft, North American Vertical Datum of 1988 (NAVD88). High-resolution Global Positioning System (GPS) will be used to determine elevations at a later date.
[b]All coordinates are UTM North American Datum of 1983 (NAD83) Zone 11.
[c] Meloy Spring is an alternate site that will replace Littlefield Spring if property access is granted.
[d]Monitoring performed by USFWS. Data provided to SNWA will be presented in the annual data report.

3.4.1 DDC Biannual Spring Monitoring

Eight DDC springs will be monitored biannually. These springs are characterized as mountain-block springs that do not have a hydrologic connection to the regional aquifer. However, biannual baseline monitoring will be performed to evaluate variability in spring conditions.

Springs included in the program are Grassy Spring in Delamar Valley; Coyote, Big Mud, and Littlefield springs in Dry Lake with Meloy Spring as an alternate if property access is obtained; Parker Station and Cave springs in northern Cave Valley; and Lewis Well and Silver King Well in southern Cave Valley. Spring locations are presented in Figure 2.

Sites will be visited in the spring and fall of each year. Spring discharge (if measurable) and field chemistry, including pH, electrical conductivity, and temperature will be documented. Photos will also be taken of each spring during each visit.

3.4.2 White River and Pahranagat Valleys Springs

Nine springs located in White River and Pahranagat valleys are included in the monitoring network. Five of these springs are currently being monitored through a cooperative funding arrangement between SNWA, the U.S. Geological Survey (USGS), and the Nevada Division of Water Resources (NDWR). These springs are Flag Springs Complex, Hot Creek, Moorman, Ash, and Crystal springs. The monitoring frequency of each spring is listed in Table 4. SNWA will monitor, or fund a mutually agreed-upon third party to monitor, these locations.

Hiko and Hardy springs were evaluated by SNWA and NSE for technical feasibility of monitoring and property access. SNWA and NSE worked with the property owner of Hiko Spring to install a flow meter and data logger in order to obtain continuous data on the spring discharge pipeline. SNWA and NSE also worked to obtain approval for installation of a flume at Hardy Springs.

SNWA and Nevada Department of Wildlife (NDOW) worked together to install a flume and continuous monitoring instrumentation at Middle Flag Spring. South and North Flag Springs will be measured biannually. Maynard Spring will be monitored quarterly by SNWA. SNWA will perform measurements at these sites dependent upon continued property access. Cottonwood Spring will be monitored by USFWS, and data provided will be included in the annual SNWA data report.

3.5 Precipitation Stations

SNWA will compile and report data from selected precipitation stations with an established historical record in the vicinity of the study area as long as the data are available and stations are in operation. The precipitation network will assist in assessing climate variability in the vicinity of the project basins and discerning pumping effects from natural variability. The precipitation network stations are listed in Table 5 and presented on Figure 3.

Table 5
DDC Precipitation Station Locations

Station Name	Location[a]		Surface Elevation[b] (ft amsl)	Data Source
	UTM Northing (m)	UTM Easting (m)		
Ward Mountain	4,333,562	677,114	9,200	NRCS
Mt. Wilson	4,236,086	728,118	9,200	USGS
Geyser Ranch	4,282,815	706,113	6,020	WRCC
Hiko	4,157,377	657,455	3,940	WRCC
Key Pittman WMA	4,164,774	657,315	3,950	WRCC
Lake Valley Steward	4,243,927	705,365	6,350	WRCC
Lund, Nevada	4,302,024	673,483	5,570	WRCC
Pahranagat Wildlife Refuge	4,126,112	666,918	3,400	WRCC
Sunnyside	4,254,266	672,777	5,300	WRCC
Highland Peak	4,196,772	712,963	9,330	USGS
Quinn Canyon Range	4,228,798	620,297	9,050	USGS
Mt. Irish	4,168,657	641,845	8,610	USGS
Unnamed Peak S. of Chokecherry Peak	4,154,830	700,904	7,800	USGS
Unnamed Peak in S. Delamar Mountains	4,135,352	701,473	7,800	USGS

[a]All coordinates in UTM North American Datum of 1983 (NAD83) Zone 11.
[b]Elevations are North American Vertical Datum of 1988 (NAVD88).

The precipitation station network includes the following:

- Six high-altitude precipitation stations maintained and operated by USGS through a cooperative funding agreement with SNWA and the NDWR.

- Seven National Oceanic and Atmospheric Administration, National Weather Service Stations. Data will be obtained through the Western Regional Climate Center (WRCC).

- One U.S. Department of Agriculture National Resources Conservation Service (NRCS) SNOwpack TELemetry (SNOTEL) site located in the Egan Range. This site provides precipitation and snow-accumulation data.

SNWA will continue to compile and report precipitation data from these sites as long as the data are made available and the stations are in operation.

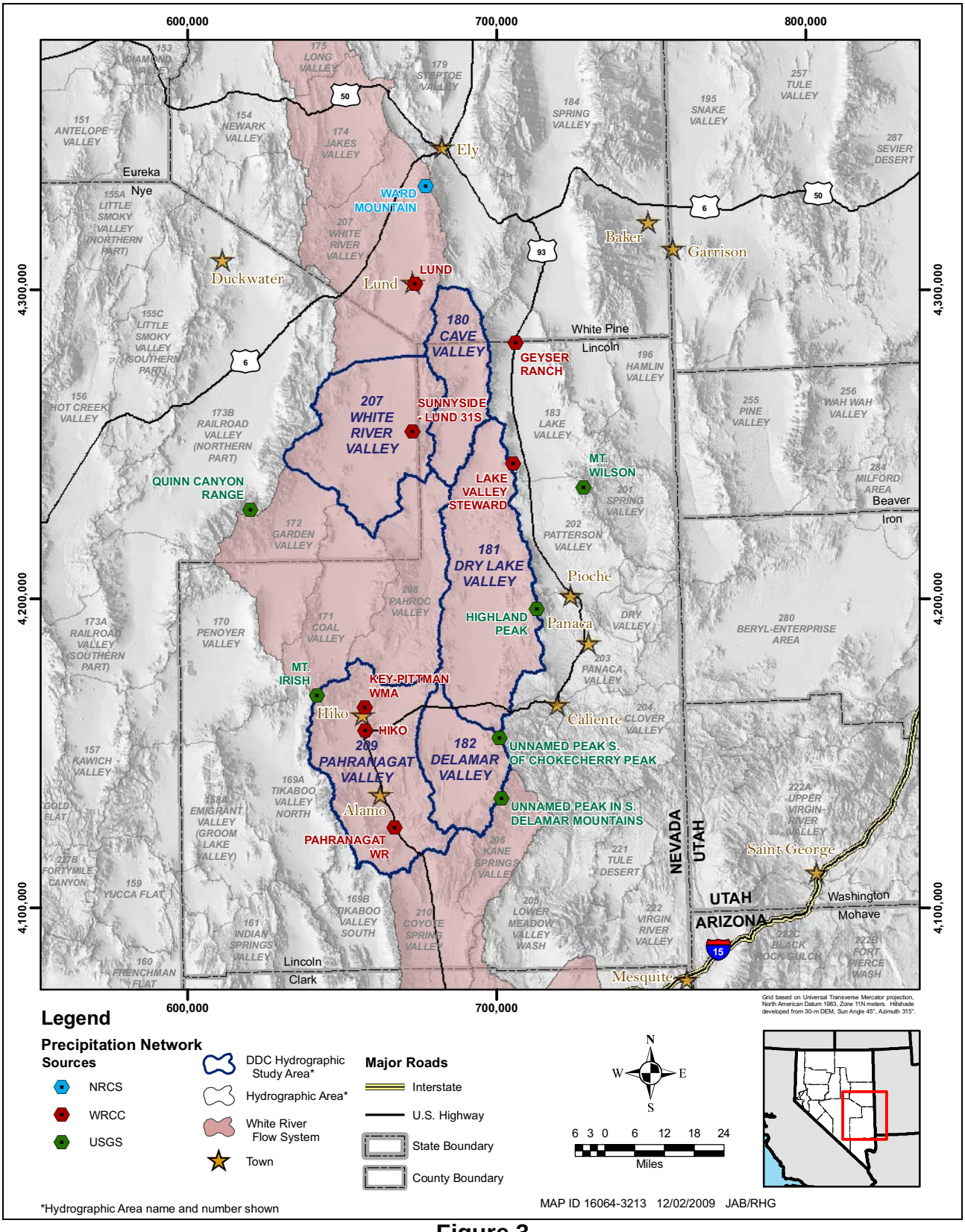


Figure 3
DDC Precipitation Station Locations

3.6 Water-Chemistry Baseline Data Monitoring Program

Monitoring of groundwater and surface-water chemistry will be implemented to establish baseline conditions. The sampling program will consist of the collection of 10 samples from representative springs and monitor wells determined by the SNWA and NSE. Two sampling events will be performed at 6-month intervals to collect baseline data. SNWA will collect and submit samples for chemical analysis for the water-chemistry parameters listed in Table 6.

Table 6
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[a]	Chromium
Dissolved oxygen	Chloride	Carbon-14[a]	Lead
	Bromide	Carbon-13[a]	Mercury
	Fluoride	Strontium-87[a]	Selenium
	Nitrate	Uranium-238[a]	Silver
	Phosphate		Manganese
	Sulfate		Aluminum
	Alkalinity		Iron
	Silica		Bromide
	Magnesium		Fluoride

[a]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 plan.

Subsequent sampling will be performed once every five years following the start of groundwater production by SNWA.

3.7 Numerical Modeling of Regional Groundwater Flow

SNWA will develop, maintain, update, and operate a regional groundwater flow system numerical model. Modification of the conceptual and numerical model of the regional groundwater flow system may occur based upon additional hydrologic, geologic, geophysical, and/or geochemical data collected.

SNWA will update the NSE-approved groundwater flow model every five years after pumping begins and submit the updated predictive results under pumping conditions for 10-, 25-, and 100-year periods.

SNWA will provide model output for evaluation by the NSE in the form of input files, output files, drawdown maps, tabular data summaries, and plots of simulated water levels for the aquifer system.

3.8 Data Collection Methodology and Quality Control Procedures

All data collection and processing will be performed following SNWA procedures, which meet or exceed industry standards. Applicable standards from organizations, such as the American Society for Testing and Materials, the U.S. Environmental Protection Agency, and USGS, for each element of the program are incorporated as appropriate. A quality assurance (QA)/quality control (QC) program will be followed, which includes the following elements: (1) identification of QA/QC procedure and direct organizational responsibilities; (2) staff training; (3) project work plans and reviews; (4) instrumentation deployment, maintenance and calibration with the use of methodologies and appropriate industry-recognized standards with traceability to the National Institute of Standards and Technology when appropriate; (5) data collection protocols and documentation; (6) sample collection, chain of custody, and laboratory-analysis procedures; (7) data processing and review procedures; and (8) data storage protocols.

4.0 DATABASE DEVELOPMENT AND REPORTING

4.1 Database Management

All data collected pursuant to this plan will be processed according to the applicable SNWA procedure(s) and stored in an appropriate, computerized database and/or physical file. Database quality will be maintained by verifying database input against original data files. Internal cross-checks of new data in the database will be performed at the time of entry to identify anomalous new or existing data. Original data will be maintained in paper or electronic archives to ensure integrity and traceability. Data reviews will be performed to verify that data are collected and entered into the database properly and accurately.

4.2 Reporting

Using data from groundwater-level measurements of all production and monitor wells used in this plan, SNWA will produce groundwater contour maps and water-level change maps for both the basin-fill and carbonate-rock aquifers (1) at the end of baseline data collection and (2) annually thereafter at the end of each year of groundwater withdrawals by SNWA.

Water-level and groundwater-production data will be submitted to the NSE quarterly in electronic format as specified by the NSE. Water-chemistry laboratory reports will be made available to the NSE within 90 calendar days of receipt.

SNWA will report the results of all monitoring and sampling pursuant to this plan in an annual monitoring data report submitted to the NSE by March 15 of each year that this plan is in effect. The annual monitoring report will include SNWA's proposed schedule of groundwater withdrawals for the immediately succeeding two calendar years.

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5.0 MANAGEMENT AND MITIGATION ACTIONS

SNWA will implement management and mitigation actions as required by the NSE.

Mitigation measures may include, but are not limited to, one or more of the following:

- Geographic redistribution of groundwater withdrawals.
- Reduction or cessation of groundwater withdrawals.
- Provision of consumptive water-supply requirements using surface and groundwater sources.
- Augmentation of water supply for existing water-rights holders and groundwater-dependent and environmentally sensitive resources using surface and groundwater sources.
- Implementation of other measures as required by the NSE.

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