F3.3.4

Water Quality Characterization

Water Quality Characterization

The groundwater data assembled and evaluated by SNWA (2008) included data collected by SNWA in the 1990s as well as data collected from 2003 through 2006, additional data obtained from the USGS NWIS website, the DRI, the Nevada Bureau of Mines and Geology, and reports by independent consulting firms. Many of the samples were obtained from springs, because they are easier to sample (SNWA 2008). Data from deeper carbonate-aquifer wells are sparse, and it is uncertain whether the spring samples adequately represent the deeper carbonate-rock aquifer (SNWA 2008). To screen the data for quality, SNWA calculated the "reaction error" for the analyses, which is based on the assumption that the sum of the cations should equal the sum of the anions. In most cases, the data that were deemed acceptable had a reaction error of 2 to 5 percent, although a small amount of data were included that had reaction errors of up to 10 percent.

Great Salt Lake Desert Flow System

Spring, Hamlin, and Snake valleys are located within the Great Salt Lake Desert flow system. The general direction of groundwater flow is from Spring Valley, through Hamlin Valley, and into the northeast corner of Snake Valley (Welch et al. 2007). Spring and well water samples were obtained from these valleys (SNWA 2008, Figure 6-1). The geographic distribution of the water samples is uneven, reflecting the compilation of data from a variety of sources. Sample locations are more evenly distributed within Spring Valley. Water quality data for the Great Salt Lake Desert flow system are summarized in **Table F3.3.4A**. Trilinear plots of water samples from the Great Salt Lake Desert flow system indicate that most samples had a calcium-magnesium-bicarbonate composition (SNWA 2008, Figure 6-2). This indicates that the water compositions were mainly controlled by interaction with the carbonate rocks that underlie the valleys (SNWA 2008). In a few samples, sodium concentrations indicate contact with sodium-rich rocks, whereas sulfate concentrations in a few other samples indicate the dissolution of evaporite minerals or sulfide minerals associated with the carbonate rocks (SNWA 2008). The water compositions do not appear to evolve along the flow path (SNWA 2008). However, Welch et al. (2007) observed higher chloride concentrations in the northern portion of Snake Valley. The difference in observations between these two studies may reflect the small number of samples evaluated by SNWA (2008) in the northeastern portion of the valley.

Minor element data indicate that the maximum concentrations observed in the samples were less than or equal to the USEPA Maximum Contaminant Levels (MCLs) for all constituents (SNWA 2008, Table 6-1). SNWA (2008) reported that maximum concentrations in the Spring Valley water samples exceeded the U.S. Secondary Maximum Contaminant Levels (SMCLs) for aluminum, chloride, iron, manganese, pH, and total dissolved solids (TDS). Maximum concentrations in the Snake Valley water samples exceeded the USEPA SMCLs for aluminum, iron, and TDS. Only pH, aluminum, and iron concentrations exceeded Nevada SMCLs in the Spring Valley water samples, and no Hamlin Valley or Snake Valley samples exceeded Nevada SMCLs.

In their study of Great Basin carbonate-rock aquifer systems that included Snake Valley, Welch et al. (2007) found that the groundwater quality was generally good, with only arsenic and fluoride concentrations greater than MCLs at more than one sampling site. Secondary MCLs were more often exceeded than primary standards, with pH outside the acceptable range and chloride and sulfate concentrations greater than SMCLs at for some sampled sites. Welch et al. (2007) found that 7 out of 10 sites in northern Snake Valley had chloride concentrations greater than the SMCL.

Data for deuterium and oxygen-18 fall close to the Global Meteoric Water Line (GMWL) and the Local Meteoric Water Line (LMWL). These lines represent the relationship of deuterium and oxygen-18 concentrations for rain/snow globally (GMWL) and in the region (LMWL). The stable isotopic data indicate that the waters undergoes little evaporation prior to recharge and the principal source of recharge to the groundwater in Spring and Snake River valleys is recent winter precipitation (SNWA 2008).

Table F3.3.4A Water Quality Data from the Great Salt Lake Regional Flow System Spring and Well Sources in Relation to Primary and Secondary Water Quality Standards

	Drinking Water Standards		Spring Valley		Hamlin Valley		Snake Valley	
Constituent[1]	**Primary**[2]	**Secondary**[3]	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**
pH (standard units)	–[4]	6.5–8.5	7.46–8.49	**6.71–9.1**	7–8	7.3–8.17	7.7–8	6.6–8.19
Electrical Conductivity (µmhos/cm)	–	–	131–394	62.7–1821	350–413	265–825	383–412	11–1280
Temperature (°C)	–	–	11.3–24.1	8.3–22.9	12.1–14.8	7.6–18.7	15.2–20.4	0.9–27
Dissolved Oxygen (mg/l)	–	–	2.02–6.8	0.06–7.85	0.5–6	2.2–9.01	3.6–6.5	3.7–9.86
Calcium (mg/l)	–	–	16–47	7.01–191	43–50.8	25.2–111	35.1–51.2	24–131
Magnesium (mg/l)	–	150	0.67–29	1.77–53.6	12.2–21.4	4.58–53.2	19.4–38.1	2.8–94.7
Sodium (mg/l)	–	–	5.88–17	1.4–117	12.5–24.5	2.88–25.8	14.6–23	2.23–110
Potassium (mg/l)	–	–	0.62–2.9	0.24–4.56	4.05–4.21	0.38–8.17	1.57–3.93	0.54–4.8
Alkalinity (HCO_3^-) (mg/l)	–	–	63.8–270	31.2–420	134–175	116–502	128–225	83.7–474
Chloride (mg/l)	–	400	1.9–11	1–352	11–16.8	3.4–41.5	22.6–23.2	2.4–94
Sulfate (mg/l)	–	500	3.2–21	2.4–162	20–36	5.4–24.7	13–30	3.4–234
Nitrate (as N)	10	–	0.62–4.6	0.01–8.1	–	0.12–2.85	–	ND–0.93
Silica (mg/l)	–	–	15–55	5–114	23.9–54	11.3–63.5	22–37	7.6–46
TDS (mg/l)	–	1,000	88–260	137–660	–	–	–	202–680
Aluminum (mg/l)	–	0.2	**<0.002–0.32**	**<0.002–1.2**	<0.002–0.0672	0.0039–0.0043	0.0031–0.0043	0.002–0.16
Arsenic (mg/l)	0.01	–	0.001–0.0066	<0.0005–0.01	0.003–0.0047	0.0006–0.0034	0.0032–0.0058	<0.0005–0.0076
Boron (mg/l)	–	–	0.023–0.063	ND–0.2	–	0.079	–	ND–0.33
Bromine (mg/l)	–	–	0.0006–0.086	0.00005–0.76	0.06–0.07	0.25	0.07–0.1	0.021–0.4
Fluoride (mg/l)	4	–	0.00027–0.96	ND–0.74	0.48–0.88	<0.200	0.06–0.39	0.09–1.8
Iron (mg/l)	–	0.6	**<0.00005–5.7**	**<0.010–1.3**	<0.050–0.17	<0.008–<0.050	<0.050	<0.010–0.13
Lithium (mg/l)	–	–	ND–0.036	ND–0.0338	0.0245–0.0524	0.0024–0.0181	0.0098–0.0181	0.001–0.049
Manganese (mg/l)	–	0.1	<0.0002–0.062	<0.0002–0.088	0.0012–0.0457	<0.0002–0.0299	0.0007–0.0009	<0.0002–0.03
Molybdenum (mg/l)	–	–	0.00038–0.0067	0.00024–0.0025	<0.002–0.0033	0.0003	<0.002	<0.001–0.005
Nickel (mg/l)	–	–	<0.0004–0.0023	<0.0004–0.0016	<0.0004	<0.0004–0.004	<0.0004–0.0015	<0.0004–0.0023
Antimony (mg/l)	0.006	–	<0.0003–0.00038	<0.0003–0.00067	<0.0003–<0.0003	<0.0003	<0.0003	<0.0003–0.0003
Strontium (mg/l)	–	–	0.08–0.546	0.0324–1.15	0.223–0.372	0.0593–0.471	0.213–0.239	0.0516–1.57
Thallium (mg/l)	0.002	–	<0.0001–0.00042	<0.0001–0.0001	<0.0001	<0.00004–<0.0001	<0.0001	<0.0001–0.0002

Table F3.3.4A Water Quality Data from the Great Salt Lake Regional Flow System Spring and Well Sources in Relation to Primary and Secondary Water Quality Standards

	Drinking Water Standards		Spring Valley		Hamlin Valley		Snake Valley	
Constituent[1]	**Primary[2]**	**Secondary[3]**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**
Uranium (mg/l)	–	–	0.0008–0.00324	<0.0001–0.0215	0.00174–0.00597	0.00042–0.0104	0.00079–0.00267	0.00042–0.00302
Vanadium (mg/l)	–	–	0.0007–0.0112	<0.0005–0.0253	0.0014 – 0.0076	0.0012 – 0.011	0.0041–0.009	0.0005–0.004
Oxygen 18 (‰)	–	–	-15.12 to–14.6	-16.2 to–10.85	-15.04 to–14.94	-14.59 to–12.68	–	-16 to–12.3
Deuterium (‰)	–	–	-113.36 to -106.59	-125.58 to -87	-114 to -112.7	-106.8 to -102.1	–	-129.5 to -90

[1]Silver, barium, beryllium, cadmium, chromium, cobalt, copper, mercury, lead, selenium, and zinc concentrations were below the maximum contaminant levels (MCLs) in all samples; bismuth concentrations were below the analytical detection limit in all samples, cobalt concentrations were below the analytical detection units in all samples.
[2]USEPA, MCLs, except copper and lead (action levels).
[3]Nevada Administrative Code (NAC) 445A.455.
[4]not applicable or not analyzed.
ND = Not detected; constituents indicated in bold had at least one value that exceeded primary or secondary standards.
Mg/l = milligrams per liter.
µmhos/cm = micromhos per centimeter.
HCO_3 = bicarbonate.
‰ = One part per thousand.

White River Flow System

Cave, Dry Lake, Delamar, and Coyote Spring valleys lie within the White River flow system. Sample locations within Cave, Delamar, and Dry Lake valleys appear to be evenly distributed along the length of the valleys (SNWA 2008, Figure 6-4). Samples in Coyote Spring Valley are clustered in only a few locations, with no samples available from the western portion of the valley (SNWA 2008, Figure 6-5). The general direction of flow is from the north to south, from Cave Valley through Dry Lake, Delamar, and Coyote Spring valleys.

Water quality data for Cave, Dry Lake, Delamar, and Coyote Spring valleys in the White River flow systems are summarized in **Table F3.3.4B**. The dominant water compositions in Cave Valley are calcium-bicarbonate and calcium-magnesium-bicarbonate, which reflects the influence of the carbonate-rock aquifer (SNWA 2008). Water compositions in Dry Lake Valley are mostly calcium-magnesium bicarbonate and calcium-sodium-bicarbonate; these compositions also reflect the influence of both carbonate rock and volcanic rock weathering (SNWA 2008). Samples from a well located in the southern portion of Dry Lake Valley have calcium and sodium cations plus a mixed bicarbonate-sulfate-chloride anion composition; these water samples appear to reflect the increased influence of the dissolution of evaporite minerals and volcanic rocks (SNWA 2008). The dominant water compositions in Delamar Valley include calcium-sodium-bicarbonate and sodium-calcium-bicarbonate; these compositions reflect the influence of both carbonate rock and volcanic rock weathering (SNWA 2008). Coyote Spring Valley water samples have sodium-calcium-magnesium-bicarbonate sulfate and calcium-sodium-magnesium-sulfate-bicarbonate compositions. The Coyote Spring Valley waters have higher TDS values than those from the other basins; these higher TDS values appear to be caused by evaporite mineral dissolution (SNWA 2008). Along the general direction of groundwater flow from north to south in the White River Flow System, the groundwater composition evolves from a calcium-magnesium-bicarbonate composition, through a calcium-sodium-magnesium-bicarbonate composition to a sodium-calcium-magnesium-bicarbonate-sulfate composition near the end of the flow system. This evolution appears to be caused by increasing dissolution of volcanic rocks and evaporites with flow distance.

Maximum concentrations of minor elements in water samples from the White River flow system exceeded USEPA MCLs for only a few constituents. Maximum antimony concentrations in the Dry Lake and Coyote Spring valleys exceeded the USEPA MCL value of 6 micrograms per liter (μg/L). Maximum fluoride concentrations in Delamar and Coyote Spring valleys exceeded the USEPA MCL value of 4 mg/l. These MCLs were exceeded by the concentrations in few samples. Maximum arsenic concentrations in Dry Lake, Delamar, and Coyote Spring valleys exceeded the USEPA MCL value of 10 μg/L; the majority of the arsenic values (10 out of 16 reported values) from Coyote Spring Valley exceeded the USEPA MCL of 10 μg/L. A single reported thallium concentration of 2.2 μg/L in the Cave Valley water samples exceeded the USEPA MCL for thallium of 2 μg/L.

Maximum concentrations reported for some water samples in the White River flow system exceeded some USEPA SMCLs (SNWA 2008, Table 6-2). The aluminum SMCL of 50 to 200 μg/L was exceeded by the maximum concentrations for Cave, Dry Lake, and Delamar valleys; the 300 μg/L iron USEPA SMCL and 600 μg/L iron Nevada SMCL were exceeded by the maximum concentrations in the samples from all 4 valleys in the White River Flow System; the manganese SMCL of 50 μg/L was exceeded by the maximum concentrations in the samples from Cave, Dry Lake, and Coyote Spring valleys. The USEPA TDS SMCL of 500 μg/L was exceeded by the maximum values reported for Cave and Coyote Spring valleys, although no samples exceeded the 1,000 μg/L Nevada SMCL for TDS.

A plot of deuterium verses oxygen-18 (SNWA 2008, Figure 6-7) indicates that the water samples from the White River flow system fall below the GMWL and the LMWL. Water samples from the White River flow system analyzed by Thomas and Dettinger (1996) also fall below the GMWL and LMWL. The position of where these deuterium and oxygen-18 stable isotopic plot relative to this reference lines indicate that the water undergoes some evaporation prior to recharge or it was recharged during a different climatic period (SNWA 2008).

Table F3.3.4B Water Quality Data from the White River Flow System Spring and Well Sources in Relation to Primary and Secondary Water Quality Standards

	Drinking Water Standards		Cave Valley		Dry Lake Valley		Delamar Valley		Coyote Spring Valley
Constituent[1]	**Primary[2]**	**Secondary[3]**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**	**Well Samples**
pH (standard units)	–[4]	6.5–8.5	7.43–7.8	7.2–8.12	6.9–8.12	6.8–7.8	**7.93–8.52**	7–7.94	6.98–8.25
Electrical Conductivity (µmhos/cm)	–	–	362–441	81.5–519	470–618	188–807	361–443	554–801	505–1356
Temperature (ºC)	–	–	13–18.5	8.5–17	22.5–29.8	9.2–22.2	34.8–40	10.2–25	23–41.9
Dissolved Oxygen (mg/l)	–	–	1.2–5.48	4.15–7.84	0.2–4.92	6.4–8.3	3.65–4.34	2.3–7.7	1.47–4.63
Calcium (mg/l)	–	–	37–54	16–80.6	21–80	21.8–96.2	9–19	67–116	37–86
Magnesium (mg/l)	–	150	18–22	2.2–27.9	7.1–30	5.9–25.8	4	9.3–20.7	0.82–31
Sodium (mg/l)	–	–	8–13	3.1–23.2	19–71	8–180	49–55	29.5–51	26–220
Potassium (mg/l)	–	–	1–6	0.34–2.36	5–7	1.66–10.7	1–8	0.5–2.3	4–16
Alkalinity (HCO_3^-) (mg/l)	–	–	190–270	48.4–304	110–403	153–331	120–180	242–339	170–286
Chloride (mg/l)	–	400	7–15	1–11.8	6–27	4.9–70.3	5–11	17.3–70.7	18–58
Sulfate (mg/l)	–	500	12–17	4.5–26.2	21–55	7.8–105	9–20	18.7–69	46–220
Nitrate (as N)	10	–	0.91–1.9	0.09–0.93	0.05–1.1	–	0.89–1.2	–	0.12–1.2
Silica (mg/l)	–	–	24–46	2.1–51.7	27–38	32.4–82.7	50–73	27.8–48.7	20–44
Total Dissolved Solids (mg/l)	–	1,000	210	72–740	300–380	268	210	–	300–630
Aluminum (mg/l)	–	0.2	<0.002–0.015	**<0.002–0.43**	**0.002–0.99**	<0.005	**0.43**	<0.005	<0.002–0.031
Arsenic (mg/l)	0.01	–	0.0018–0.0038	<0.001–0.003	**0.0061–0.0115**	0.01	**0.0021–0.017**	<0.005–0.004	**0.0008–0.02**
Boron (mg/l)	–	–	0.031–0.053	<0.250	0.073–0.34	–	0.11–0.2	<0.250	0.11–0.46
Bromine (mg/l)	–	–	0.082–0.15	<0.050–0.095	0.07–0.21	0.22	0.047–0.097	0.41–0.6	ND–0.19
Fluoride (mg/l)	4	–	0.16–<0.2	0–0.11	0.22–0.6	0.2–0.5	**2.2–5.9**	0.2–0.3	**0.67–4.6**
Iron (mg/l)	–	0.6	**0.049–0.65**	0.044–0.22	**0.38–2.4**	0.07	**0.13–1.3**	<0.050	**ND–3.3**
Lithium (mg/l)	–	–	ND–0.0103	0.003–0.0068	0.017–0.12	0.0079	0.02–0.028	0.01	0.016–0.28
Manganese (mg/l)	–	0.1	**0.0018–0.12**	<0.0002–0.009	0.0043–0.094	0.007	0.0087–0.038	<0.002–<0.005	ND–0.097
Molybdenum (mg/l)	–	–	0.0004–0.0017	<0.001–<0.010	0.0018–0.0059	0.002	0.0017–0.0056	<0.001–0.001	ND–0.0068
Nickel (mg/l)	–	–	0.0011–0.017	<0.0004–<0.005	0.002–0.00525	<0.005	ND	<0.005	ND–0.0078
Antimony (mg/l)	0.006	–	0.0002–0.001	<0.0003–<0.001	**0.0005–0.0614**	<0.001	ND	<0.001	**ND–0.0066**
Strontium (mg/l)	–	–	0.16–0.206	0.0421–0.746	0.32–0.85	0.3	0.045–0.09	–	0.53–2.6
Thallium (mg/l)	0.002	–	**<0.00004–0.0022**	<0.0001–<0.002	**ND–0.0026**	<0.002	ND	<0.002	ND–0.0004

Table F3.3.4B Water Quality Data from the White River Flow System Spring and Well Sources in Relation to Primary and Secondary Water Quality Standards

	Drinking Water Standards		Cave Valley		Dry Lake Valley		Delamar Valley		Coyote Spring Valley
Constituent[1]	**Primary[2]**	**Secondary[3]**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**	**Well Samples**	**Spring Samples**	**Well Samples**
Uranium (mg/l)	–	–	0.00067	0.00092–0.00364	0.0027–0.0031	–	0.0021–0.0047	–	–
Vanadium (mg/l)	–	–	0.0025–0.0041	0.0013–0.0053	0.0031–0.0084	0.009	0.002–0.013	0.011–0.013	ND–0.0061
Oxygen 18 (‰)	–	–	-14.12 to -14.12	-14.78 to -13.05	-13.67 to -13.5	-13.06 to-11.76	-14.07 to-13.33	-12.87 to-10.62	-13.41 to-10.3
Deuterium (‰)	–	–	-105.6 to -104.7	-111.9 to -100	-105 to -104.6	-102 to -90	-109.6 to -99.9	-96.9 to -87.5	-102.5 to-75.8

[1]Silver, barium, beryllium, cadmium, chromium, cobalt, copper, mercury, lead, selenium, and zinc concentrations were below the MCLs in all samples; bismuth concentrations were below the analytical detection limit in all samples.
[2]USEPA, MCLs, except copper and lead (action levels).
[3]NAC 445A.455.
[4]Not applicable or not analyzed.
ND = not detected; constituents indicated in bold had at least one value that exceeded primary or secondary standards.