Water-Resources Assessment and Hydrogeologic Rebuttal Report for Cave, Dry Lake, and Delamar Valleys

PRESENTATION TO THE OFFICE OF THE NEVADA STATE ENGINEER

Prepared by

SOUTHERN NEVADA
WATER AUTHORITY

December 2007

Water-Resources Assessment and Hydrogeologic Rebuttal Report for Cave, Dry Lake, and Delamar Valleys

Submitted to:
Tracy Taylor, P.E. State Engineer
State of Nevada
Department of Conservation & Natural Resources
Division of Water Resources
901 S. Stewart Street, Suite 2002
Carson City, Nevada 89701

Pertaining to:
Groundwater Applications 53987 through 53992 in
Cave, Dry Lake, and Delamar Valleys

December 2007

Prepared by:
Southern Nevada Water Authority
Water Resources Division
P.O. Box 99956
Las Vegas, Nevada 89193-9956

Andrew G. Burns

Andrew G. Burns, Water Resources Division Manager — Date: 12-19-07

James M. Watrus, Sr. Hydrologist — Date: 12/19/07

Gary L. Dixon, Principal Geologist — Date: 12/19/07

Advocates for Community and Environment - Exhibit 1101

Myers (2007)

Myers (2007) conducted a water budget analysis for parts of the White River Flow System, specifically Cave, Dry Lake, Delamar, White River, and Pahranagat valleys, and presents an overview of water rights in these basins. Based on this information, Myers (2007) concludes that there is no available groundwater to permit any water rights associated with the Southern Nevada Water Authority (SNWA) applications, and any water that is developed will affect downstream springs. Myers (2007) bases this conclusion on the water budget analysis presented in the report and the following opinions drawn from it:

1. *"There is no available water in the targeted basins. Most recharge in the targeted basins becomes interbasin flow to downgradient basins where it is completely used by water users with water rights."*

2. *"The groundwater system in White River and Pahranagat Valleys is completely appropriated and dependent on interbasin flow from upgradient including the targeted basins."*

3. *"Most spring and surface water rights in White River and Pahranagat Valleys depend on groundwater including interbasin flow."*

4. *"The existing level of water rights development in the valleys will decrease the discharge from Pahranagat Valley to almost zero."*

5. *"If granted, the proposed applications will reduce the interbasin flow from Pahranagat Valley to much less than zero."*

6. *"The published perennial yield for Dry Lake and Delamar Valleys is substantially too high."*

There are serious flaws involving the data selection, technical approach and data analysis presented by Myers (2007) that lead to the erroneous conclusions listed above. Furthermore, Myers (2007) provides little technical basis in terms of data and data analysis to substantiate the opinions expressed in the report. These are summarized below, and are discussed in greater detail in subsequent sections of this rebuttal report.

Data Selection

1. Myers (2007) selects data that is most advantageous in supporting his pre-determined conclusions. For example, Myers (2007) adopts recharge numbers from the Reconnaissance Series Reports which are almost always the lowest estimates of recharge for these basins. Conversely, Myers (2007) adopts more recent and larger estimates of groundwater

evapotranspiration (ET). These estimates are inappropriately applied in Myers (2007) yielding a pre-development water budget that does not balance (Myers, 2007, Table 7). In this pre-development budget, only 19,100 acre-feet per year (afy) enters Coyote Spring Valley and when summed with the locally derived recharge (6,000 afy), the resultant volume is unable to support the minimum observed spring discharge in the Muddy River Springs Area of 37,000 afy (Eakin, 1966).

2. In adopting the groundwater ET estimate for White River Valley, Myers (2007) offers the following rationale:

   "It must be assumed that the recent estimate, in BARCASS, is more accurate because of the modern technology and research." (p. 34)

   Myers (2007, p. 18-22) applies a different rationale to select the recharge estimate, discounting the recent advances made in the derivation of precipitation distributions (i.e., PRISM) and estimates of recharge (i.e., BCM) which incorporate modern technology and research and more data and information than previous works.

3. Myers (2007) geologic setting description is based on the 1:500,000 scale mapping from Stewart and Carlson (1978). Since that time, there have been numerous publications at much greater detail that should have been used in the description of the geologic setting and effects analysis (see reference list for SNWA, 2007). Myers (2007) use of the large-scale mapping led him to erroneous conclusions regarding the geologic framework and routing of interbasin flow.

Technical Approach and Data Analysis

1. Myers (2007, p. 18) presents the primary parameters for the water balance of an aquifer system, and goes on to discuss at great length the Maxey-Eakin method, highlighting the following excerpt from Maxey and Eakin (1949):

   "The recharge estimates were then balanced by trial-and-error with the discharge estimates."

   While it is appropriate to apply the water-balance method in an assessment of the groundwater budget for the WRFS, it is inappropriate to use recharge estimates based on one set of discharge estimates, and then apply independent and separate discharge estimates in the budget accounting. In doing so, Myers (2007) violates the fundamental concepts of steady-state mass-balance expressed by the equation listed on page 18 of his report. In adopting the groundwater ET estimates of Welch and Bright (2007) for White River Valley, Myers (2007) should have completed the water-budget analysis and derived new estimates of recharge. Because this was not done, the water-budget accounting presented in Myers (2007) is fundamentally flawed, and any opinions/conclusions derived from them are equally flawed.

2. No genuine attempt was made by Myers (2007) to compile the requisite data and complete the necessary analyses to support the direction and magnitude of interbasin flow described in the

report. No geologic, potentiometric, or geochemical data are presented to substantiate the interbasin flow interpretations presented in the report. It is important to recognize this serious limitation because these interpretations are used by Myers (2007) to describe the water budget accounting and potential effects related to the SNWA applications. Not considering this information has led to conflicting and confusing statements of interbasin flow and potential effects that are unsubstantiated.

3. Myers (2007) does not account for the development of transitional storage in the water budget accounting or the effects analysis presented in the report. For example, Myers (2007, Table ES-1) presents a water budget analysis for the White River Flow System for full development of the SNWA applications. In this analysis, interbasin flow to White River Valley from Cave Valley is captured by pumping the SNWA points of diversion (PODs). Instead of reducing the groundwater ET budget in White River Valley that supposedly relies on the Cave Valley outflow, Myers (2007) reduces the outflow from White River Valley to downgradient basins. In contradictory statements, Myers (2007; pp. 34, 47) represents that the interbasin flow originating in the project basins can not be captured by the application PODs. Yet in the water budget accounting and in the effects analysis, this pumping can capture interbasin flow from the downgradient basins and reduce spring discharge without affecting the groundwater ET (Table ES-1). This concept is fundamentally flawed.

Specific Comments to Myers (2007)

1. *"Dry Lake and Delamar Valleys have 5,000 and 1,000 afy of recharge based on the Maxey-Eakin method, respectively. There is no discharge within the basins, so <u>the entire amount discharges as interbasin flow to Pahranagat Valley. It is a major part of the interbasin flow supporting springs and water rights within that valley.</u>"* (p. 1, emphasis added).

   First, Myers (2007) provides no basis for this flow interpretation. Locally derived recharge in Dry Lake and Delamar valleys is not a major part of the interbasin flow supporting springs and water rights in Pahranagat Valley based on isotopic and temperature data which reflect a different recharge source (Thomas et al., 2001). The springs are regional springs controlled locally by geologic structure as indicated by the geologic cross sections presented in Figures 1 through 3 of this rebuttal report. Furthermore, the geologic framework is such that interbasin flow between these basins is unlikely given the thick sequences of volcanic rocks comprising the North and South Pahroc Ranges which separate these basins. Hydraulic data reflect a north-south gradient which would be the most likely flow path within the basin-fill and along the east and west range-front faults of the North and South Pahroc Ranges and the Delamar Mountains.

2. *"Existing development has reduced the steady flow from Pahranagat Valley to about a third of its pre-development value."* (p. 96)

   This statement suggests that the pre-development spring flow was 75,000 afy given the current measured flow of about 25,000 afy (SNWA, 2007; Part A, p. 4-14). There is absolutely no evidence presented in this report to substantiate this statement. The Nevada

State Engineer Report for the period January 1, 1931 to June 30, 1932 (Malone, 1933; p. 40-42) describe a Pahranagat Valley that is essentially water-logged, requiring drainage network to reclaim the land for agricultural use and livestock grazing. As described, the drains were required to lower the water table and route the water to Pahranagat Lake; there is no indication that this effort or any pumping in upgradient basins (i.e., White River Valley) has reduced the "steady flow from Pahranagat Valley to a third of its pre-development value." Groundwater pumping in Pahranagat Valley has been estimated at 4,805 afy (Nevada Division of Water Resources, 2006) and 2,790 afy (Lopes and Evetts, 2004, Table 1, p. 25). Clearly, development of this magnitude has not reduced the spring flow to a third of its pre-development value.

3. *"Pahranagat Valley is the most downstream valley in the system; developing either SNWA's application amount or the published perennial yield <u>will cause discharge from Pahranagat Valley to become negative</u> once steady state becomes reestablished (Table ES-1)."* (p. 2, paragraph 2) - **AND** - *"As discussed, with development proposed by SNWA, <u>the discharge to Coyote Spring Valley may become negative.</u> SNWA's proposal will have negative consequences for the flow from Muddy River Springs."* (p. 59, paragraph 1, emphasis added).

   The basis for these comments is not presented in the report, and it is unclear how discharge can become *negative*. It appears that these statements are based on the flawed water budget analysis and flow interpretations for which comments were previously provided. These are unsupportable statements that suggest that not only can the interbasin flow be entirely captured in the project basins and in downgradient basins, but that the gradients will reverse such that flow from Coyote Spring Valley will be induced (see Tables 14 and 15, Myers, 2007). A review of the potentiometric data indicates that the hydraulic potential between Pahranagat Valley (Ash Springs) and Coyote Spring Valley (CSVM-3) is about 1,400 ft (SNWA, 2007; Part A, p. D-16). For groundwater discharge from Pahranagat Valley and Coyote Spring Valley to become *negative*, the drawdown at the boundaries would have to be greater than 1,400 ft. This concept lacks credibility given (1) the volume of water in storage as compared to the proposed pumping volumes, (2) the heterogeneity of the geologic framework between the application PODs and these areas, and (3) distance between the application PODs and these areas.

4. *"The Pahranagat River Springs lose about 2 cfs within 20 years, likely harming water rights' holders dependent on the springs. Over 2000 years, the flow from Pahranagat Valley springs reduces by about one-third."* (p. 3, paragraph 2)

   In the previous statement, Myers (2007) asserts that the discharge from Pahranagat and Coyote Spring Valley will become *negative*. If the springs in Pahranagat Valley only decrease by one third (to about 17 cfs) after 2,000 years, when will the discharge become *negative*? These statements are a reflection of the flawed analyses presented in the report.

5. *"Full development of the applications will cause Moon River and Hot Creek Springs to lose a third of their flow within three years; eventually these springs go dry."* (p. 3, paragraph 2)

   This statement is not substantiated by any analysis of the existing data and information.

A review of the existing geologic, hydrologic, and geochemical data indicate that Hot Creek and Moon River springs in south-central White River Valley are (1) regional springs structurally controlled by the normal fault comprising the western part of a horst that occurs in and along middle portion of the basin (Figure 4), and (2) their recharge source is not Cave Valley based on isotopic and temperature data. For comparison purposes, Table 1 lists isotopic and temperature data for representative groundwater sites in Cave Valley and Moon River and Hot Creek Springs in White River Valley. The deuterium and temperature data for Moon River and Hot Creek Spring ranges from -120 to -119.2 per mil and 31.3°C, while the values for the representative sites in Cave Valley range from -102.2 to -105 per mil and 11.7 to 18.5 °C. These are significant differences and are indicative of different water sources.

Table 1
Isotopic and Temperature Data for Selected Groundwater Sites in White River and Cave Valleys

Site ID	Sample Date	δD (per mil)	$\delta^{18}O$ (per mil)	Temperature (°C)	Source[a]
Cave Valley					
180W501M	5/17/2006	-105.63	-14.2	18.5	SNWA
180W902M	5/18/2006	-105.05	-14.13	18.2	SNWA
Cave Valley (MX)	7/10/2003	-105	-13.94	13	USGS NWIS
Cave Valley Seeding Well	7/25/2005	-105.36	-13.75	– –	SNWA
Big Spring	7/13/2006	-105.8	-13.86	12.8	DRI
Cave Spring	7/142006	-102.2	-14.2	11.7	DRI
White River Valley					
Moon River Springs	4/27/1982	-120	-15.8	– –	USGS NWIS
Hot Creek Spring	10/28/2006	-119.2	-15.77	31.3	DRI

[a]DRI = Desert Research Institute unpublished data.
SNWA = Southern Nevada Water Authority.
USGS NWIS = U.S. Geological Survey National Water Information System.

Myers (2007) assertion that development of the SNWA applications would reduce the flow from Moon River and Hot Creek Springs by one third within three years is difficult to believe given (1) the geologic heterogeneity (i.e., geometry, structure, and lithology of the hydrogeologic framework) between the springs and the application PODs, (2) the volume of storage in the basin fill and carbonate-rock aquifer, and (3) the proximity of the application PODs to the two springs and the mountain ranges that lie between.

6. *"In Cave Valley, the lack of GW ET from areas around the playa (Welch and Bright, 2007) reflects the lack of groundwater flow through the valley from north, where there is more recharge, to south."* (p.17, paragraph 2)

A review of the geologic, potentiometric, and geochemical data would have led to a more credible interpretation of flow. There is a clear hydraulic gradient within the basin fill from north to south that is indicative of groundwater flow to the south (SNWA, 2007; Part B, p. 3-5). Hydraulic heads within the carbonate aquifer are affected, in part, by structural features defining the framework, such as the fault block that extends across the central part of the valley. Even so, a hydraulic gradient exists from north to south based on the elevation of Cave Spring and carbonate wells in the south, and is indicative of groundwater flow to the south. It is interpreted that flow occurs along the west range-front fault of the Schell Creek Range, from north to south.

7. *Based on this gradient, most recharge in the Egan Range portion of Cave Valley would reach White River Valley without becoming part of the main aquifer system in Cave Valley."* (p. 43; paragraph 1).

   Myers (2007) does not present data or data analyses to support this statement. Furthermore, it is unclear how recharge in Cave Valley would be transmitted to White River Valley without becoming part of the aquifer system.

8. *"SNWA's applications for Cave Valley are both in the south half of Cave Valley. As proposed, these applications would not capture any of the natural groundwater discharge from the basin."* (p. 34)

   This statement is contrary to the water budget accounting and effects analysis presented in Myers (2007) which indicate the capture of the application volume in Cave Valley (Myers, 2007; Table ES-1) and conclusions that springs in White River Valley will be affected (i.e., Moon River and Hot Creek Springs). These are inconsistencies that point to the flaws in the water-budget accounting which Myers (2007) uses to support his conclusions.

U.S. Fish and Wildlife Service - Exhibit 501

Mayer (2007)

Mayer (2007) provides a review of previous studies and compares water budget information from these studies to form opinions on water availability based on estimates of perennial yield and water right appropriations. Mayer (2007) shares many of the same concepts as Myers (2007) related to the propagation of effects to downgradient basins, specifically White River Valley, Pahranagat Valley, and Coyote Spring Valley. Like Myers (2007), Mayer (2007) offers little to no data or data analysis to support opinions expressed in his report. Specific issues are addressed in the following discussion:

1. Mayer (2007; p. 4, paragraph 2) presents a groundwater discharge estimate for the Muddy River Springs Area reported by Prudic et al. (1993), and notes that the estimate is greater than the measured spring flow. This discharge includes spring discharge, groundwater ET, and underflow, the volume of which Mayer (2007) asserts is too great citing personal communications with other Department of Interior agencies. No data, analysis, or explanation is provided to support this claim.

Dry Lake and Delamar Valleys

2. Mayer (2007, p. 10) concludes that existing appropriated water rights in downgradient hydrographic areas exceed estimates of water availability. As such, any development in Dry Lake and Delamar valleys threaten FWS water rights and resources in the downgradient valleys, specifically Pahranagat and Coyote Spring valleys.

   Mayer (2007) provides no data or analysis to substantiate his claims that resources in the downgradient basins will be impacted by pumping in Dry Lake and Delamar valleys. Mayer (2007) states the following:

   "The propagation of climate and pumping effects has been rapid and widespread in parts of this flow system, as documented by Mayer and Congdon…"

   It appears that the reference to Mayer and Congdon (Exhibit 510) is used to equate the hydraulic connectivity of the lower part of the WRFS (i.e., Coyote Spring Valley, Muddy River Springs Area, Hidden Valley, Garnet Valley, California Wash, etc.) with that of the upper part of the flow system (i.e., above the Pahranagat Shear Zone). While the hydraulic connectivity of the lower part of the flow system is generally accepted, it is presumptuous to suggest that the upper part of the flow system has the same connectivity. To the contrary, the potentiometric data in the upper part of the flow system indicate much steeper regional and local gradients (SNWA, 2007; Part A, p. D-8, D-12, D-14, D-15).

3. Mayer (2007; p. 10) uses this concept of hydraulic connectivity of the flow system and the groundwater appropriation in downgradient basins as a basis for the following statement:

   "By any such measure, the system is completely appropriated and the State Engineer should deny all water right applications in Dry Lake and Delamar Valleys."

   As stated previously, no analysis of the potential pumping effects is presented in Mayer (2007) that provides any indication of how the effects might propagate (timing, magnitude and distribution) and whether they might be considered adverse or not. Only qualifications that there is uncertainty in the timing of when the effects might occur are offered.

Cave Valley

4. Mayer (2007, p. 12) makes statements that groundwater development in Cave Valley will affect both environmental resources and water-right holders downgradient in White River and Pahranagat valleys. These include the following:

   "These springs support unique aquatic organisms and may be threatened by pumping upgradient in the southern part of White River Valley, where the SNWA applications are located."

Mayer (2007) provides no data or effects analysis to support these opinions other than a simplistic accounting of previously published recharge and discharge numbers. Mayer (2007) mistakenly states that the SNWA applications are located in White River Valley. It is unclear if this influenced the conclusions presented in the report.

Furthermore, Mayer (2007) makes no mention of the proximity of the SNWA application PODs to the areas of concern (as identified in his report), the geologic features that would likely contain the propagation of effects or greatly attenuate them, or the concept of capturing transitional storage. Like his conclusion for Dry Lake and Delamar valleys, Mayer (2007, p. 12) offers no explanation of the time frame in which potential effects may occur.

In Cave Valley, the SNWA application 53988 is nearest to Flag and Butterfield Springs, and is seven miles (straight line) away with the southern Egan Range lying in between. It is highly unlikely that effects from pumping this POD would propagate through the Egan Range given the geologic framework and the fact that Egan Range is an area of recharge that has likely created a significant groundwater divide between the two basins. A more appropriate distance measurement is from the POD to the north, and to White River Valley through the Shingle Pass Fault. This distance is about 30 miles. Pumping will first extract groundwater from storage in Cave Valley before the capture zone lowers the water table or intercepts any spring discharge in White River Valley. Just in the top 100 ft of saturated basin fill, it is estimated that 805,996 afy of groundwater is in storage in Cave Valley, and 5,627,559 afy in White River Valley (Welch and Bright, 2007). These values do not include storage volumes for the carbonate aquifer. With this huge volume of storage, the great distances to the areas of concern, and the hydraulic potential to overcome, it is highly unlikely that the effects of pumping the SNWA applications would result in adverse impacts to senior-right holders and environmental resources in White River Valley.

References

Lopes, T.J., and Evetts, D.M., 2004, Ground-water Pumpage and Artificial Recharge Estimates for Calendar Year 2000 and Average Annual Recharge and Interbasin Flow by Hydrographic Area, Nevada, U.S. Geological Survey Scientific Investigations Report 2004-5239, 88 p.

Malone, G.W., 1933, Report of the State Engineer for the Period January 1, 1931, to June 30, 1932, Inclusive, Carson City, Nevada, 166 p.

Maxey, G.B., and Eakin, T.E., 1949, Groundwater in the White River Valley, White Pine, Nye, and Lincoln counties, Nevada: State of Nevada, Office of the State Engineer, Water Resources Bulletin No. 8, 59 p.

Nevada Division of Water Resources, 2006, Groundwater Pumpage Inventory for Pahranagat Valley, No. 209.

Prudic, D.E., Harrill, J.R., and Burbey, T.J., 1993, Conceptual Evaluation of Regional Ground-Water Flow in the Carbonate-Rock Province of the Great Basin, Nevada, Utah, and Adjacent States, U.S. Geological Survey Open File Report 93-170, 103 p.

Southern Nevada Water Authority, 2007, Water-Resources Assessment and Hydrogeologic Report for Cave, Dry Lake, and Delamar Valleys. Presentation to the Office of the Nevada State Engineer. Las Vegas, Nevada.

Stewart, J.H., Carlson, J.E., 1978, Geologic Map of Nevada: U.S. Geological Survey, scale 1:500,000.

Thomas, J.M., Calhoun, S.C., and Apambire, W.B., 2001, A deuterium mass-balance interpretation of groundwater sources and flows in southeastern Nevada: Desert Research Institute Publication No. 41169, 46 p.

Tschanz, C.M., and Pampeyan, E.H., 1970, Geology and mineral deposits of Lincoln County, Nevada: Nevada Bureau of Mines and Geology Bulletin 73, 187 p.

Welch, A.H., and Bright, D.J., eds., 2007, Water resources of the Basin and Range Carbonate-Rock Aquifer System, White Pine County, Nevada, and adjacent areas in Nevada and Utah—Draft Report: U.S. Geological Survey Open-File Report 2007-1156, 103 p.

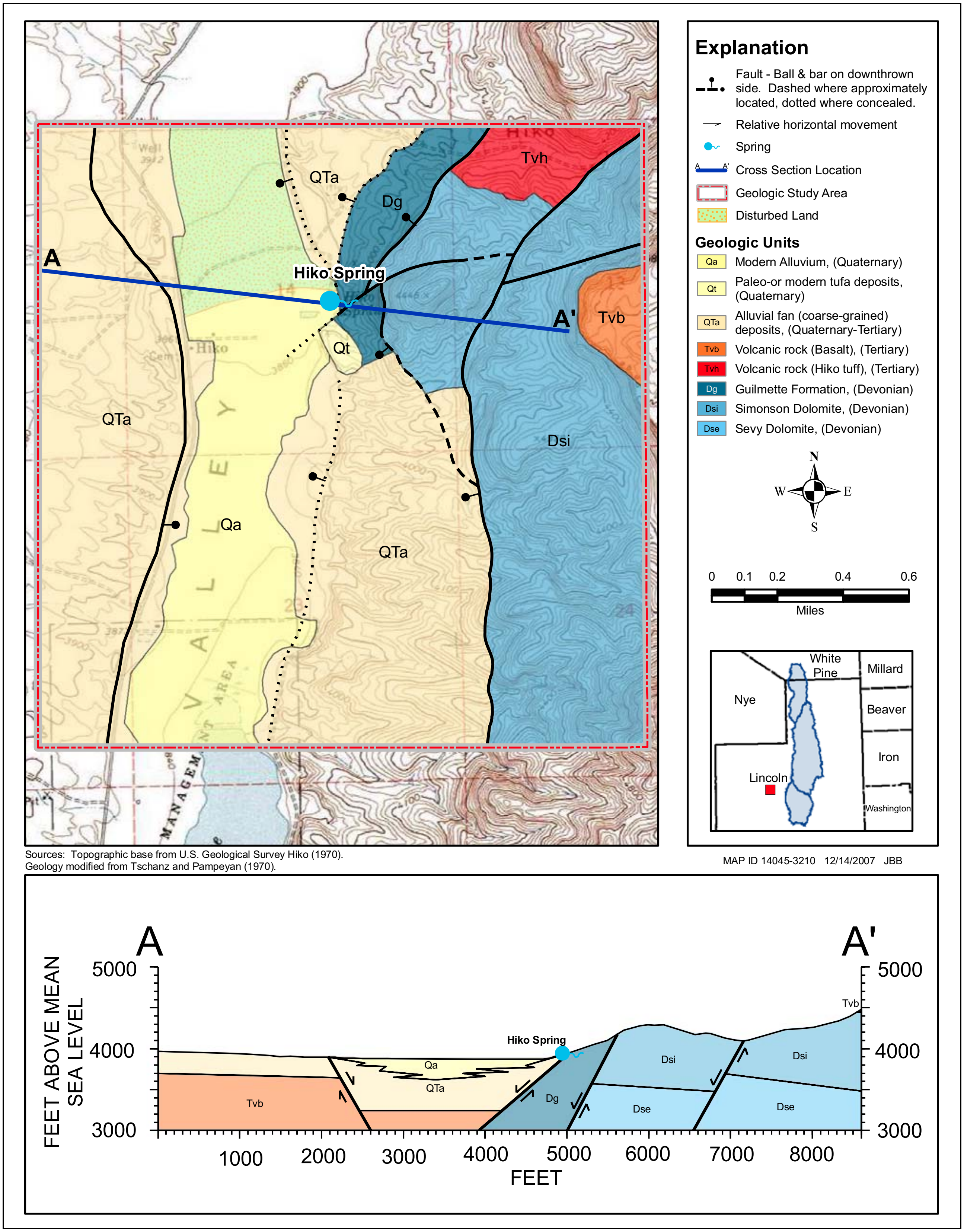

Figure 1
Geology Hiko Spring

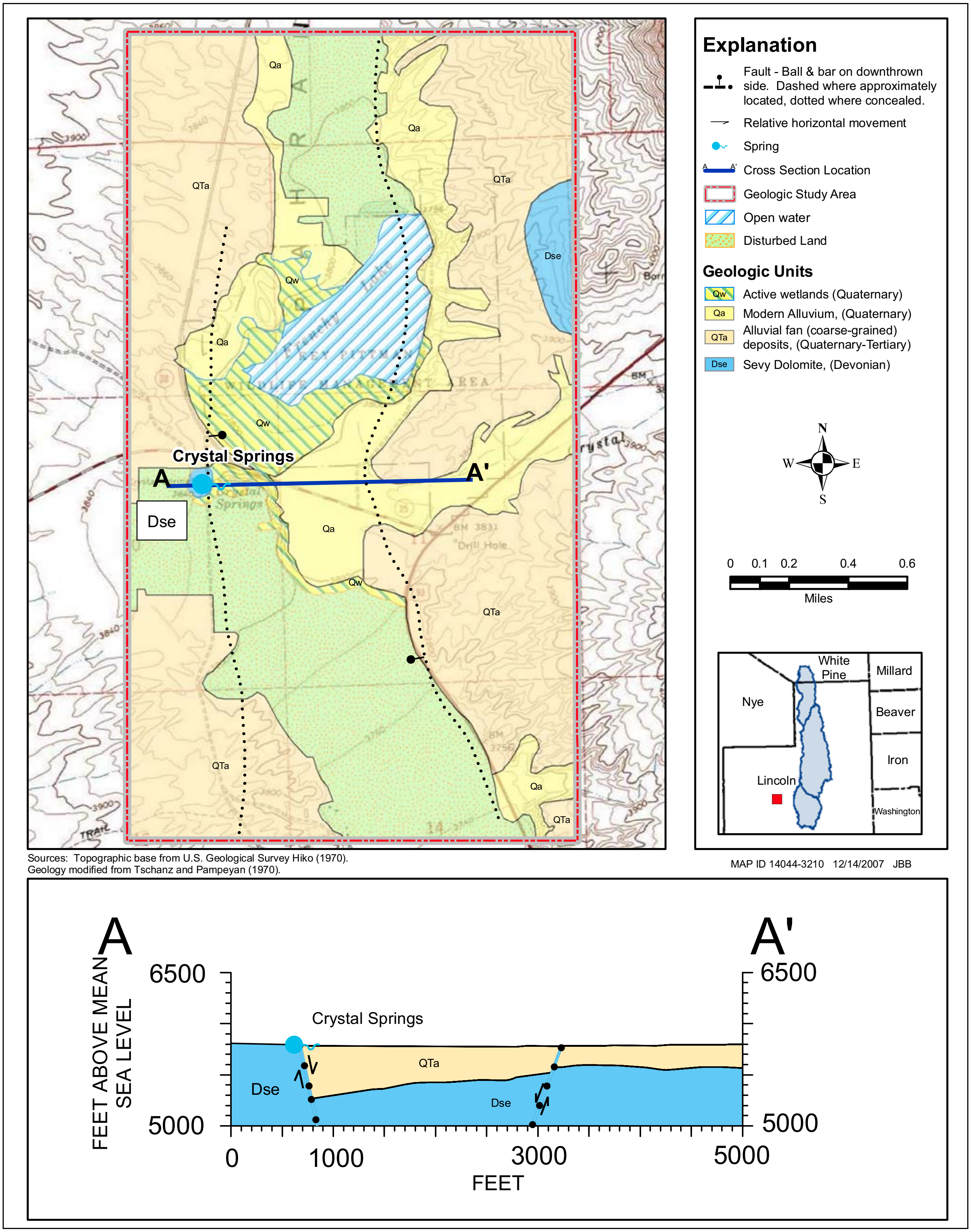

Figure 2
Geology Crystal Spring

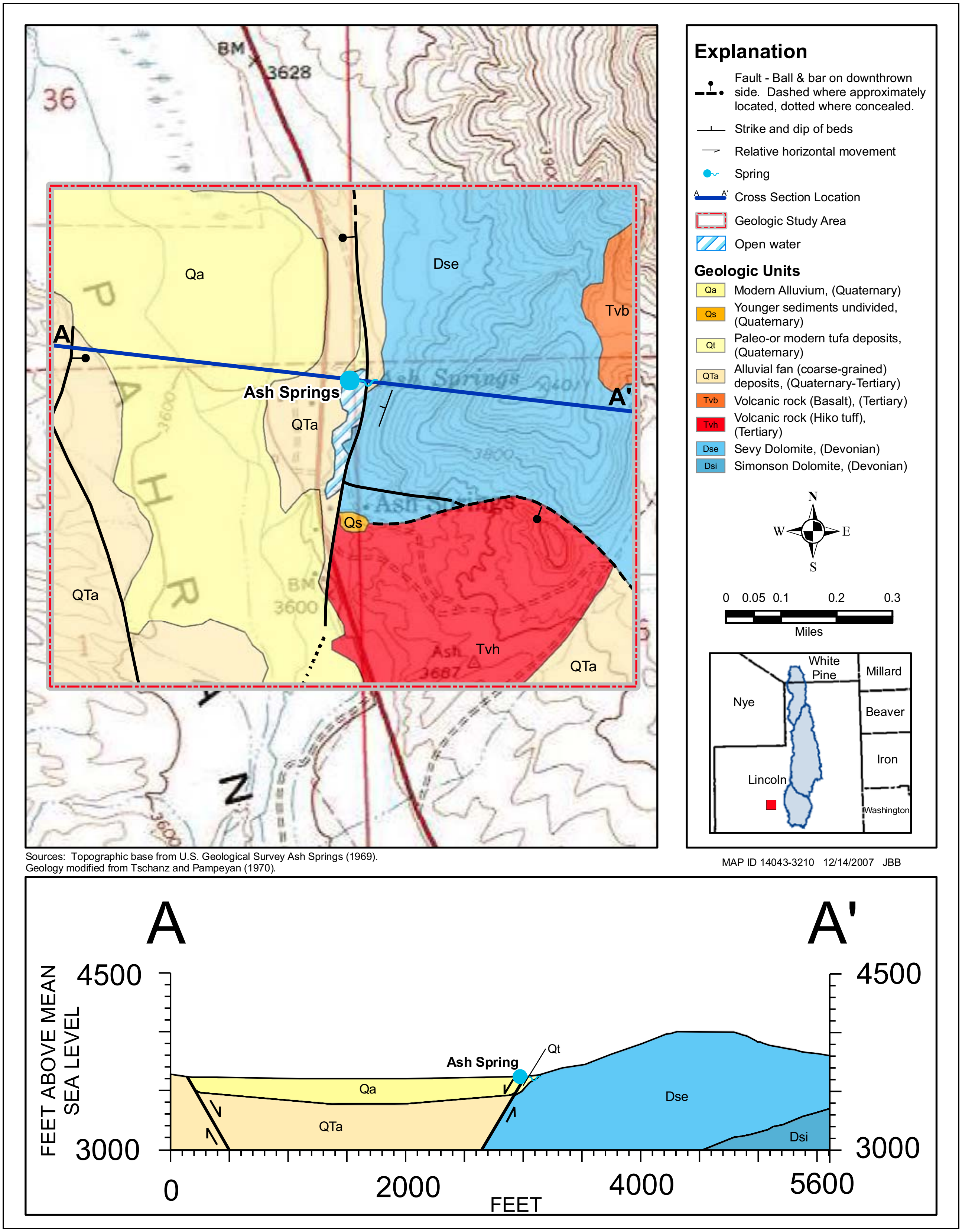

Figure 3
Geology Ash Spring

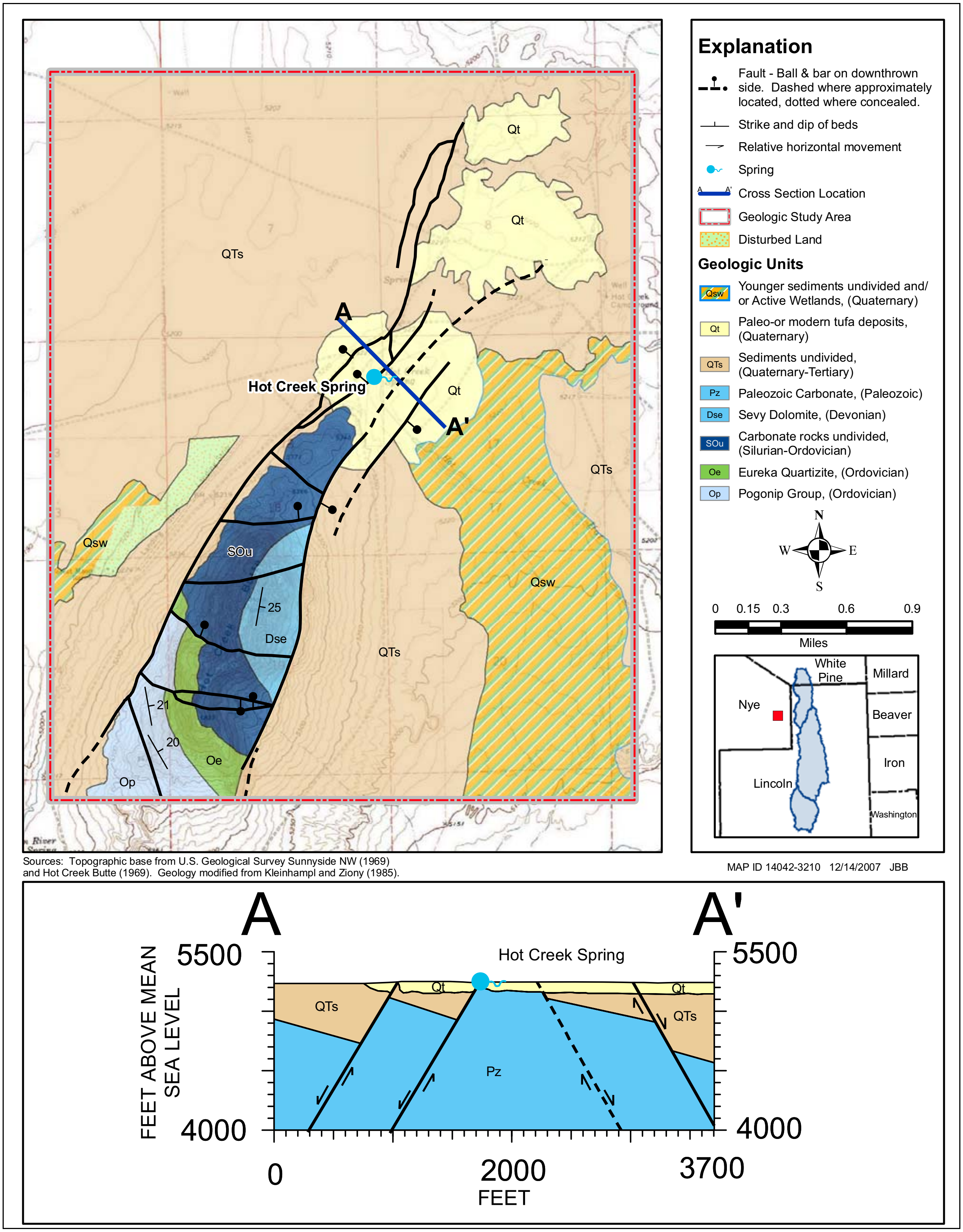

Figure 4
Geology Hot Creek Spring