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SOUTHERN NEVADA WATER AUTHORITY

Water Resources Division

Hydrologic Monitoring and Mitigation Plan for Spring Valley (Hydrographic Area 184)

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CONTENTS

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FIGURES

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TABLES

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ACRONYMS

BLM	Bureau of Land Management
BWG	Biological Working Group
DOI	U.S. Department of the Interior
DTW	depth to water
EC	Executive Committee
GBNP	Great Basin National Park
HA	hydrographic area
LVVWD	Las Vegas Valley Water District
NAD83	North American Datum of 1983
NDWR	Nevada Division of Water Resources
NSE	Nevada State Engineer
NWIS	National Water Information System
QA	quality assurance
QC	quality control
SNPLMA	Southern Nevada Public Lands Management Act
SNWA	Southern Nevada Water Authority
TRP	Technical Review Panel
UGS	Utah Geological Survey
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

ABBREVIATIONS

amsl	above mean sea level
bgs	below ground surface
cfs	cubic feet per second
ft	foot
in.	inch
m	meter
mi	mile

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1.0 INTRODUCTION

The purpose of this document is to present the proposed Southern Nevada Water Authority (SNWA) Monitoring and Mitigation Plan for Spring Valley hydrographic area (HA) 184. The location of the Spring Valley hydrographic area is presented in Figure 1. SNWA proposes that this Monitoring and Mitigation Plan be included by the Nevada State Engineer (NSE) as a permit condition associated with SNWA groundwater permits for applications 54003 through 54021.

1.1 Previous Studies and Reports

Numerous studies related to Spring Valley and adjacent basins have been performed since the late 1940s. These studies have included water resource investigations, geologic and hydrogeologic studies, recharge and discharge estimations, and other hydrologic studies. Studies included Nevada Division of Water Resources (NDWR)/U.S. Geological Survey (USGS) Reconnaissance Investigations, U.S. Air Force MX Missile Siting Investigation-Water Resource Program Study, Basin and Range Carbonate Aquifer System Study, and numerous SNWA and LVVWD studies. These studies are summarized by Burns and Drici (2011).

Since the applications were filed in 1989, LVVWD and SNWA have worked to define the basin characteristics and hydrologic baseline conditions in Spring Valley. This has been done by acquiring groundwater and surface water data and conducting hydrologic and geologic investigations within Spring Valley and adjacent basins. SNWA has completed numerous hydrologic study reports associated with Spring Valley. Recent reports document results from geophysical studies, test well completions, aquifer testing, evapotranspiration studies, and hydrologic and biological monitoring.

Additional summary reports were prepared in support of the 2011 water right application hearing. These include *Geology and Geophysics of Spring, Cave, Dry Lake, and Delamar Valleys, White Pine and Lincoln Counties and Adjacent Areas, Nevada and Utah: The Geologic Framework of Regional Groundwater Flow Systems* (Rowley et al., 2011), *Hydrology and Water Resources of Spring, Cave, Dry Lake, and Delamar Valleys, Nevada and Vicinity* (Burns and Drici, 2011), *Committed Groundwater Resources in four Nevada Hydrographic Areas: Cave, Dry Lake, Delamar, and Spring Valleys* (Stanka, 2011), and *SNWA Hydrologic Management Program for Groundwater Development in Spring, Cave, Dry Lake, and Delamar Valleys, Nevada* (Prieur, 2011), and *Environmental Evaluation Regarding SNWA Applications in Spring, Cave, Dry Lake, and Delamar Valleys* (Marshall and Luptowitz, 2011).

1.2 Hydrologic Monitoring Data Reports

Data have been provided to the NSE and DOI on a quarterly basis and in annual status and data reports which have been published since 2008. The previously approved Monitoring and Mitigation

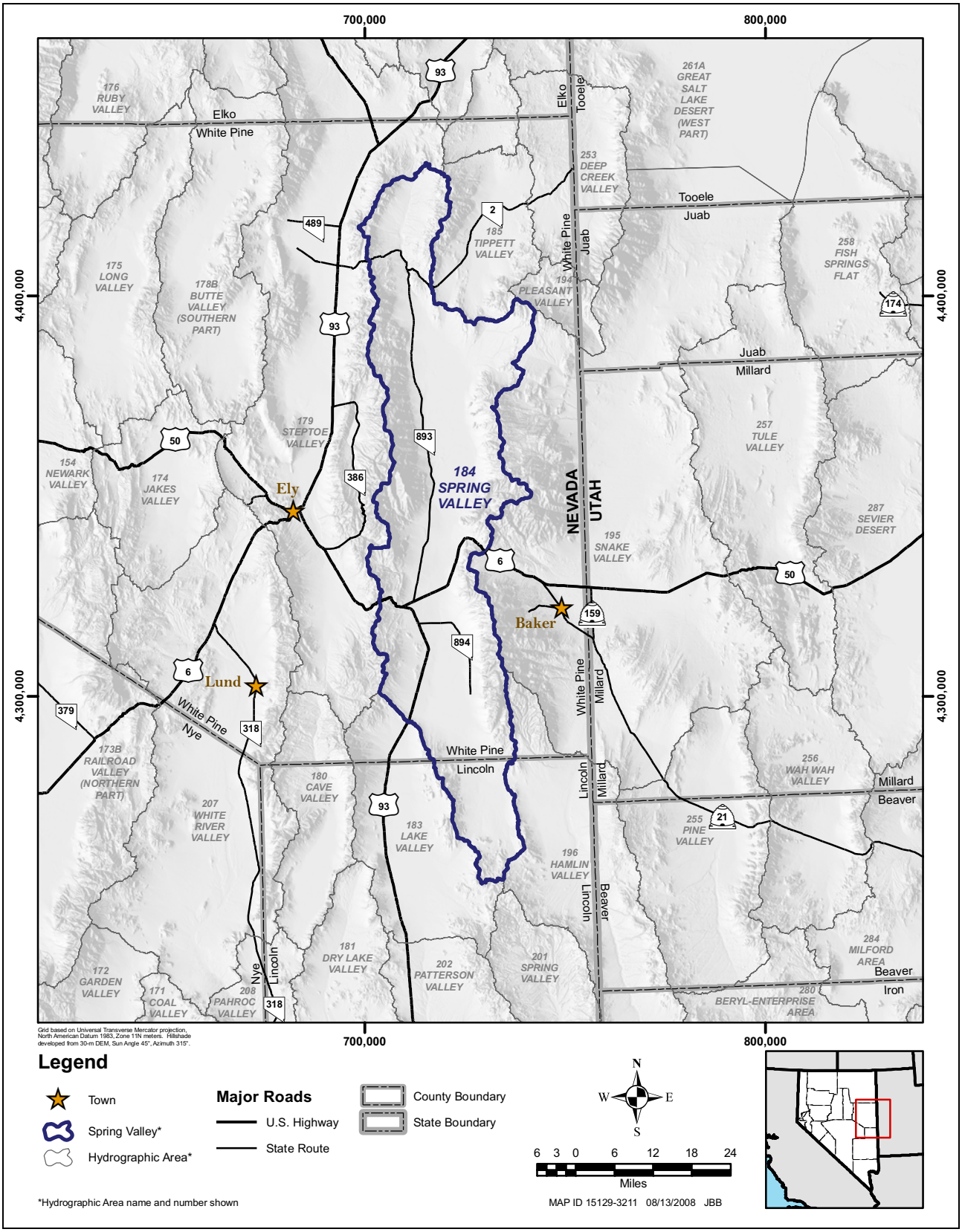

Figure 1
Spring Valley Hydrographic Area 184

Plan has been implemented with plan-specific data collection occurring since 2007. This program builds upon historical hydrologic data which dates as far back as 1914 (at Cleve Creek). The plan status and data collected for each element of the monitoring and mitigation plan as of January 2011 is presented in the *2010 Spring Valley Hydrologic Monitoring and Mitigation Plan Status and Data Report* (SNWA, 2011). The previous annual reports presenting historical and specific data collected in 2007-2009 are presented in SNWA (2008, 2009, and 2010).

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2.0 MONITORING AND MITIGATION PLAN REQUIREMENTS

This section summarizes the key objectives and requirements of the monitoring and mitigation plan. The tasks that satisfy these requirements are presented in Section 3.0.

2.1 Stipulation Agreement

On September 8, 2006, a Stipulation for Withdrawal of Protests (Stipulation) was entered into between SNWA and the U.S. Department of the Interior (DOI), on behalf of the Bureau of Indian Affairs, the Bureau of Land Management (BLM), the National Park Service, and the U.S. Fish and Wildlife Service (collectively known as the DOI Bureaus) (Stipulation, 2006). Exhibit A to the Stipulation requires development of a hydrologic monitoring plan. As part of the Stipulation, an Executive Committee (EC) was established to oversee the implementation of the Stipulation. The hydrologic Technical Review Panel (TRP), composed of technical expert representatives of the parties to the Stipulation, was also established to develop and oversee implementation of the hydrologic monitoring and mitigation plan, review program data, and modify the plan, if necessary.

Development and implementation of a biological monitoring, management, and mitigation plan was also required pursuant to Exhibit B of the Stipulation. A Biological Working Group (BWG), was established to develop and oversee implementation of the biological monitoring, management and mitigation plan.

The goals stated in the Stipulation are: (1) to manage the development of groundwater by SNWA in the Spring Valley hydrographic area without causing injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources in the Area of Interest; (2) to accurately characterize the hydraulic gradient from the Spring Valley hydrographic area to the Snake Valley hydrographic area via Hamlin Valley; and (3) to avoid any effect on Federal Resources located within the boundaries of the Great Basin National Park (GBNP) from groundwater withdrawal by SNWA in the Spring Valley hydrographic area.

Additional common goals are: (1) to manage the development of groundwater by SNWA in Spring Valley hydrographic area in order to avoid unreasonable adverse effects to wetlands, wet meadow complexes, springs, streams, and riparian and phreatophytic communities (Water-Dependent Ecosystems) and to maintain biologic integrity and ecological health of the Area of Interest over the long term; (2) to avoid any effect to Water-Dependent Ecosystems within the boundaries of the GBNP; and (3) to avoid an unreasonable degradation of the scenic values of and visibility from the GBNP due to a potential increase in airborne particulates and loss of surface vegetation that may result from groundwater withdrawals by SNWA in Spring Valley.

2.2 Proposed Monitoring Requirements for Non-Federal Water Rights

The requirements for monitoring water rights not subject to the Stipulation (private and other non-Federal water rights regulated by the NSE) may include the following:

- Develop a monitoring and mitigation program which is approved by the NSE.
- Conduct monitoring that will provide data to ensure existing water rights are protected.
- Collect a minimum of 5 years of biological and hydrological baseline data. The baseline monitoring program must be approved by the NSE prior to the export of any groundwater resources from Spring Valley under the permits.
- File an annual data report with the NSE by March 31 of each year detailing the findings of the NSE-approved Monitoring Plan. (One combined annual data report which presents all data required by the Stipulation and NSE has been prepared each of the last 4 years).
- Update a NSE-approved groundwater flow model every 5 years and provide predictive results for 10, 25, and 100 years.
- Modify or curtail pumping under specific conditions. If pumping effects impact existing rights, conflict with the protectable interests in existing domestic wells, as set forth in Nevada Revised Statutes §533.024, threaten to prove detrimental to the public interest or are found to not be environmentally sound, SNWA will be required to curtail pumping and/or mitigate the impacts to the satisfaction of the NSE.

The Monitoring and Mitigation Plan includes all the requirements by the Stipulation with three additional elements. The additional elements are associated with non-Federal water rights and include additional spring and groundwater monitoring in the vicinity of the Cleveland Ranch (implemented in 2010 and 2011), spring discharge monitoring of Turnley Spring located on Sacramento Pass (implemented in 2008), and an additional monitor well 1 mi north of the northernmost production well on the east side of Spring Valley based upon the well configuration at time of commencement of water export from the basin (to be implemented in the future after initial production well network configuration is complete). A description of each of these three elements of the Monitoring and Mitigation Plan is presented in Section 3.7.

2.3 Monitoring and Mitigation Plan Elements

The Monitoring and Mitigation Plan was developed to meet Stipulation and non-federal water right monitoring objectives and requirements. The key elements of the program are presented below with the current status of each element of the monitoring program described in parenthesis.

- General Requirements
  - Design and implement a baseline hydrologic data collection program.

- Monitor Well Data Collection

  - The groundwater monitor well network was selected in consensus with the TRP and NSE technical representatives. Emphasis was placed on selecting wells with known well construction attributes and integrity. Wells were selected to provide spatial and vertical data in varying hydrogeologic conditions. Wells completed in carbonate, basin fill and volcanic materials are included in the network.

  - Collect water-level data at 10 existing monitor wells on a quarterly basis (started in 2007 and is currently ongoing).

  - Collect water-level data at 15 existing monitor wells on a continuous basis (started in 2007-2009 and is currently ongoing). The description and construction attributes of the existing wells measured quarterly and continuously are presented in Section 3.2.1.

  - Install two monitor wells in the vicinity of Shoshone Ponds. Water-level data will be collected continuously from each well (installed in 2011).

  - Install two monitor wells between the Interbasin Groundwater Monitoring Zone (Zone), (an area located in southeast Spring Valley, eastern Hamlin Valley and southwestern Snake Valley as described in Section 3.2.2.1), and the two SNWA production wells located closest to the Zone. Water-level data will be collected continuously at these near-Zone wells. (The well locations will be determined and installed after the production well network configuration is established).

  - Record quarterly water-level data in all SNWA exploratory and test wells in Spring Valley. (Started in 2007 and is currently ongoing). The TRP will identify selected exploratory wells for continuous monitoring subsequent to the beginning of groundwater withdrawals should the TRP agree additional monitoring is needed.

  - Install four new monitor wells in the vicinity of the Cleveland Ranch as required by NSE (implemented in 2010 and 2011). Locations were selected in consensus with the NSE and the property owner (Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-Day Saints).

  - Install an additional monitor well 1 mi north of the northernmost production well on the east side of Spring Valley based upon the well configuration at time of commencement of water export from the basin as required by NSE (to be implemented in the future after the configuration of the production well network is determined).

- Spring, Hamlin, and Snake Valleys Hydrologic Relationship

  - Develop a network of four carbonate and two basin-fill wells to monitor the Zone and characterize the hydraulic gradient from the Spring Valley hydrographic area to the Snake Valley hydrographic area via Hamlin Valley. One of the wells is planned to be installed in the immediate vicinity of Big Springs in southern Snake Valley. (One well is in place and

an additional five wells will be installed in the future to meet plan time frame requirements). Two additional wells have been installed by USGS as part of the Southern Nevada Public Lands Management Act (SNPLMA) program in the carbonate rock southwest and in basin-fill material northwest of Big Springs.

- Future Production Well Monitoring

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

- Surface Water Streams and Springs

  - Program spring and stream monitoring sites were determined in consensus with the TRP and NSE. Site locations are presented in Section 3.4. A summary of the sites are presented below.

  - Install 12 shallow piezometers adjacent to spring locations determined by the TRP. Piezometer locations are listed in Section 3.4.1 (installed in 2010). Water-level data will be collected continuously from each location. One additional mountain block spring (Rock Spring) was selected by the TRP for collection of spring discharge data only (installed in 2009).

  - Spring discharge monitoring of Turnley Spring located on Sacramento Pass as required by NSE (implemented in 2008).

  - Install two flumes at two springs and one shallow piezometer located on Cleveland Ranch as required by NSE (installed in late 2010 and early 2011). Locations were selected in consensus with the NSE and the property owner (Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-Day Saints).

  - Spring discharge is recorded at network locations where discharge is measurable. Current locations are presented in Section 3.4.1.

  - Operate and maintain surface-water gages at Cleve Creek (period of record since 1914) and Big Springs Creek (period of record since 2006) (currently ongoing).

  - Collect two sets of synoptic-discharge measurements during irrigation and non-irrigation seasons for the Big Springs Creek and Lake Creek surface water system from Big Springs to Pruess Lake. The two sets of measurements will be repeated every 5 years following the start of groundwater withdrawals in Spring Valley hydrographic area by SNWA. (The study will be performed in the future to meet monitoring plan time frame requirements before the start of groundwater withdrawals in Spring Valley). The Utah Geological Survey (UGS) has installed and is operating continuous gaging stations at Stateline and Clay Springs within the complex to provide gain loss data over segments of the streams.

- Precipitation Network

  - Select a regional precipitation network from stations with an established historical record in the vicinity of the study area (completed in 2008).

- Baseline Water Chemistry

  - Perform chemical analyses of selected parameters on three rounds of samples collected from wells, piezometers, and surface water sites determined by the TRP. The program will consist of three sampling events at 6-month intervals. (The TRP agreed to perform an initial round of sampling at 35 locations completed in late 2010 and early 2011. Second and third rounds will be completed after installation of the five Zone monitor wells at 40 locations). Water chemistry sample site locations are presented in Section 3.6.

  - Perform an additional round of sampling every 5 years after the commencement of groundwater production.

- Modeling

  - Continue to maintain and update a numerical flow model of the regional groundwater flow system.

- Reporting

  - Provide data collected associated with the monitoring plan as required by the NSE as described in Section 4.2.

  - File an Annual Hydrologic Data Report with the NSE by March 31 of each year detailing 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 Monitoring and Mitigation Plan encompass those set forth by the Stipulation and by the NSE, which focus on the identification and assessment of potential impacts to existing water-right holders and areas of interest within Spring Valley. As changes to the Stipulation monitoring and mitigation requirements occur, the Monitoring and Mitigation Plan will be updated with the approval of the NSE.

3.1 Baseline Hydrologic Monitoring Program

The Monitoring and Mitigation Plan focuses on establishing a network to collect hydrologic data for the purposes of defining baseline conditions prior to SNWA withdrawals and detecting the effects of these withdrawals as pumping occurs. The network includes monitoring at valley-floor and higher-elevation springs; monitor wells completed in the basin fill, carbonate, and volcanics which are spatially distributed across the valley; and stream monitoring at Cleve Creek in Spring Valley and near Big Springs in Snake Valley. The program uses existing regional precipitation stations with an extended period of record located in the vicinity of Spring Valley. Data is collected at a frequency designed to meet Monitoring and Mitigation Plan objectives and requirements as well as to provide representative data on temporal fluctuations.

Acquisition of baseline hydrologic and hydrogeochemical data will follow the program presented in the Monitoring and Mitigation Plan with modifications as determined by the NSE. Consensus modifications by the TRP with appropriate approval by the EC will be incorporated into the plan with NSE approval.

3.2 Monitor Wells

Data collected under this Monitoring and Mitigation Plan provides representative hydrologic data on the valley aquifer systems. The Monitoring and Mitigation Plan includes monitoring of new and existing wells completed in basin fill, carbonate, and volcanic materials at strategic locations to provide representative data across the study area. Monitor well locations were selected through consensus agreement with the TRP and NSE technical representatives with due consideration for the hydrogeologic conditions at each site, location of potential pumping centers and areas of interest. Geologic reconnaissance, stratigraphic and structural field mapping, aerial photo analysis, surface geophysics, and review of existing hydrogeologic data was performed to assist in well selection. Some sites were selected to provide background data and provide identification and quantification of propagation of drawdown, or early warning, between potential pumping centers and areas of interest. The network also includes monitor wells within the Zone to assist in the evaluation of the relationship of groundwater flow between Spring, Hamlin, and Snake Valleys.

3.2.1 Existing Well Network

SNWA will record water levels quarterly in 10 representative monitor wells and continuously in 15 representative monitor wells in the Spring Valley and Hamlin Valley hydrographic areas. The data collection interval for continuous measurements is hourly. The approved monitor well locations, including completion information and measurement frequency, are presented on Figure 2. Well construction attribute data and recent groundwater level data for each location is presented in Table 1. Map identification numbers relate to Table D.1-1 in the SNWA Water Resources Assessment for Spring Valley (SNWA, 2006) which was submitted to the NSE on June 30, 2006. Site Number 391224114293601, the Cleve Creek well site in the original monitoring plan, was replaced with two new Cleve alluvial fan wells described in Section 3.7. The Cleve Creek well had limited access and well construction information. The new wells provide increased well construction integrity and provide vertical hydraulic gradient data at the site.

The wells were selected to: (1) serve as monitoring points and early warning indicators between SNWA's future production wells and existing water-right holders as well as Federal Water Rights and Federal Resources; (2) provide spatially distributed hydrologic data from basin-fill, carbonate, and volcanic aquifers within Spring and Hamlin Valleys in order to analyze and produce annual groundwater-level contour and water-level drawdown maps; (3) calibrate the groundwater flow model; and (4) evaluate the effects of SNWA's groundwater withdrawals.

Modification of this element of the Monitoring and Mitigation Plan, including any addition, subtraction, or replacement of the wells initially selected by the TRP or changes to the frequency of monitoring for these wells, would be made through consensus recommendations from the TRP, or as required by the NSE. Monitoring locations may be eliminated or alternative locations selected if private property access is restricted.

3.2.2 New Monitor Well Locations

In the Stipulation, the DOI Bureaus agreed to expedite the National Environmental Policy Act review and other clearances, within the limits of applicable laws, to help meet the requirements of future monitor well installation included in the Monitoring and Mitigation Plan. The construction of future monitor wells is contingent upon private property accessibility and issuance of appropriate rights-of-way by various Federal and State agencies.

3.2.2.1 New Monitor Wells in the Interbasin Groundwater Monitoring Zone

An objective of the Monitoring Plan is to effectively characterize the hydraulic gradient between Spring, Hamlin, and Snake Valleys. This area was identified by the establishment of the Interbasin Groundwater Monitoring Zone. The Zone boundaries are presented on Figure 3.

SNWA, in consultation with the NSE and TRP, is required to construct and equip four monitor wells in the carbonate-rock aquifer and two monitor wells in the basin-fill aquifer within the Zone. The agreed upon locations for the six SNWA monitor wells within the Zone are presented on Figure 3 and listed in Table 2. Carbonate Well 184W502M has already been installed. Right-of-way applications

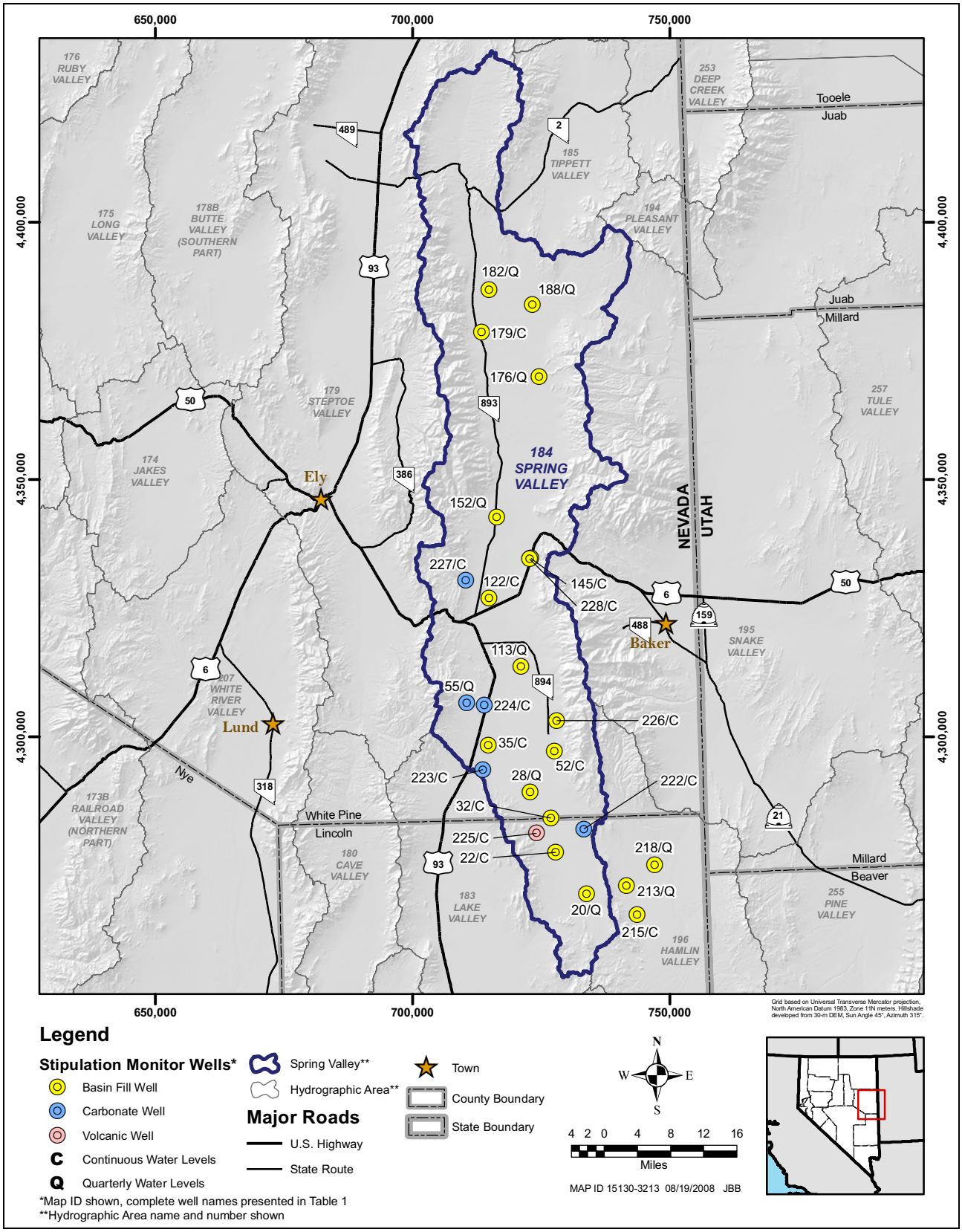

Figure 2
Spring Valley Existing-Well Monitoring Network

Table 1
Spring Valley Existing-Well Monitoring Network

Map ID	Site Number	Station Local Number	Location[a]		NDWR Log Number	Surface Elevation (ft amsl)	Completion Date	Drill Depth (ft bgs)	Well Depth (ft bgs)	Well Casing Diameter (in.)	Screened Interval (ft bgs)	Open Interval (ft bgs)	Date of Recent DTW Meas.	Recent DTW Meas. (ft bgs)	Aquifer	Monitor Frequency
			UTM Northing (m)	UTM Easting (m)												
22	383704114225001	184 N09 E68 30AAAB 1 USGS-MX (Spring Valley S.)	4,277,594.57	727,759.99	22176	6,002.52	8/7/1980	700	679	11	559 to 679	50 to 700	9/15/2010	224.90	Basin Fill	Continuous
32	384039114232701	184 N10 E68 31CD 1 USGS-MX	4,284,275.68	726,871.51	---	5,896.49	---	---	150	2	---	50 to 150	9/15/2010	118.35	Basin Fill	Continuous
35	384831114314301	184 N11 E66 23AB 1 USGS-MX	4,298,411.13	714,633.01	---	5,842.94	---	102	102	2	---	50 to 102	9/14/2010	47.52	Basin Fill	Continuous
52	384745114224401	184 N11 E68 19DCDC 1 USGS-MX (Spring Valley)	4,297,304.22	727,554.19	---	5,900.18	---	200	200	2	---	50 to 200	9/15/2010	100.11	Basin Fill	Continuous
122	390352114305401	184 N14 E66 24BDDD 1 USGS-MX (Spring Valley N.)	4,326,894.19	714,873.84	---	5,846.04	1980	---	160	2	---	50 to 160	9/15/2010	38.76	Basin Fill	Continuous
145	390803114251001	184 N15 E67 26CA 1 USGS-MX	4,334,740.47	722,963.02	---	5,727.21	---	---	200	2	---	50 to 200	9/15/2010	40.30	Basin Fill	Continuous
179	393211114320701	184 N19 E66 11B 1	4,378,627.03	713,381.69	---	5,698.43	4/22/1960	---	400	---	---	50 to 400	9/15/2010	43.12	Basin Fill	Continuous
215	383023114115302	196 N08 E69 35DC 2 USGS-MX (Hamlin Valley S.)	4,265,403.02	743,597.36	---	5,837.67	8/7/1980	520	435	2	320 to 420	35 to 520	9/15/2010	174.76	Basin Fill	Continuous
222	184W502M	184 N09 E68 11 BD 2	4,282,116.34	733,294.42	102843	6,189.72	1/25/2007	1,828	1,799	8	495 to 1,779	58 to 1,828	9/15/2010	482.33	Carbonate	Continuous
223	184W504M	184 N11 E66 34 DD 2	4,293,712.49	713,647.12	102158	5,900.11	11/17/2006	1,040	1,020	8	309 to 999	61 to 1,040	9/16/2010	100.75	Carbonate	Continuous
224	184W506M	184 N12 E66 26 BA 2	4,306,214.21	713,939.81	102132	6,014.04	10/19/2006	1,160	1,140	8	430 to 1,120	80 to 1,160	9/14/2010	216.05	Carbonate	Continuous
225	184W508M	184 N09 E67 11 DB 1	4,281,308.68	724,070.89	102139	6,056.19	12/15/2006	1,180	1,160	8	376 to 1,140	241 to 1,180	9/15/2010	276.79	Volcanic	Continuous
226	SPR7007M	184 N11 E68 05 BC 2	4,303,146.59	727,976.03	---	6,017.73	8/17/2007	1,040	1,020	8	300 to 1,000	101 to 1,040	9/15/2010	147.20	Basin Fill	Continuous
227	SPR7005M	184 N14 E66 09 AB 2	4,330,471.51	710,372.44	---	6,395.68	7/10/2007	1,412	1,404	8	663 to 1,383	439 to 1,412	9/15/2010	494.24	Carbonate	Continuous
228	SPR7008M	184 N15 E67 26 CD 2	4,334,702.61	722,865.27	---	5,704.86	7/25/2007	960	946	8	226 to 926	54 to 960	9/15/2010	14.47	Basin Fill	Continuous
20	383351114180201	184 N08 E68 14A 1 USBLM	4,269,504.76	733,845.43	---	6,184.22	---	---	495	6	50 to 495	50 to 495	8/4/2010	406.52	Basin Fill	Quarterly
28	384310114261401	184 N10 E67 22AA 1 USGS-MX (Spring V Central)	4,289,331.34	722,826.33	---	5,853.54	---	---	100	2	---	50 to 100	8/3/2010	65.58	Basin Fill	Quarterly
55	184 N12 E66 21CD 1	184 N12 E66 21CD 1	4,306,700.53	710,871.15	10440	6,370.31	9/13/1966	631	631	6	3 to 631	3 to 631	8/3/2010	570.20	Carbonate	Quarterly
113	385636114265501	184 N13 E67 33DDA 1	4,313,590.54	721,086.82	---	5,769.73	---	---	--	36	---	---	5/5/2010	7.47	Basin Fill	Quarterly
													8/4/2010	Dry		
152[b]	391224114293601	184 N16 E66 36DBAD 1 USBLM - Cleve Creek Well	4,342,683.25	716,362.90	---	5,870.25	---	---	--	---	---	---	8/3/2010	207.74	Basin Fill	Quarterly
176	392703114230501	184 N18 E67 01CCAA 1	4,369,956.56	724,523.82	---	5,587.78	---	---	42	38	---	---	8/3/2010	35.13	Basin Fill	Quarterly
182	184 N20 E66 13AB 1	184 N20 E66 13AB 1	4,386,884.19	714,871.84	9157	5,774.93	6/26/1966	907	296	16	135 to 296	---	8/3/2010	125.91	Basin Fill	Quarterly
188	393442114231801	184 N20 E67 26ABBD 1 USBLM	4,383,955.15	723,240.35	---	5,708.77	---	130	130	6	---	50 to 130	8/3/2010	118.39	Basin Fill	Quarterly
213	383325114134901	196 N08 E69 15B 1	4,271,103.41	741,539.28	---	5,729.98	---	---	110	6	---	50 to 110	8/4/2010	71.41	Basin Fill	Quarterly
218	383533114102901	196 N08 E70 06B 1 USBLM - Monument Well	4,275,166.91	747,014.36	548	5,676.76	7/22/1947	---	164	6	111 to 115/ 152 to 164	---	8/4/2010	89.67	Basin Fill	Quarterly

[a]All coordinates are Universal Transverse Mercator (UTM), North American Datum of 1983 (NAD83), Zone 11.
[b]The Cleve Creek well will be replaced by a new monitor well approximately 1 mi to the north.
Well-construction data are based upon best available information from well logs, MX Project Report, and direct field measurements.

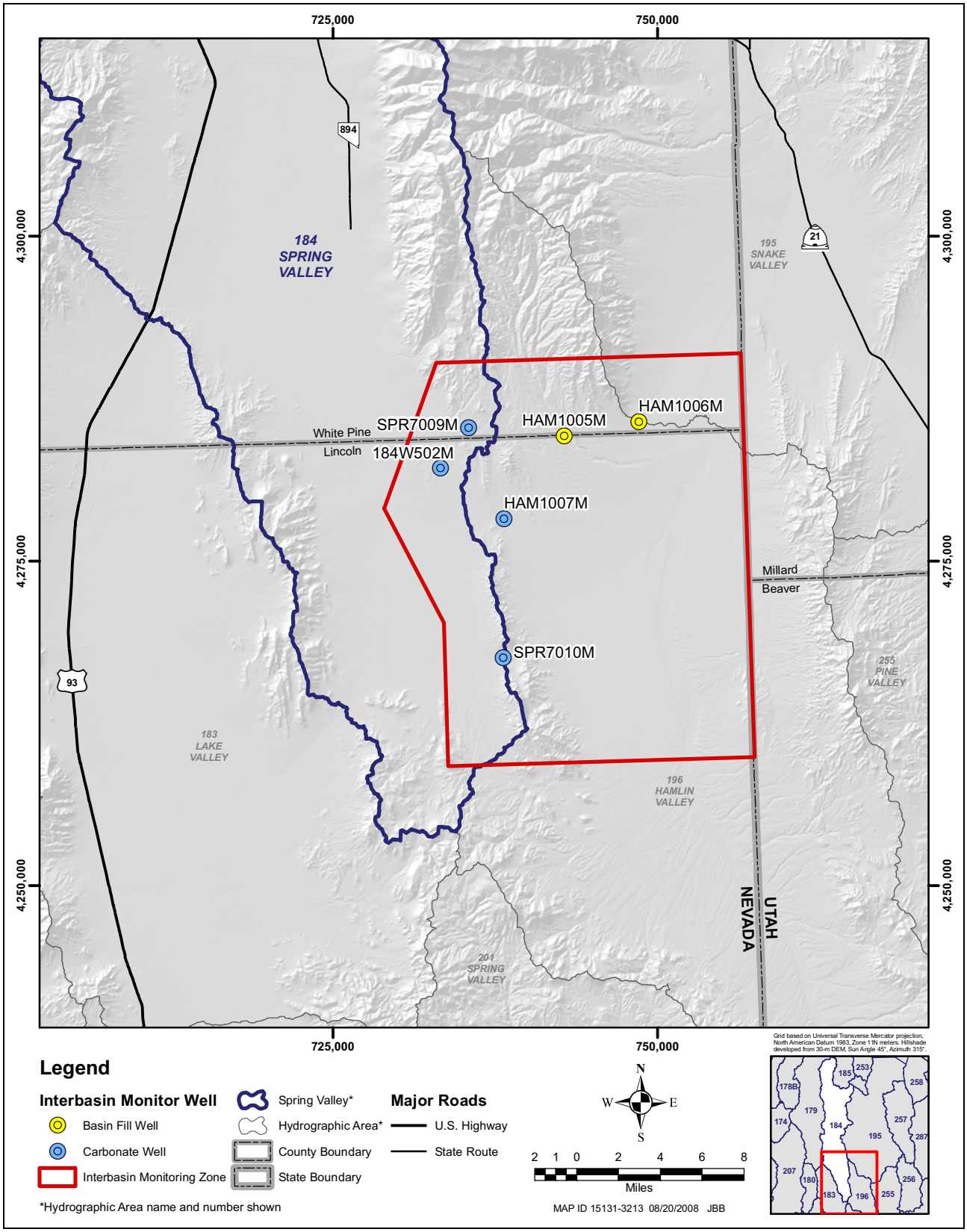

Figure 3
SNWA Interbasin Monitoring Zone Well Locations

Table 2
SNWA Interbasin Monitoring Zone Well Locations

Site Number	Well Alias Name	Well Common Name	Location[a]		Estimated Surface Elevation[a] (ft amsl)
			UTM Northing (m)	UTM Easting (m)	
Basin Fill					
196 N10 E69 02 BBA 1	HAM1005M	Wash Alluvial Well	4,284,588	742,819	6,397
196 N95 E70 32 AAD 1	HAM1006M	Big Springs Well	4,285,699	748,554	5,797
Carbonate					
184 N10 E68 36 ACC 1	SPR7009M	North Carbonate Well	4,285,242	735,445	6,494
196 N09 E69 20 BCB 1	HAM1007M	Troughs Carbonate Well	4,279,203	737,774	6,025
184 N08 E69 29 CBB 1	SPR7010M	Limestone Hills Well	4,267,545	738,113	6,458
184 N09 E68 11 BD 2	184W502M[b]	184W502M	4,282,116.34	733,294.42	6,189.72

[a]Coordinates and elevations are approximate and will be updated based upon professional survey of well location.
[b]Existing Well, professional survey complete.

for the five new well locations were submitted to the BLM for approval on November 26, 2007 and approved on October 8, 2009. The five new wells will be completed to a depth of approximately 250 to 300 ft below the water table depending upon hydrogeologic conditions encountered during drilling. The wells will be installed in the future to meet the Monitoring and Mitigation Plan time frame requirements.

In addition to the new SNWA wells, four existing wells completed in the basin-fill are located in the Zone and are included in the existing well monitoring program, as presented in Section 3.2.1. Two additional wells have been installed by USGS in the immediate vicinity of Big Springs as part of the SNPLMA program. The wells, which are currently maintained by USGS, are completed in the carbonate rock-aquifer southwest and in basin-fill aquifer northwest of Big Springs.

3.2.2.2 New Monitor Wells between the Zone and the nearest SNWA Production Wells

SNWA, in consultation with the TRP and NSE, is required to install and equip two new monitor wells between the Zone and the two future SNWA production wells that are constructed closest to the Zone boundary. Proposed locations of the two new monitor wells are presented on Figure 4; however the final locations will be selected after the production network configuration is determined. Monitor wells SPR7025M and SPR7026M are proposed for completion in basin-fill and carbonate aquifers, respectively. The final completion depth and lithology will be dependent upon hydrogeologic conditions encountered during drilling and will correspond to the completion depths of the nearest SNWA production wells. Near-Zone monitor well locations, designs, and installation schedules have not been finalized and are dependent upon TRP and NSE approval. Continuous water-level measurements will be recorded at the two near-Zone wells.

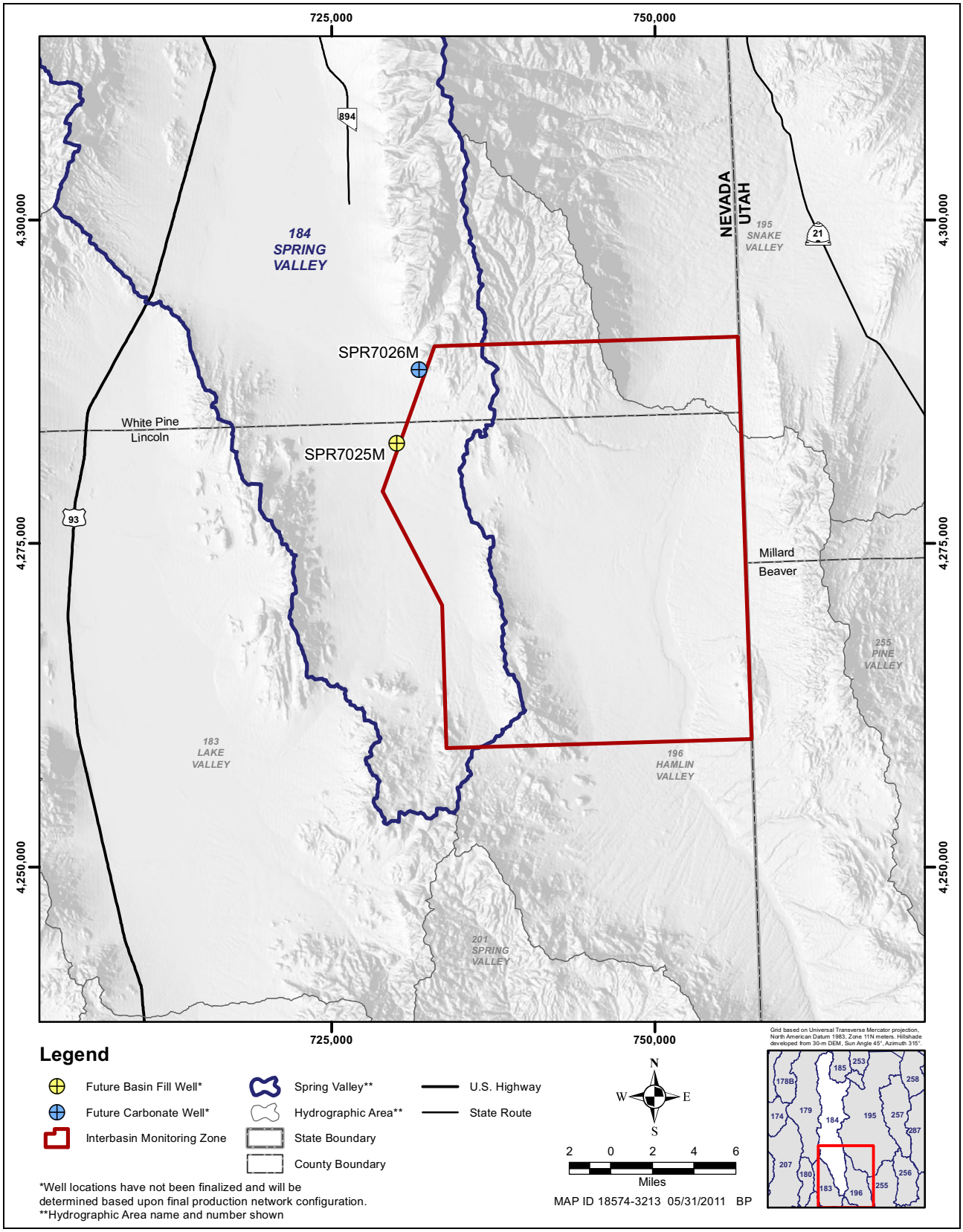

Figure 4
Proposed Near-Zone Monitor Well Locations in Spring Valley

3.2.2.3 New Monitor Wells in the Vicinity of Shoshone Ponds

SNWA constructed and equipped two 4-in. diameter monitor wells located approximately 0.7 mi south-southeast of Shoshone Ponds. The well locations were selected and approved by the TRP and NSE. Both wells were completed in the basin-fill aquifer due to hydrogeologic conditions present. The wells were originally located 0.4 mi south-southeast of Shoshone Ponds. However, the wells were relocated due to the recent establishment of an Area of Critical Environmental Concern in the Shoshone Ponds area. The wells were completed in 2011 at depths of approximately 250 and 700 ft bgs (Mace, 2011c). The wells and provide data on the vertical hydraulic gradient at the sites. The two locations, SPR7024M and SPR7024M2, are presented on Figure 5. SNWA will continuously monitor the water levels in the two wells.

3.2.3 Production and Test 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. Following the beginning of groundwater production pursuant to any SNWA permits, the TRP and NSE will select a representative number of exploratory wells for which SNWA will continuously record water levels.

As of June 2011, SNWA has installed eight 8-in. diameter exploratory and six 20-in. diameter test wells in Spring Valley. Locations of the wells are presented on Figure 6. Well construction, aquifer testing, and groundwater chemistry summary data for the exploratory and test wells are presented in (SNWA, 2008; 2009).

3.3 Aquifer Characterization

Aquifer characterization will be performed using constant-rate pumping tests to evaluate aquifer parameters, such as transmissivity (*T*), hydraulic conductivity (*K*), storage coefficient (*S*), and specific yield (*Sy*). The tests may also identify boundary conditions, provide information on aquifer heterogeneity, and evaluate long-term sustainable pumping rates. In fracture-flow systems, depending upon conditions, the tests may estimate fracture and matrix properties. Aquifer testing results would be used to assess well performance, provide aquifer property data for the groundwater flow model, and evaluate long-term pumping effects.

Well performance step tests and 72- to 120-hour constant-rate tests have been performed on the six Spring Valley SNWA test wells. These locations (184W101, 184W103, 184W105, SPR7005X, SPR7007X, and SPR7008X) are presented on Figure 6. A Geologic Analysis Report, presenting drilling and downhole geophysical data, lithologic descriptions, and structural evaluation, have been prepared for each location and submitted to the NSE (Eastman and Muller, 2009a, b, and c; Mace and Muller, 2010a, b, and c). A Hydrologic Analysis Report, including hydrologic data, well performance and aquifer test analysis, and water chemistry results, have been prepared and submitted for each test well location (Prieur et al, 2010a, b, and c; 2011a, b,and c). These reports are also summarized in the Annual Data Reports (SNWA 2008; 2009). Similar testing may also be performed on selected future test wells.

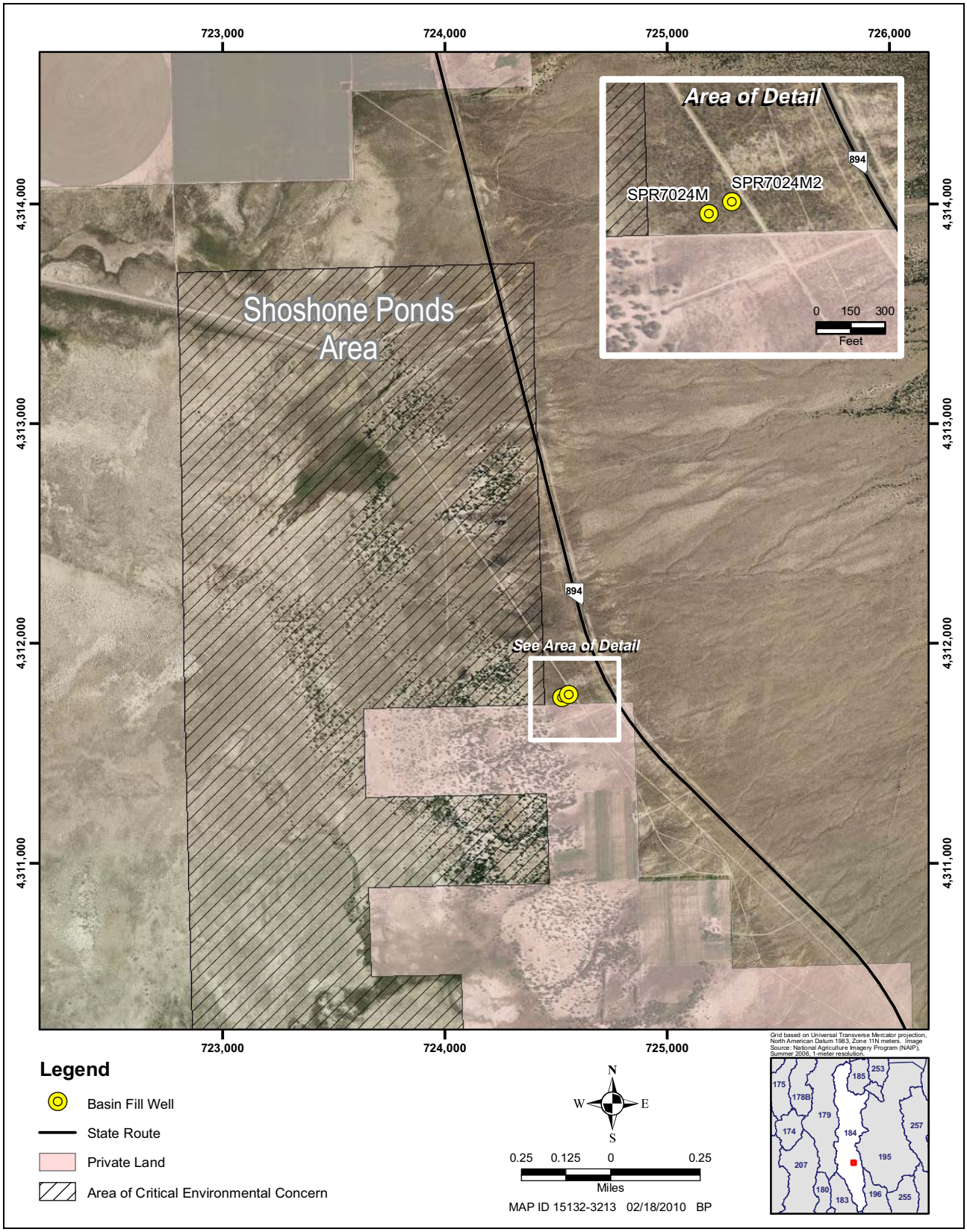

Figure 5
Location of Monitor Wells near Shoshone Ponds

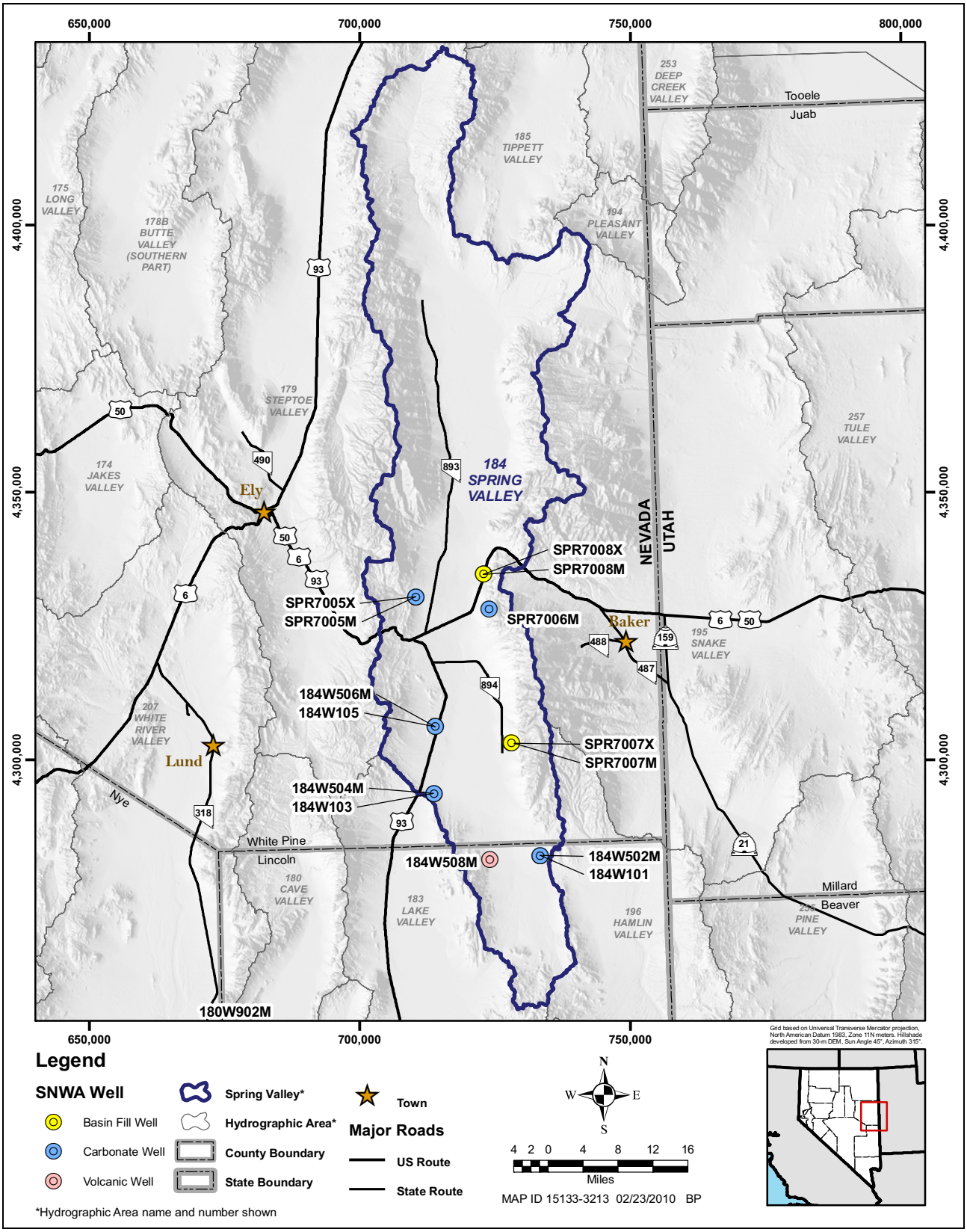

Figure 6
SNWA Exploratory and Test Wells in Spring Valley (as of June 2011)

The test wells were sited in locations of anticipated high hydraulic conductivity such as the alluvial fan and carbonate rock range front fault zone environments. The range front faults are expected to exhibit higher fracture density and secondary porosity compared to areas in the formation away from the fault zone. As a result, the hydraulic conductivity derived from the carbonate test well aquifer tests would be more representative of high fracture areas than low fracture density areas located away from fault zones.

In addition, as required by the Stipulation, one constant-rate aquifer test will be performed by pumping the SNWA basin-fill aquifer production well located closest to the boundary between the Spring Valley and Hamlin Valley hydrographic areas. Similarly, one constant-rate aquifer test will be performed by pumping the SNWA carbonate production well located closest to the boundary between the Spring Valley and the Hamlin Valley hydrographic areas. In the event that SNWA constructs a production well at the point of diversion specified in Application No. 54019, SNWA will perform one constant-rate aquifer test pursuant to the parameters determined by the TRP and NSE.

3.4 Spring and Stream Monitoring

3.4.1 Spring and Associated Piezometer Monitoring

The TRP, in consultation with the biological working group and NSE agreed upon 13 locations associated with the Stipulation to be included in the spring monitoring program. The sites were selected to provide a geographic distribution across the valley and include both valley floor, range front, and mountain block springs. The sites also include basin-fill and carbonate locations. The stipulation springs are listed in Table 3. Spring monitoring requirements at three additional springs,

Table 3
Stipulation Spring Monitoring Locations

Spring Name	Location[a]		Geology
	UTM Northing (m)	UTM Easting (m)	
4WD Spring	4,335,263	716,235	Alluvium/Fan Margin
Blind Spring	4,298,008	724,733	Alluvium/Valley Floor
Keegan Spring	4,369,762	714,908	Alluvium/Fan Margin
Layton Spring	4,331,746	720,069	Alluvium/Valley Floor
Minerva Spring	4,301,007	726,143	Alluvium/Fan Margin
Rock Spring (discharge only)	4,340,195	726,796	Carbonate/Mountain Block
South Millick Spring	4,353,608	725,148	Alluvium/Valley Floor
Stonehouse Spring	4,406,492	710,547	Alluvium/Valley Floor
Swallow Spring	4,302,902	728,648	Alluvium/Range Front
The Seep	4,306,264	724,091	Alluvium/Valley Floor
West Spring Valley Complex 1	4,353,816	717,270	Alluvium/Fan Margin
Willow Spring	4,397,093	713,757	Alluvium/Valley Floor
Unnamed 5 Spring	4,340,632	718,890	Alluvium/Valley Floor

[a]Coordinates are approximate. All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.

Turnley and Cleveland Ranch North and South, associated with existing private water rights required by the NSE are presented in Section 3.7. All Monitoring and Mitigation Plan springs are presented on Figure 7.

Piezometers were installed at 12 Stipulation springs and at Cleveland Ranch North Spring to provide baseline water-level data. SNWA will continuously monitor the water level in each Stipulation piezometer using a pressure transducer and data logger. Spring discharge or spring pond level data will be collected, if possible, during site visits or at least quarterly and correlated to piezometer water levels. At Rock Spring, discharge is measured continuously and a piezometer was not installed because of the hydrogeologic conditions present. At Swallow Springs discharge monitoring is more representative of spring conditions than piezometer water level due to hydrogeologic conditions present at the site. The piezometer installed at Swallow Springs will not be used as the primary monitoring location. Continuous discharge data is collected from near the Swallow south spring orifice and periodic discharge measurements are performed at least quarterly near the Swallow north spring orifice.

3.4.2 Stream Discharge Measurements

SNWA will directly, or indirectly, through funding of an agreed-upon third party, operate and maintain stream gages on Cleve Creek and Big Springs and report such measurements over the Internet via the USGS, National Water Information System (NWIS), or other appropriate website(s) throughout the duration of the Monitoring and Mitigation Plan. Stream measurement locations and recent discharge measurements are listed in Table 4 and presented on Figure 8.

3.4.3 Big Springs Synoptic Discharge Measurement Study

Contingent upon private property access, SNWA will collect, or fund the collection of, at least two sets of synoptic-discharge measurements (also known as “gain/loss runs”) from the spring orifice to Pruess Lake for the Big Springs Creek - Lake Creek surface water system. The Big Springs Study area is presented on Figure 9. These data will be collected during the irrigation and non-irrigation seasons at least 1 year prior to groundwater production by SNWA, and again during the irrigation and non-irrigation seasons every 5 years following the start of groundwater production. The TRP will recommend the number of measurement sites during the discharge study. Measurements at each site are planned to include discharge, water temperature, pH, and electrical conductivity.

The UGS has installed and is operating continuous gaging stations at Stateline and Clay Springs to provide gain loss data over segments of the streams. Data available from the UGS will be utilized in the studies and will provide, along with the Big Springs gages, additional continuous data on the Big Springs - Lake Creek complex behavior.

SNWA will work with the TRP to collect data to investigate the relationship between discharge at Big Springs and hydraulic head in the basin-fill and regional carbonate-rock aquifers. This investigation includes the installation, equipping, and maintenance of Well HAM1006M located in the immediate vicinity of Big Springs. This well is included as part of the Zone Monitoring Network, Section 3.2.2.1.

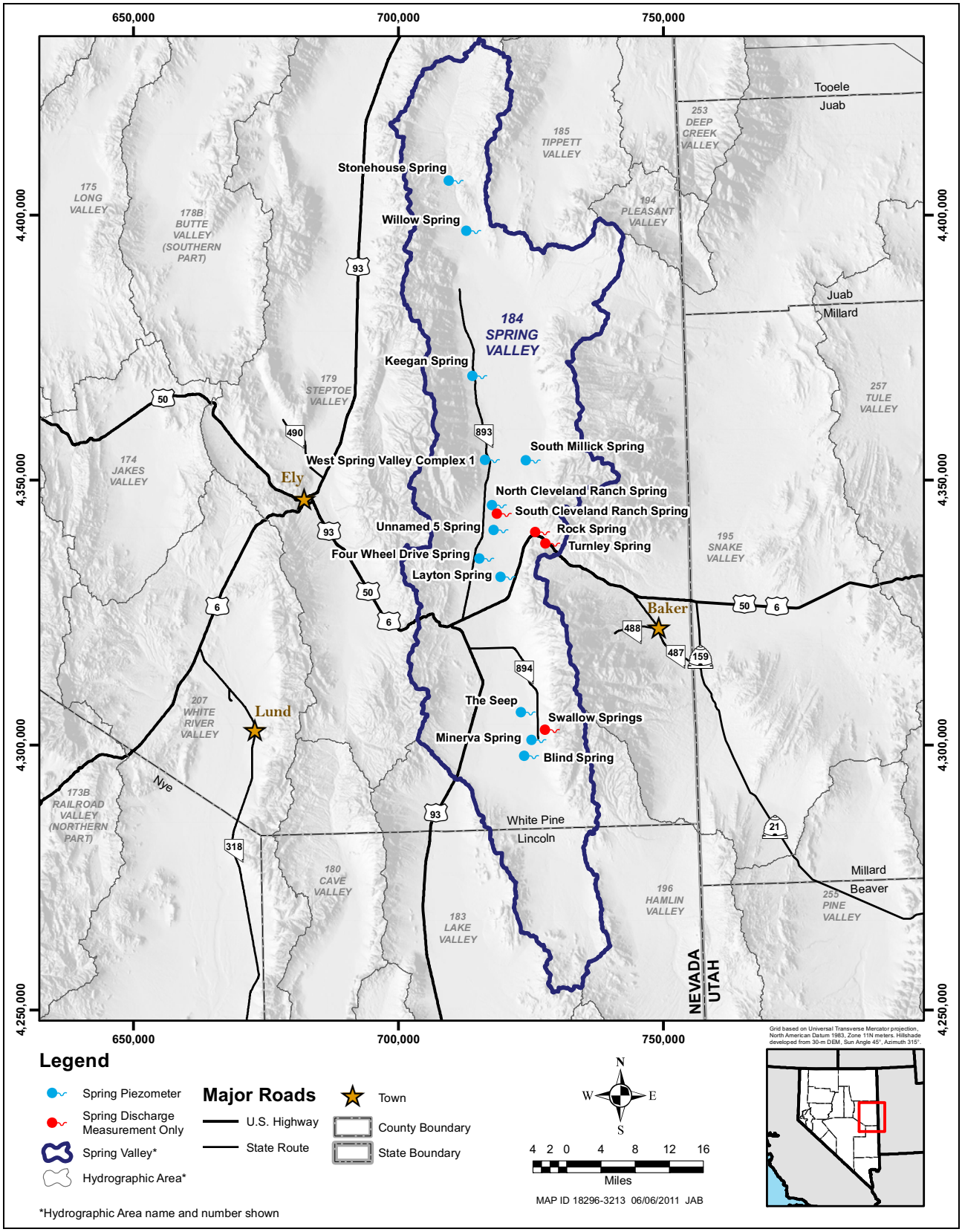

Figure 7
Spring Monitoring Locations

Table 4
Cleve Creek and Big Springs Monitoring Locations

Station Number	Station Name	Location[a]		Discharge Statistics Period of Record (cfs)[b]			Discharge Statistics Water Years 2005 - 2010 (cfs)		
		UTM Northing (m)	UTM Easting (m)	Minimum	Maximum	Mean	Minimum	Maximum	Mean
1841611	Cleve Creek near Ely	4,343,423	712,669	5.15	22.2	10.4	6.66	21.6	11.4
1951901	Big Springs at Gaging Station[c,d]	4,287,293	749,422	9.54	10.3	9.90	9.54	10.3	9.90

[a]All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.
[b]Source: USGS NWIS. Period of record for Cleve Creek is 1914 - 2010, and 2005 - 2010 for Big Springs.
[c]Discharge data is the combination of the northern and southern channels.
[d]Water Year 2005 had an incomplete record and was omitted.

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 basin. The current precipitation stations are listed in Table 5 and presented on Figure 10. The precipitation network includes three high-altitude precipitation stations in the Snake and Schell Creek Ranges; these stations are maintained and measured by USGS through a cooperative funding agreement with SNWA and NDWR. Four established precipitation stations located in Ely, McGill, and GBNP in Nevada and Eskdale, Utah provide regional data. SNWA has also established and operated additional valley floor stations at Shoshone 5N at the Bransford Ranch in southeast Spring Valley and the Robison Ranch in northwest Spring Valley.

3.6 Water Chemistry Baseline Data Monitoring Program

Monitoring of groundwater and surface water chemistry will be implemented to establish baseline conditions. Chemical analyses of selected parameters will be performed on three rounds of samples collected from wells, piezometers and spring and stream sites determined by the TRP and NSE. The program will consist of three sampling events at 6-month intervals. The TRP agreed to perform an initial round of sampling at 35 locations which was completed in late 2010 and 2011. These sample locations are presented in Figure 11. The five new Zone monitor wells will be sampled after installation. The second and third rounds of the water chemistry program will be completed after installation and sampling of the five Zone monitor wells. The second and third rounds will consist of 40 locations which include the five new Zone wells and 35 initial round locations. SNWA will collect and analyze water chemistry for the parameters listed in Table 6.

Subsequent sampling will be performed once every 5 years following the start of groundwater production in Spring Valley by SNWA. The NSE or the TRP in consultation with the BWG may change any aspect of this water chemistry sampling program, including, but not limited to, the

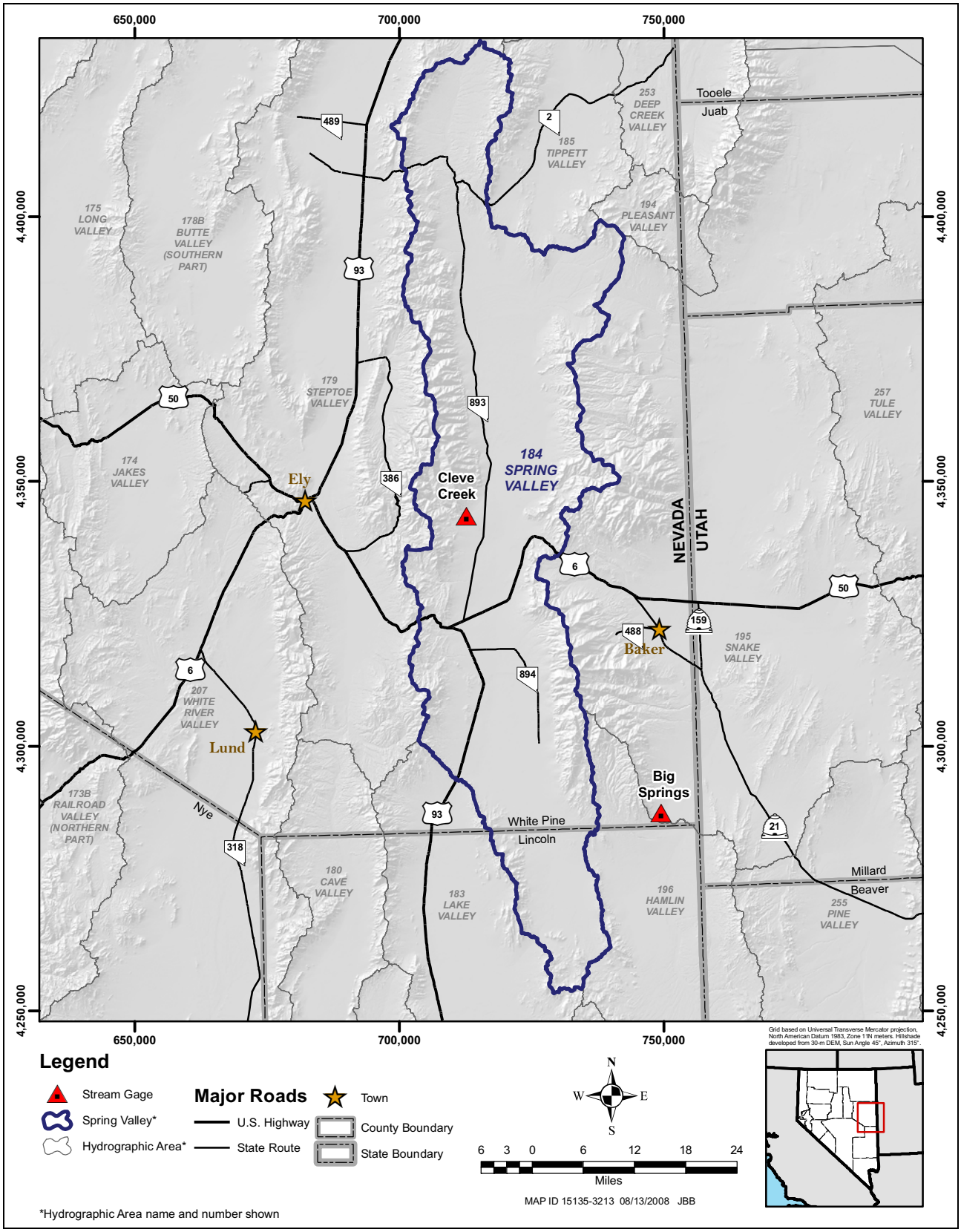

Figure 8
Cleve Creek and Big Springs Discharge Gaging Stations

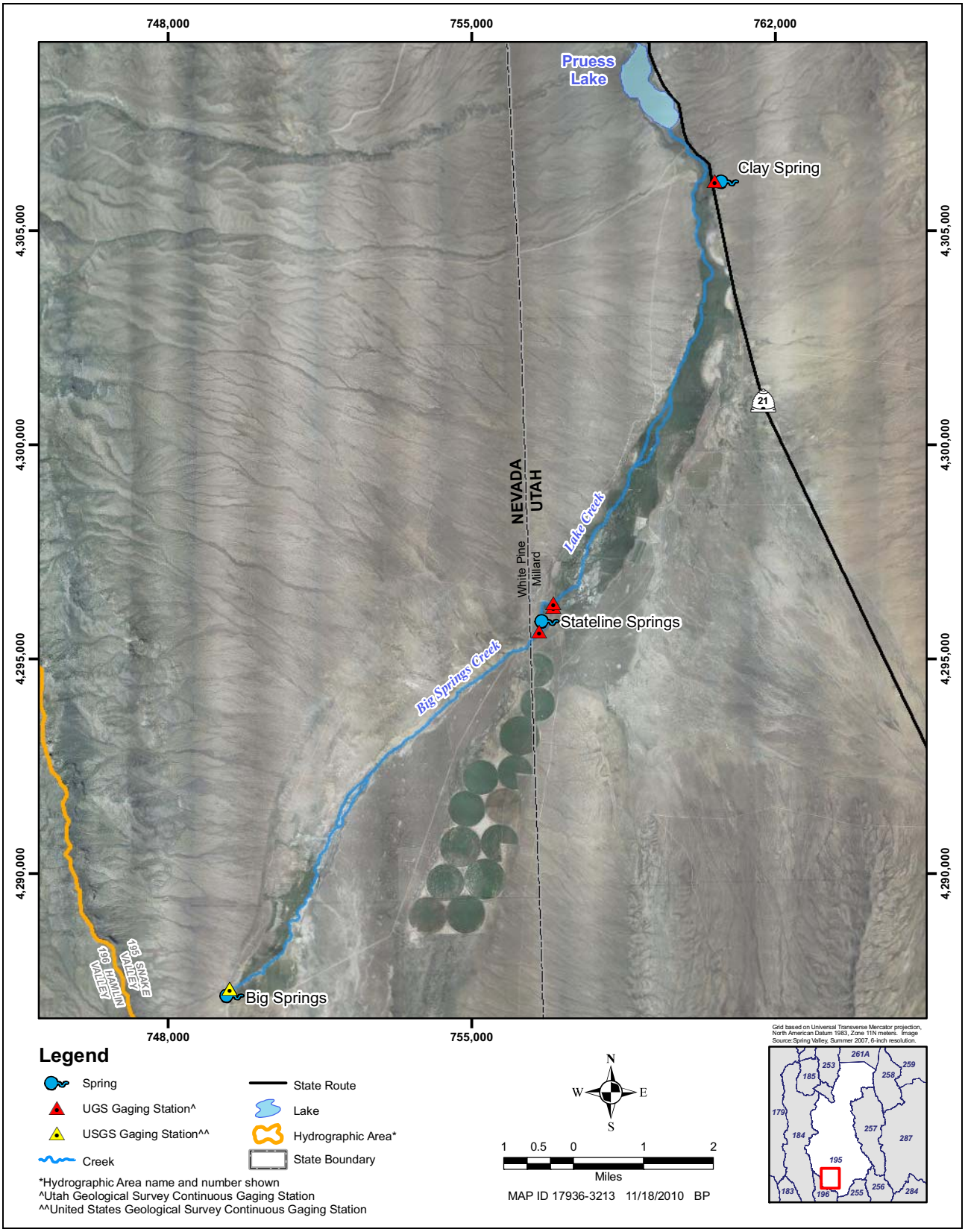

Figure 9
Big Springs Synoptic-Discharge Measurement Study Area, Snake Valley

Table 5
Precipitation Station Locations

Site Number	Station Name	Elevation (ft amsl)	Location[a]	
			UTM Northing (m)	UTM Easting (m)
391913114143101	Bulk Precipitation Station NW of Mt. Moriah	9,300	4,355,938	737,691
390946114364901	Bulk Precipitation Station on Cave Mountain	10,650	4,337,545	706,106
385409114185401	Mt. Washington Bulk Precipitation Station	10,440	4,309,376	732,764
267450	Shoshone 5N	5,930	4,310,746	725,419
---	Robison Ranch	5,695	4,378,103	713,347
263340	Great Basin National Park (GBNP)	6,830	4,320,462	741,031
264950	McGill	6,300	4,363,546	692,301
422607	Eskdale	4,980	4,334,157	763,696
262631	Ely WBO	6,260	4,350,419	685,436

[a]All coordinates are Universal Transverse Mercator, North American Datum, 1983, Zone 11.

addition and/or deletion of sampling sites, the addition and/or deletion of water-chemistry parameters, and the increase and/or decrease in sampling frequency.

3.7 Existing Water-Rights Monitoring

The Monitoring and Mitigation Plan establishes a network which provides a means to document baseline and long-term hydrologic conditions in order to identify and quantify potential effects of SNWA groundwater withdrawal on Federal and non-Federal water-rights holders and resources.

Additional monitoring activities specifically associated with non-Federal water-rights holders will be performed at three areas: (1) groundwater and spring discharge monitoring will be performed in the vicinity of Cleveland Ranch owned by the Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-Day Saints; (2) spring discharge measurements will be collected at Turnley Spring located at Sacramento Pass; and (3) an additional deep basin-fill or carbonate monitor well will be completed approximately 1 mi north of the northern-most production well on the east side of the valley. The location of the Cleveland Ranch and Turnley Spring are presented on Figure 12.

Monitoring locations in the vicinity of Cleveland Ranch are presented on Figure 13 and will consist of the following elements:

- Eliminated the Cleve Creek well (site #391224114293601) from the Monitoring and Mitigation Plan. Due to limited accessibility and well construction data. Installed two clustered monitor wells in 2011 on the Cleve alluvial fan approximately 1 mi north of the Cleve well on BLM managed land with approved right-of-way. The shallow 4 in. monitor well (SPR7029M) was completed to a depth of 260 ft bgs. A deeper 12 in. monitor well (SPR7029M2) was completed in a separate borehole at a depth of approximately 430 ft bgs (Mace, 2011b). The goal of the clustered wells is to determine the site hydrogeologic conditions, evaluate the vertical hydraulic gradient at the site, and monitor seasonal variations over time. Replacement of the original Cleve well provides improved well integrity and

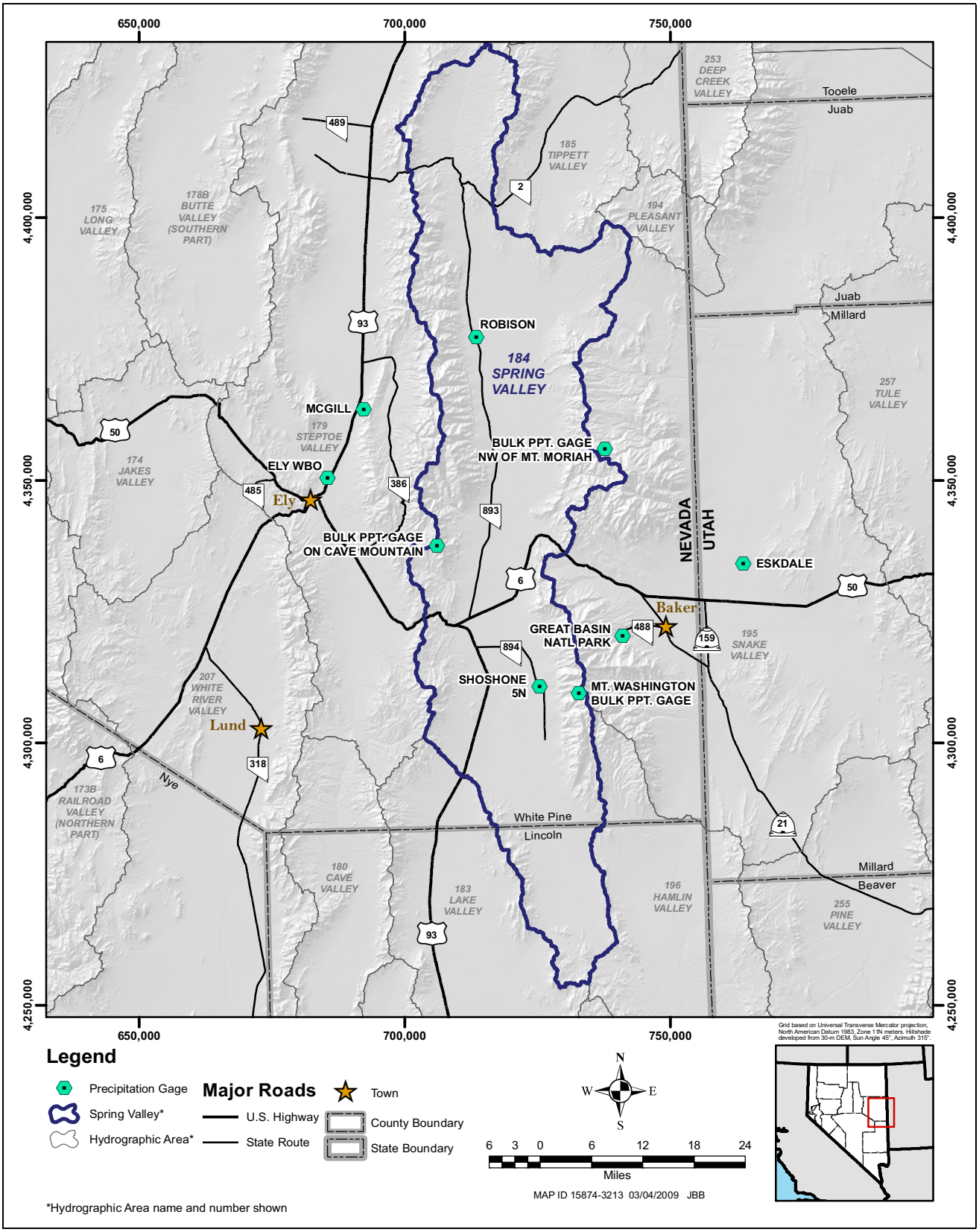

Figure 10
Precipitation Station Locations

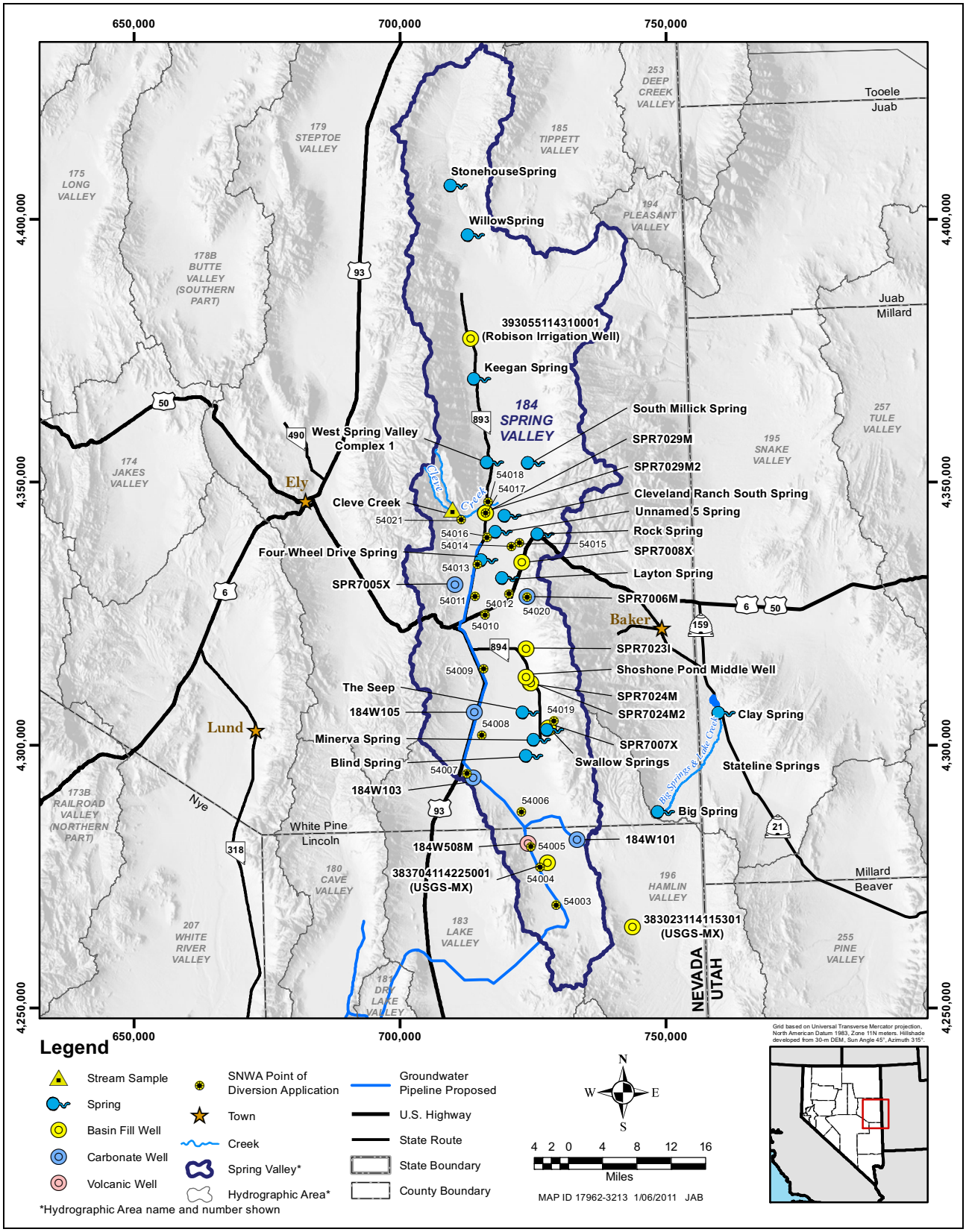

Figure 11
Spring Valley Monitoring Plan Water Chemistry Program Sample Locations

Table 6
Water Chemistry Parameters

Field Parameters	Major Ions	Isotopes	Metals
Water temperature Air temperature pH Electrical conductivity Dissolved oxygen	TDS Calcium Sodium Potassium Chloride Bromide Fluoride Nitrate Phosphate Sulfate Carbonate alkalinity Alkalinity Silica Magnesium	Oxygen-18 Deuterium Tritium Carbon-14 Carbon-13 Strontium-87	Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver Manganese Aluminum Iron

documentation of site lithology and hydrogeologic conditions. A 120-hour constant-rate aquifer test was performed on the deeper monitor well (SPR7029M2) to provide data on aquifer properties. Preliminary data from the hydraulic testing program is presented in Prieur and Ashinhurst (2011).

- Two boreholes were advanced, and shallow and deep 4 in. monitor wells, SPR7030M and SPR7030M2, were completed near the spring (Cleveland Ranch South Spring) located in the southeast part of Section 29, T16N, R67E (Mace, 2011a). A flume was also installed to gage the discharge of the spring. The gage and well locations were determined in consultation with the NSE and a representative from the property owner, (Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-Day Saints) and installed in late 2010 and early 2011.

- A shallow piezometer and a small flume to gage spring discharge at a small spring (Cleveland Ranch north spring) located in the southwest part of Section 20, T16, R67E was installed in late 2010 and early 2011.

Spring discharge monitoring at Turnley Spring owned by William and Katherine Rountree, has been performed on a six week to quarterly interval since late 2008. Monitoring will continue on a quarterly basis as long as property access is granted. Both Turnley and Rock Spring are mountain block springs located in the same general area near Sacramento Pass, with generally similar hydrogeologic conditions, Rock Spring is monitored on a continuous basis and has clear access. The Rock Spring discharge record may be compared over time with the results from Turnley Spring and may be considered as a substitute for Turnley Spring in the future in consultation with the spring owner and the NSE.

One additional monitor well, intended to observe deeper water levels within the basin-fill or carbonate aquifer, will be installed approximately 1 mi north of the northernmost production well on the east side of the valley. The location has not yet been determined and will be based upon the configuration of production wells at the commencement of water export from the basin.

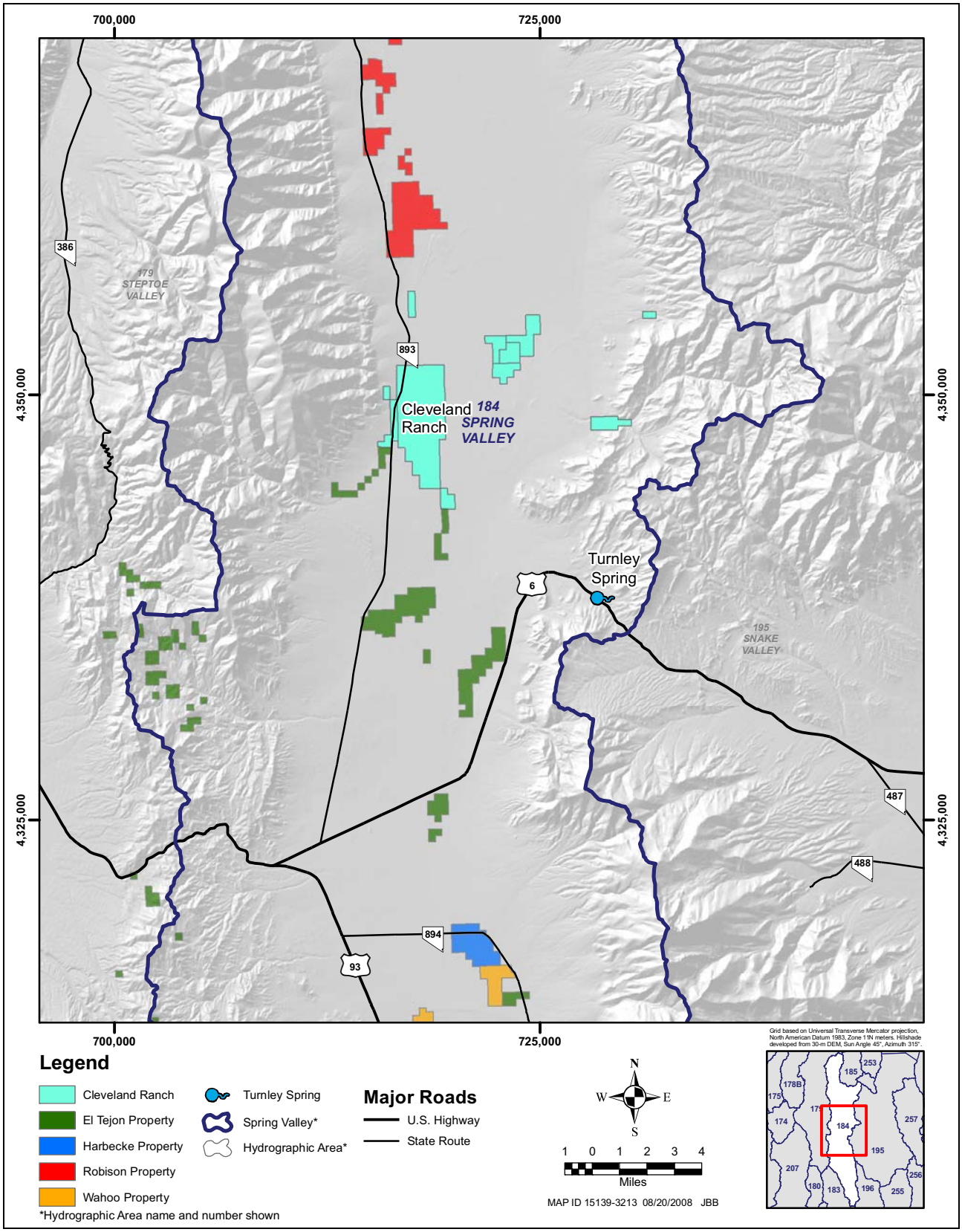

Figure 12
Location of Cleveland Ranch and Turnley Spring

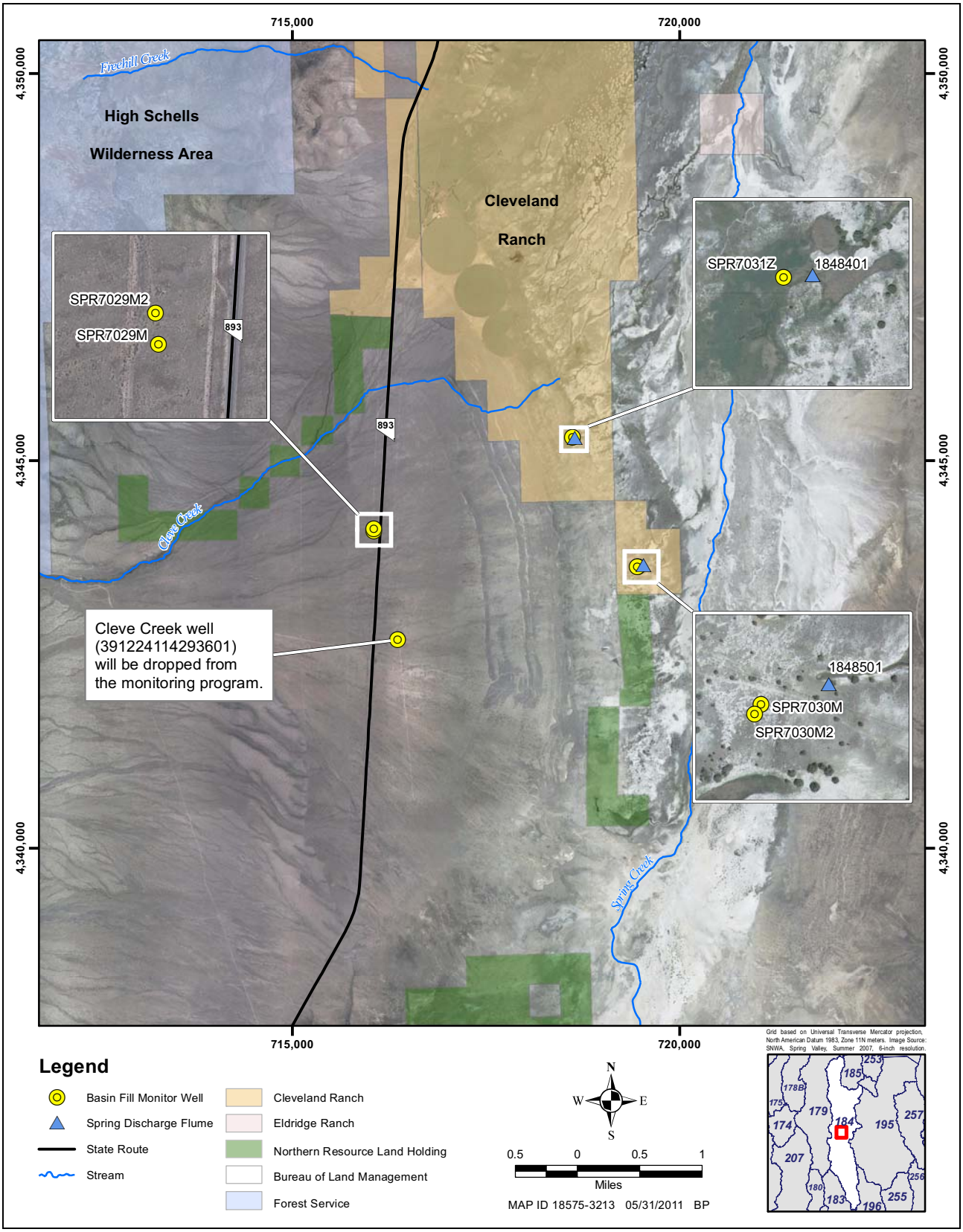

Figure 13
Monitoring Locations Associated with Cleveland Ranch

3.8 Data Collection Methodology and Quality Control Procedures

All data collection and processing will be performed following SNWA procedures. Applicable standards from organizations, such as the American Society for Testing and Materials, the U.S. Environmental Protection Agency, and the USGS, for each element of the program are incorporated as appropriate. A quality assurance/quality control (QA/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 industry-recognizable standards and traceable 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.

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4.0 DATABASE DEVELOPMENT AND REPORTING

4.1 Database Management

All data collected pursuant to this Monitoring and Mitigation 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 in the database properly and accurately.

4.2 Reporting

Using data derived from groundwater level measurements of all production and monitor wells used in this Monitoring and Mitigation 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, or at a frequency agreed upon by the TRP, or as required by the NSE.

Water-level and production data will be submitted to the NSE quarterly in an electronic format, as specified by the NSE. Water chemistry laboratory reports will be made available to the NSE within 90 calendar days of receipt or within an alternative time frame required by the NSE.

SNWA will report the results of all monitoring and sampling pursuant to this Monitoring and Mitigation Plan in an annual monitoring report submitted to the NSE by March 31 for each year that this Monitoring and Mitigation 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 NUMERICAL MODELING OF REGIONAL GROUNDWATER FLOW

The Stipulation parties agreed that the Monitoring and Mitigation Plan must include a well-calibrated regional groundwater flow system numerical model. SNWA proposes the use of one model to satisfy the requirements of both the Stipulation and Ruling on SNWA applications. SNWA will maintain, update, and operate the model, in cooperation with the TRP and NSE, and may subcontract this obligation to a third party, if approved by the TRP and NSE.

Numerical groundwater modeling along with the monitoring program are components of the hydrologic adaptive management approach. The model results must be qualified based on a comparison of the accuracy of the model and the capability of the model to predict actual observed conditions. Modification of the numerical model of the regional groundwater flow system may occur based upon additional hydrologic, geologic, geophysical, and/or geochemical data collected under the Monitoring and Mitigation Plan. SNWA will update the NSE-approved groundwater flow model every 5 years after groundwater withdrawals by SNWA and submit the updated predictive results.

SNWA will provide model output for evaluation by the NSE or TRP in the form of input files, output files, drawdown maps, tabular data summaries, and plots of simulated water levels for the aquifer system. Additional information will be provided, as required by the NSE.

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6.0 MANAGEMENT AND MITIGATION ACTIONS

SNWA will implement management and mitigation actions as required by the NSE. The Stipulation presents criteria and a process for the TRP to initiate consultation, management or mitigation actions. The TRP is tasked with reviewing water-level responses and model results to evaluate if potential injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources and if any effects on federal resources within the boundaries of GBNP are occurring or are predicted to occur due to ongoing or proposed groundwater withdrawals by SNWA in Spring Valley.

SNWA shall mitigate any injury to Federal Water Rights and/or unreasonable adverse effects to Federal Resources and/or effects to Federal Resources within the boundaries of GBNP as agreed upon by the EC or as required by the NSE. SNWA shall work with the NSE to implement management and mitigation actions relative to injury to private or non-Federal water-right holders.

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

- Geographic redistribution of groundwater withdrawals;
- Provision of consumptive water supply requirements using surface and groundwater sources;
- Augmentation of water supply for Federal and existing water rights and Federal Resources using surface and groundwater sources;
- Reduction or cessation in groundwater withdrawals; and
- Other measures as agreed to by the Stipulation parties and/or required by the NSE.

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