IN THE OFFICE OF THE STATE ENGINEER
OF THE STATE OF NEVADA

IN THE MATTER OF APPLICATIONS 73960, 73961, 73962, 73963, 73965, 73966 AND 74368 FILED TO APPROPRIATE OR CHANGE THE PUBLIC WATERS OF AN UNDERGROUND SOURCE WITHIN THE RED ROCK VALLEY HYDROGRAPHIC BASIN (99), WASHOE COUNTY, NEVADA.	)	**RULING** **#5816**

GENERAL

I.

Application 73960 was filed on March 3, 2006, by Red Rock Valley Ranch, LLC, to change the place of use and manner of use of 2.236 cubic feet per second (cfs), not to exceed 598.40 acre-feet annually (afa), a portion of underground water previously appropriated under Permit 29181, Certificate 11619. The existing manner and place of use is for irrigation and domestic purposes described as being located within the SE¼ NE¼, NE¼ SE¼ of Section 11, SW¼ NW¼, NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M. The proposed manner of use is for municipal and domestic purposes. The proposed place of use is described as being located in the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The existing and proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[1]

II.

Application 73961 was filed on March 3, 2006, by Red Rock Valley Ranch, LLC, to change the point of diversion, place of use and manner of use of 0.1812 cfs, not to exceed 40 afa, of underground water previously appropriated under Permit 58343. The existing manner and place of use is for irrigation and domestic purposes described as being located within the SW¼ SW¼, SE¼ SW¼ of Section 2, NW¼ NW¼ of Section 11, T. 23N., R.18E., M.D.B.&M. The proposed manner of use is for municipal and domestic purposes. The proposed place of use is described as being located in the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The existing point of diversion is described as being located within the SW¼

[1] File No. 73960, official records in the Office of the State Engineer.

SW¼ of Section 2, T.23N., R.18E., M.D.B.&M. The proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[2]

III.

Application 73962 was filed on March 3, 2006, by Red Rock Valley Ranch, LLC, to change the point of diversion, place of use and manner of use of 0.1762 cfs, not to exceed 36.594 afa, of underground water previously appropriated under Permit 29683, Certificate 10522. The existing manner and place of use is for irrigation and domestic purposes described as being located within the SE¼ SE¼ of Section 32, T.24N., R.18E., M.D.B.&M. The proposed manner of use is for municipal and domestic purposes. The proposed place of use is described as being located in the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The existing point of diversion is described as being located within the SE¼ SE¼ of Section 32, T.24N., R.18E., M.D.B.&M. The proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[3]

IV.

Application 73963 was filed on March 3, 2006, by Red Rock Valley Ranch, LLC, to change the point of diversion, place of use and manner of use of 640 afa of underground water previously claimed under Proof V-03111. The existing manner and place of use is for irrigation and domestic purposes described as being located within the SE¼ NE¼, NE¼ SE¼ of Section 11, SW¼ NW¼, NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M. The proposed manner of use is for municipal and domestic purposes. The proposed place of use is described as being located in the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The existing point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M. The proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[4]

V.

Application 73965 was filed on March 3, 2006, by Red Rock Valley Ranch, LLC, to change the point of diversion, place of use and manner of use of 0.5181 cfs, not to

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[2] File No. 73961, official records in the Office of the State Engineer.
[3] File No. 73962, official records in the Office of the State Engineer.
[4] File No. 73963, official records in the Office of the State Engineer.

exceed 114.40 afa, of underground water previously appropriated under Permit 30268, Certificate 10525. The existing manner and place of use is irrigation and domestic purposes described as being located within the SW¼ SW¼, SE¼ SW¼ and the SW¼ SE¼ of Section 2, NE¼ NW¼ of Section 11, T. 23N., R.18E., M.D.B.&M. The proposed manner of use is for municipal and domestic purposes. The proposed place of use is described as the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The existing point of diversion is described as being located within the SE¼ SW¼ of Section 2, T.23N., R.18E., M.D.B.&M. The proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[5]

VI.

Application 73966 was filed on March 3, 2006, by Redrock Valley Ranch, LLC, to appropriate 5.0 cfs, not to exceed 500.0 afa, of underground water for municipal and domestic purposes. The proposed place of use is described as being located within the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[6]

VII.

Application 74368 was filed on March 3, 2006, by Redrock Valley Ranch, LLC, to appropriate 5.0 cfs of underground water for municipal and domestic purposes. The proposed place of use is described as being located within the Lemmon Valley Hydrographic Basin as further described in Exhibit "A" attached to the application. The proposed point of diversion is described as being located within the NW¼ SW¼ of Section 12, T.23N., R.18E., M.D.B.&M.[7]

VIII.

Applications 73960, 73961, 73962, 73965, and 73966 were timely protested by Ron Brown, Sierra Ranchos Property Owners Association, Washoe County, Lassen County, Sandra Gail McGill, and Joseph Donohue. In addition, Applications 73963 and 73966 were timely protested by the Voters for Sensible Growth and Application 74368

[5] File No. 73965, official records in the Office of the State Engineer.
[6] File No. 73966, official records in the Office of the State Engineer.
[7] File No. 74368, official records in the Office of the State Engineer.

was timely protested by Ron Brown, Washoe County and Lassen County. The general grounds of the various protests can be summarized as:[1,2,3,4,5,6,7]

- Will jeopardize existing domestic wells.
- Will conflict with existing irrigation rights.
- Water should not be exported from the basin.
- Changes from irrigation to municipal should be limited to historic consumptive use and/or will change more water than historic practices.
- Exceeds perennial yield of the basin.
- Interbasin transfer criteria must be met.
- Insufficient ground water at the source.
- Additional study is necessary.
- Adverse impact to springs and seeps.
- Impact to flows of Long Valley Creek.
- Project will result in water mining and be a long-term detriment to the aquifer.
- Large claim of vested right filed but not adjudicated.

IX.

After all parties were duly noticed by certified mail, a public administrative hearing was held on June 12, 2007, regarding Applications 73960, 73961, 73962, 73963, 73965, 73966 and 74368 in Carson City, Nevada, before representatives of the Office of the State Engineer.[8]

FINDINGS OF FACT

I.

At the administrative hearing, appearances were taken for the record. The Applicant was present with counsel but there were no Protestants present that wished to present a full case. For the Protestants, it was indicated before the hearing that only Washoe County would be attending for the purposes of presenting evidence and testimony and to cross-examine the Applicant's witnesses. However, Washoe County reached a stipulation with the Applicant whereby a portion of its protests were withdrawn and, in conjunction with the stipulation, Protestant Washoe County withdrew from the

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[8] Exhibits and Transcripts, public administrative hearing before the State Engineer, June 12, 2007, official records in the Office of the State Engineer (Hereafter, "Transcript" and "Exhibits").

hearing process and was not present on the day of the administrative hearing.[9] In brief, under the stipulation the Applicant will seek to export a net amount of water limited to 1,273.39 afa, will implement a monitoring and mitigation plan as approved by the State Engineer, and will request the State Engineer to defer action on Application 73963 (V-03111) and to defer action on any portion of applications that may exceed 1,273.39 afa pending further study and evaluation of the effects of the pumping related to the 1,273.39 afa.

For the remaining Protestants, some were present in the audience and added public comment at the end of the hearing. The Protestants in attendance were Ron Brown, Sierra Ranchos Property Owners Association, and Sandra Gail McGill on behalf of herself and the Voters for Sensible Growth. Protestants that did not make an appearance at the hearing were Washoe County, Lassen County, and Joseph Donohue.[10]

II.

State Engineer's Order No. 718, issued August 3, 1978, described and designated the Red Rock Valley Hydrographic Area as a ground-water basin in need of additional administration under the provisions of NRS § 534.030.[11] The State Engineer finds that Applications 73960, 73961, 73962, 73963, 73965, 73966, and 74368 have proposed points of diversion that are located within the hydrologic boundaries of the designated Red Rock Valley Hydrographic Area.

III.

The United States Geological Survey (USGS) estimates the perennial yield of the Red Rock Valley Hydrographic Area is approximately 1,000 afa.[12] It should be noted that the Applicant has also provided information regarding the perennial yield of the Red Rock Valley Hydrographic Area as discussed in later sections of this ruling.

The committed ground-water resource, in the form of permits and certificates issued by the State Engineer to appropriate underground water from the Red Rock Valley Hydrographic Area, is about 965 afa.[13] However, due to the consumptive use factor applied

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[9] Exhibit No. 60.
[10] Transcript, pp. 7-11.
[11] State Engineer's Order No. 718, issued August 3, 1978, official records in the Office of the State Engineer.
[12] Rush, F.E., and Glancy, P.A., (1967). Water-Resources Appraisal of the Warm Springs-Lemmon Valley Area, Washoe County, Nevada. Water Resources – Reconnaissance Series Report 43, United States Geological Survey and Nevada Division of Water Resources.
[13] Nevada Division of Water Resources' Water Rights Database, Hydrographic Basin Summary, Red Rock Valley Hydrographic Area (99), September 12, 2007, official records in the Office of the State Engineer.

to irrigation water rights in the Red Rock Valley Hydrographic Area,[14] the actual committed resource is 610.25 afa, not including domestic wells.

Existing and future domestic well demand was estimated by the Applicant at 389 afa, assuming every eligible parcel had a domestic well.[15] While the Division of Water Resources (Division) does not agree fully with the techniques and values used to derive this estimated domestic well demand, the calculated value is reasonable when compared to independent analyses by the Division, albeit somewhat lower; i.e., it is a less conservative approach than typically used by the Division. The Division calculates the potential domestic demand by first reviewing available parcel information, including size, type and existing development. Based on this review and the Division's experience in estimating water usage on a domestic well parcel, it is apparent that the average domestic well water usage is less than the maximum allowed duty of 2.0 afa. However, since domestic well usage is not monitored and the domestic wells are not metered in the Red Rock Valley Hydrographic Area, a cautious approach is warranted. In consideration of all the facts and circumstances, including potential recharge from septic systems, the Division has applied a duty of 1.0 afa to each existing and potential domestic well. The resultant calculation over 695 parcels yields a potential domestic well demand of 695 afa.

The State Engineer finds that the current perennial yield as estimated by the USGS is 1,000 afa, but additional review of this reconnaissance level estimate may be warranted. The State Engineer further finds that the committed ground-water resource, including existing and future domestic well demand, is about 1,300 afa.

IV.

The Applicant has requested that the State Engineer approve the subject applications for 1,273.39 afa, defer action on vested claim V-03111 (Application 73963), and defer action on any application in excess of the 1,273.39 afa requested.[16] In addition, it was requested that if the State Engineer imposes a consumptive use reduction on the change applications that any water considered non-consumptive be re-appropriated under Application 74368 up to the requested 1,273.39 afa.[17] A review of each application was made to determine whether the Applicant's request can be accommodated.

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[14] See, Consumptive use limitation explained in Section VIII.
[15] Transcript, p. 65 and Exhibit No. 53.
[16] Exhibit No. 41, p. 3 and Exhibit No. 60, p. 2.
[17] Transcript, pp. 25-26 and 229-230.

It bears reminding that Applications 73960, 73961, 73962, 73963, and 73965 seek to change existing water rights, previously approved within the Red Rock Valley Hydrographic Area and Applications 73966 and 74368 seek to appropriate new underground water within the Red Rock Valley Hydrographic Area.

For change Applications 73960 and 73963, an examination of the existing places of use sought for change shows that Permit 29181, Certificate 11619 and vested claim V-03111 are supplemental by virtue of their respective places of use. As such, action cannot be taken separately on change Applications 73960 (29181) and 73963 (V-03111). In this regard, the term supplemental irrigation refers to two ground-water rights, which have a place of use appurtenant to the same land and therefore are limited by a total combined duty of 4.0 acre-feet per acre. This is further indicated in the permit terms under which Permit 29181 was issued that state, "The amount of water to be appropriated shall be limited to the amount which can be applied to beneficial use, and not to exceed 2.7 cubic feet per second, but not to exceed a yearly duty of 4.0 acre-feet per acre of land irrigated from any and/or all sources." The summary of ownership indicates that the amount of water owned by the Applicant under both Permit 29181 and V-03111 is 598.4 afa. The validity of vested claim V-03111 can only be determined through the proper adjudication of the source and vested claim V-03111 has not been adjudicated. Typically, change applications filed against non-adjudicated claims of vested right are not acted upon until the validity of the claim has been determined through the adjudication process. In this case, the Applicant has requested that the State Engineer withhold action on change Application 73963 (V-03111). However, the circumstances of this situation are complicated by Permit 29181, which was filed and approved prior to the filing of vested claim V-03111 on the same place of use. As previously established, the maximum amount of water on the place of use is 4.0 acre-feet per acre from any and/or all sources. If Application 73960 is approved, all of the water will be stripped from the land and the land will be dry. To then withhold action on Application 73963 (V-03111) would leave the impression that water remains appurtenant to the land that could then be changed under Application 73963 at a later date or used on the place of use under V-03111. This would result in a double counting of the water. One solution to this dilemma is to require the withdrawal of the vested claim upon approval of change Application 73960 (Permit 29181, Certificate 11619). Alternatively, change Applications 73960 and 73963 can be approved simultaneously, with the knowledge that the approval of Application 73963 does not validate the vested claim. If the vested claim is later validated through an adjudication, the priority date of the water under change Applications 73960 and 73963 would trace back to vested claim V-03111 as opposed to Permit 29181.

For change Applications 73961 and 73962, the amount of water eligible for change is correctly reflected on the applications at a duty of 40.0 afa and 36.594 afa, respectively.

For change Application 73965, the amount of water requested for change is 114.40 afa. However, a review of the summary of ownership of base right Permit 30268 shows that the Applicant owns only 98.4 afa and therefore, only this amount may be transferred.

The available water for transfer under all the change applications may be derived by adding the available water as detailed above. The total is calculated as follows:

$$598.4 + 40.0 + 36.594 + 98.40 = 773.394 \text{ afa}$$

By performing this simple calculation it is apparent where the Applicant derived its request for 1,273.39 afa. By taking the total amount requested under the change applications of 773.394 afa and adding the 500 afa requested under Application 73966, the total becomes 773.394 + 500 = 1,273.394 afa.

The remaining application to be considered is Application 74368. As indicated by the Applicant, this application was filed to off-set any reduction that may be necessary in transferring only the consumptive duty of the existing irrigation water rights. As such, the application specifies a diversion rate of water only with the duty of water to be determined by the amount of water to "make-up" any consumptive use reduction. Under NRS § 532.120(3.3), the State Engineer may consider the consumptive use of a water right and the consumptive use of a proposed beneficial use of water in determining whether a proposed change in the place of diversion, manner of use or place of use complies with the provisions of subsection 5 of NRS § 533.370.[18] As found in later sections of this ruling, the consumptive use for irrigation in the Red Rock Valley Hydrographic Area is 2.5 acre-feet per acre ((2.5/4.0)*100 = 62.5%). By applying this consumptive use factor, the amount of water eligible for change to municipal use under the proposed change applications is 484 afa. Note that the values from this point forward

[18] NRS § 533.3703(1).

are rounded to the nearest acre-foot. The difference between the full duty and the consumptive duty totals is 773 - 484 = 289 afa.

The State Engineer finds that action cannot be deferred on vested claim V-03111 (Application 73963). The State Engineer finds that the amount of water that can be changed from irrigation to municipal use under Applications 73960, 73961, 73962, 73963 and 73965 is 484 afa. The State Engineer finds that the Applicant's request for 1,273 afa (484 + 289 + 500 = 1,273 afa) may be considered if it can be demonstrated through the evidence that sufficient water is available at the source and all other statutory requirements are met.

V.

The Nevada Revised Statutes (NRS) chapters 533 and 534 and the policies developed by the Office of the State Engineer control the appropriation of water within the State of Nevada. By the provisions found under NRS § 533.370(1)(c), before an application that requests a new appropriation of underground water can be considered for approval, the Applicant must provide proof satisfactory to the State Engineer of his intention in good faith to construct any work necessary to apply the water to the intended beneficial use with reasonable diligence and his financial ability and reasonable expectation actually to construct the work and apply the water to the intended beneficial use with reasonable diligence. The answer to these questions can often be determined from the information provided on the submitted application form and associated map. However, it is not uncommon for the State Engineer to request additional information regarding the proposed project and the necessary water requirements, to ensure that the statutory criteria regarding beneficial use are satisfied.

The Applicant provided several documents regarding financial ability and of being contractually connected to the Truckee Meadows Water Authority (TMWA).[19] It was indicated that the Applicant would complete the project and would sell the entire completed project to TMWA under the contract submitted into evidence at this hearing.[20]

After a thorough review of the documents, the State Engineer finds that the Applicant has satisfied the provisions of NRS § 533.370(1)(c), and has shown through its contractual agreement with TMWA that the water will be placed to its intended beneficial use with reasonable diligence.

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[19] Exhibit Nos. 49 and 55.
[20] Transcript, pp. 39-40 and 56.

VI.

The subject applications are requesting an interbasin transfer of water from the Red Rock Valley Hydrographic Basin to the Lemmon Valley Hydrographic Basin. Nevada water law provides for the interbasin transfer of water; however, additional statutory criteria apply.[21]

The State Engineer finds that Nevada water law provides for the interbasin transfer of water. The State Engineer further finds the evidence provided at the administrative hearing indicates that the additional statutory requirements under NRS § 533.370(6) can be satisfied provided sufficient limitations and conditions are placed on the applications.

VII.

The issue of whether a consumptive use reduction should be applied to the Applicant's proposed conversion of irrigation water rights to municipal water rights was brought up by both the Applicant and the Protestants and merits discussion.

The Applicant estimated the consumptive use at 3.5 feet per year, as derived from Division of Water Planning Report 3 from 1980.[22] As discussed below, the State Engineer has computed his own estimate using updated and more modern methods.

Consumptive use of a crop can be defined as that portion of the annual volume of water diverted under a water right that is transpired by growing vegetation, evaporated from soils, incorporated into products, or otherwise does not return to the waters of the state. Consumptive use does not include any water that falls as precipitation directly on the place of use or water lost due to inefficiencies or waste during the irrigation process. The consumptive use of a crop is equal to the crop evapotranspiration less the precipitation amount that is effective for evapotranspiration by the crop.

The State Engineer's consumptive use estimate for Red Rock Valley is based on the Penman-Monteith short reference evapotranspiration equation and crop coefficient approach for estimating growing season crop evapotranspiration, similar to methods of the California Irrigation Management Information System (CIMIS). The standardized methods are described by the American Society of Civil Engineers[23] and the Food and

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[21] NRS § 533.370 (6).
[22] Exhibit No. 53, pp. 8.
[23] The ASCE Standardized Reference Evapotranspiration Equation, 2005, official records in the Office of the State Engineer.

Agriculture Organization of the United Nations,[24] and are for a crop of alfalfa with a growing season from the last killing frost to the first killing frost of 20° F. Daily weather data of temperature, relative humidity, wind speed, and incoming solar radiation used as input to the Penman-Monteith equation were obtained from the Washoe County Department of Water Resources (WCDWR), which maintains and operates a weather station in Red Rock Valley, approximately 0.5 mile from the Applicant's existing place of use, and has been in operation since 2003. Mean annual last and first frost dates for Red Rock Valley were estimated to be from April 10th and October 22nd, respectively, using a 50 percentile probability killing frost temperature of 20° F. Temperature data used for the analysis were obtained from the Nevada State Climatologist, in which daily minimum and maximum temperature and precipitation were recorded from 1986-2002 in Red Rock Valley at the Hesselschwerdt residence, approximately 0.75 mile from the Applicant's existing place of use. Using these methods, the State Engineer estimates the crop evapotranspiration during the growing season in Red Rock Valley to be 3.0 feet per year.

Effective precipitation, as defined by the Natural Resource Conservation Service (NRCS) National Engineering Handbook[25] (NEH), is the part of precipitation that can be used to meet the evapotranspiration of growing crops. The NRCS NEH outlines an empirical method for computing the effective precipitation based on 22 studies. Because the Hesselschwerdt residence precipitation record was missing numerous weeks to months, the National Weather Station (NWS) Stead weather station (267820) precipitation record from 1985-2007 was used for estimating effective precipitation. Using the mean monthly precipitation for the period of record at the NWS Stead weather station as reported by the Western Regional Climate Center, and applying the NRCS effective precipitation method during the growing season and monthly soil water balance during the non-growing season, the estimated mean annual effective precipitation is 0.5 feet per year. The State Engineer finds that by using a crop evapotranspiration rate of 3.0 feet per year with an effective precipitation rate of 0.5 feet per year, the annual consumptive use of irrigated areas in Red Rock Valley is 2.5 feet per year.

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[24] FAO Irrigation and Drainage Paper No. 56. Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements, 1998, official records in the Office of the State Engineer.

[25] Irrigation Water Requirements, 2003, official records in the Office of the State Engineer.

VIII.

The State Engineer has historically used water budget and perennial yield estimates from the reconnaissance series reports that were completed during the 1950s, 1960s and 1970s. Hydrographic basin water budgets for many basins have been updated by the USGS and private-party studies in the intervening years, and in many cases the State Engineer has updated the perennial yield. Reconnaissance Report 43 authored by Eugene Rush and Patrick Glancy originally established the perennial yield of Red Rock Valley.[26] Using the 1965 Hardman precipitation map,[27] which estimated approximately 21,500 acre-feet per year of precipitation, and applying slightly modified Maxey-Eakin recharge coefficients,[28,29] Rush and Glancy estimated 900 acre-feet per year of ground-water recharge from precipitation in the Red Rock Valley Hydrographic Area, which equates to approximately 4% of precipitation. In addition to the in-basin recharge, Rush and Glancy also estimated 200 acre-feet per year of ground-water recharge from the adjacent Bedell Flat Hydrographic Area, which discharges via subsurface flow to Red Rock Valley. In estimating the outflow water budget components, Rush and Glancy estimated the ground-water evapotranspiration (ET) in Red Rock Valley from mixed phreatophyte shrubs of greasewood, rabbitbrush, and saltgrass. Using published ground-water ET rates from phreatophyte shrubs of greasewood, rabbitbrush, and saltgrass,[30,31,32] and recognizing that the density of phreatophyte shrubs is likely related to the amount of ground-water ET, Rush and Glancy estimated the ground-water ET rate to equal 0.3 feet per year for an approximate phreatophyte density of 25%. The area of phreatophytes within Red Rock Valley was estimated to be 2,100 acres, yielding a ground-water discharge volume of 630 acre-feet per year. Consumption of spring flow from irrigation originating at the Tunnel Spring and Red Rock Valley Ranch spring complex

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[26] Rush, F.E., and Glancy, P.A., (1967). Water-Resources Appraisal of the Warm Springs-Lemmon Valley Area, Washoe County, Nevada. Water Resources – Reconnaissance Series Report 43, United States Geological Survey and Nevada Division of Water Resources.

[27] Hardman, G., (1965). Nevada precipitation map, adapted from map prepared by George Hardman and others, 1936; Nevada University Agricultural Experimental Station Bulletin 185.

[28] Eakin, T., et al., (1951). Contribution to the Hydrology of Eastern Nevada: Nevada State Engineer, Water Resources Bulletin No. 12, United States Geological Survey and Office of the State Engineer, p. 80.

[29] Rush, F.E., and Glancy, P.A., (1967). Water-Resources Appraisal of the Warm Springs-Lemmon Valley Area, Washoe County, Nevada. Water Resources – Reconnaissance Series Report 43, United States Geological Survey and Nevada Division of Water Resources, p. 21.

[30] Lee, C. H., (1912). An intensive study of the water resources of a part of Owens Valley, California: U.S. Geological Survey Water Supply paper 294, p. 135.

[31] White, W. N., (1932). A method of estimating ground-water supplies based on discharge by plants and evaporation from soil: U.S. Geological Survey Water-Supply paper 659-A, p. 1-105.

[32] Young, A. A., and Blaney, H. G., (1942). Use of water by native vegetation: California Dept. Public Works, Div. Water Resources Bull. 50, p. 154.

was estimated at 220 acre-feet per year, while subsurface outflow occurring to the west into the Long Valley subarea was estimated to be minor. Using a ground-water recharge estimate from precipitation and subsurface inflow of 1,100 acre-feet per year, and a ground-water outflow estimate from ground-water ET and irrigation consumption of spring flow of 850 acre-feet per year, the Red Rock Valley ground-water budget and perennial yield was estimated to be 1,000 acre-feet per year, an approximate average of the estimated inflow and outflow.

Because the State Engineer often considers the capture of natural discharge to be the basis for determining the perennial yield of a closed basin, a re-estimation of the basin discharge is commonly used by applicants for water rights where the application amount exceeds the reconnaissance report estimate of perennial yield. Two methods are commonly used. One method uses micrometeorological methods to measure ET at several representative locations in a basin and applies those measurements to similar vegetative communities within the basin, thereby deriving a new ET estimate for the entire basin. This method requires a minimum of one year of measurements in the basin of interest. A longer measurement period reduces uncertainty. A second technique is to identify and classify the vegetation communities in a basin and apply the ET rates estimated for those communities from published literature. This second technique was used by the Applicant in the Red Rock Valley Hydrographic Area. Assuming present-day steady-state conditions, the Applicant estimated ground-water ET in the basin and determined that to be the basin's perennial yield.

The State Engineer finds the most accurate and practical method of determining ground-water ET discharge in a basin such as Red Rock Valley would be through field measurement of ET with micrometeorological tools and methods. Estimating ground-water ET by comparison with published literature is a scientifically accepted practice, but the State Engineer finds the estimation of ET by such methods will have a larger uncertainty than by field measurements. The Applicant requested a hearing before the State Engineer before such measurements could be collected and analyzed, so that the State Engineer is now asked to make a revised determination of the basin's perennial yield using less certain estimates of ET.

IX.

The Red Rock Valley Hydrographic Area is topographically divided into eastern and western parts by the Little Valley/Porcupine foothills, a north-trending range of granitic basement rocks. Because these basement rocks will limit the flow of ground water between the eastern and western parts of the valley, the Applicant considered Red Rock Valley as two separate basins, which the Applicant refers to as sub-basin 99A and sub-basin 99B, where sub-basin 99A is the west side of Red Rock Valley and includes the Rancho Haven area, and sub-basin 99B is the east side of Red Rock Valley and includes the Sierra Ranchos area. The Applicant used both field mapping and remote sensing methods to delineate and classify the ground-water discharge areas, however, in their final analysis the areas were selected using the remote sensing technique. Phreatophyte areas contributing to ground-water discharge were estimated to be 718 and 2,289 acres for the west and east side, respectively.[33,34] The remainder of the analyses focused on the east side of the valley, where the pending applications are located.

The State Engineer finds that because the subject applications are all located in the eastern part of the Red Rock Valley Hydrographic Area, the Applicant's use of ground-water budget and ET estimates on the east side of the valley to determine the sustainable yield may be appropriate. The State Engineer further finds that the Applicant's estimate of ET can be used in determination of the sustainable yield, but because of concerns about the method's accuracy, other techniques and estimates will also be analyzed by the State Engineer.

X.

The Applicant's expert hydrologist, Ms. Carpenter, states that an unsupervised classification remote sensing method, similar to the one used in USGS WRI 2001-4195,[35] was used in Red Rock Valley to classify different vegetation and landform types of bare ground, scrub-shrub upland, grassland upland, seasonal wetland, perennial wetland, and open water.[36] From the Applicant's remote sensing analysis, the final acreages of vegetation and landform types within the ground-water discharge area were estimated for the east side of Red Rock Valley and are listed in Table 1, where the scrub-shrub and grassland upland

[33] Exhibit No. 51, Attachment 2, Table 14a.
[34] Exhibit No. 51, p. 58.
[35] Exhibit No. 51, Volume 6a, Attachment 6, p. 6a-16-16.
[36] Exhibit No. 51, Volume 1, p. 58.

comprise 90% of the total area, making the accuracy of ground-water discharge estimates for these areas extremely important.[37]

Applicant's Vegetation/Landform	Acreage	Percent of Total Discharge Area
Bare Ground	50.96	2.23
Scrub-Shrub Upland	1297.94	56.70
Grassland Upland	775.60	33.88
Seasonal Wetland	109.35	4.78
Perennial Wetland	54.72	2.39
Open Water	0.67	0.03
Total Discharge Area	2289.24	100

Table 1. Applicant's acreage of each vegetation and landform type in the area of ground-water discharge in the eastern part of Red Rock Valley.

Based on the evidence submitted, the State Engineer finds that the Applicant's expert did not use a remote sensing approach identical to that outlined by USGS WRI 2001-4195. In USGS WRI 2001-4195, vegetation units incorporate variations such as sparse, moderate, and dense growth within a single vegetation unit such as grassland, which allows for the scaling of the assigned ET rate. In the USGS WRI 2001-4195 report, several different vegetation/landform classifications were delineated from a combination of an unsupervised classification technique, the modified adjusted soil vegetation index, and a maximum likelihood classification technique.[38] The Applicant simply applied an unsupervised classification approach, which resulted in gross vegetation/landform units that were not adequately delineated by taking into account the variation of vegetation density, vigor, and soil moisture within units and prohibited the ability to scale ET rates based upon those variations.

Because the Applicant did not measure ET within the ground-water discharge area, rates of ET associated with each vegetation and landform type were estimated by averaging respective ET rates that were acquired from published studies of measured ET from around the world. Geographic and climatic regions from which the published ET measurements were made varied widely and are shown in Table 2, which lists the location and number of ET rates compiled and analyzed by the Applicant.[39] Final ET rates for Red Rock Valley are

[37] Exhibit No. 51, Volume 1, Attachment 2, Table 14c.
[38] Exhibit No. 51, Volume 6a, Attachment 6, p. 6a-16-18.
[39] Exhibit No. 51, Attachment 2, Table 5a.

shown in Table 3, where the Applicant averaged published ET rates from locations and respective vegetation and landform types shown in Table 2.

The State Engineer finds that the Applicant's compilation and subsequent averaging of ET rates from around the world is consistently biased toward higher rates of ET due to the selection of ET measurement sites and the respective climate, vegetation density, and vigor.

XI.

As listed in Table 2, sites used in estimating ET rates for scrub-shrub and grassland, which comprise 90% of the ground-water discharge in Red Rock Valley, were almost entirely estimated from locations where there is more evaporative demand and longer growing season than that of Red Rock Valley. For example, 21 of the 23 measurements of ET used for calculating an average grassland ET rate of 2.33 feet per year were made in phreatophyte areas in southern Nevada, Owens Valley and Death Valley, CA, and southern Arizona. From observation of Figures 1 and 2 (Appendix 1) , it is obvious that there are significant differences between the type, density, and vigor of grassland phreatophytes at the Fairbanks Meadows USGS ET site in Amargosa Valley, NV, and the grassland phreatophytes as classified by the Applicant in Red Rock Valley. The ET rate at the Amargosa site was 3.07 feet per year, and that rate was used for grassland phreatophytes in Red Rock Valley. It is important to note that the photos taken by State Engineer staff on September 27, 2006, as illustrated in Appendix 1, followed a near record water year precipitation amount of 20.4 inches, as recorded at the NWS Stead weather station.

The only measurement of ET used in the calculation of an average grassland ET rate for Red Rock Valley with similar temperature and precipitation was from Carson Valley, however the ET rate of 1.7 feet per year was measured over a non-irrigated pasture with a depth to ground water from 6 to 7 feet.[40,41] While it is apparent that the Carson Valley non-irrigated pasture grass site may be representative of some grassland areas in Red Rock Valley, the density of vegetation and the amount of bare soil and shrubs within grassland areas vary substantially.[42] Figure 3 (Appendix 1) illustrates the Carson Valley ET-6 site of non-irrigated pasture, where the measured ET rate of 1.7 feet per year is assumed to transfer

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[40] Exhibit No. 51, Attachment 2, Table 5a, p. 13.
[41] Exhibit No. 51, Volume 5a, Attachment 5, p. 5a-11-21.
[42] Exhibit No. 51, Volume 4a, Attachment 8, Appendix 3.

to the Applicant's classified grassland area in Red Rock Valley illustrated in Appendix 1, Figure 1.

Measurement sites selected for developing an average ET rate for the Applicant's scrub-shrub classification, which comprises 57% of the ground-water discharge area, also deviate significantly from the climate, density, and vigor of phreatophyte shrubs observed in Red Rock Valley. For example, 5 of the 16 ET rates used for calculating an average ET rate for Red Rock Valley were derived from Owens Valley, CA, 3 ET rates were derived from Spain, and 1 site was from Oasis Valley, NV. The ET measurement sites with highest ET rates were from Carson Valley, NV and the Carson Desert, NV. While these sites may have climate that is more representative of the climate in Red Rock Valley, the density and vigor of shrubs at these site appears to significantly exceed the density and vigor of shrubs in Red Rock Valley. For example, the ET rate of 1.9 feet per year was measured at the Carson Valley USGS ET-1 site over a stand of rabbitbrush, sagebrush, greasewood, and mixed grasses where the water table was 3 to 5 feet below and surface and plant density estimated

Location	Bare Soil	Scrub Shrub	Grassland	Seasonal Wetland	Perennial Wetland	Open Water
Gila River, AZ				1		
Havasu, AZ			2	1		
San Padro River, AZ			1	2		1
Death Valley, CA	5		2	1		
Owens Valley, CA	4	5	5			
Everglades, FL					9	2
Orange County, FL			1			
West-Central, FL					2	
Middle Rio Grande, NM				4		
Ash Meadows, NV	1		8	2	1	
Carson Valley, NV		2	1	1		1
Oasis Valley, NV	1	1	3	1		
Ruby Valley, NV		2			1	1
Smith Creek, NV	2	1				
Soda Lake, NV	2	1				
Spain		3			6	
Escalante Valley, UT	4	1				
TOTAL	19	16	23	13	19	5

Table 2. Number of published ET rates for respective vegetation and landform types used by the Applicant for computing an average ET rate for the Red Rock Valley Hydrographic Area.

Location	Avg. Bare Soil	Avg. Scrub Shrub	Avg. Grassland	Avg. Seasonal Wetland	Avg. Perennial Wetland	Avg. Open Water
Gila River, AZ				3.23		
Havasu, AZ			2.65	3.54		
San Padro River, AZ			3.13	4.05		3.79
Death Valley, CA	0.35		2.45	3.9		
Owens Valley, CA	0.66	1.51	2.43			
Everglades, FL					3.84	4.61
Orange County, FL			2.03			
West-Central, FL					3.16	
Middle Rio Grande, NM				3.7175		
Ash Meadows, NV	0.62		2.50	2.955	3.91	
Carson Valley, NV		1.70	1.70	3.5		5.00
Oasis Valley, NV	0.62	1.38	2.40	3.14		
Ruby Valley, NV		1.16			4.19	5.30
Smith Creek, NV	0.63	1.05				
Soda Lake, NV	0.74	1.70				
Spain		1.29			4.17	
Escalante Valley, UT	0.44	1.06				
AVERAGE	0.53	1.39	2.45	3.55	3.89	4.66

Table 3. Average of published ET rates for respective vegetation and landform types. Note that final averaged ET rates are slightly different from the Applicant's final averaged ET rates due to rounding or other unknown reasons.

to be 73 percent,[43] while the ET rate of 1.5 feet per year was measured at the Carson Valley USGS ET-7 site over a 5 to 7 foot tall stand of bitterbrush, sagebrush, and mixed grasses where the water table was about 60 feet below land surface.[44] ET at Carson Valley USGS ET-7 is likely entirely precipitation because the water table is 60 feet deep and the site is located on an alluvial fan of the Carson Range where more precipitation likely occurs than on the valley floor. That is, ground-water ET at Carson Valley site ET-7 is nil, all ET comes from precipitation. From observation of Figures 4, 5, and 6 (Appendix 1), it is obvious that there are significant differences between the density and vigor of scrub-shrub phreatophytes at Carson Valley ET sites 1 and 7 and the scrub-shrub phreatophytes in Red Rock Valley, and hence the ET rates for scrub-shrub phreatophytes in Red Rock Valley should be commensurately less than the rates measured in Carson Valley.

The State Engineer finds that the Applicant did not present sufficient or convincing evidence supporting the statistical analysis of averaging rates from around the world without

[43] Exhibit No. 51, Volume 5a, Attachment 5, p. 5a-11-18.
[44] Exhibit No. 51, Volume 5a, Attachment 5, p. 5a-11-18.

consideration of precipitation amount, evaporative demand, and vegetation conditions in which the published ET rates were measured. In addition, the State Engineer finds that the Applicant's vegetation classification is subjective and is not consistent with the vegetation classifications used in the publications from which the respective ET rates are statistically analyzed and applied to Red Rock Valley.

XII.

A significant amount of evidence was submitted totaling 23 peer reviewed publications pertaining to remote sensing techniques for estimating ET, mapping phreatophytes, scaling of ET rates based on remotely sensed plant density and vegetation indices, hydrologic modeling of ET, and the integration of remotely sensed ET with hydrologic models;[45] however, none of the methods outlined in the submitted evidence were applied in Red Rock Valley. The State Engineer finds that if phreatophyte ET rates are to be transferred from one basin to another, the climate, vegetation type and condition from which the ET measurements are taken must be considered, and the ET rates which are applied to the basins of interest must reflect those considerations.

The Applicant presented an ET rate of bare soil arguing that only a portion of precipitation should be deducted from the ET rates of delineated vegetation and landform units for estimating the ground-water discharge. The Applicant argued that since the average ET rate of bare soil was calculated to be 0.47 feet per year, a deduction of precipitation more than 0.47 feet would result in a negative ET rate, therefore only a portion of precipitation should be subtracted.[46] In estimating the bare soil evaporation rate for Red Rock Valley, the Applicant assumed that bare soil consisted of areas with less than 25% vegetation cover, and were mainly compiled from USGS-published ET rates. A total of 19 measured bare soil ET rates were compiled and averaged, which ranged in location from Smith Creek, NV, to Escalante Valley, UT, to Death Valley, CA. Because the Applicant did not consider the precipitation amount at the measurement sites respective to Red Rock Valley, and because there was no consideration of the soil moisture conditions at the measurement site, where it is obvious that there will be a higher ET rate for a consistently moist bare soil/playa area verses a lower ET rate for a consistently dry bare soil/playa area, the State Engineer finds that the Applicant's analysis and argument cannot be accepted.

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[45] Exhibit No. 51, Volume 6a, Attachment 6.
[46] Exhibit No. 51, Volume 1, p. 63.

In addition to compiling and averaging published ET rates from around the world to estimate ET from phreatophyte vegetation in Red Rock Valley, the Applicant used the Penman-Monteith reference ET equation and the Food and Agricultural Organization crop coefficient methodology (FAO-56) to "independently validate" statistically derived ET for phreatophyte vegetation in Red Rock Valley, even though the FAO-56 crop coefficient methodology is meant to be used for agricultural settings that are under optimum soil water conditions.[47] The reference ET was calculated by applying the FAO-56 Penman-Monteith equation to weather data collected in Red Rock Valley by the Washoe County Department of Water Resources (WCDWR) and weather data collected at a Remote Automated Weather Station (RAWS) located in Doyle, CA. The Applicant estimated the actual ET from phreatophyte vegetation by applying crop coefficients to the calculated reference ET from both weather stations. The effects of various weather conditions on ET are incorporated into the reference ET, and the characteristics that distinguish the crop of interest from the reference crop are integrated into the crop coefficient. By multiplying the reference ET by the crop coefficient, actual ET is determined.[48] The Applicant applied FAO-56 crop coefficients to seasonal and perennial wetlands, and open water areas, which were specified in FAO-56 as cattails and bulrushes with no killing frost, reed swamp with standing water, and open water less than 2 meters depth, respectively. In addition, the Applicant assumed that FAO-56 crop coefficients for grazing pasture/extensive grazing, and grazing pasture/rotated grazing, which are designed for irrigated areas or areas under optimum soil water conditions, would be appropriate for the application to areas of non-irrigated scrub-shrub and grassland upland, respectively. Also, a crop coefficient was selected for bare ground, which is specified as no crop in the source reference.[49] The Applicant estimated ET from each vegetation and landform type using FAO-56 methods by multiplying respective crop coefficients for each season to respective time periods of calculated reference ET derived from the WCDWR and Doyle weather stations, however, the final analysis was limited to results derived from the WCDWR weather station located in Red Rock Valley.[50]

[47] FAO Irrigation and Drainage Paper No. 56. Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements, 1998, p. 89, official record in the Office of the State Engineer.
[48] FAO Irrigation and Drainage Paper No. 56. Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements, 1998, official record in the Office of the State Engineer.
[49] Allen R.G., Clemmens A. J., Burt C. M., Solomon K., O'Halloran T., (2005). Prediction Accuracy for Projectwide Evaportanspiration Using Crop Coefficients and Reference Evapotranspiration. Journal of Irrigation and Drainage Engineering. p. 28.
[50] Exhibit No. 51, Attachment 2, Table 14c.

The State Engineer finds that the Applicant's application of the FAO-56 method is inappropriate because crop coefficients designed for irrigated grazing lands were used for estimating ET from non-irrigated grassland and scrub-shrub upland areas. Methods proposed by FAO-56 clearly state in an entire chapter titled "Crop ET under soil water stress conditions," that when rainfall or irrigation is low, water stress is induced and the ET will drop below the standard crop ET, and a reduction in the crop coefficient under conditions of low soil water availability is determined using a stress coefficient, which is based on available soil moisture.

In the original and post-hearing filing of evidence, the Applicant analyzed published ET rates from two USGS studies conducted in Carson Valley (SIR 2005-5288 and SIR 2006-5305) and Ruby Valley (WRI 01-4234)[51] and compared USGS ET rates to those derived from her statistical and FAO-56 analysis.[52,53] In the comparison, the Applicant selected USGS ET rates measured over specific vegetation and landform types and assumed that those ET rates would transfer to their defined vegetation and landform types. The Applicant assumed that an ET of 3.0 feet per year measured over flood irrigated pasture (average of USGS ET 3 and 4 sites)[54,55] would transfer to non-irrigated grassland upland areas in Red Rock Valley. Also, it was assumed that an ET rate of 1.9 feet per year measured at the Carson Valley USGS ET-1 site over a stand of rabbitbrush, sagebrush, greasewood, and mixed grasses where the water table was 3 to 5 feet below and surface and plant density estimated to be 73 percent,[56] would be directly comparable to her scrub-shrub upland category. Measurements of ET made by the USGS in Ruby Valley over mixed phreatophyte shrubs (Phreatophyte-1)[57] and non-phreatophyte shrubs (Desert-shrub upland)[58] were averaged by the Applicant to produce an ET rate of 1.16 feet per year, which was assumed to transfer to scrub-shrub upland area in Red Rock Valley. In addition, the Applicant selected ET rates for playa, grassland, meadowland, marsh, and open-water areas in Ruby Valley report WRI 01-4234 and applied them to assumed bare soil, grassland, seasonal wetland, perennial wetland, and open water areas in Red Rock Valley.

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[51] Exhibit No. 51, Attachment 5, Volumes 5a-8, 5a-11, and 5a-9.
[52] Exhibit No. 51, Attachment 2, Table 14c.
[53] Exhibit No. 63, Appendix A.
[54] Exhibit No. 51, Volume 5a, Attachment 5, p. 5a-11-30.
[55] Exhibit No. 51, Volume 5a, Attachment 5, p. 5a-8-53.
[56] Exhibit No. 51, Volume 5a, Attachment 5, p. 5a-11-18.
[57] Exhibit No. 51, Attachment 5, Volumes 5a-8, p 5a-9-17, Table 2.
[58] Exhibit No. 51, Attachment 5, Volumes 5a-8, p. 5a-9-17, Table 2.

The State Engineer finds that the Applicant's comparison and application of USGS ET rates from Carson Valley and Ruby Valley are inconsistent and are not directly transferable to Red Rock Valley. For illustration purposes, Figures 4 and 5 (Appendix 1) respectively illustrate classified scrub-shrub upland areas in Red Rock Valley and the Carson Valley ET site where the associated ET rate of 1.9 feet per year is proposed to be equivalent to ET from Red Rock Valley scrub-shrub areas, while Appendix 1, Figures 7, 8 and 9 respectively illustrate the Red Rock Valley grassland area delineated by the Applicant, and the Carson Valley ET sites in which the associated average ET rate of 3.0 feet per year from irrigated pasture is proposed to be equivalent to ET from assumed Red Rock Valley grassland areas. The State Engineer finds that there are significant differences in vegetation density, vigor, and available water in the assumed grassland and scrub-shrub upland areas in Red Rock Valley when compared to Carson Valley ET sites chosen for analysis; therefore, ET rates measured at the Carson Valley ET sites illustrated cannot be directly transferred to Red Rock Valley due to the presence of irrigation at these sites, differences in soil water availability, and vegetation condition.

In Ruby Valley report WRI 01-4234, the USGS did not measure ET, but estimated ET for grassland and meadowland areas by applying ET estimates based from a remotely sensed plant cover – ground-water ET relationship outlined in USGS PP1628,[59] also referred to as the Nichols report. Also in WRI 01-4234, the ET rate for playa and bare soil was not measured but was estimated from USGS PP1628. The State Engineer finds that the Ruby Valley grassland and meadow ET rates that the Applicant presented in support of its statistically derived ET rates are flawed because grassland areas classified by the USGS have significantly different vegetation and moisture availability than the grassland area assumed by the Applicant in Red Rock Valley. In addition, grassland and meadowland ET rates in USGS WRI 01-4234 were not derived from ET measurements but were estimated using the Nichols remotely sensed plant cover – ground-water ET method. The State Engineer has been hesitant to adopt the Nichols remote sensing method for estimating ground-water discharge because the source data for Nichols' empirical relationship between plant cover and ground-water ET was almost entirely derived from Ash Meadows, NV, and Owens Valley, CA, which are areas that have less precipitation, longer growing season,

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[59] Exhibit No. 51, Volume 6a, Attachment 6, p. 6a-2-1.

greater evaporative demand, and hence greater ground-water ET rates for the given plant cover than in northern or central Nevada.

In estimating the recharge for the east side of Red Rock Valley, the Applicant estimated the ground-water discharge by applying ET rates to respective vegetation and landform types, and by subtracting only a portion of the mean annual precipitation from the ET rates. The Applicant opined that only a portion of precipitation should be deducted from the ET rates, claiming that through an unsaturated zone modeling exercise using the HYDRUS software with daily time steps, it was estimated that 49% to 55% of the annual precipitation of 11.8 inches reaches the water table when the water table depth is 2.5 feet below land surface.[60] The Applicant further analyzed that 33% to 46% of the annual precipitation would reach the water table when the depth to water is 5 feet, and stated that the percent of precipitation that reaches the water table would be reduced as the water table is lowered.[61,62] This approach of deducting only a portion of precipitation from the total ET to determine the ground-water portion of ET was discussed at length at the hearing.[63] The Applicant opined that if water from precipitation reaches the water table, that amount of precipitation should not then be subtracted from the total ET rate to arrive at a ground-water discharge estimate. However, numerous USGS publications submitted into evidence by the Applicant clearly state that all precipitation needs to be subtracted from the total ET estimate to arrive at a ground-water discharge estimate. For example, "Estimates of mean annual ET include precipitation falling on the area that evaporates or recharges the shallow ground-water flow system and later is evaporated or transpired from within the area. Because the precipitation component of ET is not derived from ground water, it must be removed prior to estimating ground-water discharge."[64] Also, "As estimated, annual ET includes any precipitation falling on the local area that is evaporated, or that recharges the shallow ground-water flow system and later is evaporated or transpired. The estimate also may include some component of upward leakage (diffuse upflow) from the regional carbonate-rock aquifer. Annual ET is adjusted to remove any water contributed by local precipitation prior to computing ground-water recharge."[65]

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[60] Exhibit No. 51, p. 49.
[61] Exhibit No. 51, p. 49.
[62] Transcript, p. 144.
[63] Transcript, pp. 132 - 155.
[64] Exhibit No. 51, Attachment 5, Volume 5a-2-30-34.
[65] Exhibit No. 51, Attachment 5, Volume 5a-1-46.

In estimating ground-water ET rates for each vegetation and landform type, the Applicant subtracted the amount of precipitation that did not reach the water table in the HYDRUS model, from the total ET rates. Table 4 shows a summary of the estimated mean annual ET rate, precipitation amount consumed by ET, ground-water ET rate, recharge rate in the discharge area, and the percent of precipitation assumed to recharge in the discharge area.

Applicant's Vegetation/Landform	Applicant's Statistical Analysis ET rate (ft/yr)	Applicant's Precipitation Amount Assumed to be Used by ET (ft/yr)	Applcant's Ground-Water ET rate (ft/yr)	Applcaints Precipitation Amount Assumed to Recharge in the Discharge Area (ft/yr)	Percentage of Preciptation Assumed to Recharge in the Discharge Area
Bare Ground	0.47	0.47	0	0.51	52
Scrub-Shrub Upland	1.39	0.57	0.82	0.41	42
Grassland Upland	2.33	0.59	1.74	0.39	40
Seasonal Wetland	3.51	0.48	3.03	0.50	51
Perennial Wetland	4.03	0.00	4.03	0.98	100
Open Water	4.66	0.00	4.66	0.98	100

Table 4. Applicant's ET rate, precipitation amount consumed by ET, ground-water ET rate, precipitation amount to recharge in the discharge area, and the percent of precipitation assumed to recharge in the discharge area.

The State Engineer finds that the Applicant's analysis considering the amount of precipitation, which should be deducted from total ET to estimate ground-water discharge is flawed and deviates from accepted methodologies of experts in the field, including peer-reviewed publications submitted into evidence by the Applicant. The State Engineer finds 100% of the precipitation that falls on the discharge areas should be deducted from the total ET for computing a ground-water budget; failure to do so has resulted in inflated estimates of ground-water ET by the Applicant.

A summary of the total ground-water discharge for Red Rock Valley as presented by the Applicant is shown in Table 5. The total ground-water discharge estimate for Red Rock Valley is 4,362 acre-feet per year, with 2,972 afa of that amount occurring in the east part of the valley.[66,67] Table 6, which uses the total ET from Table 4 and subtracts all precipitation, estimated at 0.98 feet, results in ground-water ET of 2,025 afa for the east side of the valley. The State Engineer finds that the Applicant's ground-water ET estimate should have been

[66] Exhibit No. 51, Attachment 2, Tables 14a-c.
[67] Exhibit No. 63, Appendix A.

computed as shown in Table 6, by subtracting all precipitation falling within the discharge area from the total ET to arrive at a ground-water ET estimate. The State Engineer also finds the Applicant's methodology for delineating vegetation/landform areas and applying assumed ET rates are subjective because both the vegetation/landform classifications assumed for Red Rock Valley and the applied rates are subjective and, in part, inconsistent with professional and peer-reviewed publications. The State Engineer finds these interpretations have resulted in an overestimation of ground-water ET for the Red Rock Valley. As an example, the Applicant's assumed grassland upland classification in Red Rock Valley would likely be considered a moderate to dense shrubland based upon USGS evidence submitted, and the rate would be 0.1 to 1.4 feet per year rather than the Applicant's rate of 1.74 feet per year.

Applicant's Vegetation/Landform	West Side Acreage	East Side Acreage	Applicant's Ground-Water ET rate (ft/yr)	West Side Ground-Water ET Volume (ac-ft/yr)	East Side Ground-Water ET Volume (ac-ft/yr)
Bare Ground	6	51	0	0	0
Scrub-Shrub Upland	267	1,298	0.82	220	1,070
Grassland Upland	188	776	1.74	326	1,347
Seasonal Wetland	196	109	3.03	593	331
Perennial Wetland	58	55	4.03	232	221
Open Water	4	1	4.66	19	3
TOTAL	718	2,289		1,390	2,973

Table 5. Summary of Applicant's ground-water discharge estimates.

Applicant's Vegetation/Landform	East Side Acreage	Applicant's Statistical Analysis ET rate (ft/yr)	Precipitation Amount (ft/yr)	Re-estimated GWET rate (ET rate -precip. ft/yr)	Recomputed Ground-Water ET Volume (ac-ft/yr)
Bare Ground	51	0.47	0.98	0.00	0
Scrub-Shrub Upland	1,298	1.39	0.98	0.41	532
Grassland Upland	776	2.33	0.98	1.35	1047
Seasonal Wetland	109	3.51	0.98	2.53	277
Perennial Wetland	55	4.03	0.98	3.05	167
Open Water	1	4.66	0.98	3.68	2
TOTAL	2,289				2,025

Table 6. Recomputed estimate of ground-water ET using Applicants total ET rate and deducting all precipitation.

XIII.

In addition to the Applicant's analysis of ground-water discharge as the basis for determining the ground-water recharge, the Applicant's expert hydrogeologist, Dr. Pohll, provided a ground-water recharge analysis using three separate methods to evaluate the range of ground-water recharge from precipitation estimates in Red Rock Valley.[68] Using the Maxey-Eakin recharge coefficients and a digital version of the 1965 Hardman precipitation map, the ground-water recharge for Red Rock Valley was estimated at 1,400 acre-feet per year. Using the Nichols method, a method presented in USGS Professional Paper 1628,[69] the ground-water recharge for Red Rock Valley was estimated at 5,500 acre-feet per year. The Nichols method uses a combination of the 1997 version of the 1961 to 1990 PRISM precipitation map[70] with recharge coefficients calibrated to his estimates of ground-water discharge. The basins Nichols used for his calibration are located in eastern Nevada and most of those basins are within what is generally thought of as the carbonate-rock aquifer. The third estimate of recharge was made by applying a stochastic approach developed by University of Nevada, Hydrologic Sciences masters student, Brian Epstein,[71] in which independent recharge volumes were statistically evaluated against the 1998 version of PRISM 1961-1990 precipitation volumes, and simply put, a range of recharge coefficients were developed. Using Epstein's stochastic approach the Applicant estimated the ground-water recharge from precipitation for Red Rock Valley to range between a lower 95% confidence of 1,100 acre-feet per year, to an upper 95% confidence of 2,800 acre-feet per year, with a mean of 1,900 acre-feet per year. Note that ground-water recharge estimates from precipitation are for the entire Red Rock Valley hydrographic area, not just the east side of Red Rock Valley, which is the area of interest for predicting impacts associated with the pending applications. An analysis by the State Engineer's office found that if Epstein's stochastic approach was applied to just the east side of Red Rock Valley the estimated recharge would range between a lower 95% confidence of 700 acre-feet per year, to an upper 95% confidence of 1,800 acre-feet per year, with a mean of 1,200 acre-feet per year.

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[68] Exhibit No. 52, p. 7.
[69] Exhibit No. 51, Volume 6a, Attachment 6, p. 6a-2-1.
[70] Daly, C., et al., (1994). A statistical-topographic model for mapping climatological precipitation over mountainous terrain: Journal of Applied Meteorology. V.33, pp. 140-158.
[71] Epstein, B.J., (2004). Development and Uncertainty Analysis of Empirical Recharge Prediction Models for Nevada's Desert Basins. University of Nevada, Reno, unpublished Master's thesis.

In the post hearing filing of evidence, a fourth estimate of ground-water recharge was made for Red Rock Valley[72] using empirical equations of water yield and runoff for mountain block sub-watersheds found in USGS WRI 99-4272.[73] Equations of water yield and runoff reported in USGS WRI 99-4272 were originally developed in USGS WRI 97-4191 in which non-linear regression equations were made between the area weighted depth of mean annual precipitation within mountain block sub-watersheds in the Eagle Valley Hydrographic Area, and the respective gauged mean annual surface runoff at the mountain front, and the respective mean annual subsurface flow at the mountain front estimated via chloride mass balance and Darcian flux estimates.[74] Dr. Pohll applied water yield and runoff equations to the area weighted mean annual PRISM precipitation estimates (800 meter resolution, 2007 version 1) for delineated mountain block sub-watersheds in the east side of Red Rock Valley. In addition to applying the water yield and runoff equations to the mountain block sub-watersheds, the equations were applied to the area weighted mean annual PRISM precipitation estimate for the valley floor. By applying the water yield and runoff equations to both the mountain block and valley floor/ground-water discharge area, the estimated ground-water recharge (i.e. water yield minus runoff) was 2,495 acre-feet per year. However, the water yield and runoff equations are not meant to be applied to valley floor areas.

In summary, the Applicant has estimated the ground-water recharge to the Red Rock Valley Hydrographic Area using several methods where the ground-water recharge is estimated independently of discharge, and where the ground-water discharge is estimated and is assumed to equal the ground-water recharge. Estimates of ground-water recharge for the entire Red Rock Valley Hydrographic Area range from 900 to 5,500 acre-feet per year,[75] with recharge to the eastern part of the valley being approximately one half of those amounts, or 450 to 2,700 acre-feet per year. There is also an undetermined amount of underflow from Bedell Flat Hydrographic Area, with a preliminary reconnaissance estimate by Rush and Glancy of 200 afa. Using the Applicant's ground-water discharge estimate,

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[72] Exhibit No. 63, p. 2.
[73] Berger, D.L., (2000). Water budgets for Pine Valley, Carico Lake Valley, and Upper Reese River Valley hydrographic areas, Middle Humboldt River Basin, North-central Nevada – Methods and Results. Water Resources Investigations report 99-4272. United States Geological Survey prepared in cooperation with the Nevada Division of Water Resources, Carson City, Nevada.
[74] Maurer, D.K., and Berger, D.L., (1997). Subsurface Flow and Water Yield From Watersheds Tributary to Eagle Valley Hydrographic Area, West-Central Nevada. Prepared in cooperation with the Carson City Utilities Department and the Washoe Tribe of Nevada and California.
[75] Exhibit No. 52, p. 7.

and depending on assumptions of present-day steady-state conditions and the amount of recharge in the discharge zones, ground-water recharge ranges from 2,000 to 4,500 afa,.

During the time of the hearing and preparation of exhibits by the Applicant, a USGS study of the Basin and Range Carbonate-rock Aquifer System (BARCAS) in eastern Nevada was in draft form and available to the public, in which ground-water ET from phreatophyte shrubs were measured at six locations and spatially distributed to compute ground-water discharge volumes. Because the BARCAS study was in draft form at the time of the hearing, ground-water ET measurements presented in the BARCAS study were excluded by witness Carpenter.[76] However, prior to the hearing two USGS BARCAS companion reports describing the detailed methods and results of ground-water ET measurements[77] and delineation of ET units[78] were published and available to the public. Ground-water ET estimates presented in the BARCAS draft study, which were derived from the published companion reports, have important value due to the similar climate of the BARCAS study area and Red Rock Valley, and detailed analyses regarding the variability of ground-water ET related to phreatophyte type and density.

To provide alternative estimates of ground-water discharge from phreatophyte areas in Red Rock Valley that account for the spatial variability in phreatophyte density within defined units, as well as the variability of respective ground-water ET rates, State Engineer staff used identical methods as those used in the BARCAS draft report and published companion reports to delineate ET unit areas and estimate respective ground-water ET volumes. Remote sensing methods described in SIR 2007-5087[79] were followed to delineate ET units using the Modified Soil Adjusted Vegetation Index (MSAVI) and Southwest Regional Gap Analysis Program (SWReGAP) data, which result in the delineation of ET units including xerophytes, sparse desert shrubland, moderately dense desert shrubland, dense desert shrubland, grassland, meadowland, and marshland, and open water. Landsat Thematic Mapper imagery used for the analysis was acquired on July 16, 1999, in which the antecedent precipitation was slightly above normal as recorded at the Stead NWS weather station. The boundary used to limit the analysis to the ground-water

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[76] Exhibit No. 51, p. 30.

[77] Moreo, M.T., et al, 2007. Evapotranspiration Rate Measurements of Vegetation typical of Ground-Water Discharge Areas in the Basin and Range Carbonate-Rock Aquifer System, Nevada and Utah, September 2005-2006. USGS SIR 2007-5078.

[78] Smith. J. L., et al, 2007. Mapping Evapotranspiration units in the basin and Range Carbonate-Rock Aquifer System, White Pine County, Nevada, and Adjacent Areas in Nevada and Utah, USGS SIR 2007-5087.

[79] Ibid.

discharge area in Red Rock Valley was obtained from the Applicant's submitted Geographic Information System (GIS) file of the phreatophyte area.[80] Ranges of ET rates for each ET unit were adopted directly from the BARCAS draft report.[81] As described in the BARCAS draft report, final ET rates were computed by scaling within the range of ET for each ET unit. The scaling procedure assigns the highest MSAVI value within an ET unit to the high value of the ET range and the lowest MSAVI to the lowest value of the ET range. Scaling within the ET range is done by using the average MSAVI found within each ET unit. Because the ET ranges used in BARCAS were derived from ET measurements which included precipitation, following methodology of the BARCAS report, local precipitation was subtracted from the scaled ET rates. The area weighted mean annual PRISM precipitation (800 meter resolution, 2007 version 1) estimate of 1.0 foot per year, which is essentially the same as the Applicants estimate of 0.98 foot per year, was subtracted from the scaled ET rates to compute the ground-water discharge rates for each ET unit. Volumes of ground-water discharge were computed by multiplying the computed ground-water discharge rates by respective ET unit areas, which yielded a total ground-water ET volume from the east side of Red Rock Valley of approximately 500 acre-feet per year (Table 7). However, the minimum ET rates for ET units of sparse desert shrubland and moderate desert shrubland published in the BARCAS report are below the precipitation amount in Red Rock Valley, therefore the minimum ET rates were adjusted upward to the precipitation amount of 1.0 foot per year. Scaling the range of ET rates starting from a minimum of precipitation resulted in a ground-water ET volume of approximately 710 acre-feet per year from the east side of Red Rock Valley (Table 8).

To provide an additional interpretation of ground-water ET in Red Rock Valley, State Engineer staff compiled recent USGS publications in which the ET and precipitation were measured during the same period, so that the ground-water ET rate could be determined by subtracting precipitation from the total ET. Compilation of ET and precipitation measurements were restricted to areas of similar latitude and climate, which resulted in measurements conducted in Spring Valley, White River Valley, Snake Valley, Carson Valley, and Ruby Valley. Published ground-water ET rates were grouped into representative ET units for developing ground-water ET ranges similar to the BARCAS

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[80] Exhibit No. 51, Attachment 1, Figure 25.

[81] Welch A. H., and Bright D. J., 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, USGS OFR 2007-1156, p. 58.

study, where grouping of ground-water ET rates were determined from reported vegetation descriptions and photos of the measurement sites, as well as verbal communication with USGS staff specifically involved in data collection, interpretation, and analysis.[82,83,84]Following the BARCAS methodology described above, linearly scaled ground-water ET rates for each ET unit were calculated based on the minimum, maximum, and average MSAVI values within each ET unit, and the respective minimum and maximum ground-water ET rates. Multiplying scaled ground-water ET rates by respective ET unit areas yielded a ground-water ET volume for the east side of Red Rock Valley of 940 acre-feet per year (Table 9).

ET Area (Acres)	ET Unit	Minimum ET Rate (ft/yr)	Maximum ET Rate (ft/yr)	Scaled ET Rate (ft/yr)	Local Precipitation (ft/yr)	Scaled Ground-Water ET Volume (ac-ft/yr)
-	Dry Playa	-	-	-	-	-
24	Sparse Desert Shrubland	0.50	1.10	1.1	1.0	2
1,581	Moderately Dense Desert Shrubland	0.70	1.50	1.1	1.0	190
552	Dense Desert Shrubland	1.00	1.80	1.2	1.0	132
-	Moist Bare Soil	-	-	-	-	-
67	Grassland	1.60	2.70	2.1	1.0	76
43	Meadowland	2.20	3.30	2.5	1.0	66
11	Marshland	3.60	4.60	3.7	1.0	30
-	Openwater	-	-	-	-	-
				Total Ground-Water ET Volume		**496**

Table 7. GWET total for east Red Rock valley using ET rates directly from OFR 2007-1156.

[82] Laczniak, R.J., November, 2007. Verbal communication.
[83] Moreo, M.T., October, 2007. Verbal communication.
[84] Smith, J.L., October, 2007. Verbal communication.

ET Area (Acres)	ET Unit	Minimum ET Rate (ft/yr)	Maximum ET Rate (ft/yr)	Scaled ET Rate (ft/yr)	Local Precipitation (ft/yr)	Scaled Ground-Water ET Volume (ac-ft/yr)
-	Dry Playa	-	-	-	-	-
24	Sparse Desert Shrubland	1.00	1.10	1.09	1.0	2
1,581	Moderately Dense Desert Shrubland	1.00	1.50	1.25	1.0	395
552	Dense Desert Shrubland	1.00	1.80	1.25	1.0	138
-	Moist Bare Soil	-	-	-	-	-
67	Grassland	1.60	2.70	2.13	1.0	76
43	Meadowland	2.20	3.30	2.53	1.0	66
11	Marshland	3.60	4.60	3.71	1.0	30
-	Openwater	-	-	-	-	-
			Total Ground-Water ET Volume			707

Table 8. GWET for east Red Rock Valley using ET rates modified from OFR 2007-1156 as discussed in ruling text.

ET Area (Acres)	ET Unit	Minimum Ground-Water ET Rate (ft/yr)	Maximum Ground-Water ET Rate (ft/yr)	Minimum Ground-Water ET Rate Source	Maximum Ground-Water ET Rate Source	Scaled Ground-Water ET Rate (ft/yr)	Scaled Ground-Water ET Volume (ac-ft/yr)
-	Dry Playa	-	-	-	-	-	-
24	Sparse Desert Shrubland	0.00	0.14	Assumed no GWET	SPV-1[1]	0.13	3
1,581	Moderately Dense Desert Shrubland	0.09	0.33	WRV-2[1]	SNV-1[1]	0.22	346
552	Dense Desert Shrubland	0.35	1.39	WRV-1[1]	ET-1[2]	0.66	363
-	Moist Bare Soil	-	-	-	-	-	-
67	Grassland	1.22	1.60	ET-6[2]	SPV-3[1]	1.40	94
43	Meadowland	1.60	3.56	SPV-3[1]	Bulrush marsh[3]	2.20	95
11	Marshland	3.56	3.94	Bulrush marsh[3]	ET-8[2]	3.60	39
-	Openwater	-	-	-	-	-	-
					Total Ground-Water ET Volume		940

[1] BARCAS Companion SIR 2007-5087, Table 7

[2] Carson Valley SIR 2005-5288, Table 2. Precipitation for study period taken from the Minden NWS weather station.

[3] Ruby Valley WRI 01-4234, Table 2. Precipitation for study period taken from the Ruby Lake wildlife refuge headquarters.

Table 9. GWET for east Red Rock Valley using published GWET rates from various areas in northern Nevada.

On the basis of the weight of the evidence discussed above, the State Engineer finds that a reasonable range for current ground-water ET in the eastern part of Red Rock Valley is between 800 and 2,000 acre-feet per year. The State Engineer finds that the amount of ground-water discharge under assumed current steady-state conditions in the eastern side of Red Rock Valley ranges between 1,200 and 2,400 acre-feet per year. These estimates are equal to the sum of the ground water ET plus the consumptively used ground-water pumping. Consumptive use of ground-water is based on 103 acres of irrigation[85] at the consumptive use rate of 2.5 feet per year (258 afa), and 136 existing domestic wells[86] at a

[85] Exibit No. 52, p. 22.

[86] Exhibit No. 52, p. 18.

rate of 1.0 acre-foot per well (136 afa) for a rounded total of 400 afa. The lower ET estimate is based on reconnaissance estimates of ET as well as studies by the State Engineer's staff, while the higher estimate is based on the Applicant's total ET minus total precipitation as shown in Table 6. Subsurface inflow from Bedell Flat and outflow to western Red Rock Valley, are highly uncertain and are tentatively considered to be approximately equal. In consideration of existing water rights in both the inflow and outflow basins, these flows will not be considered in determining the perennial yield of the eastern Red Rock Valley. The State Engineer finds the sustainable yield of the eastern half of the Red Rock Valley Hydrographic Area is between 1,200 and 2,400 acre-feet per year.

XIV.

The Applicant's expert hydrogeologist, Dr. Pohll, provided testimony and a report on a ground-water flow model constructed of the subject area.[87] The purpose of the model was to document their conceptual view of the hydrogeology and ground-water flow, establish hydraulic conductivity for the alluvial aquifer in the eastern half of the Red Rock basin, and predict the effects of proposed pumping on ground-water levels and water rights. Two layers were represented in the model, an unconfined surficial aquifer in the valley fill material and a deeper confined layer made up primarily of variably-weathered granitic bedrock. Ground-water recharge was simulated to occur around the perimeter of the valley floor. Ground-water discharge occurs through ET on the valley floor, as subsurface outflow to the northwest, and from existing wells. The water budget assumed present steady-state conditions. The model was calibrated to match steady-state water levels in 47 domestic and monitor wells. Water levels were derived from driller's reports as well as approximately 10 individual measurements. Model calibration was achieved by varying hydraulic conductivity in the upper model layer using the "pilot point" method in MODFLOW. Ground-water discharge due to ET was provided by the ET study.[88] Existing pumping was based on observed irrigated acreage from the May 31, 2000, Landsat image, and a count of domestic wells. Subsurface outflow to the northwest was simulated in the model with a specified head boundary, with the amount of outflow determined by the model. Ground-water recharge was simulated around the perimeter of the valley fill with specified flows, and because steady-state conditions were assumed, recharge was set to equal the total of the initial discharge estimate of 3,650

[87] Exhibit No. 52.
[88] Various reports of Huffman and Carpenter.

acre-feet per year. After steady-state calibration, the model was run in transient mode, where the applied-for water was pumped for a period of 50 years. The model simulations predicted future water levels as well as reductions in ET and subsurface discharge. As predicted by the model, water levels in the vicinity of the proposed well would decline moderately, with most of the decline occurring during the first 10 years. Water level decline at a distance of 2,500 feet was estimated to be about 15 feet after 10 years and about 20 feet after 50 years. After 50 years, most of the northern end of the basin would experience water level declines of less than 15 feet. Near steady-state conditions were predicted after about 30 years of pumping.

After the hearing, the State Engineer required the Applicant's expert to rerun the model and provide predictive results using revised estimates of ground-water recharge and specific yield. There were several reasons why the State Engineer wanted a revised model simulation.

- The Applicant's expert was asked to recalibrate and rerun the model with a reduced amount of natural ground-water recharge and discharge. Because the actual amount of recharge and discharge is unknown, a revised simulation with future pumping closer to the modeled recharge and natural discharge amounts is thought by the State Engineer to provide more useful information on potential future impacts.

- The original model distributed ground-water recharge more or less equally around the periphery of the alluvial basin; however such distribution is not supported by a conventional understanding of hydrologic processes. The distribution of ground-water recharge in a basin-fill aquifer is expected to be dependent on the source watershed, so that larger and wetter watersheds will provide more recharge to the basin. The original version of the model failed to fully consider this.

- The original model used a total recharge from local precipitation amount of 3,450 acre-feet per year for the eastern half of the basin,[89] which is far in

[89] Exhibit No. 52, p. 22.

excess of reconnaissance recharge estimate for the entire basin of about 500 acre-feet annually.[90]

- Analyses of the Applicant's ET estimate found irregularities in estimating the ground-water component of the total ET. As shown in Table 6 above, a reduction in ground-water ET in the model was deemed to be consistent with the standard methodologies using the Applicant's data.

- The hydraulic conductivity distribution for model layer 1 was higher than expected based on the Applicant's own pumping tests and specific capacity data. Because hydraulic conductivity is a calibration parameter in the model, excessively high calibrated hydraulic conductivity distributions can result from overestimating model recharge and discharge.

- Predictive simulations were to use two values for the specific yield of the basin fill aquifer. The first transient model used a value of 0.2 for specific yield and a value of 7.4×10^{-7} for specific storage, and referenced Appendix D of that report for further information. However, no mention of storage coefficients was found at that location. In the absence of measured data, employing multiple input values allows for a range of predictions to be evaluated.

As mentioned above, the Applicant submitted two steady state ground-water flow models into evidence. The first model used a total annual recharge of 3,646 acre-feet annually, while the revised model used 2,534 acre-feet annually as the annual recharge. The modeling report compares the recharge used in the first model to other published estimates, and goes on to state that the model estimate is within the range determined from previous studies.[91] However, the model area only considers the eastern part of the basin, which is somewhat more than half the area of the total basin but receives less precipitation. In comparing model recharge to published studies, it would seem more appropriate to compare the model recharge to one half of the published amount for Red Rock Basin, or about 650 acre-feet annually. That is, one half of Rush and Glancy's 900 acre-feet annually plus 200 acre-feet annually of inflow from Bedell Flat. The Nichols

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[90] Rush and Glancy, 1967.
[91] Exhibit No. 52, p.iii.

method for estimating recharge, the highest estimate shown in the model report,[92] has not been widely acknowledged as providing reasonable recharge estimates, and the State Engineer has been hesitant to use this method in estimating basin recharge.

The models were each calibrated to a set of water-level measurements using the assigned recharge, so that hydraulic conductivity was varied until water levels matched observed conditions. Each of the models used the "pilot point" method for calibrating the hydraulic conductivity; however, six of the 21 pilot points were not allowed to vary, their value being assigned directly on the basis of the pumping tests that have been completed by the consultant at those sites. The hydraulic conductivity of pilot points computed during the calibration process is significantly higher than the measured values. In the first version of the model, where recharge is distributed more uniformly around the perimeter of the valley floor, the hydraulic conductivity at the fixed pilot points averaged 1.3 meters/day (4.265 feet/day) while the computed hydraulic conductivity was 5.6 meters/day (18.37 feet/day), or approximately four times the computed value for adjacent pilot points. In the revised model, recharge was distributed on the perimeter of the valley floor with consideration given to the relative size of the up-gradient watershed using water yield and runoff derived recharge estimates. In this version of the model, the computed hydraulic conductivity was about five times the fixed value. Figure 11 of the modeling report displays approximately 30 hydraulic conductivity estimates for wells based on their measured specific capacity. Unfortunately, there was no table provided with which to compare those estimates to the modeled values. The concern here is simply that the measured hydraulic conductivity appears to be significantly lower than the values computed in the calibration process. This situation could be the result of having too much water flowing through the model domain, i.e. too much recharge and too much discharge, or a poor conceptual model, or other factors.

Another consequence of higher hydraulic conductivity in the model is its effect on computed water-level drawdown due to pumping. A higher hydraulic conductivity distribution will result in a shallower cone of depression in the immediate vicinity of the pumping well, but somewhat more drawdown at intermediate distances. As mentioned above, a hydraulic conductivity distribution higher than actually exists could be due to modeling more than the actual recharge.

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[92] Exhibit No. 52, p.7.

As mentioned previously, the model's surficial aquifer was simulated as unconfined, even though there is abundant evidence for confined conditions throughout much of the alluvial aquifer, including the Red Rock Ranch well area. Water level decline of a pumped aquifer is strongly influenced by the storage coefficient of the aquifer, with lower storage coefficients resulting in more drawdown. Because the aquifer was modeled as unconfined, the storage coefficient is equal to the specific yield, which was set at 0.1 and 0.2. In a confined aquifer the storage coefficient is significantly lower, and was estimated by the Applicant in their pumping test to be approximately 0.0002, as calculated by the specific storage of 7.4×10^{-7} times the average aquifer thickness of 300 feet. Early drawdown from proposed pumping under confined conditions was not simulated, but predicted water levels would decline faster in the early stages of pumping if confined conditions were simulated. Long term water-level decline might not differ significantly from the unconfined simulations, assuming steady state conditions are reached.

The models were completed for the purpose of simulating future proposed pumping at the Red Rock Valley Ranch and predicting future water levels. The Executive Summary of the Model Report[93] states that the model predicted total ground-water ET of 2,869 acre-feet annually. However, this statement is misleading because ET was initially prescribed by the work of Huffman and Carpenter and would only be slightly modified by the model. The Summary also implies that recharge was estimated and verified by the model. However, recharge was a fixed water budget item. Because steady-state conditions are assumed, recharge must equal the sum of the ET plus pumping plus subsurface outflow. That is, recharge equals discharge. Discharge was almost entirely predetermined, therefore recharge was also predetermined.

There was animated discussion during the hearing concerning testimony and evidence presented to show that ground-water recharge occurs on the valley floor, specifically, in the discharge areas.[94] Much of this argument revolves around the approach one takes regarding differentiating total ET versus ground-water ET. The Applicant's argument, proffered by expert witness Ms. Carpenter, is not in agreement with conventional thought on this issue. Ms. Carpenter conducted an infiltration analysis using the program HYDRUS 1D to estimate the amount of rainfall that becomes

[93] Exhibit No. 52.
[94] Testimony of Ms. Carpenter and Exhibit No. 51.

recharge.[95] The analysis shows that infiltration of precipitation to the water table would occur under present conditions with the shallow water table. However, the predictive simulations of the ground-water flow model show 10 to 30 feet of drawdown across the valley floor. Under such conditions, infiltration of precipitation to the water table would decrease, which would then result in less recharge, which would result in more water level decline and correspondingly less infiltration. The situation is such that by capturing the recharge there will be less recharge in the future available for capture. It is a circular argument, with the only realistic solution being to neglect any potential recharge in the discharge areas. The scenario of decreasing recharge with water-level decline was not considered in the model predictions because recharge is held constant in a steady-state model. In fact, the model (correctly) did not simulate any recharge on the valley floor.

The State Engineer finds the ground-water flow model does not predict or verify either recharge or ET discharge, but that these water budget components were pre-estimated and input into the model. The State Engineer further finds that the recharge estimate used in the model is significantly higher than previously published and accepted values. The State Engineer finds that the calibrated hydraulic conductivity values are not satisfactorily within the range of observed values, and rather than adding confidence to the conceptual model, raise questions about the conceptual model and/or the recharge amount used.

The above irregularities notwithstanding, the State Engineer recognizes the usefulness and need for ground-water flow models in predicting future impacts. The model adequately demonstrates that the location of the application is well-suited to capture the existing natural discharge of the eastern half of the Red Rock Valley Hydrographic Area. The modeling study also shows that the proposed project will not unduly conflict with existing water rights so long as the proposed pumping, combined with existing rights and domestic wells, does not exceed the sustainable yield of the valley. These scenarios were evaluated by two separate models. The revised model showed water level decline in the nearby domestic wells will be less than 30 feet over the next ten years, and increase to only 30 to 40 feet after 50 years. Because current water levels are very near the land surface, and wells are required to be sealed in the upper 50 feet, this is not an unreasonable amount of drawdown. However, if the natural supply is

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[95] Transcript, p. 136.

less than proposed pumping, water levels will continue to decline, and the pumping would conflict with existing water rights and domestic wells. The State Engineer finds that the modeling study does not prove either recharge or discharge in the eastern part of Red Rock Valley, but does show that development of the area within the local sustainable yield can occur without conflicting with existing rights or unreasonably effecting domestic wells.

XV.

As discussed above, the sustainable yield for the eastern part of Red Rock Valley is in the range of 1,200 to 2,400 acre-feet. The amount of water available for appropriation will be the sustainable yield minus the consumed portion of current water rights and domestic wells, with reserved water for future demand of one domestic well at each of the undeveloped parcels. There are currently 904 acre-feet of ground-water rights with a consumptive use estimate of 565 acre-feet per year. There are currently 136 developed parcels, and using the rate of 1.0 afa per parcel consumptive, annual use is 136 acre-feet. There are 128 undeveloped parcels, and 128 acre-feet per year will be reserved for future growth and development in the basin. The total of the consumed water and future needs is 829 acre-feet annually. The State Engineer finds the amount of unappropriated water is between 371 and 1,571 acre-feet.

XVI.

As discussed above, there is considerable uncertainty and disagreement in estimates of the sustainable yield and the amount of water available for appropriation. As previously stated, the State Engineer finds the sustainable yield is between 1,200 and 2,400 acre-feet, and the amount of unappropriated water is between 371 and 1,571 acre-feet. The Applicants have 484 acre-feet of existing rights that are available for export from the basin. The State Engineer finds that water rights in the amount of 371 acre-feet can be granted and available for export, so that the total available for export is 855 acre-feet. Since the Applicants have asked for a total combined duty of 1,273.39 acre-feet, there remains 418 acre-feet, which is requested for appropriation, but that amount would put the total quantity of water requested into a range of the available supply that is highly uncertain. Therefore, the State Engineer finds that a staged development of the resource is prudent and will be required before the remaining 418 acre-feet is available for export under the following two options:

OPTION 1

- An initial staged development during a minimum 10-year period during which a maximum of 855 acre-feet can be pumped in any given year. Over a ten-year consecutive period, the pumping must average at least 750 acre-feet annually.
- With the exception of incidental uses related to the project, all ground water pumped during the staged development shall be exported from the Red Rock Valley.
- A detailed monitoring and mitigation plan shall be submitted and approved by the State Engineer.
- During the development period, the Applicant shall file an annual report with the State Engineer by March 15th of each year detailing the findings of the monitoring and mitigation plan.
- At the end of the staged development period the Applicant shall submit an updated ground-water flow model together with the data collected during the staged development period.
- The State Engineer will then make a determination as to whether the remaining amount may be pumped or if additional study is necessary.

OPTION 2

The Applicant may wait for results from a new ET study for a determination on the availability of the remaining application amount and an updated estimate of the sustainable yield. The study shall be funded by the Applicant but overseen by the State Engineer's office, and will tentatively be designed as follows:

- An ET study utilizing micrometeorological stations located within the ground-water discharge area in the eastern part of Red Rock Valley.
- The study is to be conducted for a minimum of two consecutive years, during which ET data are collected on at least three sites that have representative and widespread vegetative units.
- Following the results of the study, the State Engineer will then make a determination as to whether the remaining amount may be pumped or if additional study is necessary.

CONCLUSIONS

I.

The State Engineer has jurisdiction over the parties and the subject matter of this action and determination.[96]

II.

The State Engineer is prohibited by law from granting an application to appropriate the public waters where:[97]

A. there is no unappropriated water at the proposed source;
B. the proposed use or change conflicts with existing rights;
C. the proposed use or change conflicts with protectible interests in existing domestic wells as set forth in NRS § 533.024; or
D. the proposed use or change threatens to prove detrimental to the public interest.

III.

The State Engineer concludes that the Applicant's request to defer action on Application 73963 (change of vested claim V-03111) cannot be approved.

IV.

The State Engineer concludes that the additional statutory criteria required for an interbasin transfer of water under NRS § 533.370(6) can only be met with a staged and closely monitored development of the water resource in addition to reserving water for existing and future domestic well demand.

V.

The perennial yield of the Red Rock Valley Hydrographic Area was previously estimated by the USGS, via reconnaissance level study, at 1,000 afa. Considering only the eastern half of Red Rock Valley results in a reconnaissance estimate of approximately 700 afa. Evaluation of all available evidence, including that provided at the hearing, indicates that the sustainable yield of the eastern part of Red Rock Valley is between 1,200 and 2,400 acre-feet per year; however, any sustainable yield above 1,200 acre-feet is highly uncertain; therefore, a cautious approach is warranted. By deducting the quantity of water necessary to satisfy existing rights and to satisfy existing and future domestic well demand in the eastern part of Red Rock Valley, the State Engineer concludes that there is 371 to 1,571 acre-feet of water available for appropriation.

[96] NRS chapters 533 and 534.
[97] NRS § 533.370(5).

However, the State Engineer further concludes that to appropriate any water above the 371 afa available, additional analyses must be completed as outlined in Finding XVII of this ruling.

VI.

The State Engineer concludes that Applications 73960, 73961, 73962, 73963, 73965, 73966, and 74368 may be considered for approval as follows:

- Change Applications 73960, 73961, 73962, 73963, and 73965 for a total combined duty of **484 afa**.
- Application 73966 for a duty of **500 afa**.
- Application 74368 for a duty of **289 afa**.
- The total combined duty of Applications 73960, 73961, 73962, 73963, 73965, 73966, and 74368 is **1,273 afa**.
- Applications 73966 and 74368 seek 789 afa in new appropriations; however, the Division has determined that only 371 afa of water is available with certainty. Therefore, the State Engineer concludes only **855 afa** may be exported initially and the remaining **418 afa** of water cannot be pumped until the aforementioned conditions are satisfied (Option 1 or Option 2).

VII.

The State Engineer has found that there is sufficient water available within the Red Rock Valley Hydrographic Area to support the export of 855 afa, at this time. A decision on the export of an additional 418 acre-feet will be deferred until the completion of additional studies. In addition, the Applicant must prepare a monitoring and mitigation plan to be approved by the State Engineer. In this context, the State Engineer concludes that the protest claims may be overruled.

VIII.

The State Engineer concludes that with the limitations and conditions imposed on Applications 73960, 73961, 73962, 73963, 73965, 73966 and 74368, the applications will not conflict with existing rights, will not conflict with protectible interests in domestic wells, and will not threaten to prove detrimental to the public interest.

IX.

The State Engineer concludes that the protests to the applications were not supported by any substantial evidence or testimony and the Protestants either chose not to attend the administrative hearing or chose to attend only for the purpose of giving public comment; therefore, the protest claims are dismissed.

RULING

The protests to Applications 73960, 73961, 73962, 73963, 73965, 73966, and 74368 are hereby overruled and the applications are approved subject to:

1. Approved monitoring and mitigation plan;
2. Staged development or new ET study;
3. Existing rights; and
4. Payment of the statutory permit fees.

Respectfully submitted,

TRACY TAYLOR, P.E.
State Engineer

TT/TW/jm

Dated this 15th day of

January, 2008.

Figure 1. Red Rock Valley grassland upland vegetation unit as classified by the Applicant. Photo taken by State Engineer staff on September 27, 2006, after a near record 2006 water year precipitation amount of 20.4 inches recorded at the Stead NWS weather station. Vegetation illustrated here is assumed by the Applicant to have an ET rate similar to the measured ET rate of 3.07 feet per year from Fairbanks Meadow, Amargosa, Nevada, as shown in Figure 2, and the measured ET rate of 1.7 feet per year from the Carson Valley non-irrigated pasture grass ET-6 site as shown in Figure 3.

Figure 2. USGS Fairbanks Meadow site in Amargosa, NV. The ET rate from this site of 3.07 feet per year is assumed to transfer to the grassland vegetation classification assumed by the Applicant and as shown in Figure 1. Photo was taken at this site on September 10, 2000. The USGS classifies this site as DGV, moderately dense to dense grassland vegetation.

Figure 3. USGS Carson Valley non-irrigated pasture grass ET-6 site with a depth to ground-water from 6 to 7 feet. Photo taken on June 4, 2003. The ET rate of 1.7 feet per year from this site is assumed to transfer to the grassland vegetation classification assumed by the Applicant and as shown in Figure 1.

Figure 4. Red Rock Valley scrub-shrub upland vegetation unit as classified by the Applicant. Photo taken by State Engineer staff on September 27, 2006, after a near record 2006 water year precipitation amount of 20.4 inches recorded at the Stead NWS weather station. Vegetation illustrated here is assumed by the Applicant to have an ET rate similar to the measured ET rate of 1.9 feet per year from the USGS Carson Valley ET-1 site as shown in Figure 5, and the measured ET rate of 1.5 feet per year from the USGS Carson Valley ET-7 site as shown in Figure 6.

Figure 5. USGS Carson Valley rabbitbrush and greasewood ET-1 site with a depth to ground-water from 3 to 5 feet, and vegetation density of 73 percent. Photo taken on June 4, 2003. The ET rate of 1.9 feet per year is proposed to apply to the Applicant's scrub-shrub classification in Red Rock Valley as shown in Figure 4.

Figure 6. USGS Carson Valley sagebrush and bitterbrush ET-7 site with a depth to ground-water of about 60 feet. Photo taken on June 4, 2003. The ET rate of 1.5 feet per year is proposed to apply to the Applicant's scrub-shrub classification in Red Rock Valley as shown in Figure 4. Because the depth to water is about 60 feet and this site likely experiences a larger amount of precipitation than on the valley floor due to its proximity to the mountain front of the Carson Range, ET at this site is likely solely derived from precipitation.

Figure 7. Red Rock Valley grassland upland vegetation unit as classified by the Applicant. Photo taken by State Engineer staff on September 27, 2006, after a near record 2006 water year precipitation amount of 20.4 inches recorded at the Stead NWS weather station. Vegetation illustrated here is assumed by the Applicant to have an ET rate similar to the average of the measured ET rate of 2.8 feet per year from the USGS Carson Valley flood irrigated pasture ET-4 site as shown in Figure 5, and the Carson Valley measured ET rate of 3.2 feet per year from the USGS Carson Valley flood irrigated pasture ET-5 site as shown in Figure 6. Ms. Carpenter use an average ET rate from Carson Valley flood irrigated pasture sites ET-4 and ET-3 to yield and average ET rate of 3.0 feet per year which was applied to Red Rock Valley in support of her statistically derived ET rate for grassland of 2.33 feet per year.

Figure 8. USGS Carson Valley flood irrigated pasture ET-4 site with a depth to ground-water from 3 to 4 feet. Photo taken on June 4, 2003. The measured ET rate of 2.8 feet per year was assumed to apply to the Applicant's grassland classification in Red Rock Valley as shown in Figure 7. The Applicant used an average ET rate from Carson Valley flood irrigated pasture sites ET-4 and ET-3 to yield an average ET rate of 3.0 feet per year.

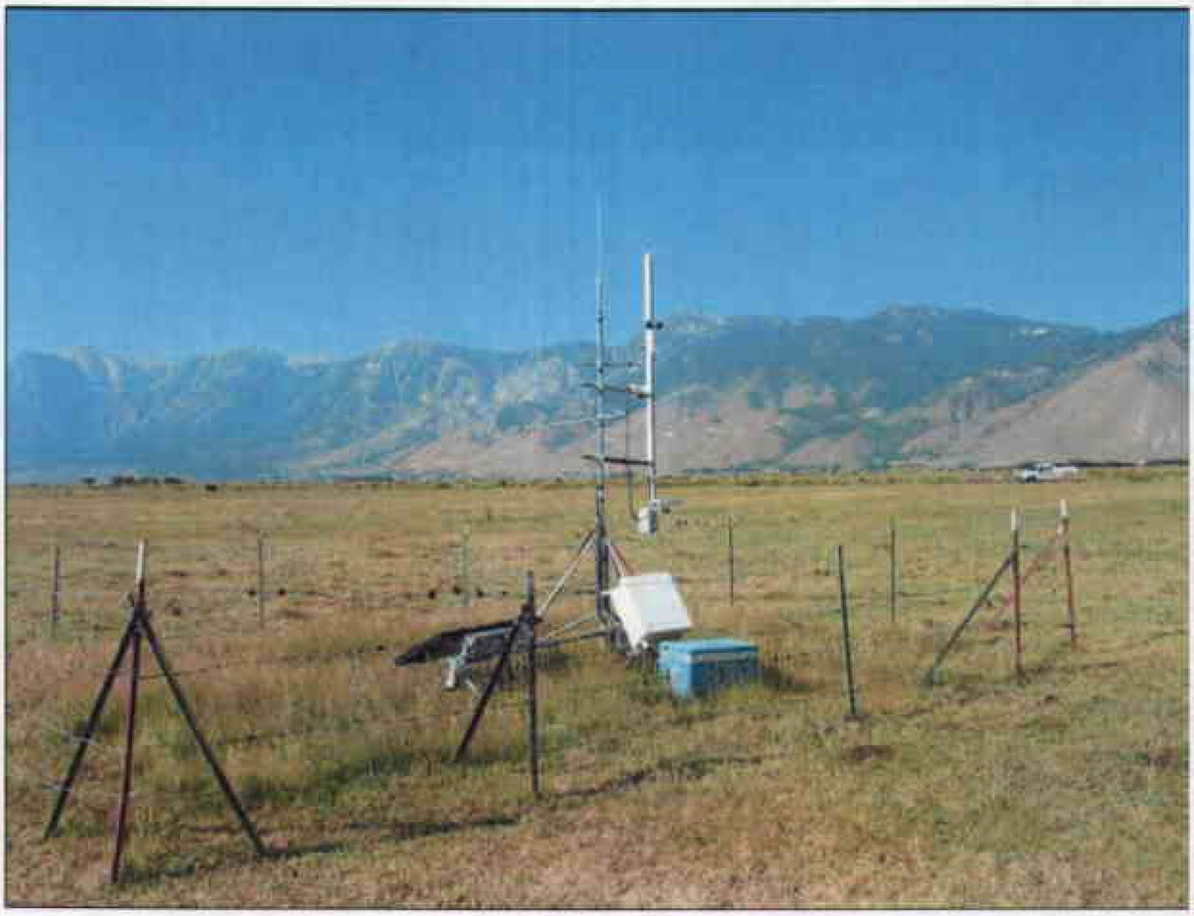

Figure 9. USGS Carson Valley flood irrigated pasture ET-3 site with a depth to ground-water from 2 to 5 feet. Photo taken on June 4, 2003. The measured ET rate of 3.2 feet per year was assumed to apply to the Applicant's grassland classification in Red Rock Valley as shown in Figure 7. The Applicant used an average ET rate from Carson Valley flood irrigated pasture sites ET-4 and ET-3 to yield an average ET rate of 3.0 feet per year.