HYDROGEOLOGY OF SPRING, CAVE, DRY LAKE, AND DELAMAR VALLEYS

IMPACTS OF DEVELOPING SOUTHERN NEVADA WATER AUTHORITY'S CLARK, LINCOLN, AND WHITE PINE COUNTIES GROUNDWATER DEVELOPMENT PROJECT

REBUTTAL TO SOUTHERN NEVADA WATER AUTHORITY'S EVIDENCE REPORTS

Presented to the Office of the Nevada State Engineer

on behalf of Protestants White Pine County, Great Basin Water Network, et al.

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Date

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Acronyms

CCFS – Central Carbonate Flow System

CFM – conceptual flow model

DVFS – Death Valley Flow System

ET – evapotranspiration

GDE – groundwater dependent ecosystem

GSLD – Great Salt Lake Desert

GWET – groundwater evapotranspiration

IBMZ – interbasin monitoring zone

NDVI - normalized difference vegetation index

NSE – Nevada State Engineer

POD – point of diversion

SNWA – Southern Nevada Water Authority

WRFS – White River Flow System

WRV – White River Valley

TVS – Tikapoo Valley South

1.0 Executive Summary

This rebuttal report responds to Southern Nevada Water Authority's (SNWA) evidence reports submitted in support of its water rights applications for the remand hearing to be held before the Nevada State Engineer regarding SNWA's Groundwater Development Project commencing September 25, 2017. The Nevada State Engineer (NSE) granted SNWA 61,127 acre-feet/year (afa) in Spring Valley, 5235 afa in Cave Valley, 11,584 afa in Dry Lake Valley, and 6042 afa in Delamar Valley in rulings 6164 through 6167 issued in 2012, respectively. However, in 2013 the Nevada District Court overturned the NSE's findings on various points and remanded the applications to the State Engineer for a reconsideration of several issues. These issues include a recalculation of available water in the subject valleys such that the basins will reach equilibrium in a reasonable time, a recalculation of the appropriations from Cave, Dry Lake and Delamar Valleys to avoid over appropriations or conflicts with down-gradient, existing water rights., and the preparation of a monitoring, management, and mitigation (3M) plan which includes defined standards, thresholds, and triggers so that mitigation of unreasonable effects may be accomplished.

This Rebuttal Report responds to three primary subjects addressed by SNWA in its initial evidentiary exchange. First, SNWA changed the application points of diversion to design an ET capture project that was the basis for its new calculation of the amount of water available from Spring Valley such that the basin will reach equilibrium between discharge and recharge within a reasonable time. As part of this effort, SNWA revised its regional numerical groundwater model. Second, SNWA performed an inventory of groundwater-committed water rights within the White River Flow System (WRFS) in an attempt to show that the amount of water granted by Rulings 6165 through 6167 is available. As part of this analysis, SNWA presented interpretations of interbasin and downgradient flow from the WRFS. Third, SNWA presented separate monitoring, management, and mitigation plans for Spring Valley and for the Delamar, Dry Lake, and Cave Valley areas.

SNWA's attempt to show a Spring Valley pumping regime which would capture most of the pumping from groundwater evapotranspiration (GWET) involved revising the GWET in the model and changing the pumping scenario from previous simulations. SNWA biased the model results to capture groundwater more easily within Spring Valley by increasing GWET within the basin. It then increased recharge based on the faulty assumption that all of the additional GWET would originate as recharge within the basin. SNWA commensurately simulated increased recharge throughout the entire Great Salt Lake Desert Flow System in a way that both minimized the potential for pumping to draw water from interbasin flow and provided water more quickly to SNWA's pumping regime. The modeling does show that pumping from 101 wells spread throughout the wetlands of the basin would capture most of the GWET, thereby completely drying all wetlands and springs within Spring Valley. However, SNWA limits its analysis to pumping to equilibrium and ignores the hydrologic impacts associated with the newly designed GWET capture project despite the fact that those impacts would be vastly different than those that were the basis for the State Engineer's findings in Ruling 6164.

SNWA also makes several erroneous assumptions regarding the amount of groundwater available for appropriation within the WRFS. First, it incorrectly assumes that groundwater which flows from the WRFS to the DVFS, if that actually occurs, is available within the WRFS because it is not appropriated within Tikapoo Valley South. SNWA errs by failing to consider whether the water is used further downgradient within the DVFS. Second, SNWA mistakenly assigns water that discharges from the Muddy River Springs to Californian Wash, outside of the WRFS, which neglects the fact that the source of the springs is the WRFS. Third, SNWA ignores the fact that the five basins the NSE chose to manage jointly in Order 1169 (because they respond together to pumping) receive their water from Pahranagat Valley and further upgradient within the WRFS.

SNWA underestimates the committed groundwater in the White River Valley by assuming that too much groundwater is supplemental to surface water rights because of the location of the hydrographs used in the analysis. The analysis also ignores the fact that most surface water in the valley bottom is linked to groundwater because it is spring discharge. The errors include not counting springs on alluvial fans, which are likely regional springs, and not counting stream rights, or surface water, downstream from multiple springs.

SNWA's 3M plans fail to design or include monitoring networks that have a likelihood of detecting the spread of groundwater pumping stresses in a timely fashion such that senior water rights and groundwater dependent ecosystems (GDEs) will be protected. Within the valleys that would be pumped, the plans leave large distances between monitoring wells through which groundwater drawdown can propagate, which could result in the masking of impacts until it is too late to effectively mitigate them. For example, between Spring Valley and Hamlin Valley, there are about ten miles between wells in carbonate rock even though carbonate rock passes most groundwater through small conduits. The plans also fail to monitor productive aquifer zones separately, so the monitoring wells will not detect some of the drawdown caused by pumping if that drawdown affects separate aquifer layers differently.

SNWA identified two action triggers that will not protect senior water rights or GDEs. An investigation trigger would be activated once drawdown lowers the water levels at a monitoring well beyond the levels that have been historically observed. However, this only initiates an investigation to determine cause and may simply increase the frequency of monitoring. This is problematic because the essential role for triggers or thresholds such as these is to prompt timely actual implementation of mitigation measures, not merely an "investigation" and possibly more monitoring to verify causation. An investigation period may essentially be a stall tactic that prevents management which could lower the impact of the pumping.

Mitigation triggers for most of Spring Valley would implement plans to deepen the wells or replace the lost water from other areas, with changing pumping rates or locations listed as only one of numerous possibilities. The 3M plans do not identify where additional water would come from or discuss the fact the deepening the well would only increase the drawdown, the very problem causing the need for mitigation.

Many senior water rights needing protection in the WRFS occur in basins downgradient from Cave, Dry Lake, and Delamar Valleys. Diversion of groundwater in Cave, Dry Lake, and Delamar Valleys, which otherwise would flow into those downgradient basins would impact those downgradient rights. The exact location of interbasin flows among WRFS groundwater basins is poorly known, but generally occurs through fracture pathways at the basin boundaries. It must be emphasized that the smaller the pathway, the faster drawdown will pass through, but also the higher the probability that it will be undetected contemporaneously or close in time to when it is occurring. Thus, calculations of the distance that drawdown propagates through the WRFS could vastly underestimate the rate of drawdown because of the complex and possible very narrow pathways. SNWA has not presented sufficient information to support even minimal confidence that any of its 3M plans can adequately detect the effect of SNWA pumping on flows between basins and protect downgradient water rights or GDEs in the WRFS.

2. Introduction

The Southern Nevada Water Authority (SNWA) proposes to develop up to 91,200 af/y of groundwater in Spring Valley and up to almost 35,000 af/y of groundwater in Cave, Dry Lake, and Delamar Valleys of eastern Nevada to support its proposed Clark, Lincoln, and White Pine Counties Groundwater Development Project. The Nevada State Engineer (NSE) granted SNWA 61,127 acre-feet/year (afa) in Spring Valley, 5235 afa in Cave Valley, 11,584 afa in Dry Lake Valley, and 6042 afa in Delamar Valley in rulings 6164 through 6167 issued in 2012, respectively.

Protestants to the applications that led to these rulings appealed the decision to Nevada District Court, which ultimately overruled the NSE on various points in a decision issued December 13, 2013[1] (decision). The Nevada District Court directed the State Engineer to reconsider several issues including a recalculation of available water in the subject valleys such that the basins will reach equilibrium in a reasonable time and the preparation of a monitoring,

[1] White Pine County and Consolidated Cases, et al v Jason King, NV State Engineer, in the Seventh Judicial District Court of the State of Nevada in and for the County of White Pine, Case No. CV1204049.

management, and mitigation plan which includes defined standards, thresholds, and triggers so that mitigation of unreasonable effects may be accomplished. The NSE has scheduled a remand hearing on these issues concerning SNWA's Groundwater Development Project applications in these four valleys commencing September 25, 2017.

SNWA submitted a suite of evidence reports in support of its applications for the remand hearing. SNWA identified four issues that the court declared needed further proceedings, and described them as follows (Drici et al 2017, p 1-3):

1. Add Millard and Juab counties, Utah, in the mitigation plan, so far as water basins in Utah are affected by pumping of water from Spring Valley Basin, Nevada
2. Recalculated water available for appropriation from Spring Valley ensuring that the basin will reach equilibrium between discharge and recharge in a reasonable time
3. Define standards, thresholds, or triggers so that mitigation of unreasonable effects from pumping of water is neither arbitrary nor capricious in Spring Valley, Cave Valley, Dry Lake Valley, and Delamar Valley
4. Recalculate the appropriations from Cave Valley, Dry Lake Valley, and Delamar Valley to avoid over appropriations or conflicts with down-gradient, existing water rights

SNWA does not argue for an increase in the amounts granted in rulings 6164 through 6167. Rather, SNWA attempts to show that equilibrium could be reached in Spring Valley if they pumped intending to dry the wetlands (Drici et al. 2017). SNWA attempts to show there is groundwater available for appropriation in the White River Flow System downgradient of the proposed diversions (Stanka 2017). SNWA also provides monitoring, management, and mitigation (3M) plans for Spring Valley (Marshall et al. 2017, SNWA 2017b) and Cave, Dry Lake, and Delamar Valleys (Marshall et al. 2017, SNWA 2017a).

This report is a rebuttal to SNWA's evidence reports. This rebuttal report was prepared on behalf of a coalition of protestants to SNWA's water right applications, including White Pine County, Nevada, and the Great Basin Water Network. This report points out significant flaws in the logic, reasoning, and results presented by SNWA in those reports. It presents new evidence where necessary to rebut these reports. It also refers to my June 2017 initial evidence report for the remand hearing (Myers 2017) to demonstrate points I brought up before, which also serve to rebut SNWA's June 2017 evidence. This rebuttal report contains three main sections, the first considering Spring Valley pumping to equilibrium issues, the second considering the water rights downgradient in the WRFS, and the third considering 3M plans.

3. Spring Valley Evapotranspiration and Equilibrium Calculation

The second issue quoted in the Introduction concerns the court finding:

> that losing 9,780 afa from the basin, over and above E.T. after 200 years is unfair to following generations of Nevadans, and is not in the public interest. In violating the Engineer's own standards, the award of 61,127 afa is arbitrary and capricious…This finding by the court requires that this matter be remanded to the State Engineer for an award **less than the calculated E.T.** for Spring Valley, Nevada, and that the amended award has some prospect of reaching equilibrium in the reservoir. (decision, p 12, 13, emphasis added)

The Court noted that the State Engineer argued to the Court that it is not possible to fully salvage the ET, because the land is public and the federal government would not allow SNWA to cover the basin with wells as would be necessary to completely salvage the ET (Decision, p 11). The Court noted that the idea that ET be salvaged results from the State Engineer's definition of perennial yield, and that the State Engineer acknowledged it is "unlikely that all of the ET in a basin will be captured" (Decision, p 12). The Court also noted that "SNWA's expert certified that uncaptured E.T. would have to be deducted from the perennial yield" (Decision, p 12). This recognition that all ET cannot practicably be captured, is reflected in the Court's direction for the State Engineer to determine an award that would be less than the full ET to allow the system to be pumped to equilibrium.

3.1 SNWA Response

SNWA presented an initial remand report (Drici et al 2017), which includes logical and numerical analysis of the Spring Valley basin attempting to show that the entire amount granted by the NSE in Ruling 6164 can be pumped to equilibrium. The report argues, counter to the district court's 2013 decision and State Engineer precedent, that Nevada water law does not require the project to come to equilibrium.

SNWA claims that the Court did not reverse the NSE's decision that "61,127 afa are available for appropriation" (Drici et al 2017, p 1-3). This statement cannot be correct, however, because the Court remanded the matter, requiring that the NSE estimate an amount that would have some prospect of reaching equilibrium. SNWA claims that the Court's decision was based on analyses that were not designed to "salvage the ET discharge in Spring Valley" (Drici et al 2017, p 1-4), as pumping the original 21 applications would not have done.

SNWA compared the court's reference to expert testimony, cited above, that uncaptured ET be deducted from the PY to the time to ET capture issue, presumably the same as the time to full capture issue (Bredehoeft and Durbin 2009) (Drici et al 2017, p 1-4). SNWA claims there is no requirement in Nevada water law that ET discharge be captured (id.), which contradicts the definition of PY cited in the court decision and in previous State Engineer rulings (e.g., Ruling 6256 at 24 (Garnet Valley 2014); Ruling 6164 at 56 (Spring Valley 2012); Ruling 6165 at 46 (Cave Valley 2012); Ruling 6166 at 45 ()Dry Lake Valley 2012); Ruling 6167 at 45 (Delamar Valley 2012); Ruling 5875 at 8 (Cave, Dry Lake, and Delamar Valleys (2008); Ruling 5726 at 26-27 (Spring Valley 2007); Ruling 5621 at 17 (Three Lakes-Tikapoo Valleys 2006); Water Resources Bulletin, Nevada's Water Resources, Report No. 3, at 13 (1971)). SNWA offers reasons why fully capturing ET discharge is not possible, including the assertion that fully capturing ET "would conflict with the processes and intent of staged development, resting of aquifers in times of decreased need, or artificially recharging aquifers when excess water is available." (Id.) These arguments are specious. Staged development is just a process of ramping the pumping rate to the point where pumping would capture the full ET. It might possibly lengthen the period until ET is fully captured, but it would not prevent the capture of ET and the drying of the wetlands.

Resting aquifers means pumping ceases or decreases for a period which would allow periods during which mining is not occurring. Artificial recharge is not considered here because SNWA does not present a plan and because there is no evidence that there is any likelihood of there being excess water in Spring Valley to support an artificial recharge program.

Finally, the claim that "the quantification of ET discharge should only be used as a metric for estimating how much water is available for appropriation, not to limit an appropriation," (id.), has the reasoning backwards. ET discharge has always been, and in the Spring Valley ruling was, the upper limit of potentially possible appropriation, which the Court decided is too high because of the inability to fully capture ET. If it cannot be captured, for whatever reason, the Court's reasoning is that the effective PY becomes lower. The ET and PY of a basin, therefore, provide the upper limits to what can be granted or captured and do not define available water. The reasons the full ET cannot be captured include environmental problems that would result from developing hundreds of wells completely drying all phreatophytes, or wetland vegetation, and springs within the valley. Thus, the amount that can be appropriated is limited not only by ET and PY but also by existing rights, the public interest, and the environment, all of which act as constraints on the amount of groundwater that is available for appropriation. The fact that SNWA's project as presented conflicts with these limitations indicates that the amount of groundwater proposed to be pumped by the project must be reduced to a level that eliminates such conflicts.

Although SNWA devotes several pages of argument to the claim that there is no provision in Nevada water law requiring that a basin reach a new equilibrium in response to pumping, they also provide an opinion as to how such a limitation should be applied (Drici et al. 2017, p 1-6). SNWA presents no facts to support its opinion. SNWA suggests that the limitation should be applied only "during or after the staged development process." (Id.) Based on observations during the staged development, SNWA asserts that the groundwater model would be improved, and if "it is determined that an appropriation must be limited based on ET capture principles, the limitation should be implemented by reducing the amount of water that can be pumped in the last stage of development." (Id.) It is reasonable to require that before additional amounts of water are pumped during a staged development many considerations including the ability to capture ET be evaluated. If monitoring or modeling based on updated models show that the basin will not come into equilibrium or that deleterious impacts are going to occur, the NSE should not allow additional pumping. To this end, the NSE, if he grants any water rights as a result of this hearing, should grant them incrementally on a schedule to be proven on the basis of analyzing impacts from staged development rather than granting the maximum amount of rights at this time, with only implementation to be staged. In other words, to begin with only a small amount of water may be granted safely, and additional amounts can only be granted safely after the first amount has been shown to come to equilibrium without deleterious impacts.

3.2 Pumping Ruling 6164 to Equilibrium

SNWA used their groundwater model, the Central Carbonate Flow System Model (CCFS) (SNWA 2009c), with modifications reviewed below, to attempt to show they could achieve equilibrium. The report presents a pumping regime using many more wells than were considered previously, which is designed to dry up the valley as quickly as possible. This changed pumping regime will have significantly different hydrologic impacts than that which formed the basis for the NSE's 2012 rulings. SNWA also does not present drawdown maps to support or allow an assessment of groundwater-related environmental impacts to the basin.

Moreover, SNWA effectively prevented an independent evaluation of those impacts by providing a version of the CCFS model that could not be run by someone with an understanding of standard USGS-developed MODFLOW routines. The version as provided requires the installation of an alternative operating system platform and also requires the installation of various MODFLOW routines that have been modified. It requires programming ability beyond a standard inputting of ASCII text MODFLOW input files into a compiled version of MODFLOW as provided by the authors of the program (the US Geological Survey), or in other words, beyond the general capability of hydrologists familiar with MODFLOW.

SNWA developed a pumping strategy designed to show the entire allotted amount from Ruling 6164 could be captured from the Spring Valley ET discharge area, allowing a new equilibrium within a "reasonable" time (Drici et al. 2017, p 1-4). SNWA developed a model scenario suggesting that, if all other concerns like the environment are disregarded, they could capture the entire pumping amount from groundwater evapotranspiration (GWET) and reach equilibrium in a reasonable time. This subsection and the next subsection discuss flaws in the modeling strategy used for showing a possibility of pumping to equilibrium.

Ruling 6164 allotted 61,127 afa to SNWA, an amount less than the 84,100 afa of GWET estimated by the NSE ruling (Drici et al 2017). The estimated GWET exceeds the amount simulated in the model, which after simulated pumping of the initial conditions from 1945 to 2004 was 73,900 afa (FEIS). However, SNWA argues that "effective capture of the ET discharge by a pumping rate of 61,127 afa in Spring Valley is impossible because the permitted volume of pumping is less than the volume of ET discharge" (Drici et al. 2017, p 2-2). This claim does not follow logically because the requirement is for pumping to capture an amount of GWET equal to the amount of pumping, not a higher amount. If the entire PY of a valley is granted, the logic would suggest that each water right capture an amount of GWET equal to the amount of the right, not that SNWA capture all of the GWET.

Continuing the faulty logic, SNWA argues that "reducing the amount of water SNWA is allowed to pump would not ensure that the reduced appropriation would be fully captured from the ET discharge area" (Id.). It may not "ensure" it, but it certainly would make it much more likely because pumping would have to capture a smaller amount of GWET from a presumably similar area. The area would be similar if the applications were still spread around a similar area. Finally, SNWA fallaciously claims, "[t]o the contrary, ET capture would be decreased and be further delayed." (Id.) It would be decreased only because there is less pumping, but it does not follow that it would be delayed with respect to capturing GWET equal to the amount of water permitted. Capture would depend on the dispersion of wells.

SNWA limits its purpose in reanalyzing pumping in Spring Valley to showing it can specify a scenario that demonstrates "that ET discharge can be effectively captured by the pumping that was approved in Ruling 6164 within a reasonable time, using a model that is consistent with the NSE's estimate of ET discharge for Spring Valley" (Drici et al. 2017, p 2-2). To capture GWET, SNWA designed a well layout and pumping regime without regard to any other consideration, including land accessibility and environmental impacts. To be consistent with the NSE's estimate of ET, SNWA adjusted the GWET rate within the CCFS model. I discuss these factors in the next subsections

3.21 SNWA Adjustment of GWET Rate in the CCFS Model

SNWA adjusted the CCFS model code by increasing the model ET discharge to be consistent with Ruling 6164 and adjusted recharge so that Spring Valley recharge volume balanced with the new estimate of GWET (Drici et al. 2017, p 2-3). Because Ruling 6164 determined that GWET equaled 84,100 afa, SNWA increased total ET rates within Spring Valley so that the GWET discharge from that valley would approximate 84,100 afa in steady state. This would increase the model simulated amount from 77,000 afa to 84,100 afa, as shown in Drici et al. Table 3-1. The 77,000 afa value had exceeded the estimate of 75,000 afa from SNWA's original Conceptual Model Report (SNWA 2009a). Myers (2017) reported pre-project GWET values for 2004, the end of the pre-project calibration period, which included pumping and storage changes.

Drici et al. (2017) does not specify how the GWET discharge was increased, such as whether it was a simple proportional increase over the entire valley, the most logical choice. SNWA simulated GWET in the CCFS using DRAIN boundaries rather than with MODFLOW evapotranspiration boundaries (SNWA 2009c). A DRAIN boundary is a head-controlled flux boundary that is limited to water discharging from the model domain. Key parameters are the DRAIN elevation and the conductance. The discharge rate from a DRAIN boundary is the product of the difference in groundwater head and the DRAIN elevation and the conductance. If the groundwater head falls below the DRAIN elevation, discharge ceases. Because discharge is proportional to conductance, the most likely way for SNWA to have increased the ET rate within the CCFS model would be to have changed the conductance assumed in the model. GWET would cease when the groundwater head falls below the DRAIN elevation. SNWA considers the DRAIN elevation tantamount to the extinction depth, or the level at which GWET ceases.

SNWA reasoned that, to provide the additional water for GWET, it was necessary to increase recharge proportionally. Therefore, SNWA adjusted the recharge factor for the entire Greater Salt Lake Desert flow system (GSLD) from 1 to 1.0947, for a 9.47 percent increase (Drici et al. 2017, p 3-2). Although the changed GWET applied only to Spring Valley, the change in recharge applied to the entire GSLD. This is because recharge was input to the CCFS model by specifying recharge efficiencies by flow system, rather than by individual basin. Recharge by flow system is a part of the model (SNWA 2009c) and changing it so that recharge changed only for Spring Valley would have required additional changes. Recharge in the GSLD flow system is based on precipitation zones of 8-12, 12-15, 15-20, and >20 inches, with the recharge rate specified for each zone within the CCFS model equaling 0.011, 0.05, 0.12 and 0.328 in/y, respectively (Drici et al. 2017, Table A-4). The update raised the rates to 0.011, 0.054, 0.132, and 0.359 in/y, respectively, throughout the entire GSLD. (Id.)

SNWA did not justify its assumption that recharge efficiency should increase at a factor equivalent to the amount that GWET increased. SNWA assumed, without reference or supporting data, that because “discharge by ET is primarily a function of recharge, recharge had to be increased in Spring Valley to increase the simulated ET discharge” (Drici et al. 2017, p 3-2). The assumption appears based on a desire to simulate GWET from Spring Valley as being mostly recharge within Spring Valley. This assumption is incorrect because GWET within Spring Valley includes, in addition to within-basin recharge, net interbasin flow to Spring Valley. An increase in interbasin flow from Steptoe Valley could offset increased GWET.

If GWET within Spring Valley actually is higher than previously estimated (SNWA 2009a), it is just as likely that SNWA’s interbasin flow estimate is too low. USGS’ interbasin flow estimates (Heilweil and Brooks 2011, Welch et al 2008) are as high as 33,000 afa. Additional interbasin flow could be the source of additional water for GWET within Spring Valley. It would be more realistic to reconsider the entire GSLD recharge solver with the new Spring Valley GWET.

SNWA did not increase GWET in other basins, but did change the recharge throughout the flow system. This would proportionally change the amount of water available in the different valleys, with increasing recharge but not GWET in adjacent basins making more water generally available for pumping within Spring Valley. It would bias the model to allow more capture within Spring Valley faster in at least two ways:

1. Increasing recharge downgradient from Spring Valley in Hamlin, Tippet or Snake Valley without increasing the GWET in those basins would increase the simulated groundwater levels and decrease the gradient for flow from Spring Valley to those valleys. Thus, increased groundwater levels downgradient would decrease the simulated flow from Spring Valley and simulate more water available for capture within Spring Valley, without drawing from adjacent valleys, as described by Myers (2017). The potential for interbasin flow from Steptoe into Spring Valley by way of Lake Valley would increase the most. More specifically, it would simulate more water available within Spring Valley for capture.
2. Increasing recharge upgradient in Steptoe Valley would increase simulated interbasin flow to Spring Valley as described above. This would ease the ability for pumping within Spring Valley to capture flow within Spring Valley.

Both of these distortions make the simulation appear to capture more water from GWET within Spring Valley within a "reasonable" time.

In addition, SNWA did not consider time-variable recharge. Myers (2017) discussed evidence that recharge is changing with time and that today's groundwater discharge may be the result of recharge from hundreds or thousands of years ago.

3.22 SNWA Revised Pumping Scenario in the CCFS Model

SWNW simulated two scenarios to demonstrate an ability to capture ET, a baseline scenario and an ET-Capture scenario, using the recharge and GWET adjustments discussed in the previous sections. The baseline scenario was 2004 pumping as considered in the BLM's 2012 FEIS with adjusted GWET. The ET-capture scenario was SNWA's strategy of pumping all the Ruling 6164 permitted groundwater, not from the application points that were the basis for that Ruling, but from 101 wells spread throughout the simulated GWET areas within Spring Valley (Figure 1). "The spatial distribution and production volumes of wells were selected to present a modeling scenario that demonstrates how the model could be used to identify new well locations to increase the effectiveness of ET capture" (Drici et al. 2017, p 4-1). "The ET-capture wells are distributed spatially within the groundwater ET discharge area in locations that (1) avoid privately owned land, (2) avoid playa deposits, and (3) have the potential of capturing ET discharge remaining from the Baseline simulation" (Drici et al. 2017, p 4-3).

SNWA gave no attention to how this newly-created pumping regime would change the hydrologic or biological impacts analysis, to protecting the environment, or to how the stipulated agreement protecting groundwater resources would be implemented. Also, Drici et al. (2017) does not discuss the depth of the pumping wells or the level at which they are screened. The report also does not provide the amount of water that each well would pump, other than to state that annual production volume of a given ET-capture well is based on its proximity to areas of high ET discharge.

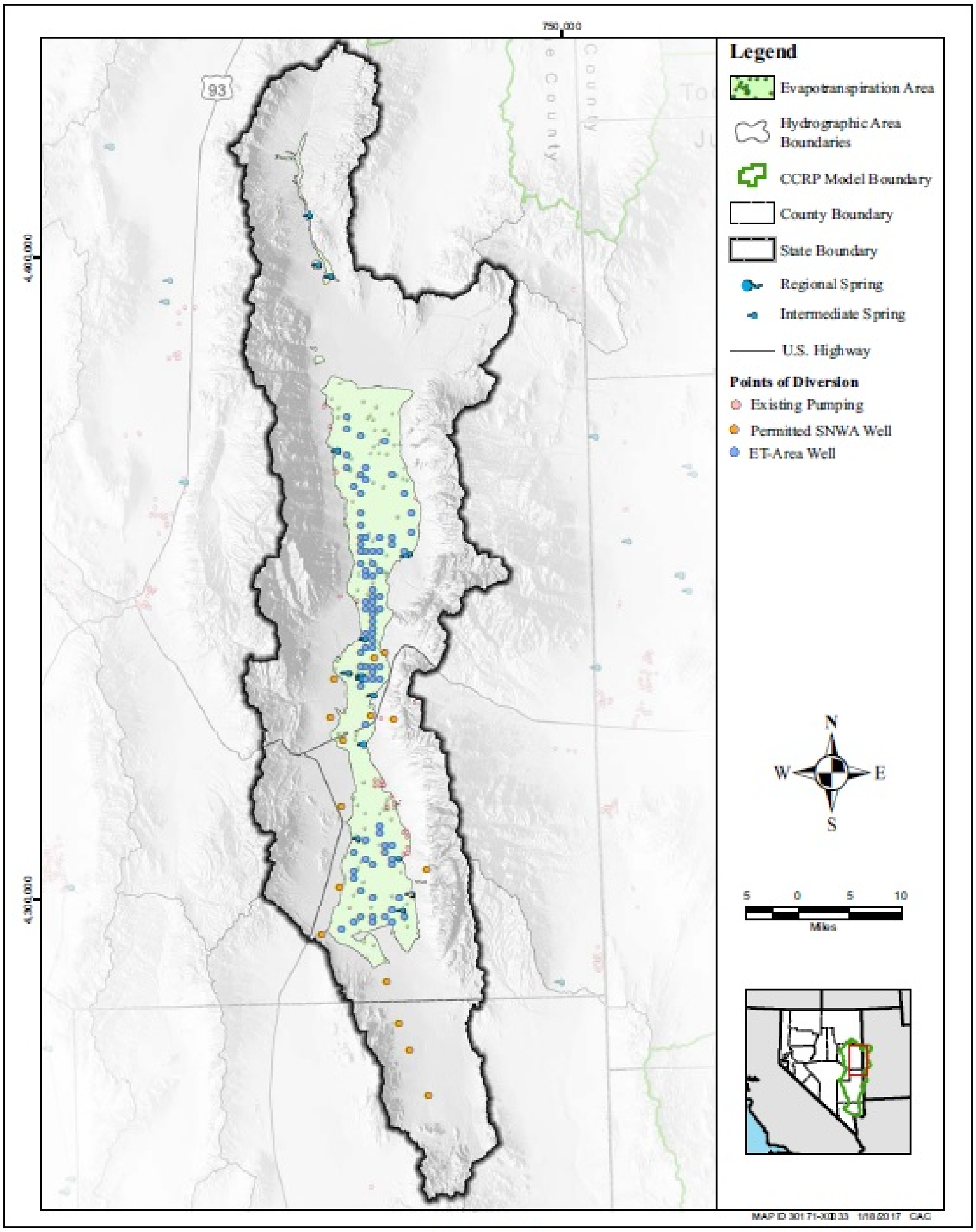

Figure 4-2
Locations of Pumping Wells for ET-Capture Scenario

Figure 1: Figure 4-2 from Drici et al. (2017) showing the ET-capture wells used to simulate SNWA's proposed pumping. The light green areas are areas of groundwater ET.

SNWA states that "the scale of such a well field is not unusual for municipal water systems" (Drici et al. 2017, p 4-3). However, SNWA does not provide references or examples to support this statement. In my experience, this is much larger than most municipal water system well fields that sustainably operate.

3.23 SNWA's Results

SNWA demonstrated that a pumping scheme could be designed that would capture most of its pumping from GWET within 200 years of starting to pump the full amount with this scenario. At 200 years, less than two percent of the pumping would be drawn from transitional storage. SNWA argues this amounts to equilibrium and meets the requirements of the court's decision.

- SNWA also provided that capturing the full amount of permitted pumping from GWET would dry up a significant amount of the wetlands and springs within Spring Valley. SNWA demonstrated pumping could reach equilibrium only if the damages pumping would cause to the environment and to other water rights are not considered.
- There is no indication as to whether the ET-capture plan would even be feasible. The Court's decision regarding the requirement that the project be capable of pumping to equilibrium would have to be applied to a feasible project.

The FEIS considered pumping strategies that would have spread the pumping around the valley using more wells than SNWA's original applications. Myers (2017) reviewed these and showed how the basin (Spring Valley), flow system (GSLD) and entire model domain were not close to coming to equilibrium after 250 years. More evidence has since been developed showing that SNWA's applications cannot be pumped to equilibrium.

As part of the evidence report prepared for another protestant to these hearings, the Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter-day Saints (CPB), Jones and Mayo (2017) used a more detailed version of the SNWA CCFS groundwater model to show that equilibrium was not reached for 2000 years. Jones and Mayo demonstrated that after 2000 years, pumping the Ruling 6164 amount was drawing only 45,000 afa from GWET (Drains), about 15,000 afa from interbasin flow (Other sources), and about 1000 afa from storage (Figure 2). Interbasin flow increased from less than 5000 to 15,000 afa, a point emphasized in the figures presented by Myers (2017).

- Jones and Mayo's (2017) simulations demonstrate conclusively that pumping SNWA's applications would not be close to reaching equilibrium for 2000 years, and the project would capture flow from surrounding basins rather than from within Spring Valley.

3.3 Summary

SNWA's attempt to present a Spring Valley pumping regime which would capture most of the pumping from GWET involved revising the GWET in the model and changing the pumping locations and amounts from previous simulations. SNWA biased the model results to capture groundwater more easily within Spring Valley by increasing GWET within the basin with the faulty assumption that all the additional GWET would originate as recharge within the basin. SNWA commensurately increased recharge throughout the entire Great Salt Lake Desert Flow System in a way that both minimized the potential for pumping to draw water from interbasin flow and provided water more quickly to SNWA's pumping regime. The modeling does show that pumping from 101 wells spread throughout the wetlands of the basin would capture most of the GWET, thereby completely drying all wetlands and springs within Spring Valley. However, SNWA does not present evidence on impacts associated with the changed pumping regime.

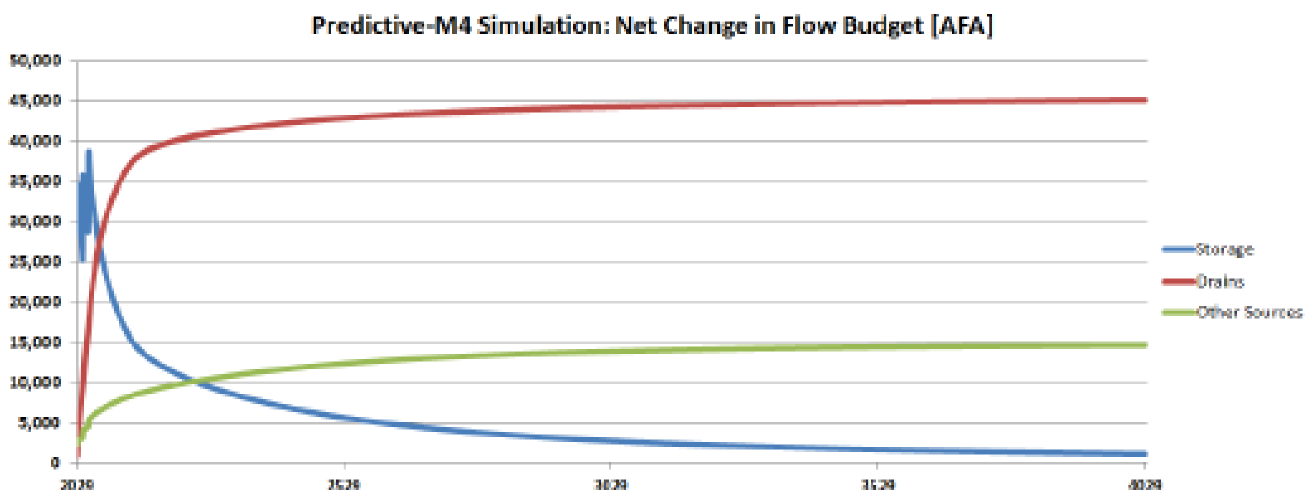

Figure 2: Figure 5-1 from Jones and Mayo (2017) showing the simulated flow budget for pumping SNWA's Ruling 6164 amount from SNWA's application points of diversion for 2000 years. Storage is groundwater storage, Drains is GWET, and Other sources was interbasin flow.

4. Committed Resources in the White River Flow System

The Court remanded the NSE's decision in Rulings 6165, 6166, and 6167 "for recalculation of possibly unappropriated water" (Decision, p 20). The Court disagreed with the NSE's argument that he could protect existing downgradient water rights that might not be impacted for hundreds of years, stating that the "statute is unequivocal, if there is a conflict with existing rights, the applications 'shall' be rejected" (Id.). The hydrogeologic concept is that groundwater originating in upgradient basins may be used or already appropriated downgradient, either as spring, stream, or underground rights.

Two of SNWA's responses were to do a survey of water rights in the WRFS and to reassess the groundwater available for those water rights. A report by Stanka Consulting (Stanka 2017) is one of SNWA's supporting documents.

4.1 White River Flow System Water Balance

Stanka (2017) attempts first to establish additional sources of groundwater to the WRFS or within the WRFS that can be appropriated. In his section 1.2, he incorrectly identifies water he believes could be available for appropriation by SNWA in the WRFS.

4.11 Groundwater Flow from Pahranagat Valley to Tikapoo Valley South

Stanka (2017, p 1-3) argues that 4100 afa that the NSE ruled flows into Tikapoo Valley South (TVS) should be available in WRFS because he claims it is not appropriated downgradient. He has not demonstrated or proven that this component of interbasin flow in the system actually is available. The NSE, in Ruling 6165, accepted an estimate for flow from Pahranagat Valley to Tikapoo Valley South (TVS) equal to 4100 afa for SNWA's use in its Excel recharge solver for the 2011 hearings regarding the CDD valleys. "The State Engineer finds interbasin flow from Pahranagat Valley to Tikapoo Valley South, for the purposes of the Applicants' [sic] recharge solver, is the average of the six estimates cited above, and will use that estimate of 4,100 afa for use in their Excel recharge solver" (Ruling 6165, p 65-65). The NSE included an estimate for flow from the Death Valley Flow System (DVFS) that SNWA had erred by ignoring. The DVFS study (Belcher 2004) found a net 6500 afa entering the WRFS from DVFS.

Regardless of the source of estimate, Stanka argues that 4100 afa in flow to DVFS, "has not been previously appropriated in down-gradient basins, and should be available for appropriations within the WRFS" (Stanka 2017, p 1-3). By not "previously appropriated," Stanka refers to the TVS Ruling No. 5465 which did not rely on flow from the WRFS into TVS. Stanka fails to consider that TVS is part of the DVFS, which has downgradient valleys that are fully appropriated.

- Without a complete assessment of downgradient UG water rights within the DVFS to determine whether this interbasin flow is not being used within the DVFS, it is not appropriate to assume this water is available for use in the WRFS.

4.12 Flow from Muddy River Springs Area to California Wash

Stanka also argues that the 43,600 afa of groundwater which flows from the Muddy River Springs Area (MRSA) to California Wash should not be considered as WRFS water because California Wash is outside the WRFS. His argument ignores the fact that the water originates within the WRFS, and that pumping within WRFS would draw water from that source. So, whether or not California Wash is considered part of the WRFS for administrative purposes, the record shows that the groundwater flow into California Wash form MRSA is downgradient from the subject basins, dependent on interbasin flow from those basins, and therefore will be impacted by upgradient pumping.

In support of his argument, Stanka quotes selectively from NSE Ruling No. 6165, which is more fully states:

> The Applicant applied this data using Darcy's Law and calculated 9,900 afa of interbasin outflow for this boundary. In addition, the Applicant also determined that **33,700 afa flows out of the MRSA to California Wash as Muddy River streamflow**, and that the source of the streamflow is the **groundwater discharge from regional springs located in the MRSA**. This brings the total outflow from the WRFS at the MRSA to 43,600 afa.
>
> Based on the evidence in the record, the difference between the inflow to and outflow from the MRSA is quantifiable and can be adopted by the State Engineer. The Applicant's estimated inflow to the MRSA was based on a prior investigation, was within the range of previously reported estimates, and was not disputed by any of the Protestants…. Accordingly, the State Engineer finds that the **Applicant's estimate of 9,900 afa of interbasin flow to California Wash is sound**. (Ruling 6165, p 68, 69, emphases added).

In the above quoted passage, the NSE was considering arguments and estimates regarding interbasin flow and discharge from the WRFS for use in SNWA's Excel-based recharge estimate.

Muddy River streamflow had been estimated based on Muddy River gaging station readings. The river does flow into California Wash basin, but, as highlighted in the quote, the river discharges from regional springs. The NSE had previously accepted the source of water at the Muddy River springs as being from the WRFS. "Dr. Thomas testified that isotopic data shows the Muddy River springs discharge is a mixture of water from Pahranagat, Delamar, Coyote Spring, and Kane Springs Valleys, and probably also Lower Meadow Valley Wash" (Ruling 6165, p 67, 68). These basins, excepting Lower Meadow Valley Wash, are all part of the WRFS, and Pahranagat and Delamar Valleys both receive interbasin flow from further upgradient within the WRFS. Therefore, the 33,700 afa discharges from WRFS after flowing through the WRFS as groundwater. Groundwater appropriations within the WRFS would draw from groundwater that otherwise would supply the Muddy River Springs.

Thus, Stanka is wrong to allocate 33,700 afa of Muddy River stream flow to California Wash, outside the WRFS (Stanka 2017, p 1-4). Stanka effectively removes the Muddy River Springs from their place as the final discharge from the WRFS. His approach is inconsistent with evidence in the record presented by SNWA in 2011.

4.13 Stanka's Removal of Coyote Spring and Muddy River Springs Area from the White River Flow System

Stanka also artificially decreases the WRFS to just eleven basins (Stanka 2017, p 1-4 to 1-7). He bases this on NSE Order 1169 and subsequent Ruling 6255, which established that Coyote

Spring Valley and the MRSA would be jointly managed along with Hidden Valley, Garnet Valley, and California Wash (Stanka 2017, p 1-4). Ruling 6255 reached this conclusion because of the very close connection within the carbonate aquifer, as demonstrated by a very flat potentiometric surface, among the five basins.

Stanka argues that the State Engineer-imposed requirement for the WRFS is that 39,000 afa must flow from Pahranagat Valley, Delamar Valley, and Kane Springs Valley, into Coyote Spring Valley, to satisfy the requirements that sufficient groundwater flow from the WRFS into Coyote Spring Valley (Stanka 2017, p 1-6). "Based on the above excerpt from Ruling 6255, it was determined that the WRFS analysis in this report could be performed on the northern 11 basins, so long as 39,000 afa remains available for subsurface flows leaving the 11-basin WRFS and entering Coyote Spring Valley." As noted, the 39,000 afa value leaving WRFS was determined in Ruling 6255.

> From that exhibit, the supply of water to the Coyote Spring Valley is estimated to be approximately 41,000 afa, of which **39,000 is subsurface inflow from upgradient basin**s and 2,000 afa is derived from in-basin recharge. **Prior to groundwater pumping in the region, all of this water flowed in the subsurface to the Muddy River Springs Area.**
>
> The **total pre-development supply of water to the Muddy River Springs Area** is estimated to be approximately 49,000 afa. The basin receives 41,000 afa from subsurface inflow from Coyote Spring Valley, and an estimated 8,000 afa from the Lower Meadow Valley Wash. In-basin recharge is minimal. Discharge from the basin by surface flow is estimated to be 33,600 afa, evapotranspiration is approximately 6,000 afa, and subsurface outflow to downgradient basins is an estimated 9,900 afa. (Ruling 6255, p 25, emphases added)

The NSE based these estimates on "SNWA Exhibit No. 452 from the 2011 hearing," with revisions. (Id.) This exhibit is an Excel workbook, or solver, which estimates recharge in the WRFS based on prescribed interbasin flows, both internal and external to the WRFS, and GWET for each basin. Figure 3 is a screen capture of the basin map from file Solver_WRFS_10-11-2011 which had been provided as a SNWA exhibit for those hearings. The numbers on Figure 3 do not reflect changes made by the NSE in his acceptance of the solver for Ruling 6165 and subsequently used in Ruling 6255 for estimating flow to Coyote Spring Valley.

As noted, the NSE relied on this solver to estimate that the inflow of water to Coyote Spring Valley is 39,000 afa. As emphasized in the quote, this inflow rate is a pre-development flow that does not account for water use throughout the WRFS, including Pahranagat Valley and White River Valley.

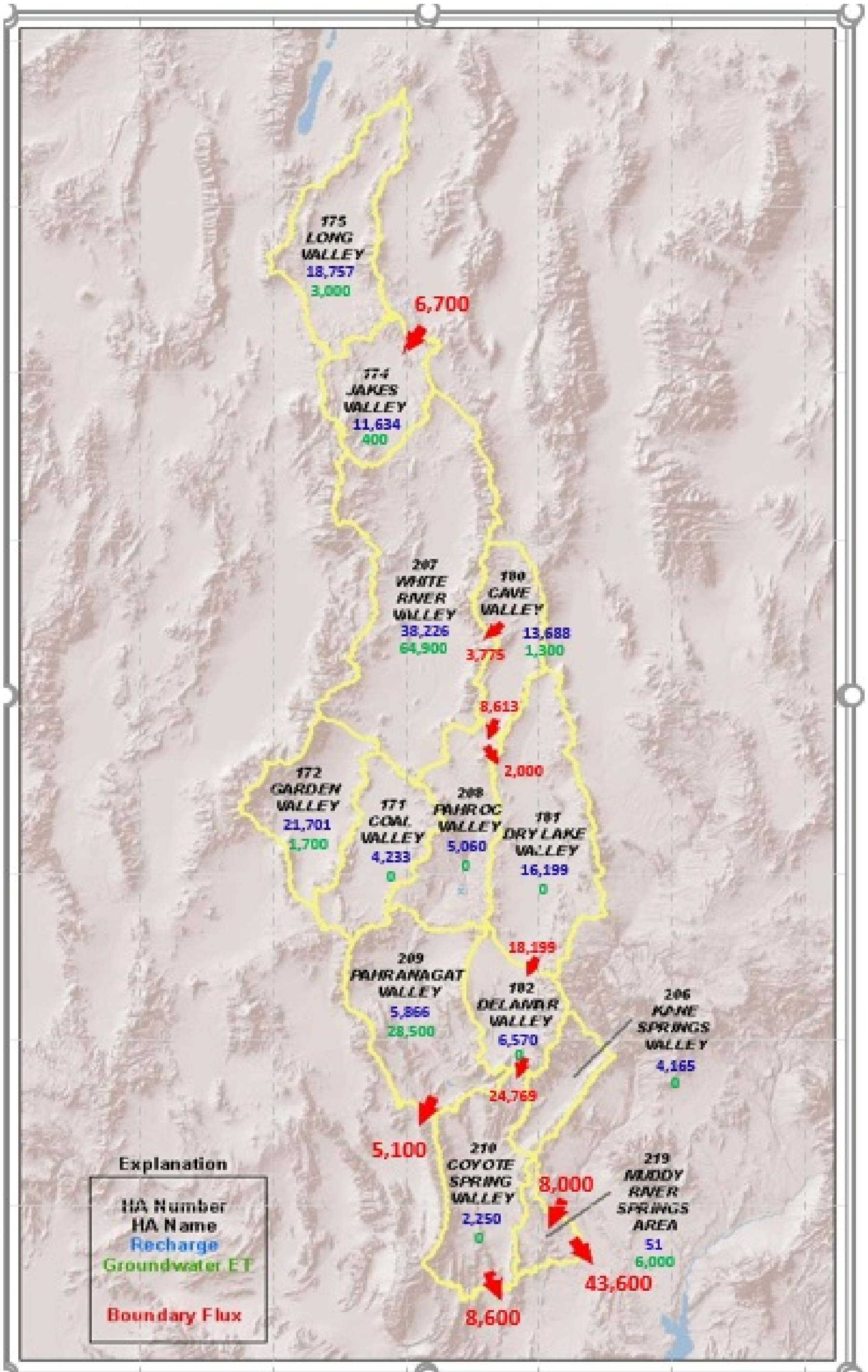

Figure 3: Map of the White River Flow System, as simulated in SNWA's Excel-based recharge solver. File Solver_WRFS_10-11-2011, Included with SNWA exhibit 258 (Burns and Drici 2011). Recharge in blue, groundwater evapotranspiration in green, interbasin flow in red. The Nevada State Engineer adjusted some assumptions, so the recharge and GWET numbers discussed by the NSE in Ruling 6255 and other places differ from those in this figure. The primary point of this figure is to show the orientation of basins and locations of interbasin flow.

Stanka misinterprets Ruling 6255 in his conclusion. The ruling reasons that "because the basins share a unique and close hydrological connection and share virtually all of the same source and supply of water … all five basins will be jointly managed" (Ruling 6254, p 24) and the "perennial yield of these basins cannot be more than the total annual supply of 50,000 acre-feet" (Id.). The ruling then notes that the "Muddy River and Muddy River springs also utilize this supply, and are the most senior water rights in the region, the perennial yield is further reduced to an amount less than 50,000 acre-feet" (Id.). Specifically, the water rights to the Muddy River are described in the Muddy River Decree. The NSE therefore linked the spring flow to the basins, and most of the inflow to those basins is the flow into Coyote Spring Valley from the upgradient basins in the WRFS.

Also, Stanka misinterprets the Court's requirement that the NSE consider downgradient committed water rights to be limited to those in the WRFS, as defined by Eakin (1966). California Wash, Hidden Valley, and Garnet Valley, by virtue of their connection to Coyote Spring Valley and MRSA, are also downgradient of all of the WRFS basins. The NSE chose to manage the five basins jointly, in Order 1169, because removing water from one was very quickly observable in the others, and at the various springs that make up the Muddy River Springs complex. It also follows that changing inflow to Coyote Spring Valley by pumping groundwater from upgradient of Coyote Spring Valley will propagate quickly through these five basins.

Thus, there is no justification to remove Coyote Spring Valley and MRSA from the WRFS analysis. In fact, as just described, Order 1169 provides justification for adding Hidden Valley, Garnet Valley, and California Wash to the WRFS for this analysis.

4.13 Perennial Yield for the White River Flow System

Stanka analyzed the availability of water resources within the WRFS (for only 11 basins as just described above) by treating the flow system as a whole. He simply compared total recharge within the flow system to the estimated outflow to Coyote Spring Valley, and determined that the difference would be available for use by committed groundwater resources in the 11-basin WRFS (Stanka 2017, p 1-10). This effectively means **developing the entire groundwater discharge within the 11-basin WRFS and would be tantamount to setting a perennial yield for the entire flow system**. He does not consider whether the excess recharge in one basin could actually be captured in the basin where the pumping occurs or could make up the lost inflow to downgradient basins. The following section shows how he grossly underestimated the committed groundwater within White River Valley (WRV), as an example of this general deficiency in the analysis of the entire WRFS.

4.2 Committed Groundwater Rights in the WRFS

Throughout the analysis of committed groundwater in the WRFS, Stanka (2017) makes three distinct errors. The first is that he treats spring rights as groundwater only if those rights are within a groundwater ET area. The assumption is that the spring discharge immediately becomes groundwater discharge. This would ignore springs that discharge to a channel which does not have substantial riparian resources and may not be considered groundwater discharge.

The second major error is that Stanka fails to realize that most surface water in the WRFS, mostly in WRV and Pahranagat Valley, depends on spring discharge. There are surface water rights to perennial streams within these valleys, and they all depend on perennial spring flow. The surface water flow within these valleys differs from the traditional concept of streams having a large snowmelt runoff period followed by a longer dry period, with many streams actually being dry in the valleys. Failing to treat streamflow rights in WRV and Pahranagat Valley as committed groundwater is a failure to account for actually committed groundwater.

The third major error is that Stanka estimates supplemental groundwater/spring right use based on streamflow hydrographs that are far from the points of diversion and are not representative of WRV surface water flow.

4.21 Spring Water Rights as Committed Groundwater

SNWA estimated "committed groundwater rights and **spring rights within groundwater discharge area**s for each of the hydrographic areas" (Stanka 2017, p 2-1). This grossly underestimates the amount of committed water rights that depend on, and is supplied by, groundwater sources because not all regional springs are located in mapped groundwater discharge areas. SNWA considered only springs located within groundwater discharge areas, which ignores springs that discharge near the base of mountains but above the zone of phreatophytes. Springs may discharge into channels that in turn discharge into the wetlands near the center of the valleys. The large difference in estimated recharge and GWET in WRV (for example, Welch et al. (2008) estimated recharge equal to 35,000 afa and GWET equal to 77,000 afa) indicates that regional springs discharge into the valley, and some are above the valley bottom. Figure 12 (below) shows a map of regional springs in the valley of WRV.

Regional and intermediate springs should be considered as committed groundwater regardless of their discharge point relative to the GWET areas. Regional springs are, by definition, discharge points for groundwater that had recharged within a different basin in the flow system. Intermediate springs are discharge points from the primary basin aquifer system. Both should be treated as committed groundwater.

4.22 Surface Water from Springs

Many streams in the WRFS, and associated surface water rights, depend on spring discharge. White River and Hot Springs Creek flow below springs in WRV. The river through Pahranagat Wash is an accumulation of spring flow from upstream, in Hiko, Crystal, and other springs. Water rights to these rivers, whether specified as such or not, depend on spring flow, and thus on groundwater from the interbasin flow system.

4.23 Supplemental Adjustment for Groundwater Rights

SNWA adjusts the underground (UG) rights and spring rights for supplemental use, with the assumption that surface water would be used first, followed by spring, and then by groundwater. The assumption that surface water is preferentially used is reasonable. SNWA's analysis of surface water based on streamflow records to show the amount of surface water available may not be representative of streamflow within the basin. I discuss this in detail in the WRV section.

In summary, SNWA (Stanka 2017) makes several erroneous assumption regarding the amount of groundwater available for appropriation within the WRFS. First, it incorrectly assumes that groundwater which flows from the WRFS to the DVFS, if that actually occurs, is available within the WRFS because it is not appropriated within Tikapoo Valley South. The error is that SNWA does not consider whether the water is used further downgradient within the DVFS. Second, SNWA mistakenly assigns water that discharges from the Muddy River Springs to Californian Wash, outside of the WRFS, which neglects the source of the springs is the WRFS. Third, SNWA ignores that five basins the NSE chose to manage jointly due to Order 1169 because they respond together to pumping receive their water from Pahranagat Valley and further upgradient within the WRFS.

4.3 Committed Groundwater in the White River Valley

Most water rights in WRV are dependent on groundwater, whether provided by well, spring, or stream rights. Most springs discharge from regional groundwater and most streamflow rights in WRV are supported by springs. Stanka (2017) ignores this fact, and others, as will be described in this section.

There are 104 UG rights for irrigation in WRV with a total duty equal to 37,481.64 afa, not adjusted for supplemental rights or for differing duty estimates (Stanka 2017, p 5-11). There are also 104 permitted and certificated UG rights, but with a total unadjusted duty equal to 42,191.83 afa. After supplemental adjustment, Stanka's estimate is reduced to 34,657 afa, with 22,346 afa having a priority date prior to October 17, 1989 (Stanka 2017, p 5-13).

4.31 Adjustment for Supplemental Rights

Stanka adjusted the groundwater/spring water rights for supplemental rights by assuming that streams are fully appropriated according to their highest flow rate month, and that UG/spring rights appurtenant to the same land would make the irrigation requirement for the rest of the month. The assumptions regarding the surface water flow distribution cause an error that follows through the analysis.

An accurate adjustment for supplemental pumping would require an estimate of how much of the year the primary right is used, followed by an estimate for how long the supplemental right is used to replace the primary right. There is no pumping data to use to estimate the amount of supplemental pumping (Stanka 2017, p 5-33), so he assumed that surface water would be fully appropriated based on the highest average monthly flow rate. He used monthly hydrographs from two streams that enter the valley, Water Canyon Creek near Preston (USGS Gage #09415515) and White River near Red Mountain (USGS Gage # 09415460) (Id.) (Figures 4 and 5) to assess the amount of water that would be appropriated and that would be supplemented with other water (spring or UG rights). He assumed the surface water source is fully appropriated, meaning that stream rights equal to the highest average monthly flow during irrigation season, and that surface water would be used preferentially to groundwater or spring water sources (Stanka 2017, p 5-33, -34, -36). Irrigation season is from April 1 to October 31 and he assumed a full irrigation season is used every year.

Water Canyon Creek has its highest average flow in July and the White River gage has its highest average flow in April and May. During those months, Stanka assumed the full gaged flow would be diverted, and during other, non-peak flow, months supplemental flow would be used to bring the streamflow to equal the full appropriation. The blue bars in Figures 4 and 5 represent the average flows by month, which were obtained from the appropriate USGS gage, and the red bars are the amount that Stanka determined would be supplemented, from UG or spring rights, to maintain a full irrigation season. He assumed that supplemental water would be available to the holder of these surface water rights

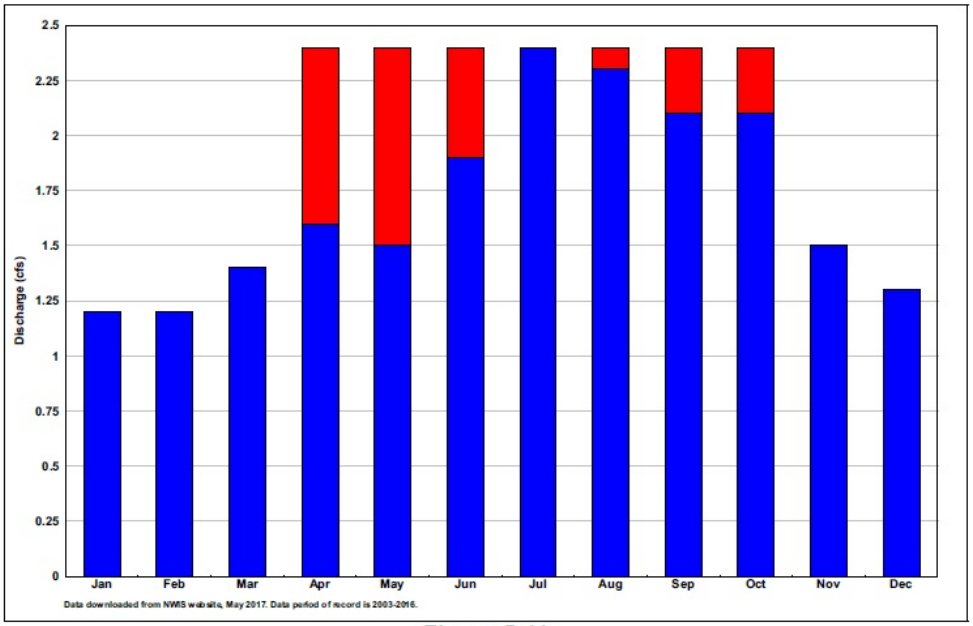

Figure 5-11
Water Canyon Creek Hydrograph with Supplemental Groundwater

Figure 4: Figure 5-11 from Stanka (2017) showing an example of supplemental pumping for Water Canyon Creek. See text for a discussion.

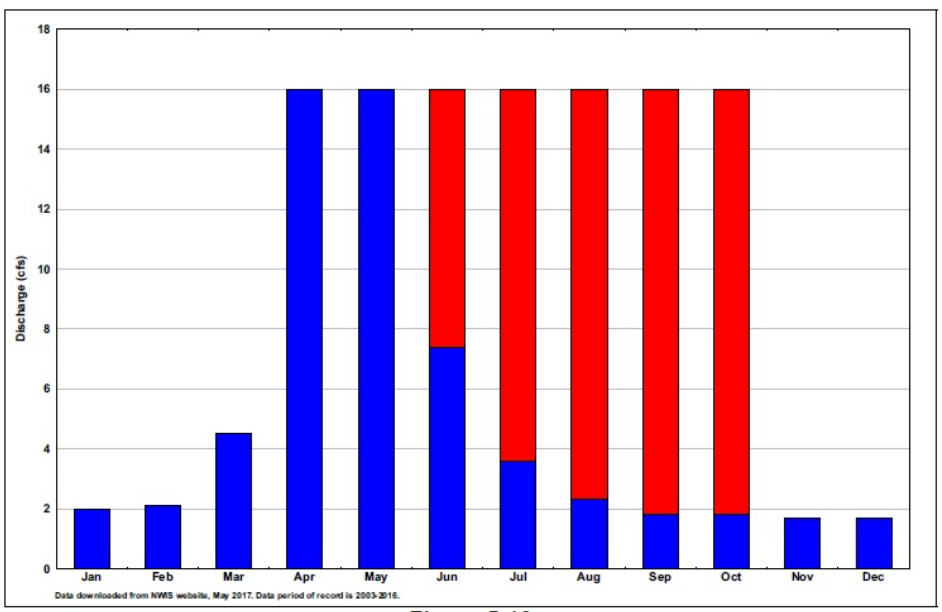

Figure 5-13
White River Hydrograph with Supplemental Groundwater/Springs

Figure 5: Figure 5-13 from Stanka (2017) showing an example of supplemental pumping for White River. See text for a discussion.

Stanka does not address whether either gage is representative of surface flows in WRV at the elevations or actual points of diversion at which they could be used for irrigation. Instead, he assumed the flows at these gages reflect surface water flows throughout the valley, even though that is unlikely.

Each gage is far above the valley bottom, meaning that diversions that could occur at the gage would be far above the areas of irrigation. The gage elevation and drainage area for Water Canyon near Preston are 6400 feet amsl and 11 square miles, and for White River near Red Mountain the gage elevation and drainage area are 6800 feet amsl and 28.2 square miles. The Water Canyon gage is high on an alluvial fan northeast of any irrigation on the WRV floor (Figures 6 and 7) into which it likely percolates and becomes recharge. The White River gage is at 6800 feet in the northwest part of WRV within the Toiyabe-Humboldt National Forest (Figure 8). Capturing surface water at the point of these gages would effectively take recharge from the WRV system.

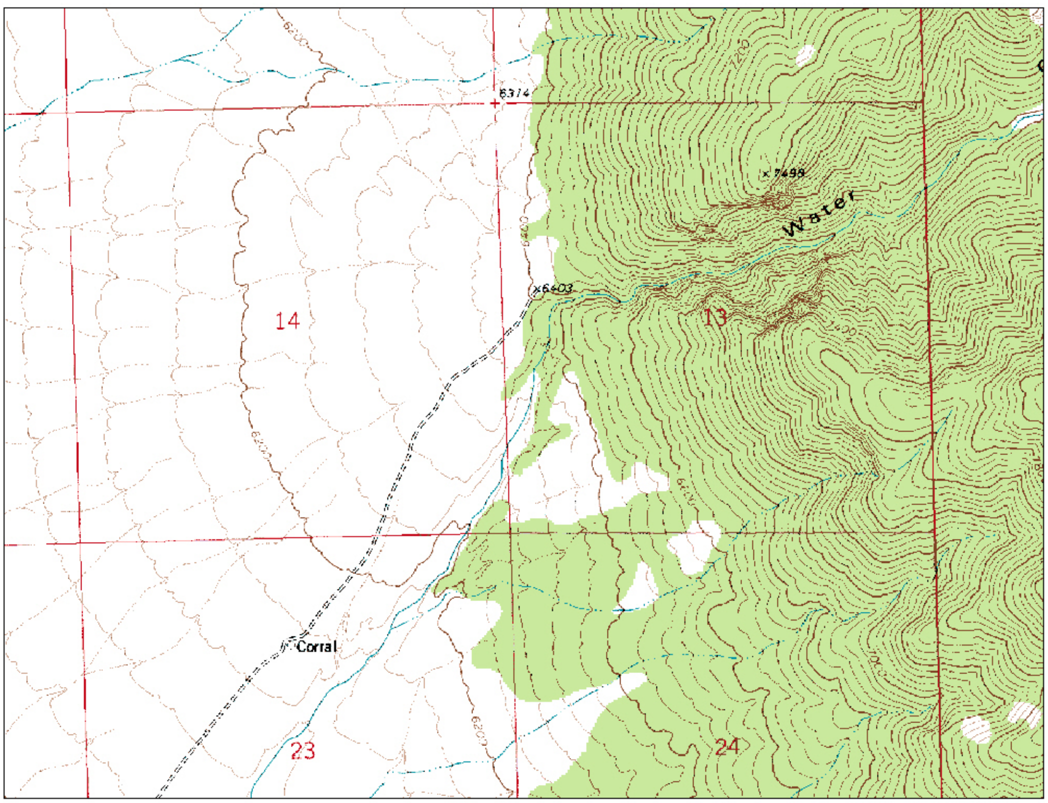

Figure 6: Portion of USGS 1:24K map, Sawmill Canyon, showing Water Canyon draining west onto an alluvial fan in the White River Valley. The gage is at the 6400' contour.

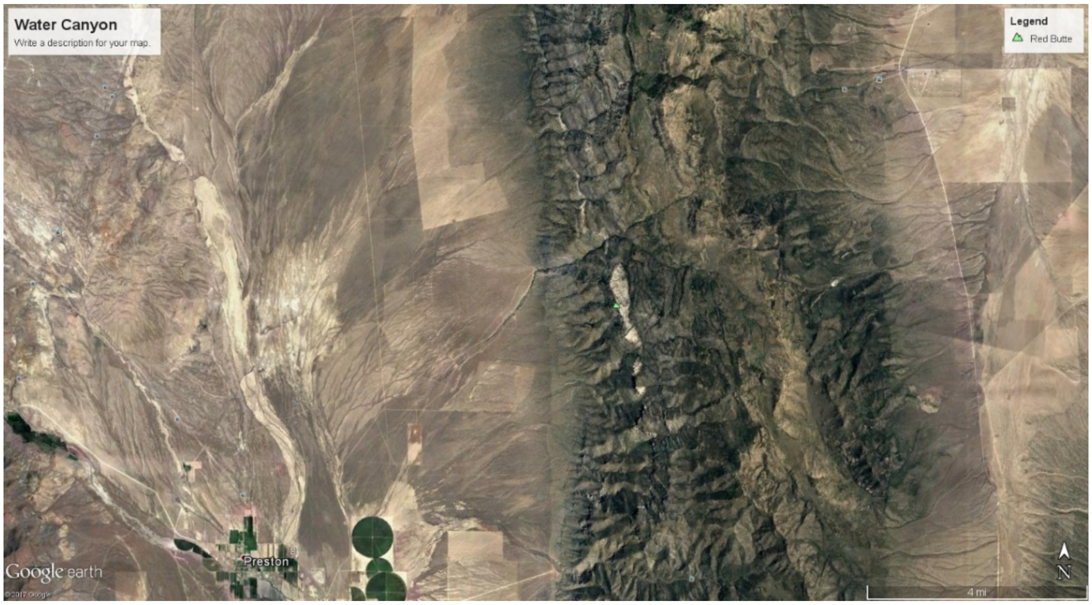

Figure 7: Google earth image of Water Canyon, in the middle of the picture, showing the canyon is several miles north of irrigation.

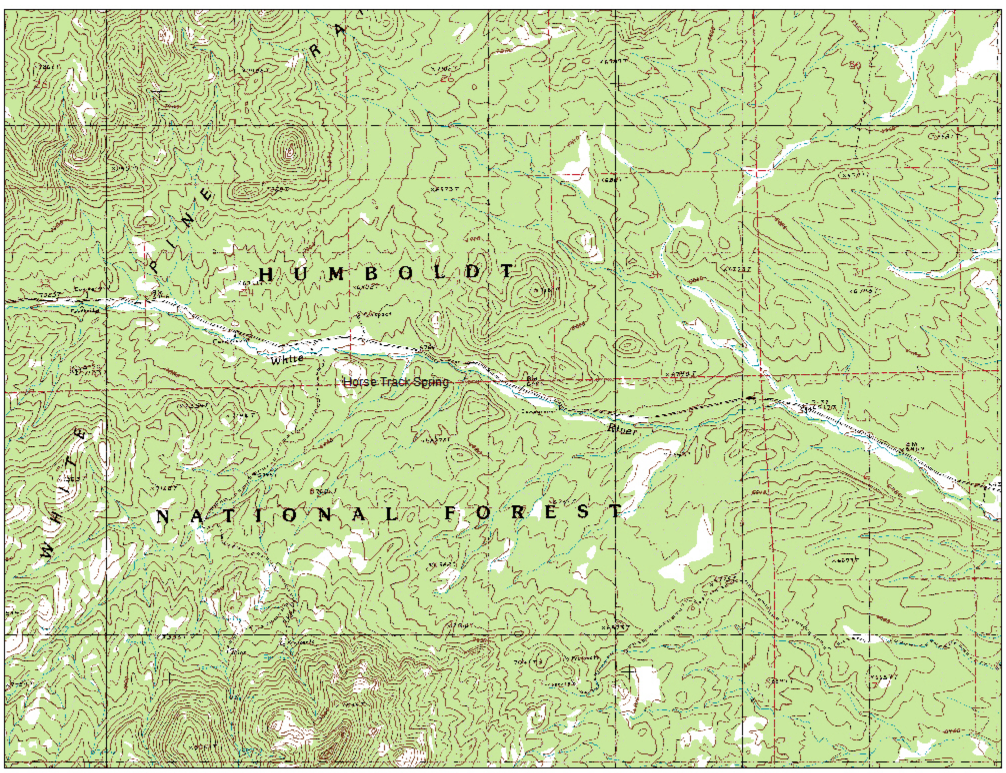

Figure 8: Portion of USGS 1:24K map, Willow Grove, showing the White River in the Humboldt-Toiyabe National Forest. The gage is at the 6800' contour.

Another error is that Stanka assumes the rivers would be fully appropriated at the gage. Only two irrigation water rights in the White River Valley Water Rights Abstract (obtained from the NSE website 7/6/17) list Water Canyon or Water Canyon Creek as a source; these are applications V01519 and 90 which date to 1917 and 1906, respectively. The duty for V01519 is 1200 afa, but it is owned by Kennecott Copper and the maps show no evidence of a diversion. The duty for app 90 is 18 afa but the diversion rate is 10 cfs. Although these applications are for much more than the average flow, there is little evidence either owner has spring or UG rights that could supplement the Water Canyon rights. Kennecott has no other irrigation rights and Adams-McGill has two decreed spring rights (V01162 and V01168) that are two townships south of Water Canyon (at T11N62E). Therefore, there is no basis for assuming the flow at this gage would be fully appropriated, or that stream rights at this point would have supplemental rights.

Stanka's methods would result in supplemental groundwater being 17.2 and 56.3 percent of the full appropriation for the Water Canyon and White River gages, respectively. Therefore, he used the average of 36.8 percent of supplemental UG/spring water to estimate the amount of supplemental UG/spring rights throughout WRV. Considering that the gages he used are not representative of most surface water sources in WRV (compare Figures 4 and 5 with Figure 10 in the next section), his adjustments are almost certainly inaccurate.

4.32 Spring Rights as Committed Groundwater

Stanka treated spring water rights as discharging from groundwater only if the springs discharged from a GWET discharge zone (Figure 12). As noted, this ignores the larger springs that discharge at the base of the mountains or on the fans. He states there are 47 irrigation rights with a spring source, and three additional White River decreed rights, presumably spring sourced, that are not in the database, and a single stream right with a POD from a spring. He then stated that 40 of these rights are within groundwater discharge areas, and "will be considered to be groundwater commitments for accounting purposes" (Stanka 2017, p 5-20). These are not listed, so it is not possible to cross-check them.[2] My list verifies the 47 irrigation rights, and I've cross-checked them with Stanka Appendix 5-32, the Place of Use of Spring Irrigation Rights (Un-sorted). Stanka lists these rights as the "40 irrigation spring rights" (Stanka 2017, p 5-21) referring to the 40 within groundwater discharge areas. Appendix 5-32 was the start of Stanka's supplemental rights calculation. Of the 47 irrigation rights in my list, 36 were in Stanka Appendix 5-32; the appendix also lists three White River Decree rights. Stanka stated there is one stream right sourced to springs, but he does not list it in Appendix 5-32 (where the rights are all identified as having spring source). Stanka's (2017) Table 5-10 lists 19,853 afa of water rights associated with springs and adjusted for supplemental rights. Stanka's primary

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[2] Stanka lists all irrigation rights in his Appendix 5-15, but this listing does not identify the rights associated with springs.

error is that he has ignored additional springs that should be considered as committed groundwater and stream rights that are also groundwater which causes an underestimate of committed groundwater rights.

I selected the spring rights shown in Figure 9 within the valley bottom Qal, Qflv, and the Qas for alluvial slope. This added application #s 699, 2420, 4163, 5336, 5337, 69363, V001166, V01170, V01167, V01171, and V01169 to the list of spring rights using groundwater. Including these water rights would add 1787 afa to the total. However, several of the vested water rights probably have a duty listed in the White River Decree, so my estimated amount still would be low.

4.33 Stream Rights as Committed Groundwater

Most WRV surface water depends on spring flow, not runoff. The surface flows would be much more consistent, as may be seen in the hydrograph (Figure 10) for Hot Creek near Sunnyside gage (gage 9415558 on Figure 9). This site is downstream from various springs which in combination created the consistent streamflow seen in Figure 10. Considering the number of large regional springs in WRV (Figure 12), most surface water in the valley bottom would be a sum of spring flow. If surface water depends on spring discharge, as it does in the WRV, stream rights should be considered dependent on groundwater.

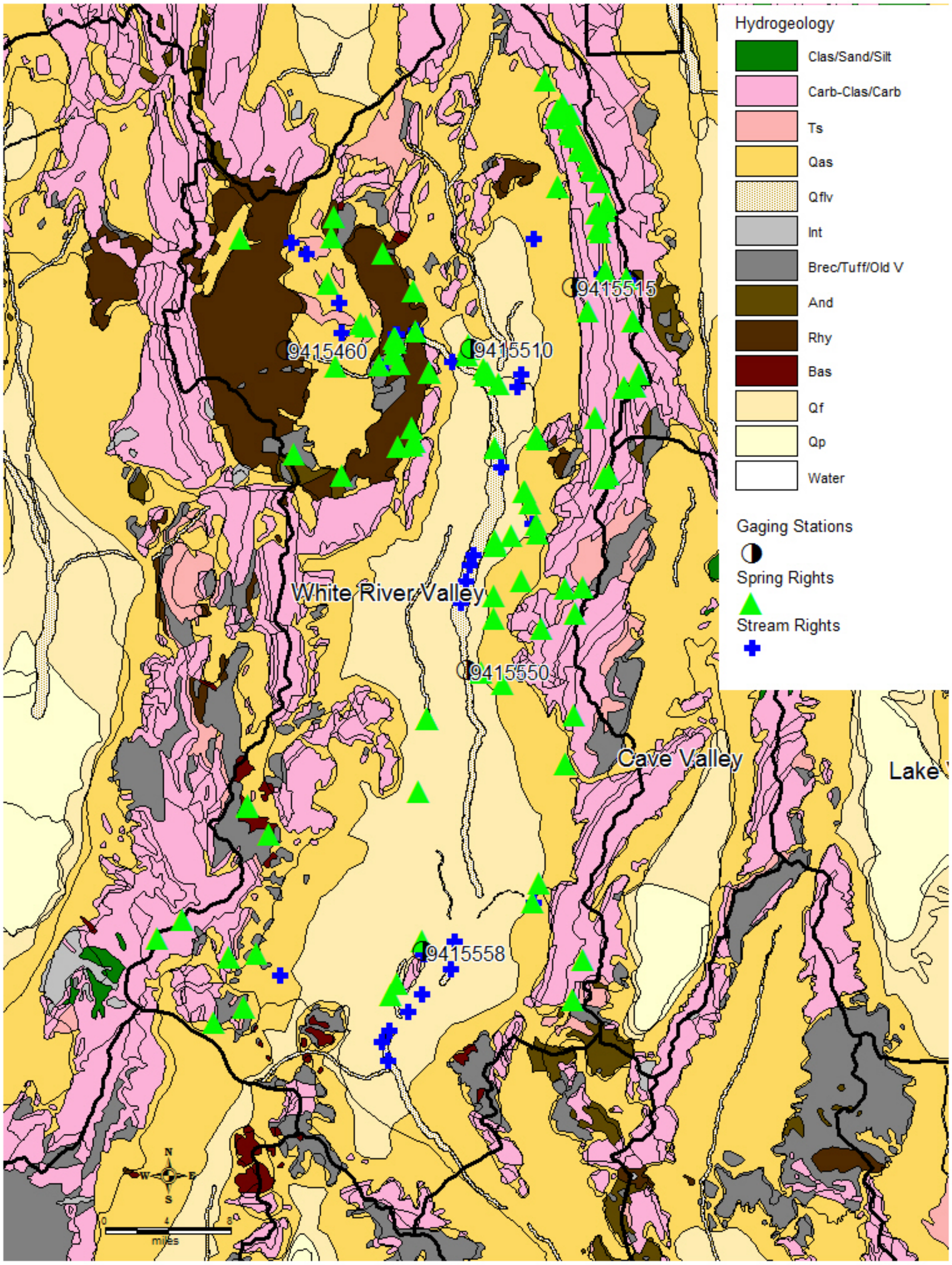

Figure 9: Map showing the location of stream and spring water rights points of diversion as tabulated in the hydrologic abstract obtained from the NSE website.

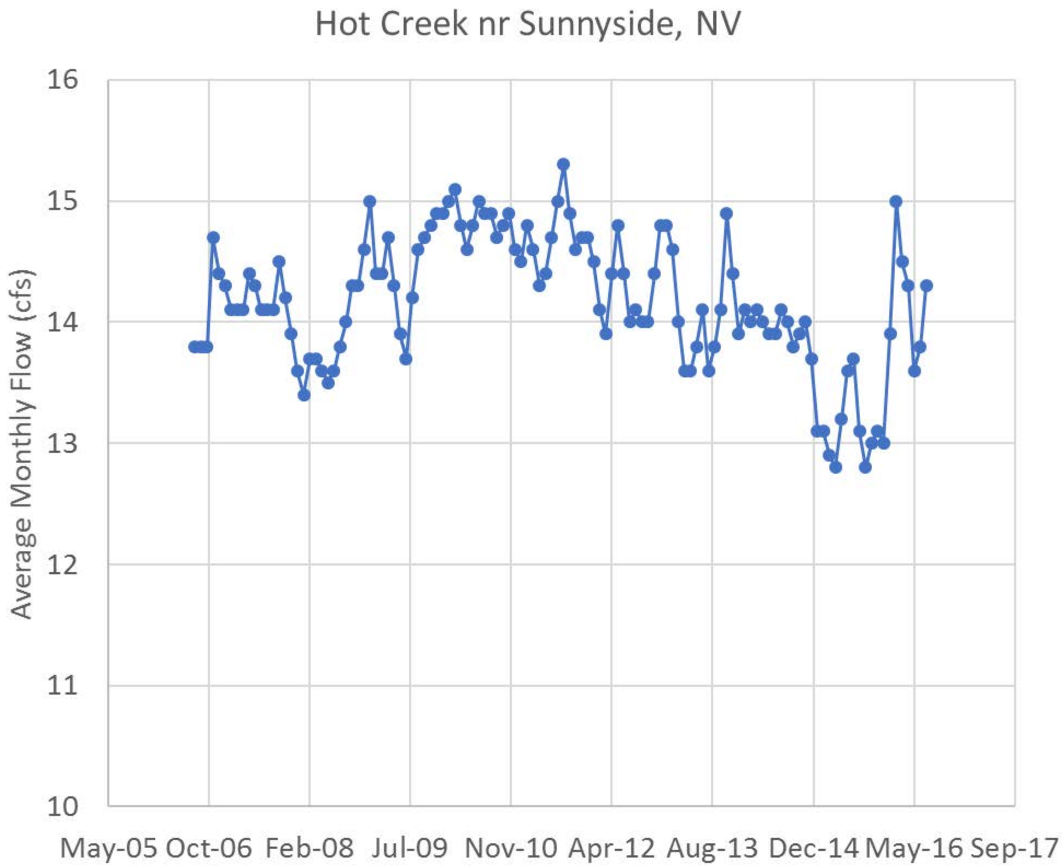

Figure 10: Monthly flow rate at the USGS gage 94155588, Hot Creek near Sunnyside, NV

The total duty for WRV water rights listed as stream with status listed as certificated, permitted, or vested, is 38,837 afa before supplemental adjustment and 32,017 afa if all stream rights listed as supplemental are removed[3]. Assuming that stream rights are preferentially used, then removing all rights listed as supplemental would provide the most conservative estimate. Most stream rights are in the WRV valley bottom (Figure 9). Figure 11 shows the detailed location of five stream water rights in southern WRV, which have a total 4710 afa duty. Rights 38205 and 23623 are wildlife rights, noted in Appendix 5-11 (Stanka 2017). The other wildlife right, 20466, is just northeast of the map in Figure 11. As noted above, most runoff would have percolated before reaching the valley floor, so the river in the valley would only flow if there are springs supporting it.

To assess the amount of stream water rights likely discharging from groundwater, I selected the stream water rights that are within the Qas or Qflv hydrogeology units, shown on Figure 9. These are listed in Table A1. The total duty, unadjusted for supplemental rights, is 29,138 afa. Removing the supplemental surface water rights from the total results in 26,181 afa of water

[3] This sum is derived from the White River Valley water rights abstract, which I downloaded from the NSE website.

rights, predating 1989, that probably depend on spring flow. The difference between the duty for the stream rights that probably depend on springs and the total stream rights for WRV is 9699 afa, not accounting for supplemental rights, which indicates that a substantial amount of stream rights, up to 26,181 afa, depends on groundwater flow. Stream rights on the alluvial fans could also be spring discharge, as discussed above, but they are not included because it is more likely that stream rights on the alluvial fans would be runoff. It is also more likely that streams discharging from a spring in this area would be considered a spring right because the POD would be near the spring discharge point. Ignoring potential stream rights on the alluvial fans being groundwater yields a conservative estimate of committed groundwater as stream rights.

SNWA has therefore underestimated committed groundwater for the WRV by as much as 26,181 afa, ignoring the rights considered to be supplemental. This is because Stanka (2017) did not consider streamflow downstream from springs as committed groundwater.

4.4 Summary

Stanka (2017) underestimates the committed groundwater for WRFS for the following reasons:

- Too much groundwater is assumed to be supplemental for surface water rights because of where the hydrographs used in the analysis are located.
- The analysis ignores the fact that most surface water in the valley bottom is dependent on groundwater because it is spring discharge. The errors include:
    - Not counting springs on alluvial fans which are likely regional springs
    - Not counting stream rights, or surface water, downstream from multiple springs.

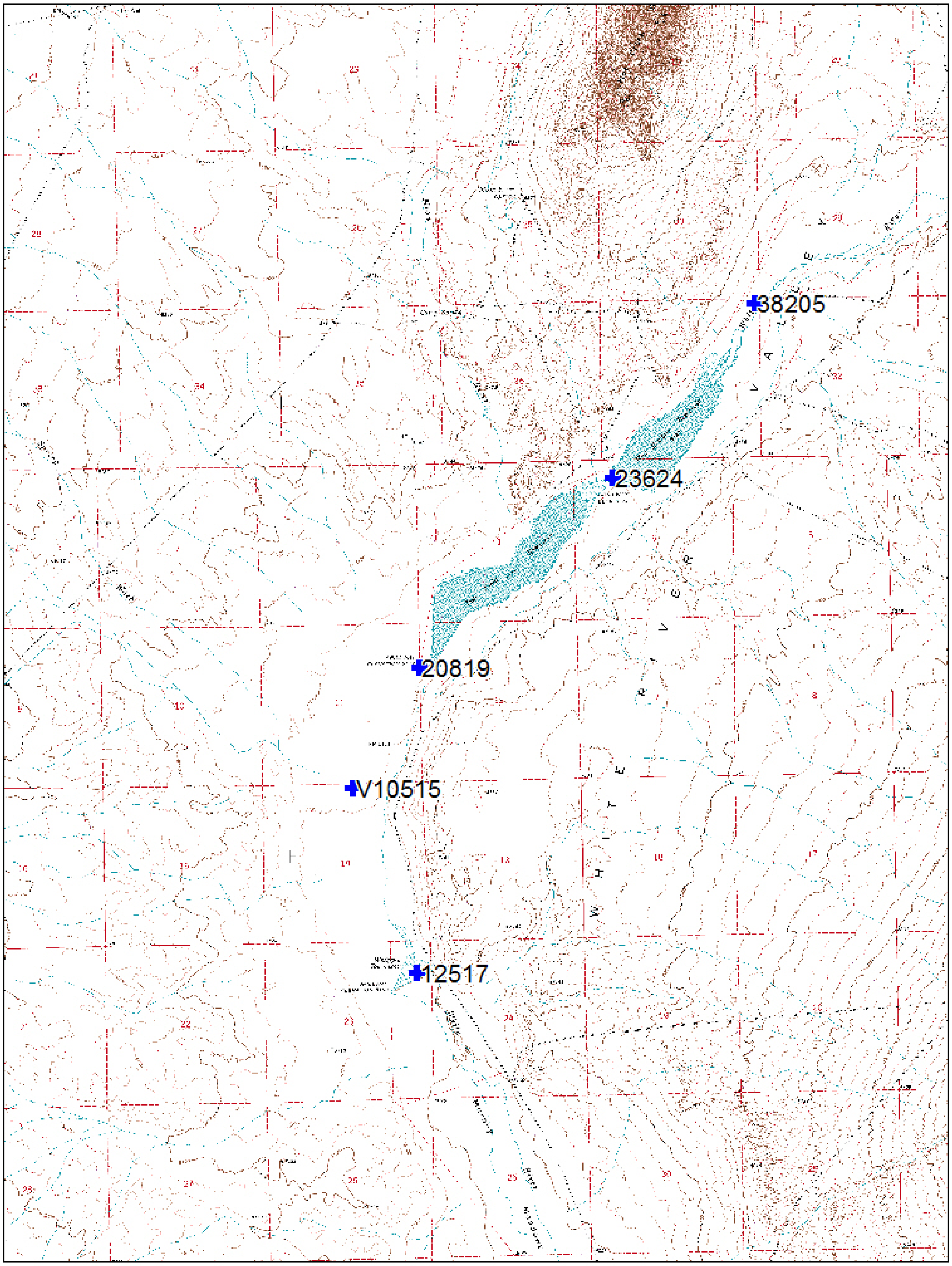

Figure 11: Location of stream water rights in southern White River Valley. Base map is Hot Creek Butte USGS 1:24000 scale map.

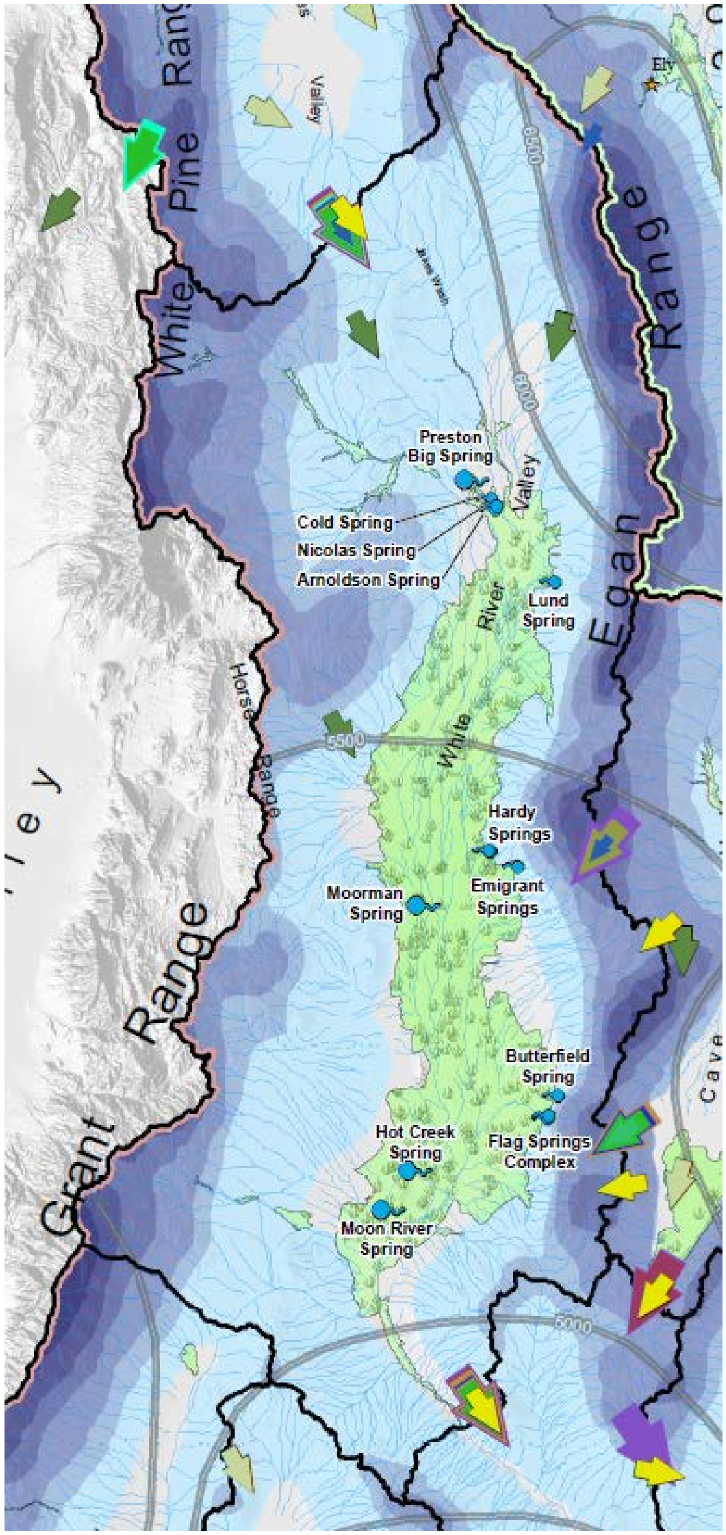

Figure 12: White River Valley portion of Plate 1, SNWA (2009a), showing springs and groundwater discharge area.

5. SNWA Monitoring Plans

Myers (2017) presented an outline for the monitoring necessary for Spring Valley and the WRFS. This section discusses details of the monitoring as proposed by SNWA. Myers (2017) provided some details of what is necessary for a monitoring plan, as quoted here.

> Four steps emerge as being necessary for the establishment of an adequate monitoring plan.
>
> 1. Identify the GDEs and water rights that should be protected. Determine what is necessary to protect them. Groundwater rights and wetlands may require a minimum depth to water whereas a spring may require minimum flow rates.
> 2. Develop a localized conceptual flow model that describes the hydrologic system that supports each GDE and water right. This would be more detailed than a CFM used for the entire region because broad-scale flows do not describe small features well. For example, some springs may be perched but could be affected by long-term drawdown beneath a confining layer.
> 3. Implement the more refined CFM to determine the level of drawdown or other measurable effect that would signal impending impacts to the GDE and water right. This may require numerical modeling or data collection to do correlation analysis of the relationship between the data and the protected feature. These levels are the triggers that monitoring would be designed to detect and prompt management changes. A regional model used for the overall project probably would not be sufficiently detailed to understand flow at individual sites.
> 4. Determine the type and location of monitoring that would allow the prediction of changes at the GDE or water right. Where does drawdown occur in advance of problematic changes in the flow rate or prior to reaching the GDE or water right being protected? Uncertainty should inform these decisions, with more monitoring required and more conservative trigger levels applied where impacts are less certain. (Myers 2017, p 69)

I reviewed the SNWA plans with these concepts in mind.

5.1 Spring Valley

SNWA presented a monitoring plan (SNWA 2017b) based on points of diversion, or wells, approved in Ruling 6164, not the pumping plan used to attempt to demonstrate pumping to equilibrium discussed in section 1 above. Thus, SNWA has not presented evidence that any pumping regime can both reach equilibrium within a reasonable time and avoid conflicts with existing rights and unreasonable environmental impacts. SNWA divided Spring Valley into five management areas (Figure 13). Management area 1 is the south end of the valley, which generally includes the area that produces interbasin flow to southern Snake Valley.

Management area 2 is the middle of the valley and includes the northernmost SNWA PODs. Management area 3 surrounds the Cleveland Ranch. Management areas 4 and 5 are further north in Spring Valley, respectively more than ten and more than 30 miles north of the SNWA PODs.

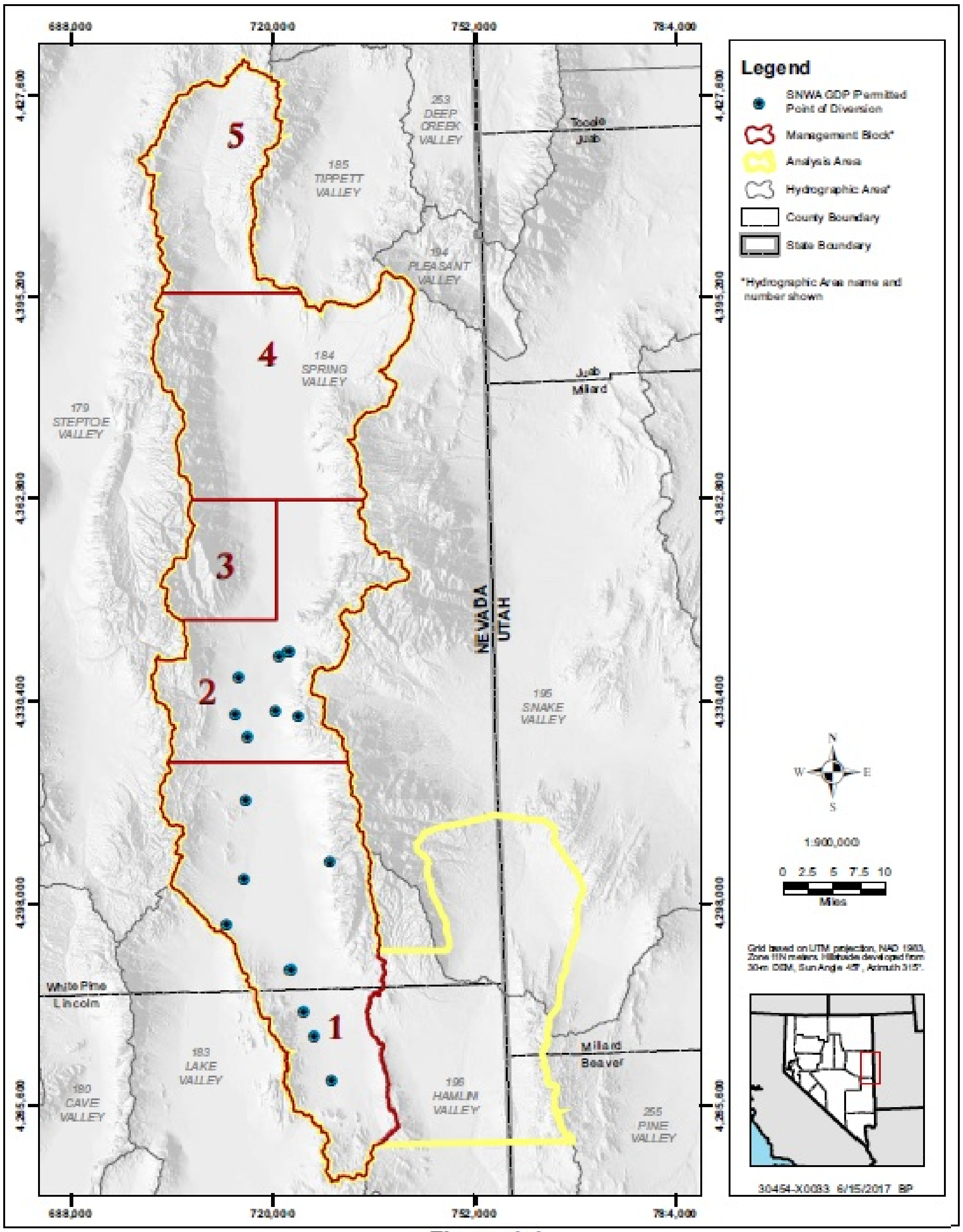

Figure 1-1
3M Plan Area for SNWA GDP Pumping in Spring Valley

Figure 13: Portion of Figure 1-1 from SNWA (2017b) showing SNWA's plan for monitoring in Spring Valley and surrounding valleys.

Outside of Spring Valley, SNWA's proposed 3M plan includes only part of northern Hamlin Valley and southern Snake Valley near Big Springs (Figure 13). It does not include Tippett or Pleasant Valley or consider any potential for the project to affect Gandy Warm Springs, meaning the SNWA monitoring plan does not consider interbasin connections found in BARCASS (Welch et al. 2008) and even SNWA's own modeling (Myers 2017).

SNWA (2017b) divided the senior water rights into five management categories, labeled as A through E based on distance from a SNWA production well and on whether the location is in an adjacent basin. The intent is to segregate risk based on distance and connectivity with the proposed PODs. However, SNWA at no point provides any analysis or justification for its proposed categories.

Categories A, B, C, D, and E apply to PODs within 3 miles, from 3 to 10 miles, greater than 10 miles but within the same basin, within an adjacent basin, or PODs "that are not in hydraulic connection with the producing aquifer in which SNWA GDP production wells will be installed" (SNWA 2017b, p 2-11), respectively. Category E is not well-described because it could be argued that PODs are not in hydraulic connection regardless of distance based on being in different aquifers.

There is no justification provided for setting the three-mile cutoff between categories A and B. The ten-mile cut-off between category B and C is loosely based on the expectation that stress would not spread further early on and that additional monitoring could be planned in future (SNWA 2017b, p 2-11).

Categories A and B would be monitored either at the senior water right POD, a proxy monitor well within the vicinity of the senior rights, or at an intermediate well which can detect propagation of drawdown toward the senior water rights (SNWA 2017b, p 2-11). Monitoring at the POD to be protected is not sufficient because once impacts are detected, it will be too late to effectively mitigate them because, as has been repeatedly explained, the drawdown cone will continue to migrate outward from the POD for a considerable amount of time even after pumping from that POD is completely halted. Also, production wells are not developed or operated to be adequate monitor wells. This is because production wells are screened over all productive zones encountered during drilling and because the production well may be intermittently pumped near the time they are being monitored. Only dedicated monitor wells that can detect drawdown substantially before the drawdown reaches the senior water rights being protected can possibly protect those rights. SNWA's proposal fails wherever it does not provide for monitor wells that are designed according to the local conceptual flow model (Myers 2017).

For the monitoring of water rights, SNWA proposes to group wells into categories based on whether the well discharge rate is above or below the water right diversion rate (SNWA 2017b, p 2-16). Springs with water rights would be grouped according to whether the spring flow is consistently above or below the water right diversion rate, or whether it usually is intermittent or dry. (Id.) SNWA does not explain why these groupings are necessary for monitoring. Intermittent or dry springs would be studied using shallow piezometers that would be compared to regional precipitation to determine the conditions under which the spring would normally flow. (Id.)

SNWA (2017b) Table 2-1 lists all the monitoring sites proposed for Spring Valley and Figure 2-1 (reproduced here as Figure 14) shows them. There is much less to that table than is apparent by simply considering its length, five pages long. There has been little added to it since 2011, the plan of which was reviewed by Myers (2017). Management area 1 would have 29 monitoring locations, many of which are already installed and several of which are simply spring flow monitoring or shallow piezometers. This is for an area that is about 30 by 10 miles. Management area 2 would have 26 monitoring locations, including several spring flow sites and piezometers. These also include as two locations various paired monitoring wells, such as SPR7005X and M or SPR7008X and M. This is for an area about 20 by 10 miles. Very little monitoring would occur north of the Cleveland Ranch which has only the sentinel wells and a spring proposed for Management Area 3 (Figure 14).

SNWA (2017b) does identify most of the groundwater dependent ecosystems (GDEs) and water rights within the valley, but does not present a localized conceptual flow model (CFM) for the specific locations, and so it is not possible to determine whether SNWA's monitoring could be effective. SNWA does not estimate the time for drawdown to pass from the monitoring points to the GDE or water right; there are no triggers proposed that would be an adequate warning for the sites. The proposed monitoring is a "one size fits all approach", with little monitoring specific to the CFM of the sites.

Figure 15 shows most monitoring proposed for Management unit 2, which lies south of the Cleveland Ranch (Figure 13). The sentinel wells just described would also be responsible for monitoring at least ten additional water rights, not on the Cleveland Ranch (Table 2-4, SNWA 2017b). Monitor well SPR7044M is an additional monitor well southeast of the Cleveland Ranch. (Id.)   Piezometer SPR7012Z and SPR7016Z would monitor about 15 additional water rights. (Id.) At least eleven water rights would be monitored only at the right's POD. (Id.) Wells SPR7041M and Z, and piezometers SPR7042Z and SPR7043Z would monitor the Swamp Cedar area. (Id.) The monitoring near the Swamp Cedars area is intended to be related to the conditions of the area, such as tree density and health, rather than provide a trigger for management and mitigation (SNWA 2017b, p 2-51). As can be seen on Figure 15, these are the sole wells available for monitoring an area of about twelve by 24 miles, which is inadequate on its face.

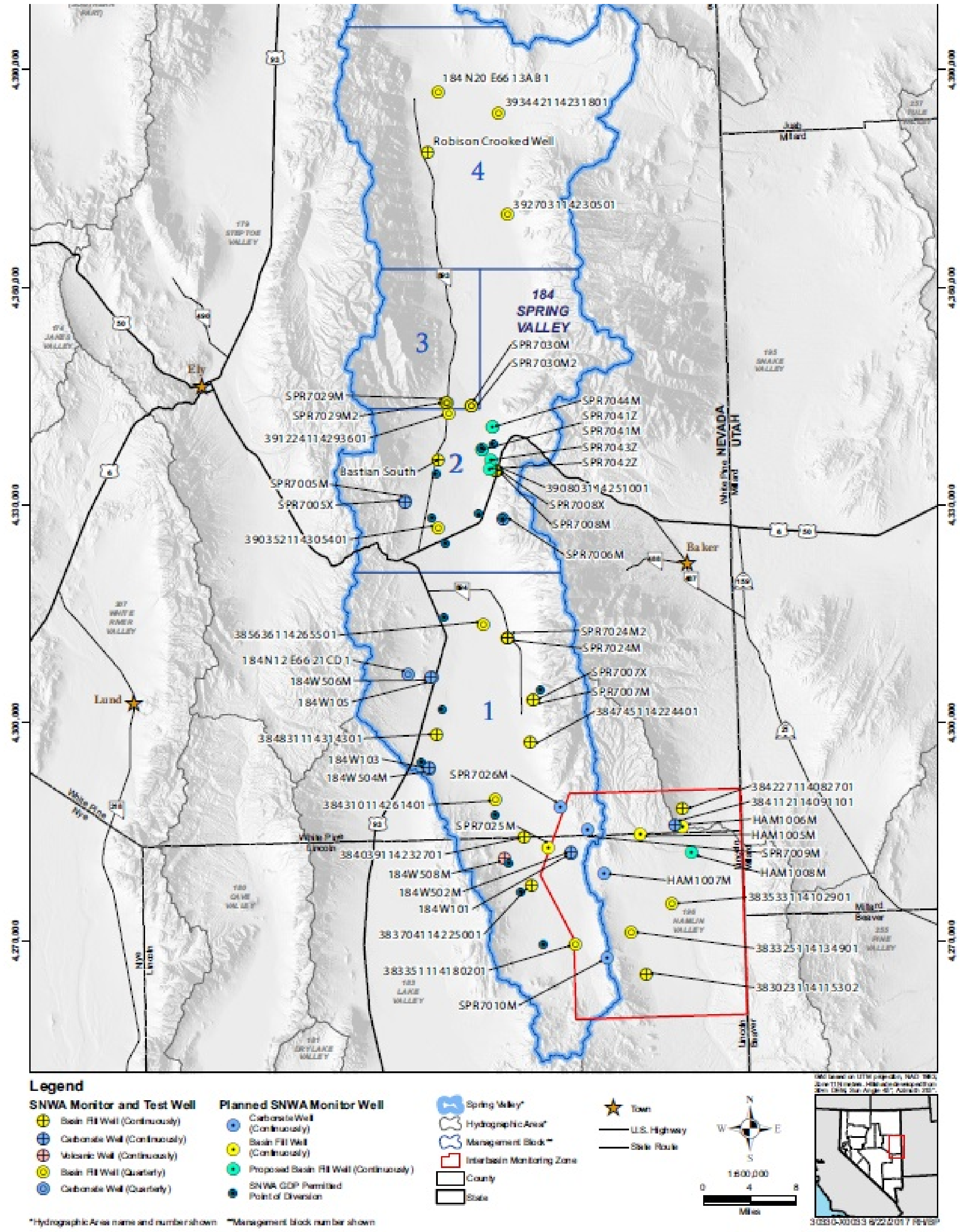

Figure 2-1
Spring Valley 3M Plan Monitor Well Network Locations

Figure 14: Figure 2-1 from SNWA (2017b) showing the location of proposed monitoring for Spring Valley.

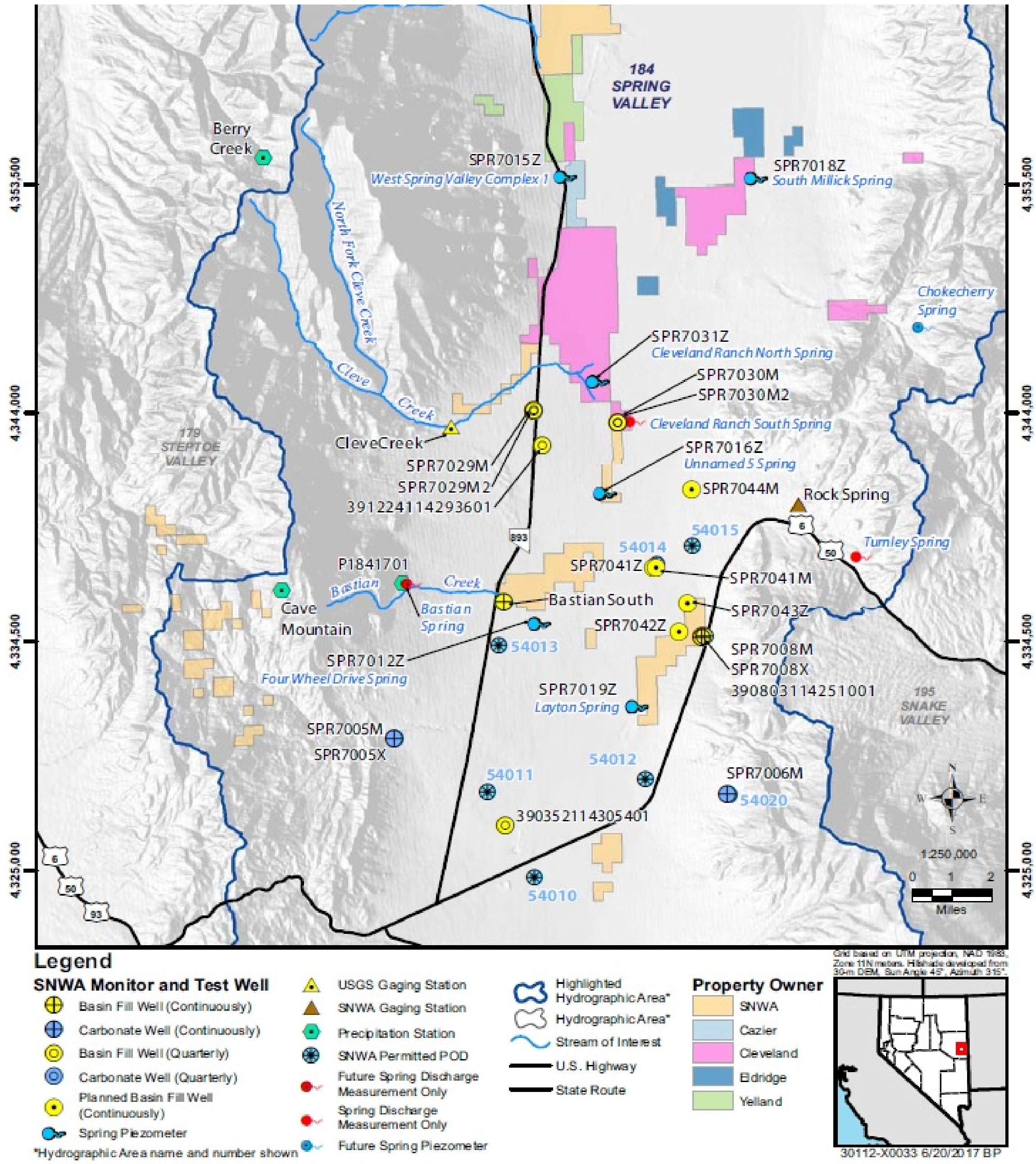

Figure 15: Portion of Figure 2-8 (SNWA 2017b) showing the SNWA PODs and proposed monitoring for the Cleveland Ranch/McCoy Creek Area.

Management Block 3, the Cleveland Ranch, would have five sentinel monitor wells near the southern end of Cleveland Ranch, as described on page 2-25 of SNWA (2017b) and shown in Figure 15. SNWA would monitor only three locations with these five wells because two locations include paired wells screened at different depths. These would be the northernmost monitoring wells and would be the sole monitoring points to detect drawdown signals for management areas 4 and 5. These three monitored locations are grossly insufficient because they are spread too far and would monitor aquifer layers that are much too thick to adequately detect a signal. As described by Myers (2017), stresses propagate differently through different aquifer levels, and to adequately protect downgradient resources, each layer must be monitored. Monitor wells are necessary for each productive zone and spacing should be no more than would allow drawdown cones to expand between them. There would be no monitoring east of the Cleveland Ranch, so a drawdown signal could expand north undetected.

SNWA proposes the Cleveland Ranch sentinel monitor wells as the sole groundwater monitoring for Management Blocks 4 and 5, which are north of the Cleveland Ranch. SNWA considers these areas to be category C or E due to their distance north of any pumping. SNWA proposes no monitor wells east of the Cleveland Ranch sentinel wells, so there would be effectively no monitoring for groundwater effects moving north east of the Cleveland Ranch.

Overall, the monitoring plan for Spring Valley is grossly insufficient. There are too few monitoring wells, and monitoring at the senior water rights does not provide an adequate warning period. The vertical discretization at the wells is insufficient to detect drawdown passing through different aquifer layers. The following points are necessary improvement to the monitoring.

- At a minimum, there should be a transect extending eastward across the valley from the proposed sentinel wells across the southern portion of Cleveland Ranch.
- Monitor wells should be spaced at no more than a mile, although using a more detailed local groundwater model, the spacing should be tested. Spacing should account for potential preferential flow zones due to unmapped heterogeneities. This would be necessary to monitor and observe the heterogeneous expansion of groundwater drawdown north through Spring Valley.
- Each monitored location should have monitoring wells with multiple completions, one for each productive zone as deep as necessary to protect water resources in Management Area 3. These can be multiport wells or nested monitor wells (Myers 2017).

SNWA divided shrubland resources into two categories – medium and low density (SNWA 2017b, p 2-46). SNWA would use a normalized difference vegetation index (NDVI), based on July through September Landsat data, and precipitation data, to monitor and model shrubland density as related to groundwater depth. Monitoring would include NDVI and precipitation data to develop a relation between them before production pumping begins. The remotely-sensed data would be supplemented with 50-m transects (SNWA 2017b, p 2-48).

SNWA would complete statistical comparisons of shrubs as a class, not as specific species as necessary to estimate changes in composition. Changes in shrub density or composition would lag behind the changes in water level or gradient, and therefore observations would probably be too late to make a difference. SNWA's intent appears to not be to protect the existing habitat but to monitor its transition to a habitat that requires less groundwater.

Piezometers, up to 50 feet deep, would be installed in shrubland habitat within GW discharge areas in different management areas (Figure 16). This would be insufficient to monitor the groundwater conditions beneath the shrubs because it does not provide information on vertical hydraulic gradient.

- SNWA should install either nested piezometers or piezometers with multiple screens to determine the vertical flow gradient. The vertical gradient would allow an assessment of the vertical flux to the shrublands.
- The piezometers should also be continuously monitored to establish the temporal variation that would be missed with quarterly sampling.

5.11 Monitoring of Interbasin Flow to Snake/Hamlin Valley

The plan includes monitoring of interbasin flow between Spring and Snake/Hamlin Valley. As described by Myers (2017), the SNWA model runs demonstrate that lowered groundwater levels in southern Spring Valley would decrease the flow to Hamlin Valley. SNWA refers to this as an interbasin monitoring zone (IBMZ). SNWA's plan (2017b) includes the use of sentinel wells in the carbonate rock between the Snake Range and the caldera south of the Limestone Hills, in which the monitoring would occur. Focusing the monitoring on the carbonate rock is reasonable, but SNWA's plans leave many areas through which drawdown could occur undetected.

Figure 17 shows five monitor wells in carbonate rock along the boundary between basins, and about seven basin fill wells within Hamlin Valley (and one within Snake Valley). SNWA claims there will be two more wells sited after their final PODs are approved (SNWA 2017b, p 2-35), but provides no information regarding the siting or other specifics of those wells.

There is a ten-mile gap in the middle of the north-south transect along the Limestone Hills between SPR7010M and HAM1007M. Two proposed SNWA PODs lie west of this gap. The sentinel monitoring plan leaves a huge gap through which drawdown can expand into Hamlin Valley. Due to the heterogeneity of flow paths in carbonate aquifers, a much denser network would be required to have any confidence in the monitoring of expanded drawdown. The currently proposed network would only detect substantial drawdown in a given aquifer layer that is much more productive than other layers intersected by the well.

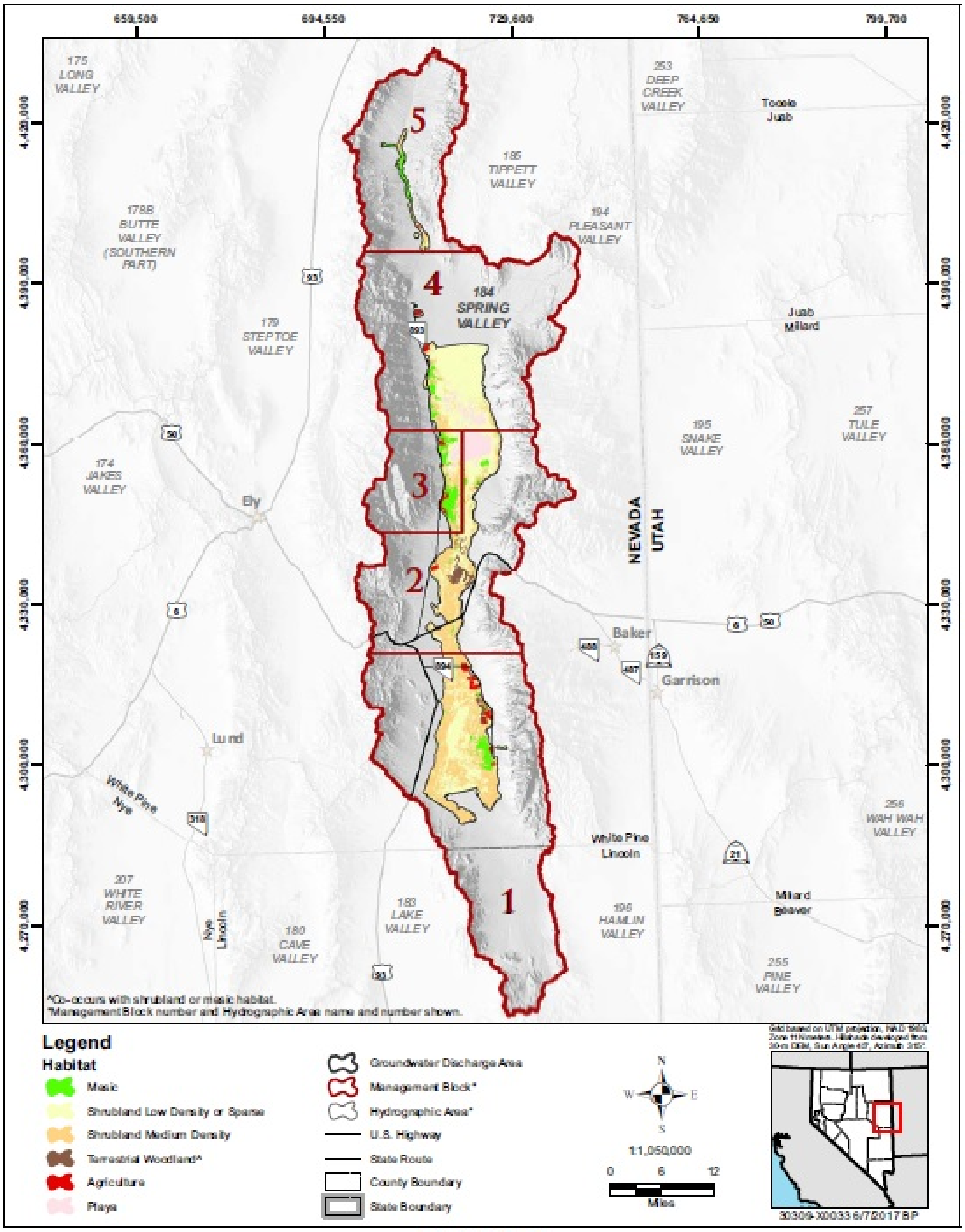

Figure 6-44
Shrublands and Other Habitat Types, Spring Valley

Figure 16: Figure 6-44 from Marshall et al. (2017) showing the shrub types and the groundwater discharge area for Spring Valley.

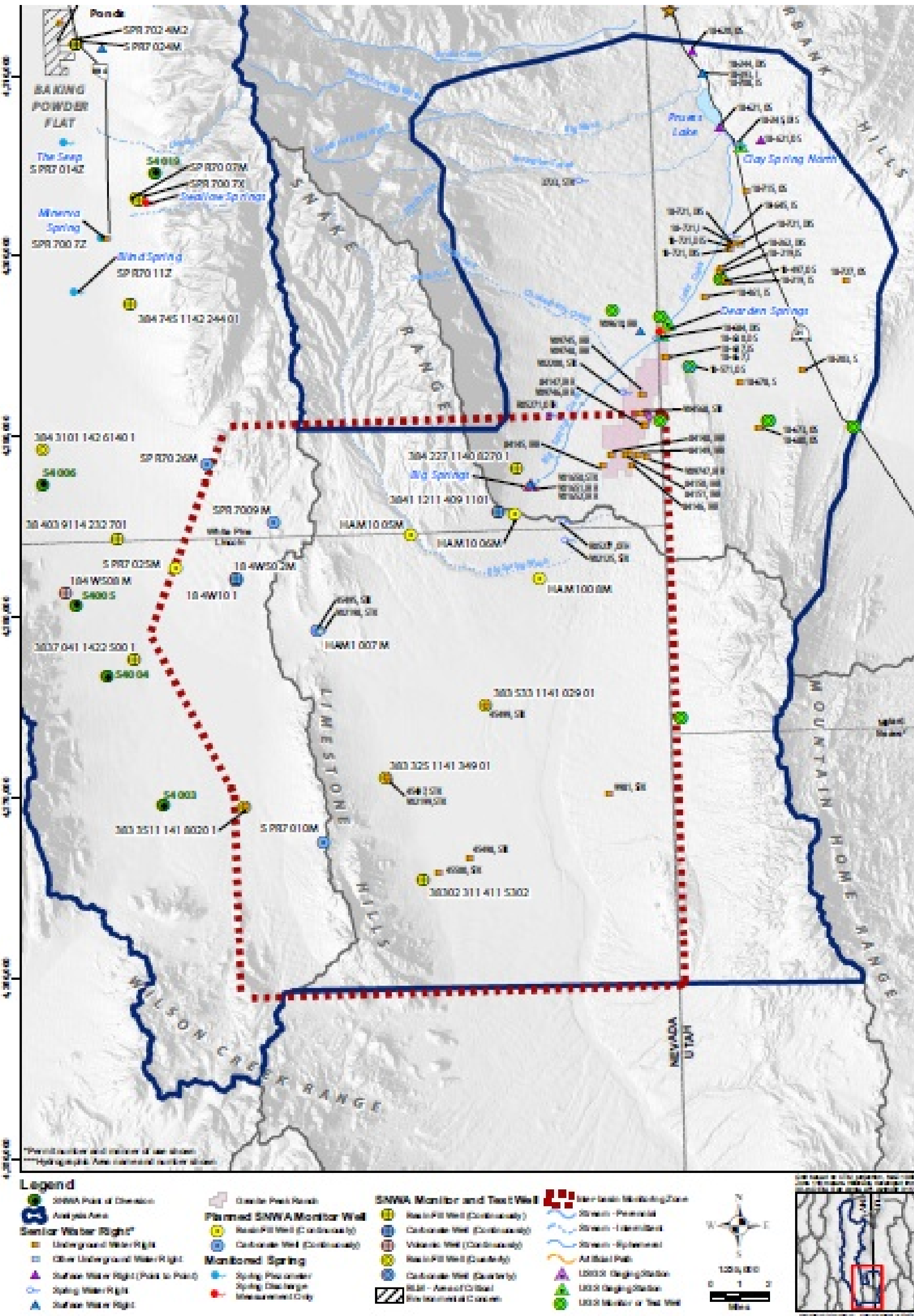

Figure 17: Portion of SNWA (2017b) Figure 2-12 showing the interbasin monitoring zone (in red dotted line), proposed monitoring, and water rights.

The basin fill monitor wells in Hamlin Valley are generally associated with specific senior water rights (Table 2-8 in SNWA 2017b, which also associates the general sentinel wells with senior water rights). As noted for the carbonate monitor wells, these wells screen broad sections of basin fill which would mask the drawdown response within them. The basin fill well locations appear to have been established with no plan other than for them to coincide with existing rights. To that extent, the well locations would provide no warning time for mitigation, and thus mitigation would have no hope of being effective. Further, there is no apparent plan to monitor broader drawdown that would allow an understanding of how a decreased interbasin flow was affecting groundwater levels in Hamlin Valley.

Shrubland habitat monitoring would begin "if the hydrologic investigation trigger at the sentinel well HAM1007M … is activated as a result of SNWA GDP pumping" (SNWA 2017b, p 2-52). Similarly, monitoring of shrubland habitat in southern Snake Valley would commence if the trigger is activated at a different well. This puts the onus on one well for each area. If the well is poorly placed, either horizontally or vertically, it could miss the hydrologic signal, as discussed elsewhere in this report and in Myers (2017), causing shrubland monitoring to never commence and allowing mitigable damages to never be identified.

- The carbonate well monitoring plan should have wells spaced on the basis of local-scale modeling showing the potential for drawdown to move through heterogeneous pathways through the hills.
- The carbonate wells should also have multiport screening or be constructed as nested wells to monitor the different productive layers.
- The basin fill well monitoring in Hamlin Valley should be redesigned to establish an accurate monitoring system of the groundwater table for the valley. This would require spacing of no less density than a monitor well per square mile, to allow for accurate interpolation of contours among the monitor wells.
- Shrubland habitat in the IBMZ should be monitored remotely, as done for the rest of Spring Valley. There should also be paired piezometers to estimate changes in vertical flux so that changes in the habitat can be modeled and predicted in advance.

5.2 Spring Valley Management and Mitigation

SNWA identified three action levels that would be triggered by various levels of measured impacts – investigation, management, and mitigation actions. Investigation means there would be additional analysis and possibly data collection to identify a cause of impacts. A management action would be "to avoid or minimize the risk of activating mitigation triggers, and support responsible groundwater development" (SNWA 2017b, p 3-3). Mitigation triggers would be to "avoid unreasonable effects and comply with Nevada water law." (Id.) Mitigation generally requires that water be replaced. (Id.)

Investigation triggers may be assigned at specific senior water rights, a specific spring or well which acts as a proxy for multiple senior water rights, an intermediate monitor well between a group of senior water rights and SNWA production wells, or at a sentinel well (a monitor surrounding the overall production area to monitor trends away from the project) (SNWA 2017b, p 3-4, -5). An intermediate location would be intended as "an early warning to detect the presence and amount of change in water level or spring discharge prior to being observed" (SNWA 2017, p 3-4) at the associated senior water rights.

Triggers and management and mitigation actions would depend on the specific management block. SNWA (2017b) Table 3-1 presents the triggers and actions for Spring Valley Management Block 1, which, as described here, would not prevent the continuing drawdown of the water table but would only try to provide replacement water from some other source.

The investigation trigger would be set at the 99.7 percent lower control limit as determined from a seasonally adjusted linear regression (SALR) model for the baseline data (SNWA 2017b, p 3-5). SNWA does not describe here what the independent variables are in the regression. The investigation trigger would be a decrease in water level below the 99.7 percent lower control limit, based on the SALR estimates of the minimum baseline, for six months. A 99.7 percent lower control limit means that there is a 99.7 percent chance that the water level would not be less than the estimated water level if there were no intervening factors (Marshall et al. 2017, Appendix A). Based on statistical inference, if the water levels go below the 99.7 confidence investigation trigger, it is very likely that there is an external cause. Once exceeded for six months in a row, there is virtually no uncertainty that the production pumping is the cause, especially in category A wells (within 3 miles of SNWA PODs). The predicted drawdown within three miles of SNWA production wells for the original application PODs (FEIS, alternative B) exceeded tens and even hundreds of feet.

However, rather than simply accept the observed drawdown with its 99.7 percent certainty and direct physical explanation (cause) as shown in the FEIS, SNWA proposes that they "investigate cause, determine significance, revise predictive tools, and apply appropriate management actions" (SNWA 2017b, Table 3.1). SNWA would therefore only investigate a cause for an observation for which there is 99.7 percent certainty that there is an external cause and even change their predictive tools. Having already waited six months since the first time the water level fell below the trigger, there will be an additional study period. Once the study period concludes the water level changes are due to production pumping, management actions that could mitigate the ongoing drawdown will be limited due to persistence in continuing drawdown – drawdown would continue to expand for a period even after changing pumping. In addition to any investigation, SNWA should implement management actions at the same time as the investigation trigger. If the investigation finds there is a different cause, the original pumping could resume.

Mitigation would be the result of the next trigger, with mitigation for senior UG rights depending on whether the well has a production capacity greater than or less than the permit value. If the well production exceeds the permitted diversion rate, the mitigation trigger would occur if water levels fall to that which would cause the pump production to fall below the permitted rate, plus a 10 percent or 10-foot buffer (SNWA 2017b, p 3-10). Alternatively, the trigger would occur if the production drops to less than 10 percent above the permitted rate along with a decrease in groundwater levels determined to be caused by SNWA pumping. If the well production is less than the permitted rate, the mitigation trigger is the same as the investigation trigger, based on the 99.7 percent lower control limit for baseline data for six months (SNWA 2017b, p 3-12). A well owner with large pump capacity would be discriminated against because the mitigation trigger is higher for that well.

For mitigation, SNWA would also compensate a senior water rights holder if the pumpage power usage increases more than 25 percent to produce a similar amount of water (SNWA 2017b, p 3-10). This is not fair to the water rights holder, if SNWA is responsible for the additional costs. SNWA should be responsible for any and all additional costs due to SNWA's lowering of groundwater levels.

The mitigation trigger for springs (SNWA 2017b, Table 3-1, p 2) could allow the spring to substantially go dry unless there is a water right for more than the spring flow rate. If the baseline spring flow rate is consistently above the permitted rate, the mitigation trigger is set to six months below a flow rate exceeding the permit by 10 percent (SNWA 2017b, p 3-12). This would not protect against a substantial long-term decrease in flow for such a spring.

If the baseline flow rate is less than the permitted diversion rate, the mitigation trigger is activated when investigation determines the cause to be due to SNWA GDP pumping. (Id.) The provisions for spring mitigation would allow springs that are not fully appropriated to be impacted more than those that have less water rights. If the spring, or well, lies within the predicted SNWA-caused drawdown cone, there should be a presumption that an observed drawdown is caused by SNWA pumping.

The proposal to mitigate springs with senior water rights is grossly insufficient and creates a situation in which SNWA can stall while they argue over who caused the springflow to decrease. If the spring flow has consistently been above the permitted diversion rate, then investigation would begin if the flow decreases to outside of the baseline range and mitigation would begin if the flow decreased to less than 10% above the permitted diversion rate. So, if the spring has a lot more water than is commonly used, the water right holder would be protected before the spring flow reaches the permitted diversion rate, but the environment, which would utilize the additional flow, would not be protected. If the spring flow is consistently less than the permitted diversion rate, investigation would begin once the flow decreases to less than the baseline range and mitigation would occur if the decreases causing the investigation trigger are determined to be "caused by SNWA GDP pumping" (Figure 18). This creates a likely conflict over deciding fault. It also puts a larger onus on the water right holder if the permitted diversion rate exceeds the baseline spring flow because there is no conflict with the water rights holder who has the spring that flows at rates higher than his permit. Experience suggests that irrigators usually claim an amount that fully uses the source during a wet period and that most of the time, the flow is less than that permit amount. Spring water rights holders would have a more difficult time getting mitigation if their diversion rate frequently exceeds the flow rate.

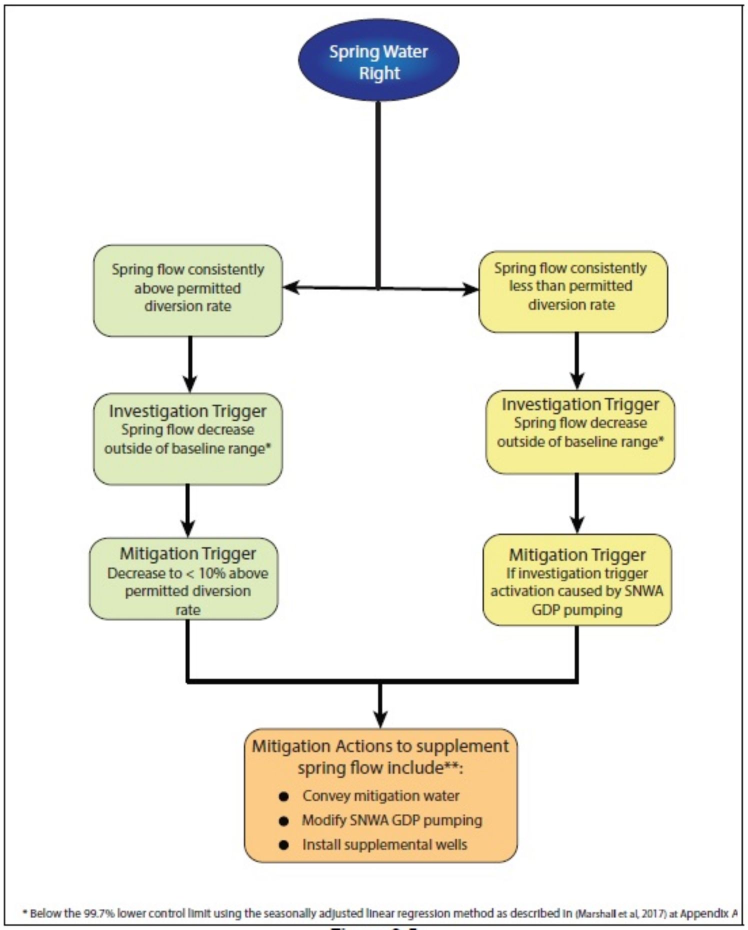

Figure 3-5
Management and Mitigation Flow Chart for Senior Spring or Stream Water Right

Figure 18: Figure 3-5 from SNWA (2017b) showing a flow chart for management and mitigation actions for a senior spring or stream water right.

Mitigation actions for senior spring or stream water rights would involve providing mitigation water, modifying production pumping, or installing a supplemental well (Figure 18). Mitigation water would be an amount equal to the beneficial use portion of the water right (SNWA 2017b, p 3-12). As Myers (2017) described, these actions would increase the environmental damages by further depleting the water source and because SNWA has applied for all unappropriated water within Spring Valley, would shift impacts to other areas, compounding impact problems.

Additionally, according to SNWA's proposed plan these actions would not have been determined to be reliable in advance if the water sources, the area from which mitigation water would be taken from, have not been identified. Modifying SNWA pumping would require a lag time before its effects would be felt. Drilling a well near the spring would likely draw water from the aquifer supporting the spring and simply increase the drawdown causing the spring to lose flow and guarantee the spring, and all its inherent values, would not ever recover.

The mitigation actions for senior UG water rights all involve improving the ability of the affected well to pump water from deeper levels (SNWA 2017b, Table 3-1, p 3). This mitigation will simply add to the drawdown and will contribute to a continuing process of drawing the groundwater levels in the valley further and further down. Because the pumping regime will not reach equilibrium (see discussion above and in Myers (2017)), the drawdown will continue essentially in perpetuity at any affected senior water right.

SNWA would use the five "sentinel" wells across the south end of Management Unit 3 to monitor expanding drawdown into that unit, and into Management Units 4 and 5 (SNWA 2017b, Tables 3-3 and 3-4). This transect is insufficient monitoring for these units. As noted above, the five wells are just three locations as two well pairs are at the same location as nested wells and they monitor drawdown only over the west half of the valley whereas Management Unit 2 extends north along the east side of unit 3 (Figure 14). SNWA proposes no monitoring on the east side of Spring Valley even though it proposes production wells on that side (Figure 14). Thus, drawdown could expand undetected to the north on the east side of Spring Valley east of the Cleveland Ranch (Management Unit 2).

5.21 Shoshone Ponds 3M Plan

SNWA bases its 3M plan for Shoshone Ponds on a fallacious understanding of the controlling hydrogeology. The underlying lithology "consists of clays inter-fingered with sand and gravel layers, which results in confined aquifer conditions in the area" (SNWA 2017b, p 3-28). Therefore, SNWA reasons that the "shallow groundwater and associated habitats are not in hydraulic connection with the underlying aquifer in which SNWA GDP wells will be installed" (Id.). SNWA therefore assumes that drawdown that may reach the ponds will not affect the layer in which the artesian well is screened. This assumption is unreliable because interfingering clay lenses probably do not form a continuous layer, so the confining layer would be at least leaky, and possibly far more porous than that, and a long-term drawdown would create a gradient that would draw groundwater from the layer of the well.

Marshall et al. (2017, p 6-58, -59) argue that Pahrump poolfish are very hardy and note significantly changeable water quality conditions that the poolfish has survived through. These include significant variations in pH and temperature. They also note the populations "experience natural population fluctuations" (Marshall et al. 2017, p 6-59), without identifying whether these fluctuations relate to water chemistry changes. This is a serious failing of SNWA's analysis, because if the fish depends on specific water chemistry, then replacing its flows with mitigation water from elsewhere may not be successful.

The investigation and mitigation triggers for the Shoshone Ponds wells are 15 and 13.5 gpm (SNWA 2017b, Table 3-5). However, flows at the well at Shoshone Ponds are not measured, and SNWA merely can state that the "well is estimated to be capable of discharging artesian flow of 15-20 gpm" (Marshall et al. 2017, p 6-62). This reliability of this statement and the proposed mitigation triggers is difficult to discern; if there are no ongoing measurements, the proposed management and mitigation triggers are based on no data. Management actions activated by flows dropping below the investigation trigger include habitat management at the ponds, but would not affect the flows. With one exception, the mitigation actions involve improving the wells or providing water from elsewhere (Id.), which would essentially add to the problem of lowering water table and decreasing flow, unless the mitigation water would be new water to the system (from outside of Spring Valley).

An exception would be modifying SNWA "pumping duration, rate, or distribution," which would also push the problem into the future because the system will never come to equilibrium as the aquifer system continues to experience groundwater mining from continued SNWA pumping. Only reductions in total extraction or complete removal of production wells from the vicinity, so that no drawdown would occur at Shoshone Ponds, would have a chance to limit the drawdown and stabilize the artesian well flow rate in the long run.

5.22 Shrubland 3M Plans

SNWA argues that groundwater drawdown beneath shrubland will only convert it to lower density rather than eliminating it or causing a large-scale shift in ecosystem type. The specific argument centers on the definition of facultative shrubland, which means the shrubs would use groundwater as a secondary source after precipitation but can and do exist on sites without access to groundwater (SNWA 2017b, p 3-34). Specifically, "the productivity of facultative phreatophytes is increased by access to groundwater, but lack of groundwater within their rooting zones does not, in and of itself, cause widespread plant loss." (Id.) They also acknowledge that the cover of a shrub may decrease if the depth to water below the main rooting zone decreases. This fails to consider or account for the result when a shrubland with easy access to groundwater, as exists in parts of Spring Valley, completely loses access to groundwater, as predicted drawdown (FEIS, Myers 2017) would indicate will occur. SNWA does acknowledge that too rapid a groundwater drawdown may cause "extensive bare ground" if it is too fast "to accommodate a gradual plant transition." (Id.) SNWA states that the plant community would likely shift to "more drought-tolerant, deeper rooted, and/or non-phreatophytic species" (Id.), meaning a shift in shrub type in addition to a change in density.

The environmental triggers for shrubland include measures of NDVI, and whether it falls below the natural range for median and low-density shrublands (SNWA 2017b, Table 3-7). Hydrologic monitoring would include piezometers. Mitigation would include, in addition to vegetation treatments and other on-the-ground management activities, supplemental watering using other SNWA water rights. Because the drawdown will be an ongoing impact of groundwater development, watering would also be required in perpetuity. For this to be accepted as a mitigation plan, SNWA must consider the environmental impacts of moving the water from its current source and use; SNWA fails to discuss that changing the point of use and beneficial use of an existing water right would require a change application with the State Engineer.

SNWA argues that a shrubland transition could be desirable, specifically if it was from a greasewood-dominated type to a big sagebrush dominated type (Marshall et al. 2017, p 6-90). This would occur if a declining water table would reduce the amount of salt brought to the surface through plant capillary action which would cause a transition from salt-tolerant to salt-intolerant species (Id.). As noted, SNWA acknowledges that if drawdown occurs too rapidly, then there could be an excessive loss of shrub cover which would cause extensive bare ground. (Id.) The SNWA mitigation plan does not preserve the existing shrub cover or type, but merely proposes to manage for "transition in shrubland plant communities" (Marshall et al. 2017, p 6-92). Their focus is on management blocks 1 and 2.

5.23 Senior Water Rights and Environmental Soundness

SNWA experts provide an explanation of "senior water right protection and environmental soundness" as they interpret it under Nevada water law in section 2.0 of Marshall et al. (2017). Their interpretation provides their "basis for the thresholds, triggers, and monitoring, management, and mitigation actions" (Marshall et al. 2017, p 2-1). They also suggest it meets the standards of the remand order requirements. (Id.) They quote extensively from NSE rulings concerning Spring Valley and Cave, Dry Lake, and Delamar Valleys with respect to environmental soundness, but never actually define what "unreasonable" means with respect to related natural resources that depend on the affected ground water system or what viable means with respect to hydrologic basins, ecosystems, or plant and wildlife communities (Marshall et al. 2017, p 2-2). The definitions provided as "unreasonable effects" are little more than uninterpreted quotes from Nevada statutes or they imply that "viable" is anything less than full and complete extirpation.

SNWA argues that protection of senior water rights in Spring Valley will protect environmental resources by keeping groundwater levels high enough (SNWA 2017b, section 3.2.2). This is true only if there are nearby senior water rights and would therefore be a byproduct rather than a goal of 3M. Protecting senior water rights at Shoshone Springs would only protect the water source, which would be mitigated by lowering the well, rather than the artesian flow which would be allowed to disappear by the mitigation proposed by SNWA (2017b).

5.3 White River Flow System

SNWA's DDC 3M plan (SNWA 2017a) focuses on the three targeted valleys, Pahranagat Valley, and part of WRV rather than all downgradient water rights and springs in the WRFS (Figure 19). This scope is insufficient, as discussed above, because it ignores valuable springs and water rights south of Pahranagat Valley, within the Muddy River Springs Area.

The categories for senior water rights are the same as discussed for Spring Valley, above. Category D for the WRFS refers to water rights in downgradient basins, which SNWA inappropriately limits to southern WRV and Pahranagat Valley (SNWA 2017a, p 2-7). SNWA relies on "sentinel" wells for monitoring impacts to downgradient basins. (Id.)

SNWA proposes a water resources assessment at the wells associated with senior water rights, similar to that proposed for Spring Valley, for all Category A and B wells (SNWA 2017a, p 2-12). SNWA would classify the well and pump as it did for Spring Valley, according to whether the pump could yield more than the permitted water rights. (Id.)

The 3M regime for southern WRV includes four sentinel wells and spring flow monitoring at Flag Springs and Butterfield Springs (Marshall et al. 2017, p 8-19). Four sentinel monitor wells assessing impacts on flows between Cave and White River Valley, existing wells 383307114471001 and 180W501M and proposed wells WRV1013M and WRV1012M (Figure 20), is grossly insufficient, as critiqued in Myers (2017). SNWA claims the "stratigraphy and structural orientation of the Egan Range makes it very unlikely for groundwater flow to occur directly across the range west to Flag Spring from Cave Valley" (SNWA 2017a, p 2-17), but this is an overly broad statement that conflicts with other documentation of the likely flow between the valleys (Welch et al. 2008, SNWA 2011a). Marshall et al. (2017) acknowledges that there is flow through Shingle Pass, but suggests that Cave Valley flow probably does not contribute directly to the warm springs but likely does contribute to the cool, range-front springs including Butterfield and Flag Springs (Marshall et al. 2017, p 8-14).

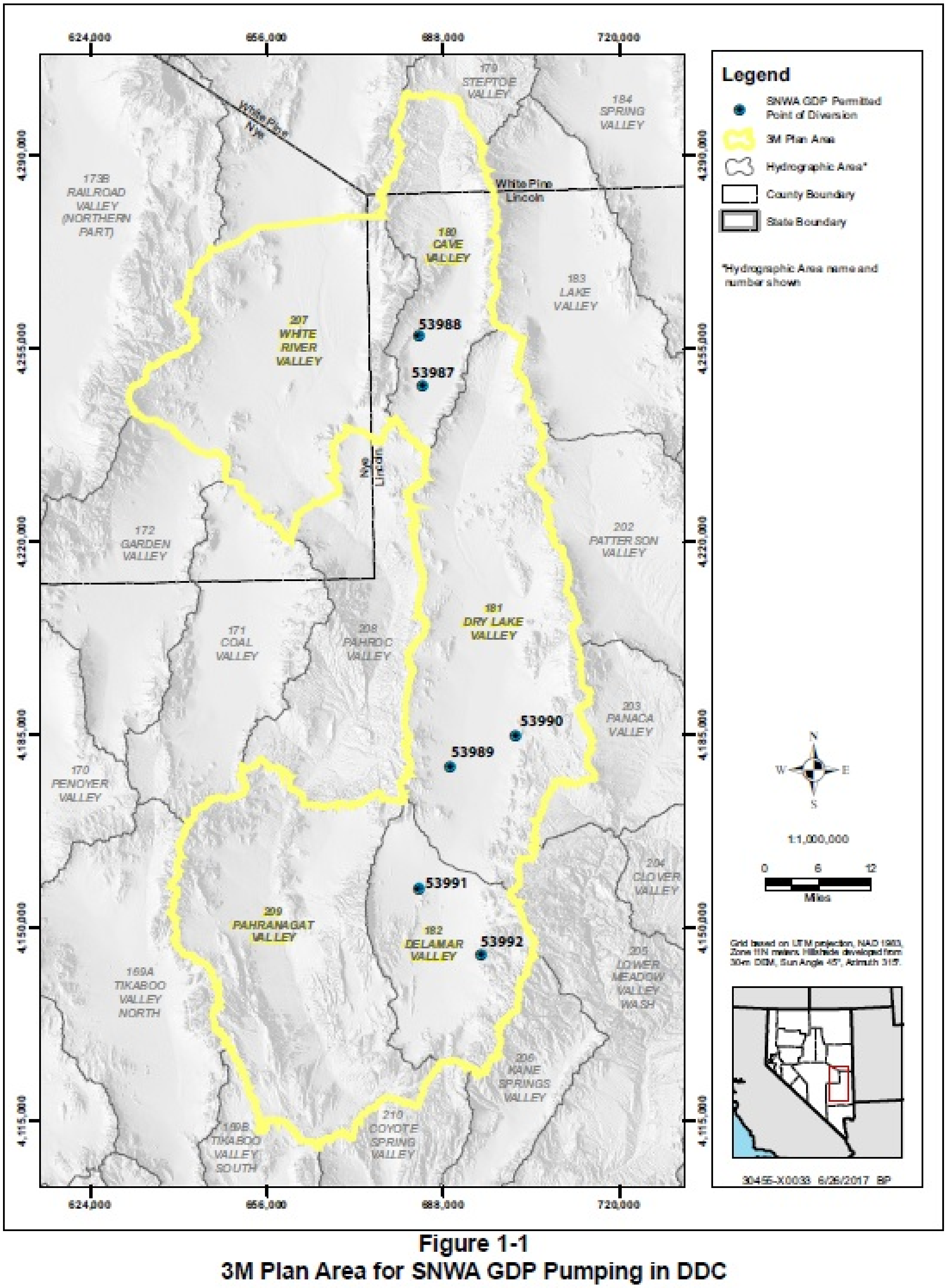

Figure 19: SNWA (2017a) Figure 1-1 showing the area to be considered in the 3M plan for Cave, Dry Lake and Delamar Valleys.

Investigation triggers would be activated at the sentinel wells at 99.7% lower control limit (Marshall et al. 2017, p 8-20), as is the case for the sentinel wells in Spring Valley critiqued above.

SNWA claims it expects no "unreasonable effects" at Flag, Butterfield or Shingle Springs because of staged development, distance from the SNWA production wells, the hydrogeologic setting, and the ability to implement early management actions based on observations at the sentinel monitoring wells (Marshall et al. 2017, p 8-14). None of these activities guarantees success in preventing unreasonable effects, for the following reasons.

- Staged development has not been required or designed in the WRFS, so there is no guarantee it will occur.
- Distance or hydrologic setting does not guarantee a lack of propagation of drawdown if the pathways are narrow, as is likely through Shingle Pass. Drawdown effects could propagate much faster than predicted by any model due to the lack of precision of the models to simulate the pathway.
- There is little confidence that the model can simulate drawdown through the basin boundaries because of uncertainty in the pathways and due to the lack of monitored stresses that would show the drawdown passing through the boundary which can be used to calibrate the model.
- Observations at the proposed sentinel monitoring wells may not provide adequate warning to implement early management actions because there is no certainty the wells are placed adequately on the flow path. That flow path could either be horizontal or vertical, since failure to monitor each productive level separately could allow a signal from one zone to be masked by flow in another zone.

The best way to protect downstream resources in WRV and Pahranagat Valley from SNWA pumping is to monitor the locations of interbasin flow between Cave Valley and WRV, and between Dry Lake and Delamar Valleys and Pahranagat Valley. SNWA proposes sentinel wells, but they are grossly insufficient as just discussed. The following is a brief description of the needed monitoring (partly a repeat of Myers 2017):

- Each identified location of interbasin flow should have a transect of sentinel wells along the basin boundary.
- The sentinel wells along the transect should be spaced no further apart than would detect drawdown expanding through the transect. The spacing should be determined with detailed local modeling, but certainly should not be any less dense than one sentinel well per one square mile due to the potential for narrow pathways.
- Each monitoring location should have all productive vertical levels monitored with either multiport sampling from one well or with nested wells.

- Investigation triggers could be the same as proposed elsewhere, 99.7 percent of the baseline variability.

Detection of drawdown would indicate that pumping has diverted a substantial amount of its rate from interbasin flow. If sentinel wells between valleys detect drawdown, the only way to protect springflows and senior water rights associated with those springs would be to cease pumping in the upgradient basin. Once an investigation trigger is activated, it would be necessary to begin management actions to stop the pumping. This is because the actual pathways will probably be quite heterogeneous, and the interbasin flow will occur through small areas.

It must be emphasized that the exact location of interbasin flows among WRFS groundwater basins is poorly known. It must also be emphasized that the smaller the pathway, the faster drawdown will pass through but also the higher the probability that it will be undetected until impacts already have propagated into downgradient basins. Calculations of the distance that drawdown propagates through the WRFS could vastly underestimate the rate because of the complicated and possible very narrow pathways. There can be little confidence that any 3M plan could adequately detect the effect of SNWA pumping on flows between basins and protect downgradient water rights or GDEs.

5.31 Northern Cave Valley

SNWA also claims it expects no effects in northern Cave Valley from the pumping in southern Cave Valley because the area is significantly higher (Marshall et al. 2017, p 8-7, -13). SNWA should consider the results of its groundwater modeling before making such a claim. FEIS Figure 3.2.2.33 (also Figure 25 in Myers 2017) showed that drawdown extends north of Shingle Pass in Cave Valley. Drawdown predictions also are not without uncertainty, and drawdown could occur beyond the predicted points. Uncertainty in predictions is part of the reason for monitoring. The CCFS model suggests that drawdown in Cave Valley draws flow from north to south and away from the pathway through Shingle Pass to White River Valley.

- There should be a transect of sentinel monitoring wells north of the production wells within Cave Valley to detect drawdown moving northward.

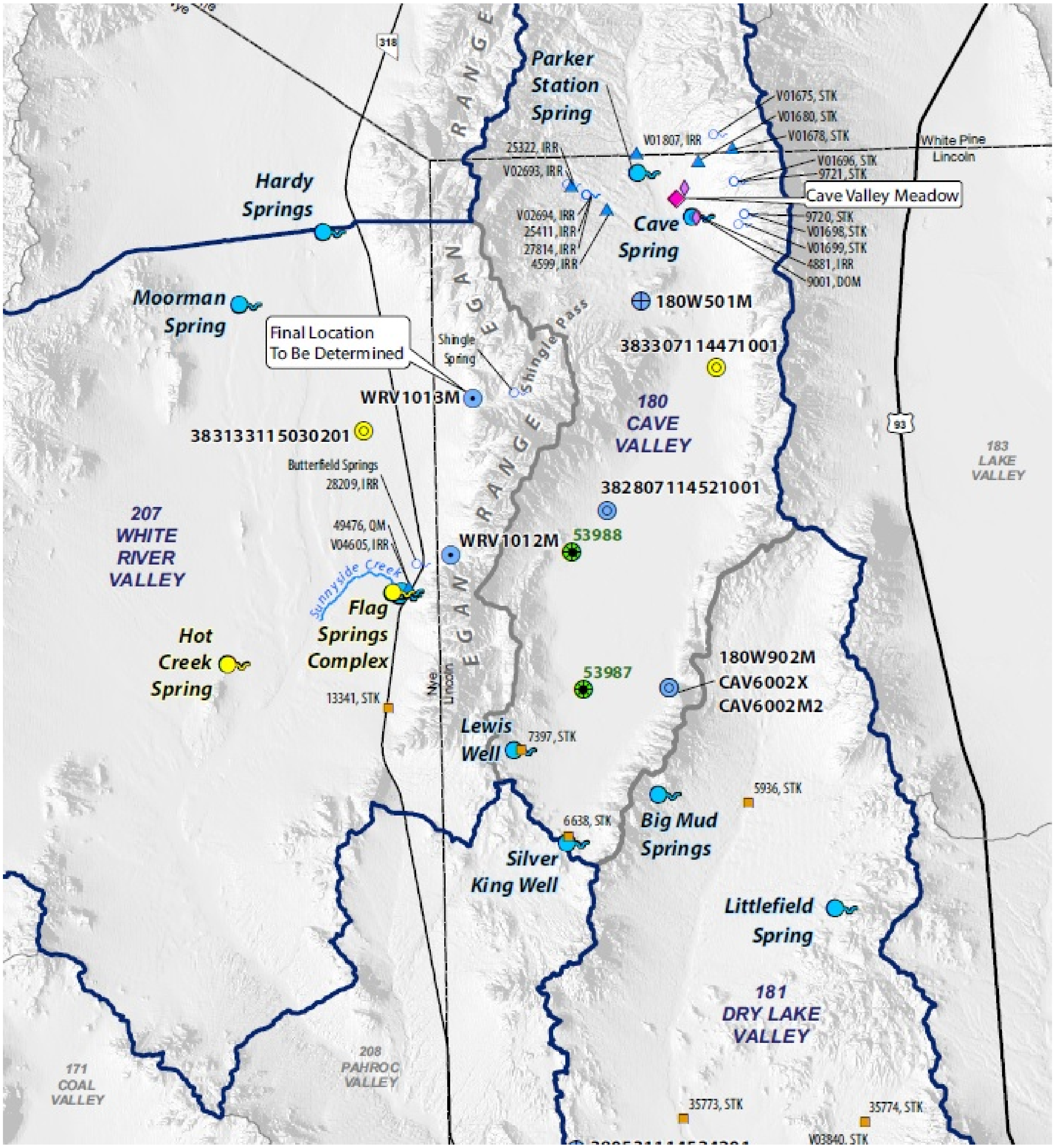

Figure 20: Portion of SNWA (2017a) Figure 2-4 showing springs, monitoring points, and points of diversion in White River Valley, Cave Valley, and Dry Lake Valley.

5.4 Groundwater Model Update

SNWA's commitment to improving groundwater models of the pumping drawdown and protected areas is cursory and very nonspecific (SNWA 2017b, p 4-1). Elsewhere, SNWA has argued that the regional model is not precise enough to predict drawdown near the pumping wells (SNWA 2009a), but SNWA does not acknowledge that argument in this monitoring plan or commit to improving the precision of the CCFS model. Improving precision would differ from redoing the calibration of the existing model in that it would require improving the discretization near the wells and protected features to improve the model calculation precision. SNWA notes it "may also use additional predictive tools during trigger investigations" and include more detailed, local-scale groundwater flow models (SNWA 2017b, p 4-1), but fails to commit to such an improvement. Local modeling would probably have to include improved telescoping of the existing CCFS model.

5.5 Summary

SNWA's 3M plans fall short of designing monitoring networks that have a likelihood of detecting the spread of groundwater pumping stresses in a timely fashion such that senior water rights and GDEs could be protected. The plans leave large distances between monitoring wells through which groundwater drawdown can propagate. The plans also fail to monitor productive aquifer zones separately, so the monitoring wells will not detect some of the drawdown caused by pumping if that drawdown affects separate aquifer layers differently. For example, between Spring Valley and Hamlin Valley, there are about ten miles between wells in carbonate rock even though carbonate rock passes most groundwater through small conduits.

Additionally, the two action triggers identified by SNWA will not protect senior water rights or GDEs. An investigation trigger would be activated once drawdown lowers the water levels at a monitoring well beyond the levels that have been historically observed. However, this event would only initiate an investigation to determine cause and could result in a simple increase in the frequency of monitoring, effectively postponing necessary management or mitigation actions. Mitigation triggers for most of Spring Valley would implement plans to deepen the impacted wells or replace the lost water from other areas; changing pumping rates or locations is listed as only one of numerous possibilities. The 3M plans do not identify where additional water would come from or discuss the fact that deepening a well would merely increase the cumulative drawdown, compounding the very problem that is causing the need for mitigation.

Many senior water rights needing protection in the WRFS are located in downgradient basins, which would be affected by the upgradient diversion of groundwater that otherwise would flow into those downgradient basins. The exact location of interbasin flows among WRFS groundwater basins is poorly known and generally occurs through fracture pathways through the boundaries. It must be emphasized that the smaller the pathway, the faster the drawdown will pass through but also the higher the probability that it will be undetected in a timely fashion. Thus, calculations of the distance that drawdown propagates through the WRFS could vastly underestimate the rate of drawdown because of the complicated and potentially narrow pathways. There can be little confidence that any 3M plan could adequately detect the effect of SNWA pumping on flows between basins such that downgradient water rights or GDEs could be protected.

6. References

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Table A 1: Valley bottom stream water rights for White River Valley, selected as being within the Qa or Qflv formation. All duty units in AFA or AFS.

App	Cert	Filing_Dt	Status	Div_Rate CFS_	Use	Priority	Duty	Owner_of_Record	Div__Balance	Duty_Balance	POU_Acre_Total	Source_Description
V01519		10/5/1917	VST	0	IRR	1/1/1902	1200	KENNECOTT NEVADA COPPER COMPANY	0	1200	200	WATER CANYON CREEK
2334	220	2/7/1912	CER	2	IRR	2/7/1912	800	CARTER-GRIFFIN, INC.	2	800	200	W. BRANCH OF WHITE RIVE
2384	444	3/25/1912	CER	3.29	IRR	3/29/1912	1316	CARTER-GRIFFIN, INC.	3.29	1316	329	WHITE RIVER
2896	773	2/27/1914	CER	0.995	IRR	2/27/1914	398	C4 HOLDING, LLC	0.995	398	99.5	EPH CREEK
3232	1869	1/11/1915	CER	1.929	IRR	1/11/1915	817.36	NEVADA-DEPARTMENT OF WILDLIFE	1.929	817.36	192.9	WHITE RIVER SLOUGH
3235	1872	1/11/1915	CER	1.222	IRR	1/11/1915	443	NEVADA-DEPARTMENT OF WILDLIFE	1.222	443	122.2	HOT CREEK
10118	3021	5/17/1937	CER	8.206	IRR	5/17/1937	3482.36	PRESTON IRRIGATION CO.	8.206	3482.36	820.61	WHITE RIVER
10174	2836	10/4/1937	CER	1	IRR	10/4/1937	544	C4 HOLDING, INC 2/3 UDI; PEACOCK, JOSEPH W. 1/3 UDI	1	544	114.02	ROWE CREEK
11076	3351	3/4/1944	CER	1.461	IRR	3/4/1944	260.35	CARTER-GRIFFIN, INC.	0.73	130.09	146.1	WHITE RIVER SLOUGH
78946		10/7/2009	PER	0.731	IRR	3/4/1944	130.26	CARTER-GRIFFIN, INC.	0.731	130.26	0	WHITE RIVER SLOUGH
11078	3352	3/6/1944	CER	1.024	IRR	3/6/1944	182.51	GUBLER, ERNEST	1.024	182.51	102.42	WHITE RIVER SLOUGH
20466	6663	5/14/1962	CER	0	WLD	5/14/1962	3040	NEVADA-DEPARTMENT OF WILDLIFE	0	3040	0	MOORMAN SPRINGS WASH
20819	7451	10/30/1962	CER	0	IRR	10/30/1962	507	NEVADA-DEPARTMENT OF WILDLIFE	0	507	218	WHITE RIVER
22354	7716	12/7/1964	CER	0	IRR	12/7/1964	9	PEACOCK, JOSEPH W. 1/3 UDI; C4 HOLDING, LLC 2/3 UDI	0	9	3	ROWE CR.&TRIBUTARIES

23624	7468	1/20/1967	CER	2.403	WLD	1/20/1967	1120	NEVADA-DEPARTMENT OF WILDLIFE	2.403	1120	0	WHITE RIVER
38205	12850	5/17/1979	CER	80	WLD	5/17/1979	1230	NEVADA-DEPARTMENT OF WILDLIFE	80	1230	0	SUNNYSIDE CR, HOT CREEK
V10515		4/28/2014	VST	12.9	IRR	1/1/1874	0	JENSEN, BRUCE A. AND PAMELA G.	12.9	0	0	HOT CREEK CHANNEL, WHITE RIVER CHANNEL AND TRIBUTARIES
V04605		7/16/1987	VST	7.69	IRR	1/1/1880	0	NEVADA-DEPARTMENT OF WILDLIFE	7.626	2187.98	551.596	SUNNYSIDE CREEK
V01351		1/11/1915	VST	0	IRR	1/1/1885	11600	NEVADA-DEPARTMENT OF WILDLIFE	0	11600	29000	HOT CREEK
V00801		1/1/1915	VST	0	IRR	1/1/1891	0	NEVADA-DEPARTMENT OF WILDLIFE	0	0	0	HOT CREEK
Total							27079.84			29137.56	32099.346	