APPENDIX E
GROUNDWATER SUPPLY AND FEASIBILITY

WORKING PAPER
Pine Nut Allotments (NV) Land Use and Development Plan

Groundwater Supply and Feasibility
Prepared by: GSI Water Solutions, Inc., 17 December 2007

Introduction

This working paper evaluates groundwater development potential for the Pine Nut Allotments, located in the Carson Valley of west-central Nevada (Figure 1). Groundwater development potential for the Pine Nut Allotments is determined by groundwater availability, groundwater quality, and sustainability of using the groundwater resource as a domestic water supply for individual land holdings. Groundwater availability is evaluated with geologic and hydrogeologic data (i.e., geologic maps and State of Nevada Water Well Reports), which indicate groundwater yield potential and distribution of geologic units in the project area. Groundwater quality is evaluated by compiling groundwater chemistry analyses from private and public wells in the project area. Groundwater sustainability is evaluated by estimating a groundwater budget for the project area and comparing the expected groundwater demand of the proposed development to the quantity of groundwater that is available. This evaluation of groundwater development potential includes:

- Regional geology and hydrogeology of the Carson Valley, and
- Geology, hydrogeology, groundwater quality, and groundwater budget for the Pine Nut Allotments.

For planning purposes, we have assumed that the minimum well capacity necessary to satisfy single-dwelling residential water use is 5 to 10 gallons per minute (gpm). The Pine Nut Allotments included in this groundwater development potential evaluation form two clusters—one on the eastern margin of the Carson Valley (northern Pine Nut Allotments) and another on the southern margin of the Carson Valley (southern Pine Nut Allotments) (Figure 2). The physical settings of the northern and southern Pine Nut Allotments are distinct; therefore, geology, hydrogeology, groundwater quality, groundwater budgets, and groundwater development potential are discussed separately.

The objective of this working paper is to evaluate the feasibility of developing the groundwater resource for the northern and southern Pine Nut Allotments. The goals of this working paper are to:

- Summarize groundwater availability, groundwater quality, and groundwater sustainability for the northern and southern Pine Nut Allotments, and
- Assess groundwater development potential for the northern and southern Pine Nut Allotments.

Regional Geology and Hydrogeology of the Carson Valley

Regional geology and hydrogeology of the Carson Valley has been summarized by the United States Geological Survey (USGS). This discussion of regional Carson Valley geology and hydrogeology is developed from USGS professional papers (i.e., Maurer, 1986; Maurer and Berger, 2006; Jeton and Maurer, 2007), geologic maps (Moore, 1969), and conversations with the USGS (i.e., personal

communication, 2007). These references were used to evaluate groundwater development potential of the northern and southern Pine Nut Allotments.

Regional Setting

The Carson Valley is an arid, high-desert basin bounded by the Sierra Nevada Mountains to the west and the Pine Nut Mountains to the east (Figure 1). The Sierra Nevada Mountains reach 11,000 feet above mean sea level (amsl), and the slightly lower Pine Nut Mountains reach 9,000 feet amsl. The valley floor elevation ranges from 4,600 to 5,000 feet amsl (USGS, 2007). Located in the rain shadow of the Sierra Nevada, the Carson Valley floor receives an average 10 inches of precipitation per year, while the Sierra Nevada and Pine Nut Mountains receive as much as 45 and 26 inches of precipitation per year, respectively (USGS, 1986).

The most significant surface water feature in the Carson Valley is the Carson River, which flows northward through the central part of the valley. The Carson River drains several ephemeral drainages originating in the Sierra Nevada and Pine Nut Mountains, and is a major source of irrigation water.

Regional Geology

The Carson Valley was formed by volcanic, tectonic and erosional events during the past 240 million years. The oldest geologic units in the Carson Valley are 138 to 240 million year old volcanic and sedimentary rocks deposited in the Jurassic and Triassic Periods. During the Cretaceous Period (63 to 138 million years ago), granitic magma of the Sierra Nevada batholith intruded into the Jurassic and Triassic sedimentary rocks, forming the basement rock of the Carson Valley and a majority of the Pine Nut and Sierra Nevada Mountains. A long period of erosion followed the intrusion, until approximately 10 million years ago when basin and range faulting created present day topography by dropping the valley floor and uplifting the Sierra Nevada and Pine Nut Mountains. Erosion of the newly-formed highlands resulted in deposition of Tertiary Sediments, consisting of 40 to 80 foot thick clay beds with 10 to 20 foot thick sand and gravel interbeds over most of the valley floor. Continued faulting between 15 and 5 million years ago tilted the Tertiary sediments towards the west, and Tertiary Andesites and Basalts erupted along the southern and western sides of the valley. During the last 2 million years, continued erosion of highlands filled the Carson Valley, covering the Tertiary Sediments with Quaternary Alluvium. The combined thickness of basin fill in the Carson Valley (i.e., Tertiary Sediments and Quaternary Alluvium) ranges from 5000 feet to 2000 feet on the west and east sides of the valley, respectively.

Regional Hydrogeology

Groundwater in the Carson Valley flows from the margins of the valley towards the Carson River in the center of the valley, and then northward along the Carson River. The United States Geological Survey identifies three water-bearing units in the Carson Valley, including (USGS, 1986):

- **Unconsolidated Alluvium.** Unconsolidated alluvium includes alluvial fan, eolian, and fluvial deposits less than 2 million years old, and is the primary aquifer in the Carson Valley. Groundwater yield from wells completed in the unconsolidated alluvium is sufficiently high to support irrigation, municipal and domestic demands. Depth to groundwater in the unconsolidated alluvium ranges from 5 feet below ground surface (bgs) near the Carson River to greater than 100 feet bgs at the margins of the valley.

- **Tertiary Sediments.** Tertiary Sediments include clays with interbedded discontinuous sand and gravel lenses. Sand and gravel zones in the Tertiary Sediments supply water primarily for domestic purposes.

- **Bedrock.** Bedrock includes Triassic and Jurassic sedimentary and volcanic rocks, as well as granitic intrusions of the Cretaceous Age. Fractured zones in the volcanic and sedimentary rock supply water primarily for domestic purposes. Few wells are completed in the Cretaceous Granite, which occurs at considerable depths in the valley (i.e., > 1000 feet).

Northern and Southern Allotment Geology, Hydrogeology, Groundwater Quality, and Groundwater Budget

Geology, hydrogeology, groundwater quality, and groundwater budgets are used to evaluate the groundwater development potential for the Pine Nut Allotments, and were summarized from State of Nevada Water Well Reports (NDWR, 2007), Environmental Assessments (CSCON, 2006a; CSCON, 2006b), and USGS reports. Because the geology, hydrogeology, groundwater quality, and groundwater budgets for the northern and southern Pine Nut Allotments are distinct, they are discussed separately.

Northern Pine Nut Allotments

The northern Pine Nut Allotments are located in the margin of the Carson Valley, in Township 13 North, Range 21 East (Figure 2). The northern Pine Nut Allotments are situated in the drainage of Buckeye Creek, an ephemeral creek that drains the Pine Nut Mountains to the east.

Geology

Figure 3 shows geology of the southeast Carson Valley. The northern Pine Nut Allotments are underlain by Tertiary Sediments (Ts) and Quaternary Alluvium (Qal, QToa). Driller's logs from wells drilled near the northern Pine Nut Allotments indicate that the Tertiary Sediments are relatively thick (up to 705 feet in log 18285) and the Quaternary Alluvium is thin (ranging from 20 feet to 68 feet in logs 33370, 75028, 89035, 47191 and 65348).

Hydrogeology

Figure 4 shows geology and the occurrence of wells for each section of the southeast Carson Valley. In the vicinity of the northern Pine Nut Allotments, the majority of groundwater wells have been drilled in alluvium, and a minor number of wells have been drilled in the Tertiary Sediments. Alluvium underneath the northern Pine Nut Allotments is generally unsaturated; therefore, groundwater development potential for the northern Pine Nut Allotments focuses on the Tertiary Sediments. Few wells have been drilled in the northern Pine Nut Allotments.

State of Nevada water well reports indicate that groundwater in the vicinity of the northern Pine Nut Allotments occurs at moderate depths (i.e., an average of 72.7 feet in Township 13 North, Range 21 East), and that well depths range from 80 to 495 feet bgs. Figure 5 is cross sectional view of northern Pine Nut Allotment geology along the A to A' transect. The location of the A to A' transect is shown in Figure 3. Wells drilled in Tertiary Sediments obtain water from 10 to 20 feet thick, discontinuous gravel interbeds in the silt and clay. If gravel interbeds are not encountered when drilling a well in the Tertiary Sediments, then the well may not produce water (e.g., Well 18285, shown in Figure 5). State of Nevada water well reports indicate that well yields range from 7 to greater than 35 gallons per minute (gpm) in the Tertiary Sediments.

Groundwater Quality

Groundwater quality results from a single well near the northern Pine Nut Allotments are listed in Table 1 and shown on Figure 2. Groundwater chemistry in the well meets drinking water standards established by the Environmental Protection Agency (EPA) [i.e., Maximum Contaminant Levels (MCLs) and Secondary Standards)]. Because the groundwater quality results in the northern Pine Nut Allotments are from a single well, definitive conclusions about groundwater quality cannot be made.

Groundwater quality results from other parts of the Carson Valley (e.g., near the southern Pine Nut Allotments) indicate that arsenic, sulfate, manganese and dissolved iron exceed either EPA MCLs or Secondary Standards; therefore, groundwater quality in the vicinity of the northern Pine Nut Allotments should be tested, and possibly treated, prior to groundwater development.

Groundwater Budget

A groundwater budget has been developed for the eastern Carson Valley by the USGS, and is shown in Figure 6. Groundwater recharge in this region originates from aerial precipitation on quaternary eolian sand (140 acre-ft/year) (Maurer and Berger, pg. 26, 2006) and inflow from Buckeye Creek, Pine Nut Creek, and subflow from underlying Mesozoic basement rock (4,300 to 15,000 acre-ft/year) (Maurer and Berger, pg. 32 - 35, 2006). This corresponds to an annual recharge rate on a per acre basis ranging from 5,306 ft^3/acre to 18,513 ft^3/acre. Groundwater leaves the Tertiary Sediments by discharge to the unconsolidated alluvium within the Carson River drainage. Groundwater in the unconsolidated alluvium then discharges to the Carson River or flows north along the regional groundwater flowpath.

Because the evapotranspiration rate in the area exceeds average annual rainfall and because the soils in the upland areas have an extreme moisture deficit, most precipitation does not infiltrate to the groundwater system. It is only during extreme rainfall events or after extended wet periods does most groundwater recharge occur. Most of this recharge is focused within drainage basins and therefore is likely not uniform.

USGS water budget estimates are available at the drainage-wide scale only (e.g., Buckeye Creek). The northern Pine Nut Allotments occupy a relatively small area in the Buckeye Creek drainage; therefore, it is difficult to estimate a quantitative groundwater budget for the northern Pine Nut Allotments. Because the regional water budget indicates that groundwater recharge is low, it can be concluded that aquifers on the northern Pine Nut Allotments receive relatively little recharge, and groundwater from pumping primarily comes from aquifer storage. Consequently, the groundwater system in this area is highly sensitive to over-pumping.

Southern Allotments

The southern Pine Nut Allotments are located on the southern margin of the Carson Valley, east and west of US-395 in portions of (Figure 2):

- Townships 10 North, 11 North and 12 North in Range 21 East, and
- Township 11 North in Range 22 East.

No major drainages are present in the southern Pine Nut Allotments.

One multi-dwelling residential development (i.e., Pine View) and at least two proposed residential developments (i.e., Buffalo Run and Pinion Pointe) are located in the southern Pine Nut Allotments. Wells have been drilled at each development, and are discussed in the following sections.

Geology

Figure 3 shows geology of the southeast Carson Valley. West of US-395, the southern Pine Nut Allotments are underlain primarily by Tertiary Basalts (Ta) (although the geologic map identifies Ta as Tertiary Andesites, the unit is basalt in the vicinity of the southern allotments). East of US-395, the southern Pine Nut Allotments are underlain primarily by Jurassic sedimentary rocks (JTrs, JTv). Minor amounts of Quaternary Alluvium (Qal, QToa) have been identified along US-395. The mountains east and west of US-395 are composed of Tertiary Basalts and Jurassic sedimentary rocks. The Quaternary Alluvium is a valley fill deposit, and therefore, exhibits a wide range of thicknesses (from 98 feet in log 16522 to 780 feet in the "new well" for the Buffalo Run development). Driller's logs from wells drilled near the northern Pine Nut Allotments indicate that the Jurassic sedimentary rocks and Tertiary Basalts are relatively thick (480 feet thick in log 46479 and 1580 feet thick in log 93374, respectively).

Hydrogeology

Figure 4 shows geology and the occurrence of wells for each section of the southeast Carson Valley. In the vicinity of the southern Pine Nut Allotments, a majority of the groundwater wells are completed in the Quaternary Alluvium and Tertiary Basalts. Only a few wells are completed in the Jurassic sedimentary rocks.

Depth to groundwater in the vicinity of the southern Pine Nut Allotments ranges from 8 to 476 feet bgs in Township 11 North Range 21 East. Large depths to groundwater are encountered at higher elevations, while shallower groundwater depths are encountered at lower elevations in alluvium filling minor drainage basins. Figure 7 is cross sectional view of southern Pine Nut Allotment geology along the B to B' transect. The location of the B to B' transect is shown in Figure 3. Wells drilled in Quaternary Alluvium obtain water from pore spaces between gravel and sand grains, and wells drilled in the Tertiary Basalts and Jurassic sedimentary rocks obtain water from 10 to 50 foot thick zones of fractured rock. If shallow fracture zones are not encountered, wells located in the southern Pine Nut Allotments may have to be drilled to significant depths (e.g., log 93374, drilled to a depth of 1580 feet bgs). State of Nevada water well reports indicate that well yields in the basalt range from 4 to 200 gpm, well yields in the alluvium range from 15 gpm (where alluvium is thin) to 300 gpm (where alluvium is thick), and well yields in the sedimentary rocks range from 5 to 10 gpm.

Groundwater Quality

Groundwater quality results from five wells in the vicinity of the southern Pine Nut Allotments are listed in Table 1 and shown on Figure 2. Three of the five groundwater quality results are from groundwater samples collected at wells on the southern Pine Nut Allotments (i.e., Buffalo Run, Buffalo Run#1, and Pinion Point). The groundwater chemistry results indicate that:

- Nitrates were detected in four of five groundwater samples collected in the vicinity of the southern Pine Nut Allotments. Nitrates in groundwater are commonly due to septic effluent and fertilizers (e.g., Kehew, et al., 2001). Nitrate concentrations are below Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs) for drinking water, which are legally-enforceable drinking water standards for public water supply systems.
- Arsenic was detected in four of five Carson Valley groundwater samples collected in the vicinity of the southern Pine Nut Allotments. In one groundwater sample (Pinion Point), located on the southern Pine Nut Allotments, the arsenic concentration exceeded EPA MCLs.
- Sulfate, dissolved iron, and manganese exceeded EPA National Secondary Drinking Water Standards (EPA, 2003) at one or more sample locations. EPA secondary standards are guidelines for contaminants that, when exceeded, may cause deleterious cosmetic effects (e.g., skin or tooth discoloration).

Groundwater chemistry results in the vicinity of the southern Pine Nut Allotments do not prohibit development of the groundwater resource. However, treatment may be required prior to use of groundwater.

Groundwater Budget

As was the case for the Northern Allotment area, a quantitative groundwater budget is not available for the Southern Allotment area; however, we can extrapolate from the regional water budget constructed by the USGS for the eastern Carson Valley. No perennial or ephemeral drainages are located near the southern Pine Nut Allotments; therefore, surface water does not contribute to recharging the Tertiary Basalts, Jurassic sedimentary rocks, or Quaternary Alluvium. Groundwater enters the Tertiary Basalts, Jurassic sedimentary rocks, and Quaternary Alluvium by underflow from the valley located south of the Carson valley. It is likely that a small amount of groundwater enters the Quaternary Alluvium by recharge from aerial precipitation. Groundwater discharges from the Tertiary Basalts, Jurassic sedimentary rocks, and Quaternary Alluvium into several springs (e.g. Double Spring), the Carson River, and the alluvial valley fill.

Consistent with the northern Pine Nut Allotments, most groundwater in the southern Pine Nut Allotments occurs as a result of historic precipitation when the climate was wetter. As discussed previously for the Northern Allotment Area, aquifers in the eastern Carson Valley receive relatively little recharge, and groundwater from pumping primarily comes from aquifer storage. Consequently, the groundwater system in this area is also highly sensitive to over-pumping.

Northern and Southern Allotment Groundwater Development Potential

Groundwater development potential for the northern and southern Pine Nut Allotments is estimated from the geology, hydrogeology, groundwater chemistry, and groundwater flow budget discussed in previous sections. Because the geology, hydrogeology, and groundwater budgets of the northern and southern Pine Nut Allotments are distinct, the groundwater development potentials are discussed separately.

Northern Allotment Groundwater Development Potential

Geology, hydrogeology, groundwater flow budget, and groundwater chemistry in the vicinity of the northern Pine Nut Allotments indicate that:

- Regionally, alluvium is the primary aquifer in the Carson Valley; however, alluvium in the vicinity of the northern Pine Nut Allotments does not appear to be saturated. Therefore, northern Pine Nut Allotments would derive groundwater from wells completed in Tertiary sediments.
- Groundwater is available from gravel and sand interbeds of the Tertiary Sediments. Domestic wells installed in the Tertiary Sediments indicate that the gravel and sand interbeds produce groundwater at rates ranging from 7 to 35 gpm.
- The water budget for the northern Pine Nut Allotments indicates that use of Tertiary Sediments to support multi-dwelling residential demand would likely not be sustainable.
- Groundwater quality analyses for wells in the vicinity of the northern Pine Nut Allotments are limited; however, available groundwater quality analyses indicate that pretreatment for nitrates, arsenic, sulfate, iron, and manganese may be necessary prior to groundwater use for domestic purposes.
- Overall, it is our opinion that Tertiary Sediments in the northern Pine Nut Allotments have a marginal potential for groundwater development. **The northern Pine Nut Allotments may be able to support a residential development density of 1 to 2 dwellings per acre. The availability of groundwater appears to be quite variable depending on location and so test wells are advisable to confirm yield. Likewise, we have significant concerns about the sustainability of groundwater development due to the poor recharge. Because of the limited**

recharge, pumping over time may result in water level declines and reduced yields. Consequently, we believe that it is prudent to disclose these concerns in all lease agreements.

- Groundwater in the northern allotments does not appear to be able to support commercial or industrial demand nor is there an adequate supply to support a golf course.

Southern Allotment Groundwater Development Potential

Geology, hydrogeology, groundwater flow budget, and groundwater chemistry in the vicinity of the southern Pine Nut Allotments indicate that:

- Groundwater is available from Quaternary Alluvium, and fractured zones within Tertiary Basalt and Jurassic sedimentary rocks.
- Groundwater yields from thick alluvium sequences and fractured zones in basalt are sufficient to support single-dwelling and multi-dwelling domestic demand. Examples of multi-dwelling domestic demand being satisfied by a single well include Pinion Pointe, China Springs Youth Camp, and Pine View. However, it is more common for multiple wells to be drilled to meet multi-dwelling domestic demand [i.e., Buffalo Run, which drilled Well 1 (40 gpm), Well 2 (15 gpm), Well 3 (15-20 gpm), Well 4 (115 gpm) and Well 5 (135) to satisfy multi-dwelling domestic demand].
- Groundwater yields from Jurassic sedimentary rocks (i.e., 5 to 10 gpm) are sufficient only to support single-dwelling residential demands.
- Groundwater quality analyses in the vicinity of the southern Pine Nut Allotments indicate that pretreatment for nitrates, arsenic, sulfate, iron, and manganese may be necessary prior to groundwater use.
- In our opinion, Quaternary Alluvium and Tertiary Basalt units have moderate potential for groundwater development. **Quaternary Alluvium and Tertiary Basalt in the Southern Pine Nut Allotments may be able to support a residential development density of 1 to 2 dwellings per acre. Some wells in the area indicate that the Quaternary Alluvium and Tertiary Basalt in the Southern Pine Nut Allotments may be able to support higher residential development densities (e.g., the well located in the Pine View development). The availability of groundwater appears to be quite variable depending on location and so test wells are advisable to confirm yield. Likewise, we have significant concerns about the sustainability of groundwater development due to the poor recharge. Because of the limited recharge, pumping over time may result in water level declines and reduced yields. Consequently, we believe that it is prudent to disclose these concerns in all lease agreements.**
- In our opinion, allotments located on Jurassic sedimentary rocks have minimal to no potential for groundwater development.

Data Sources

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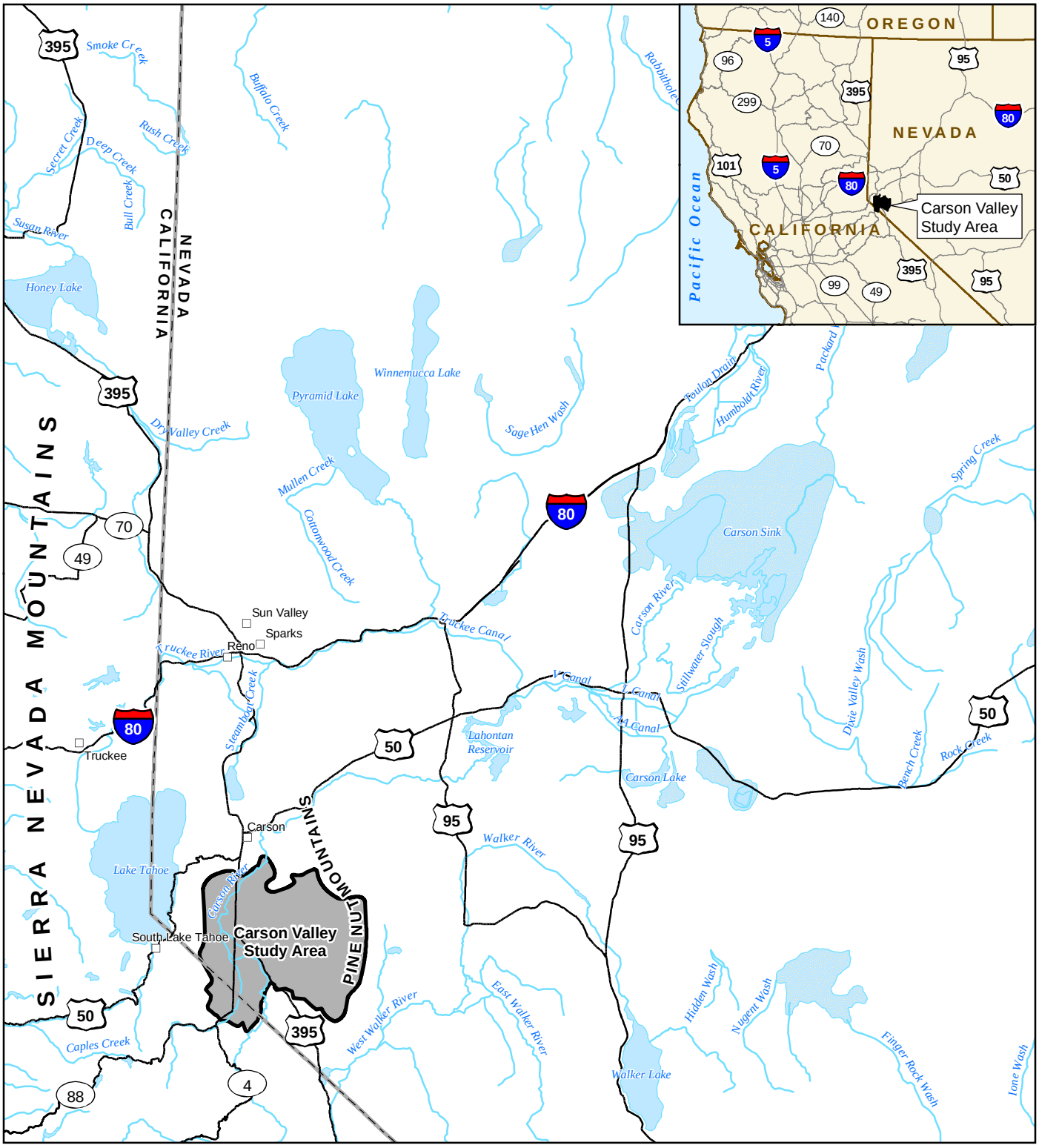

LEGEND

- Carson Valley Study Area
- Cities
- Freeways and Highways
- Rivers and Streams
- Lakes and Reservoirs
- Dry Lakes
- State Boundary

N

Scale

1:1,267,200

0 10 20 30

Miles

FIGURE 1

Carson Valley Study Area

Pine Nut Plan - Cascade Design

MAP NOTES:

Projection: Universal Transverse Mercator Zone 11 North
Datum: North American Datum of 1983
Date: November 1, 2007
Data Sources: USGS, ESRI

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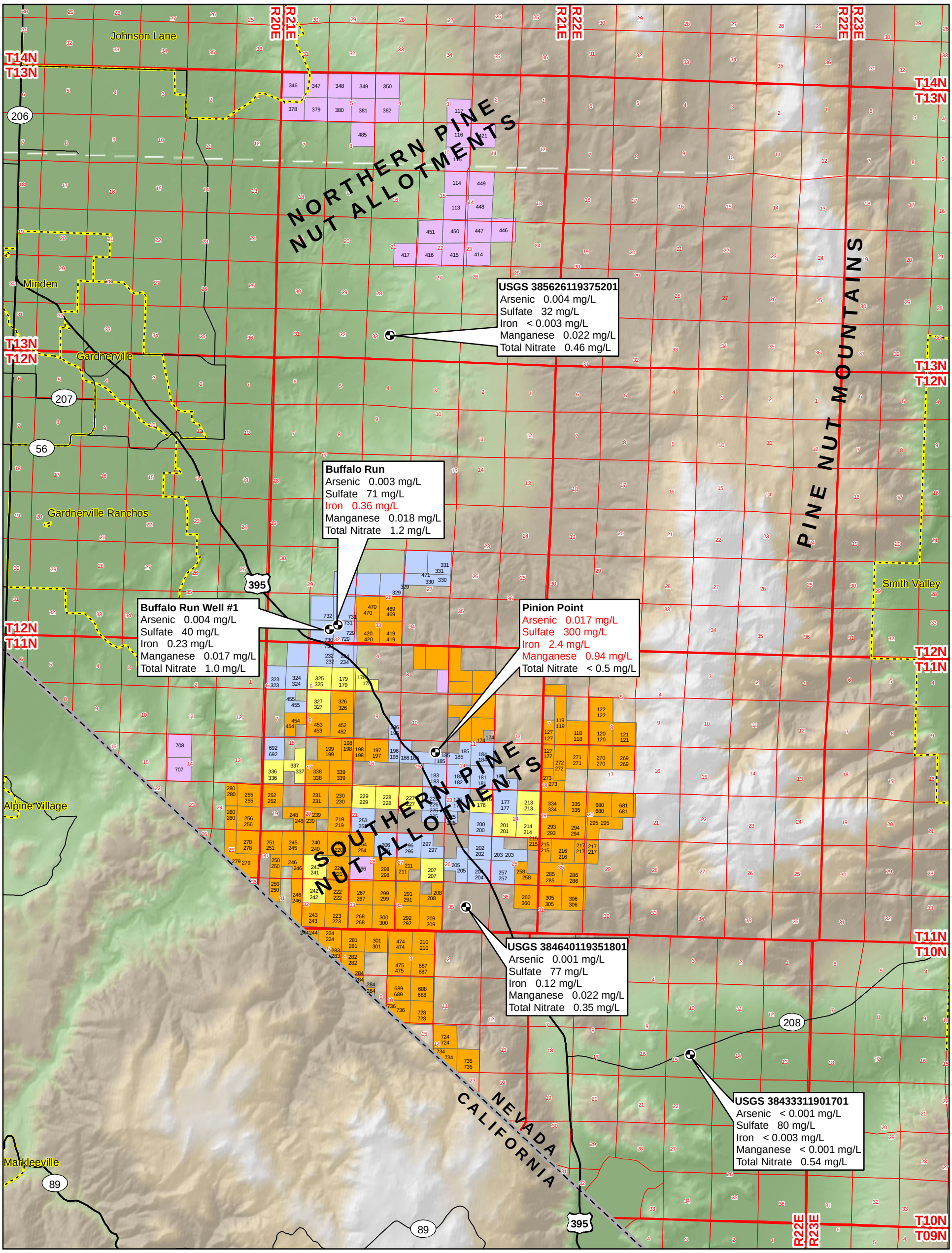

LEGEND

- Developable
- Marginal Development Potential
- No Development Potential
- Allotment Included in Master Land Use Plan
- Wells (NA = Not Analyzed)
- Cities
- Freeways and Highways
- Major Roads
- State Boundary

Elevation

9425 feet

4550 feet

N

Scale
1:126,720

0 1 2 3 4
Miles

NOTE: Red highlighting indicates concentration exceeds Environmental Protection Agency maximum contaminant level.

FIGURE 2

Groundwater Chemistry Results

Pine Nut Plan - Cascade Design

MAP NOTES:
Projection: Universal Transverse Mercator Zone 11 North
Datum: North American Datum of 1983
Date: October 31, 2007
Data Sources: USGS, ESRI

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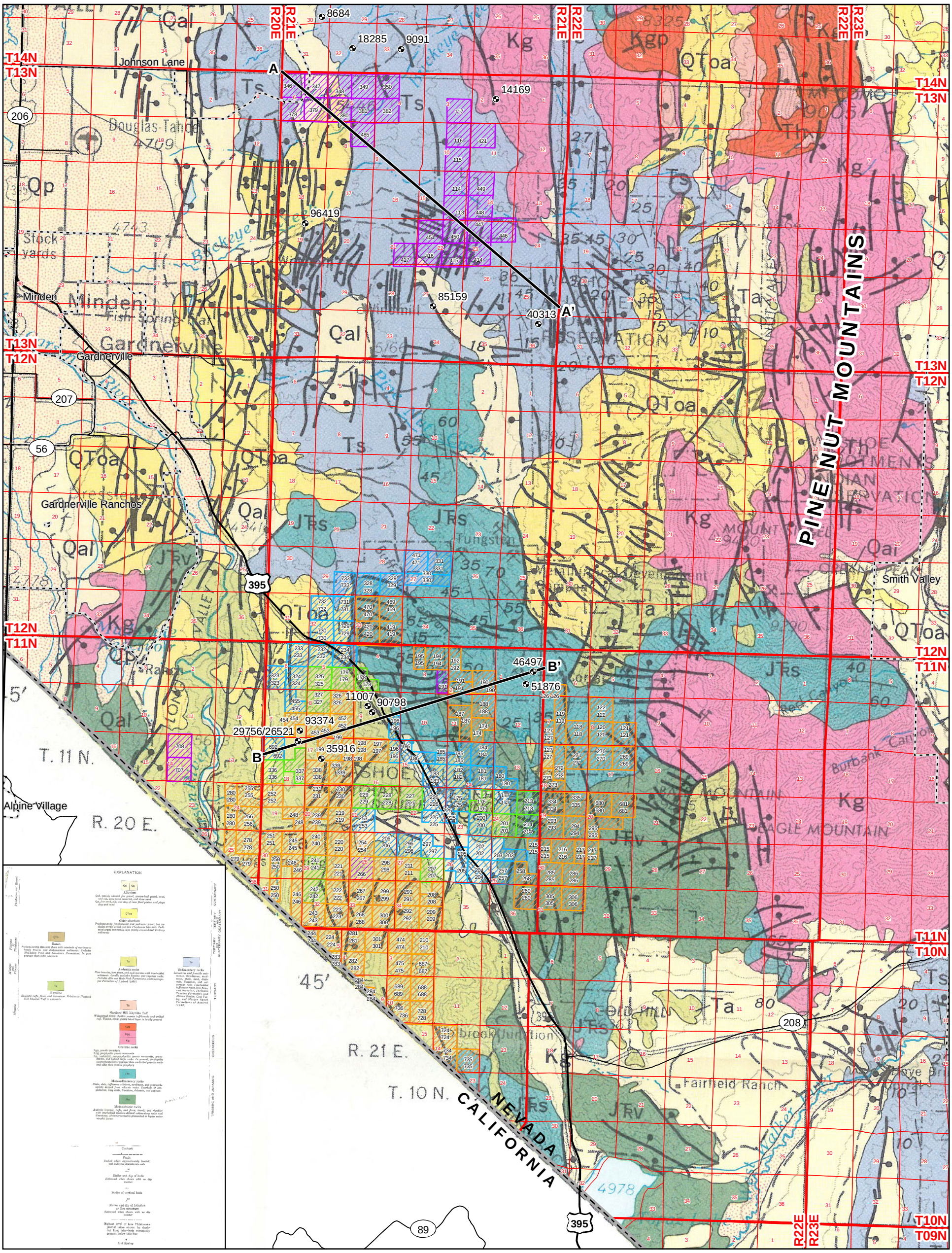

LEGEND

- Water Wells used in Cross Section
- Geologic Cross Sections
- Developable
- Marginal Development Potential
- No Development Potential
- Allotment Included in Master Land Use Plan
- Cities
- Freeways and Highways
- Major Roads
- State Boundary

N

Scale

1:126,720

0 1 2 3 4

Miles

FIGURE 3

Southeast Carson Valley Geology

Pine Nut Plan - Cascade Design

MAP NOTES:

Projection: Universal Transverse Mercator Zone 11 North
Datum: North American Datum of 1983
Date: November 1, 2007
Data Sources: USGS, ESRI

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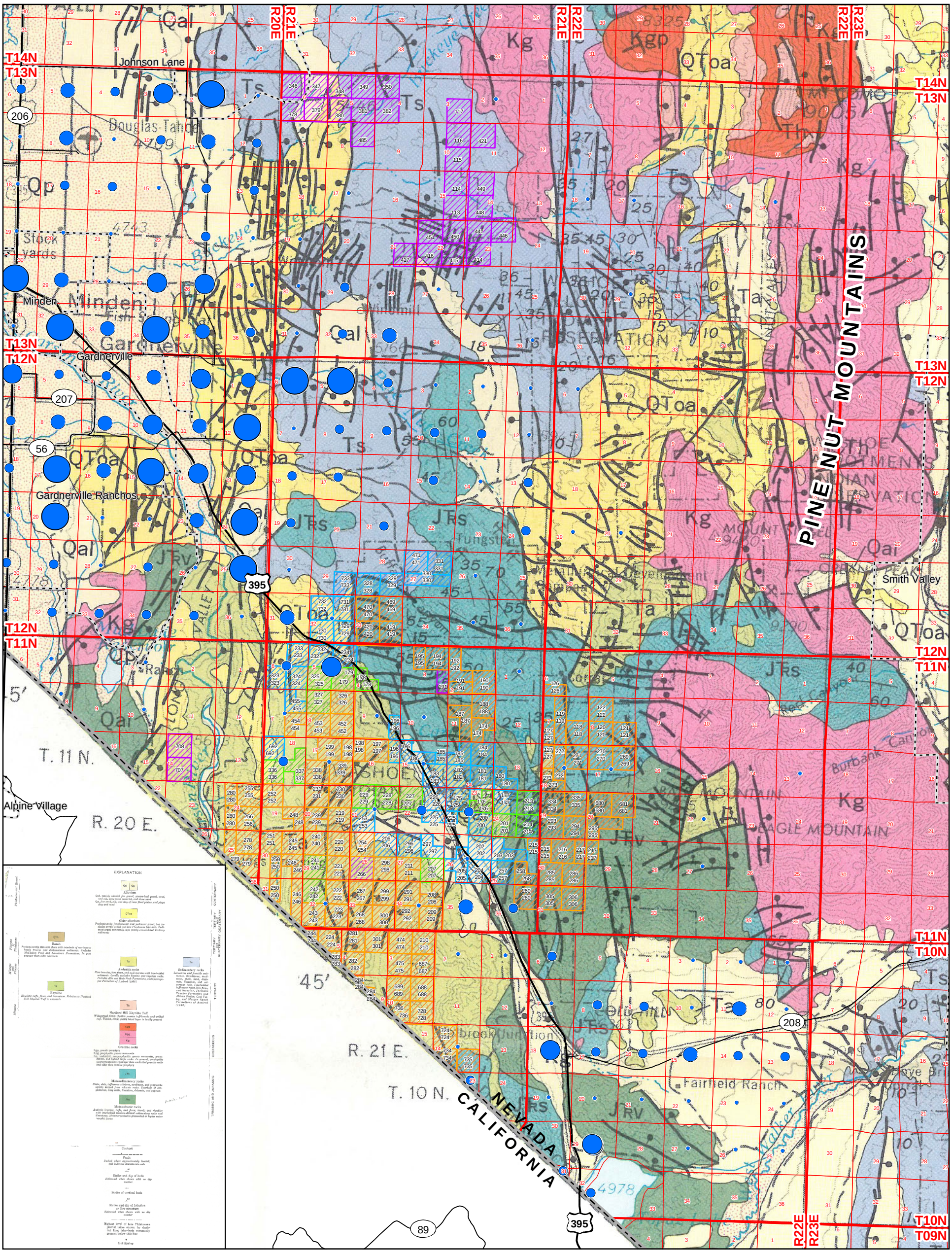

LEGEND

Number of Wells

- 1 - 2
- 3 - 5
- 6 - 10
- 11 - 20
- > 20

- Developable
- Marginal Development Potential
- No Development Potential
- Allotment Included in Master Land Use Plan
- Cities
- Freeways and Highways
- Major Roads
- State Boundary

N

Scale
1:126,720

0 1 2 3 4
Miles

FIGURE 4
Occurrence of Wells in Southeast Carson Valley
Pine Nut Plan - Cascade Design

MAP NOTES:
Projection: Universal Transverse Mercator Zone 11 North
Datum: North American Datum of 1983
Date: November 1, 2007
Data Sources: USGS, ESRI

GSI Water Solutions, Inc.

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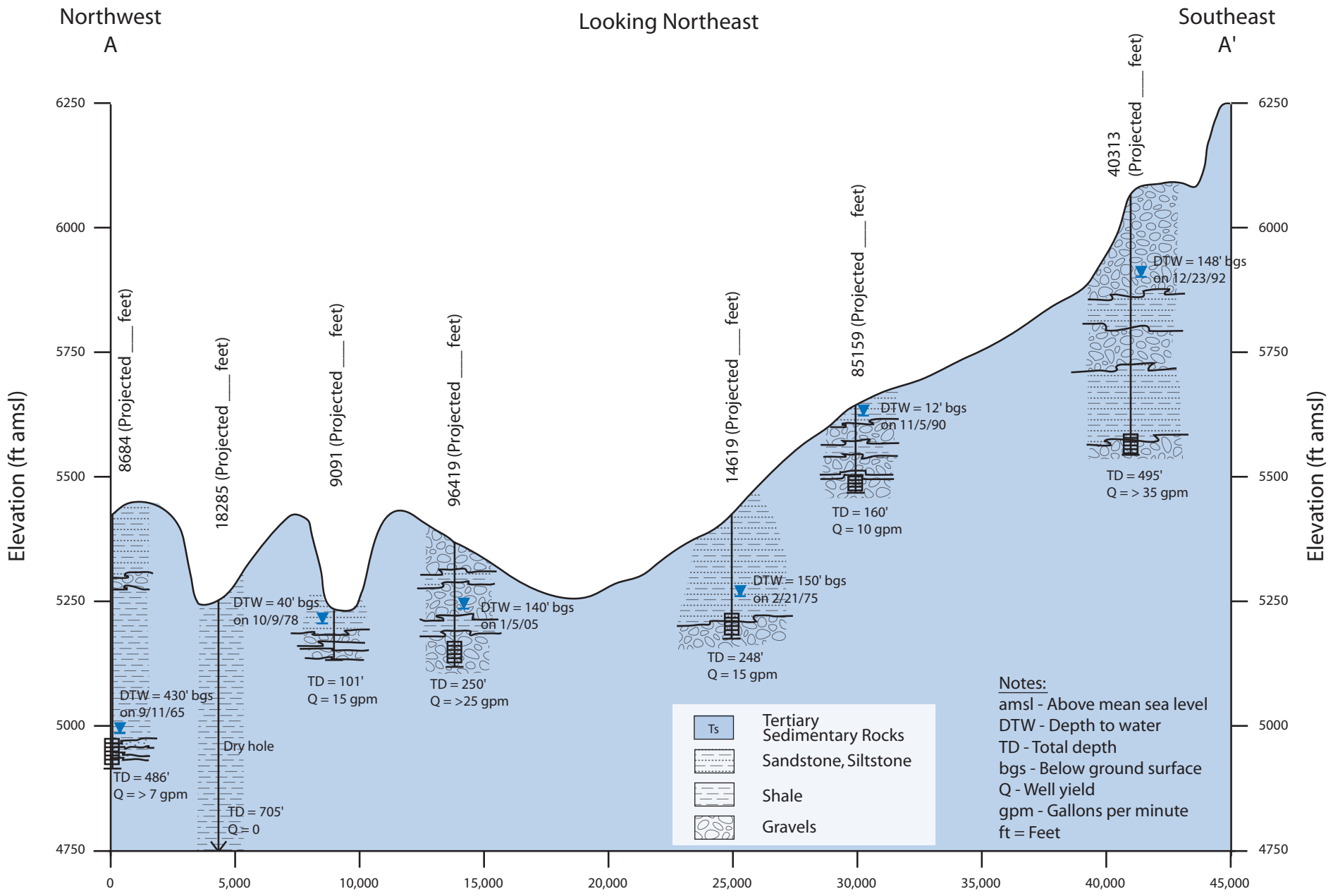

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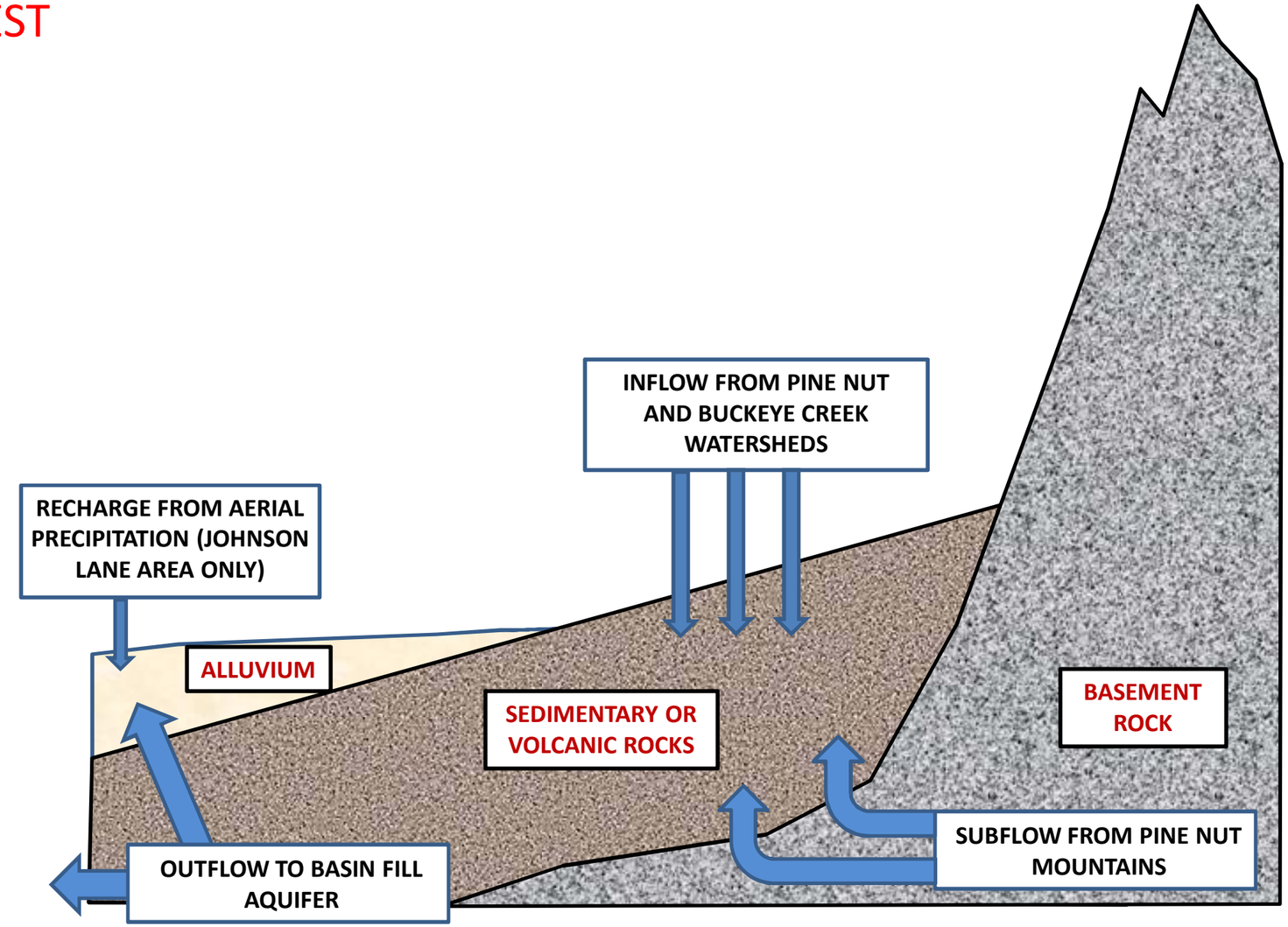
Figure 5
Geologic Cross Section A-A'
Northern Allotments
Pine Nut Plan - Cascade Design

WEST

EAST



P:\266– Cascade Design\001 Pine Nut Plan\Reports-Memos\Figure 6 – Northern Allotment Water Budget.ppt

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Figure 6
Northern Allotment Water Budget

Pine Nut Plan – Cascade Design

West
B

Looking North

East
B'

Elevation (ft amsl)

7000
6750
6500
6250
6000
5750
5500
5250
5000
4750
4500
4250
4000

0
5,000
10,000
15,000
20,000
25,000
30,000
35,000

Distance (feet)
Vertical Exaggeration = 20x

29756/26521 (Projected ___ feet)
93374 (Projected ___ feet)
35916 (Projected ___ feet)
11007 (Projected ___ feet)
90798 (Projected ___ feet)
51876 (Projected ___ feet)
46497 (Projected ___ feet)

Qal

DTW = 28' bgs
on 12/16/85

DTW = 60' bgs
on 3/27/91

TD = 152'
Q = 35 gpm

DTW = 386' bgs
on 5/26/04

TD = 400'
Q = 200 gpm

BASALTS

DTW = 35' bgs
on 5/1/70

US 395

TD = 160'
Q = 4 gpm

TD = 200'
Q = 50 gpm

DTW = 365' bgs
on 5/14/96

TD = 476'
Q = >5 gpm

SEDIMENTARY
ROCKS

DTW = 420' bgs
on 7/29/94

TD = 515'
Q = 10 gpm

?

DIORITE AND
GRANITE

TD = 1580'
Q = 114 gpm

Qal Quarternary Alluvium

Ta Tertiary Basalt

JTs Jurrassic Sedimentary Rock

Kg Granite

Fractured Rock

Screened or Perforated Interval

Open Borehole

Notes:
amsl - Above mean sea level
DTW - Depth to water
TD - Total depth
bgs - Below ground surface
Q - Well yield
gpm - Gallons per minute
ft = Feet

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Figure 7
Geologic Cross Section B-B'
Southern Allotments
Pine Nut Plan - Cascade Design

Table 1

Groundwater Chemistry Results

Pine Nut Allotments (NV) - Land Use Development Plan

Analyte	Units	Regulatory Standard	Regulatory Criterion	USGS Observation Station Number [1]			Development Name		
				384640119351801	385626119375201	384333119301701	Pinion Pointe [2]	Buffalo Run Well [3]	Buffalo Run #1 [3]
				T11N R21E Sec. 35	T13N R21E Sec. 33	T10N R22E Sec. 15	T11N R21E Sec. 15	T12N R21E Sec. 32	T12N R21E Sec. 32
				6/23/1987	6/16/1988	11/15/1985	5/30/2006	5/19/2005	6/29/2004
Temperature	degrees C			13	15.5	15	21.5	17.8	20.1
Specific Conductivity	mS/cm			437	437	538	----	----	----
Dissolved Oxygen	mg/L			----	5.5	----	----	----	----
pH	standard units	6.5 - 8.5	NSDWS	8	7.8	7.7	7.69	8.07	8.24
Turbidity	NTU			6.5	----	0.8	29	----	----
ORP	mV			----	290	----	----	----	----
Bicarbonate	mg/L			187	----	237	----	----	----
Calcium	mg/L			42	52	70	150	37	55
Carbonate	mg/L			----	----	----	----	----	----
Chloride	mg/L	250	NSDWS	6.9	5.8	3.6	----	----	6.2
Fluoride	mg/L			----	----	----	0.1	< 0.1	< 0.1
Hardness (as CaCO3)	mg/L			170	180	240	450	110	210
Magnesium	mg/L			16	12	16	19	5	17
Nitrate as N	mg/L	10	MCL	0.35	0.46	----	< 0.5	1.2	1
Nitrite as N	mg/L	1	MCL	< 0.01	< 0.01	0.02	----	----	----
Total Nitrite-Nitrate	mg/L			0.35	0.46	0.54	----	----	----
Potassium	mg/L			2.4	1.8	0.56	2	3.2	4.8
Silica	mg/L			48	28	25	----	----	----
Sodium	mg/L			27	27	19	30	38	28
Sulfate	mg/L	250	NSDWS	77	32	80	**300**	71	110
Alkalinity as CaCO3	mg/L			----	190	----	240	120	160
Antimony	mg/L	0.006	MCL	----	0.002	----	----	----	----
Arsenic	mg/L	0.01	MCL	0.001	0.004	< 0.001	**0.017**	0.003	0.004
Barium	mg/L	2	MCL	0.044	0.1	0.083	0.033	0.059	0.048
Beryllium	mg/L	0.004	MCL	----	< 0.0005	----	----	----	----
Boron	mg/L			0.02	0.02	0.01	----	----	----
Cadmium	mg/L	0.005	MCL	< 0.001	< 0.001	< 0.001	----	----	----
Chromium (total)	mg/L	0.1	MCL	< 0.01	< 0.005	< 0.01	----	----	----
Cobalt	mg/L	1.3	MCL	----	< 0.003	----	----	----	----
Copper	mg/L	1	NSDWS	<0.01	< 0.01	< 0.01	0.005	< 0.001	0.003
Iron (dissolved)	mg/L	0.3	NSDWS	0.12	< 0.003	0.009	**2.4**	**0.36**	0.23
Lead	mg/L	0.015	MCL	< 0.01	< 0.01	< 0.01	< 0.002	< 0.001	< 0.001
Manganese	mg/L	0.05	NSDWS	0.022	< 0.001	< 0.001	**0.94**	0.018	0.017
Molybdenum	mg/L			----	< 0.01	----	----	----	----
Mercury	mg/L	0.002	MCL	0.0003	< 0.0001	< 0.0001	----	----	----
Nickel	mg/L			----	< 0.01	----	----	----	----

Table 1

Groundwater Chemistry Results

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				T11N R21E Sec. 35	T13N R21E Sec. 33	T10N R22E Sec. 15	T11N R21E Sec. 15	T12N R21E Sec. 32	T12N R21E Sec. 32
				6/23/1987	6/16/1988	11/15/1985	5/30/2006	5/19/2005	6/29/2004
Selenium	mg/L	0.05	MCL	< 0.001	< 0.001	< 0.001	----	----	----
Silver	mg/L	0.1	NSDWS	< 0.001	< 0.001	< 0.001	----	----	----
Strontium	mg/L			----	0.53	----	----	----	----
Zinc	mg/L	5	NSDWS	0.058	0.004	0.014	0.02	0.018	0.06
Total Coliform	Present/Absent			----	----	----	----	Absent	Present
Fecal Coliforms	Present/Absent			Absent	----	----	----	Absent	Absent
Fecal Streptococci	Present/Absent			Absent	----	----	----	----	----
VOCs	mg/L			ND	ND	----	----	----	----
Disinfection ByProducts	mg/L			ND	ND	----	----	----	----

Notes:

mg/L = milligrams per liter

NTU = nephelometric turbidity units

mV = millivolts

C = Celcius

mS/cm = microsiemens per centimeter

ORP = oxidation reduction potential

VOCs = volatile organic compounds

EPA MCL = Environmental Protection Agency Maximum Contaminant Level

NSDWS = National Secondary Drinking Water Standards

T = Township

R = Range

Sec. = Section

N = North

E = East

[1] From National Water Information System: Web Interface. Available online at http://nwis.waterdata.usgs.gov. Downloaded by GSI in September 2007.

[2] From CSCON, 2006, "Pinion Pointe Environmental Assessment."

[3] From CSCON, 2006, "Buffalo Run Environmental Assessment."