Technical Memorandum

Comments on Carbonate Order 1169 Pump Test Data and the Groundwater Flow System in Coyote Springs and Muddy River Springs Valley, Nevada

June 25, 2013

Prepared by: Tom Myers, Ph.D., Hydrologic Consultant

Prepared For: Great Basin Water Network, Baker, NV.

Purpose and Summary

The purpose of this memorandum is to provide an analysis of the pump test completed as required by the Nevada State Order 1169, or the carbonate aquifer order. The analysis is of data published on the Nevada State Engineer web page and the U.S. Geological Survey National Water Information System web page. The data includes pumping rates, groundwater levels, and spring discharge rates. Also, the groundwater model of flow in the southern White River Flow System (Tetra Tech, 2012a and b) was briefly reviewed for predictions related to pumping from Coyote Springs and Muddy River Springs Valley.

A brief summary of the findings is that the groundwater level in the carbonate aquifer in the Muddy River Springs basin began to decrease in the late 1990s in response to increased carbonate pumping from the Arrow Canyon Well. Groundwater levels in the basin fill aquifer also began to decline in the late 1990s even though substantial basin fill pumping has been occurring since the 1980s. This suggests that decreased groundwater inflow to the basin fill from the carbonate may be causing some of the drawdown in the fill.

A wet year in 2005 contributed to a partial recovery of the carbonate groundwater levels, but the decline resumed and accelerated in the late 2000s. The decline of the carbonate groundwater level near Moapa Springs corresponded with a decrease in spring discharge from the Warm Springs and the Pederson Springs at the Moapa Springs complex. The rate of groundwater level decline increased almost at the same time as the pumping for the Order 1169 pump test commenced in late 2010. This suggests that pumping in the carbonate aquifer of Coyote Springs Valley has a cumulative effect with the pumping in Muddy River Springs Valley. The discharge at the Pederson Springs is less than half of its long-term average and the discharge from the Warm Springs dropped to 3.3 cfs, or just 0.1 cfs higher than the rate which would trigger consultation among the agencies under the Fish and Wildlife Service's (FWS) Memorandum of Understanding (MOU).

Pumpage from Coyote Springs Valley during the Order 1169 pump test occurred at rates that are much less than half of the underground water rights already granted in Coyote Springs Valley. About a third of the total current underground water rights in Muddy Springs Valley were pumped at the same time. Pumping just this small proportion of existing underground water rights has caused significant drawdown in the carbonate aquifer of the Muddy River Springs basin and in the southeast portion of the Coyote Springs Valley. The drawdown is significant because it almost caused discharge from the Moapa Springs to decrease to a critical point. Continued pumping at those rates would have lowered the groundwater table further and caused the discharge from the springs to decrease further. It is apparent from the Order 1169 pump test data and from the predictions using the groundwater model that full pumpage of even existing groundwater rights in these two valleys will cause the spring discharge to decrease to rates far insufficient for maintenance of the endangered species dependent on the Moapa Springs as outlined by the FWS. Granting of any additional underground water rights will cause the spring discharge to drop even further below required rates, and may eventually dry the discharge from some or all of the springs, destroying endangered species habitat and harming downstream water rights on the Muddy River.

Introduction

Figure 1 shows the monitoring wells in the Coyote Springs and Muddy River Springs area. They extend from well north in Coyote Springs Valley southeast to and through the Muddy Springs area and south into Garnet Valley. Both production and monitoring wells have been constructed in fill and carbonate aquifers so it should be possible to consider hydraulic connections between the aquifers.

Figure 2 shows the groundwater levels as recorded in July 2011 in the project area basins. The general trend is for water levels to be higher in the north and to drop to a range between about 1814 and 1821 ft amsl near the southeast portion of Coyote Springs Valley and the Muddy River Springs area. The water level in CE-VF-1 (Figure 2), screened in basin fill, is notable because it is about 50 feet higher than the level (not shown) in CE-VF-2, a nearby carbonate well. The very small variation between Coyote Springs Valley and the Muddy River Springs area is also notable because the very small difference in water levels indicates a very small gradient. These water levels will be interpreted with more detail below.

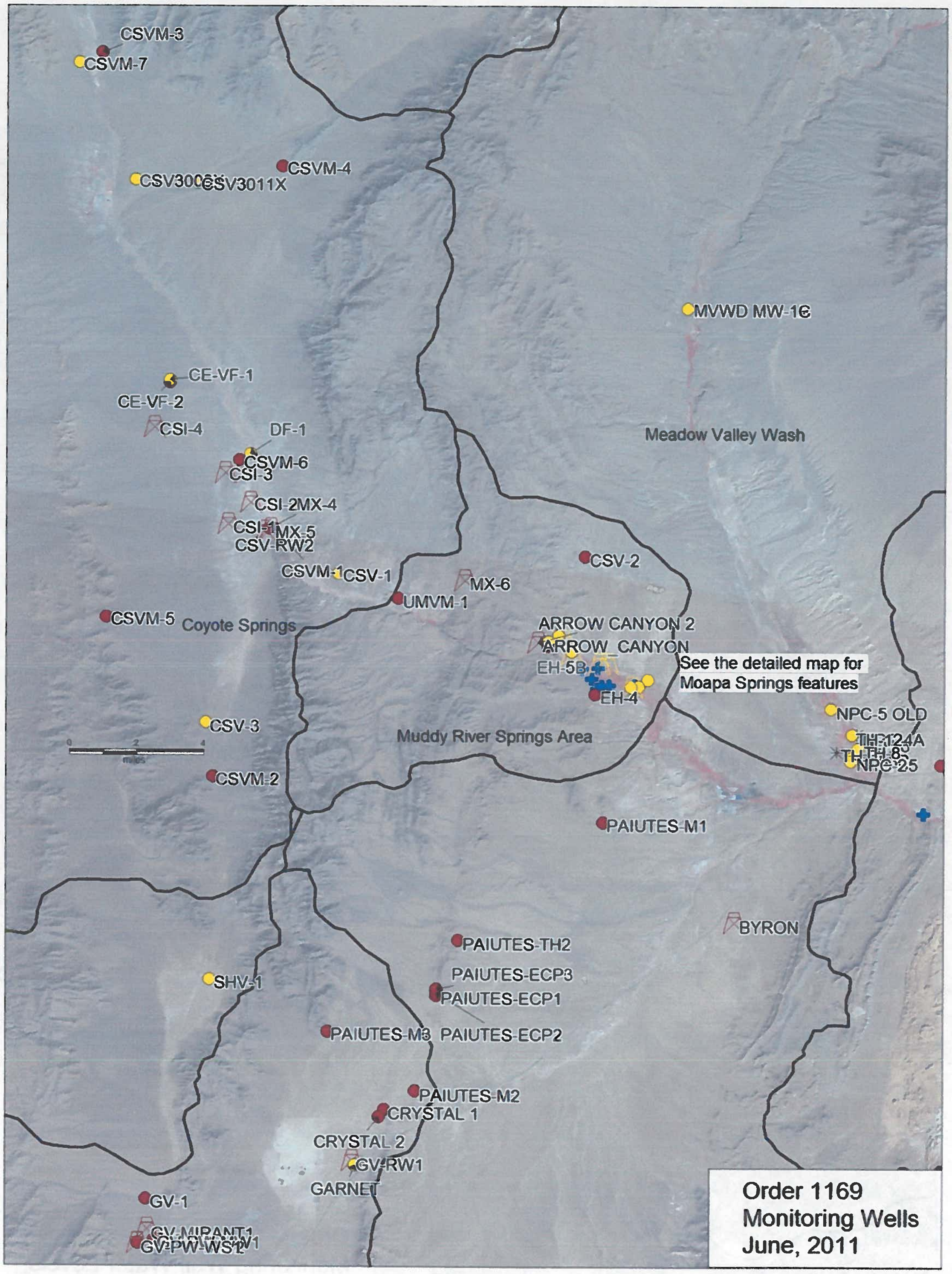

Figure 1: Coyote Springs and Muddy River Springs Area, showing monitoring and production wells. See Figure 2 for a legend explaining the symbols for the wells and Figure 3 for the details of the area around Moapa Springs.

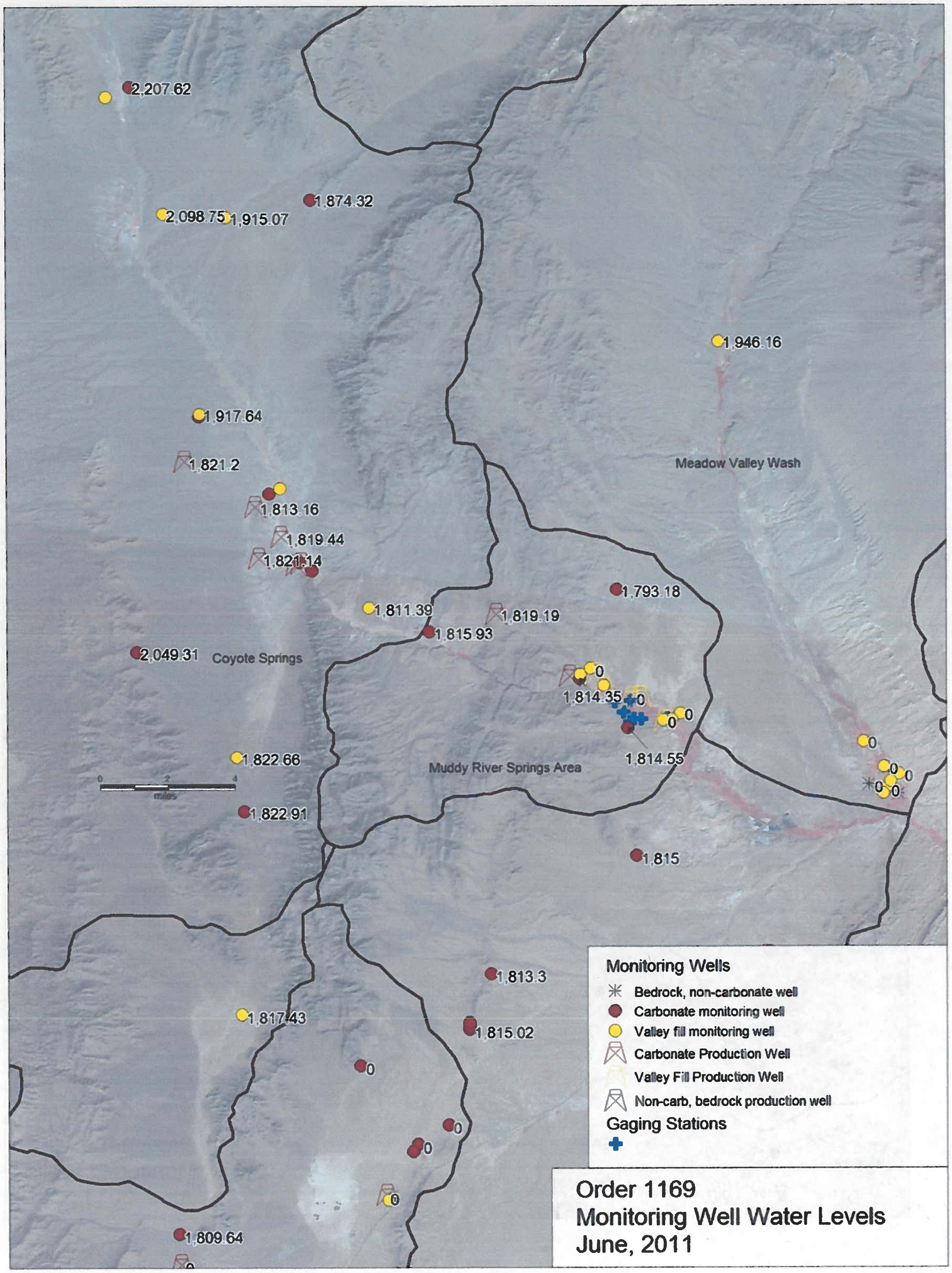

Figure 2: Groundwater levels from July 2011 for miscellaneous wells in the Coyote Springs and Muddy Rivers Springs area.

Figure 3 shows the springs and monitoring wells near the Moapa Springs. It also shows the wells around the Arrow Canyon Well about 1 mile northwest of the springs. Because it is a Landsat image, the red on the map is an infrared image showing the location of riparian vegetation in the area. The springs in the area have created a substantial riparian wetland zone downstream of the Moapa Springs.

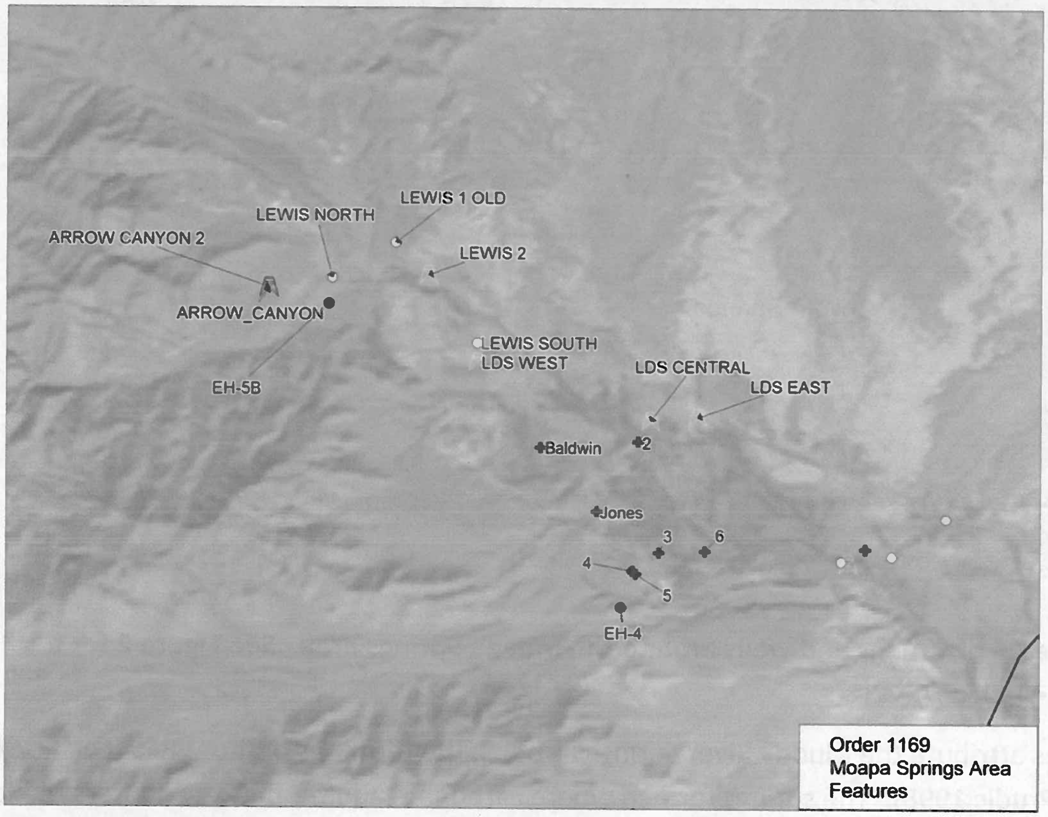

Figure 3: Detail of springs and wells around the Moapa Springs area. See Figure 2 for a legend explaining symbols. The map shows the location of monitored springs with their elevation. Only the continuous-recording stations have been analyzed in this memorandum. 2 – Muddy Springs at L.D.S. Farm near Moapa, NV (09415900); 3 – Warm Springs West near Moapa, NV (09415920); 4 – Pederson Spring near Moapa, NV (09415910); 5 - Pederson East Springs near Moapa, NV (09415908), 6 – Warm Springs Confluence at Iverson Flume near Moapa, NV (09415927)

Figure 4 shows the wells in the southeastern portion of Coyote Springs Valley. Many of the production and monitoring wells in this area are completed in the carbonate aquifer. The map shows that the ridges north and south of the well cluster are offset by about a mile, which may coincide with a significant flow pathway between valleys (Figure 5).

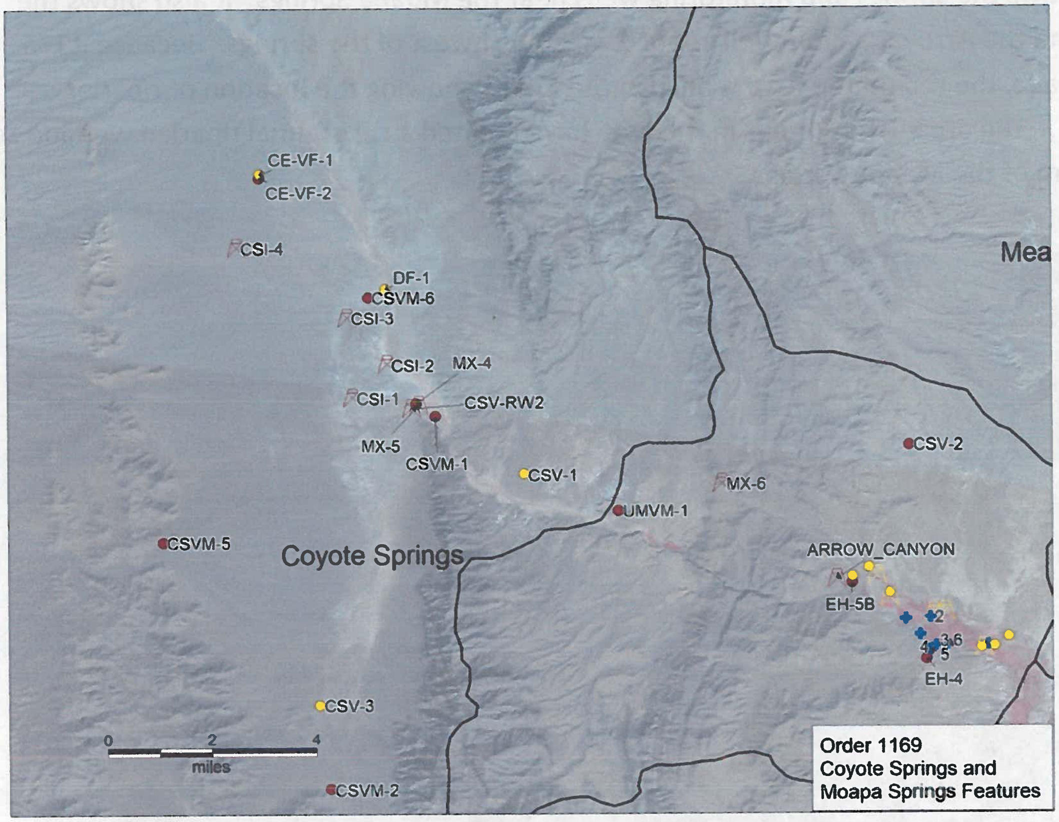

Figure 4: Detail of springs and wells around the Moapa Springs area. See Figure 2 for a legend explaining symbols.

Most studies attribute the Muddy River Springs as being the terminus of the WRFS (Eakin 1966, Harrill and Prudic 1998). The springs formed where carbonate aquifer flow encounters the low permeability Muddy Creek formation at a normal fault (Figure 5). About 20 springs in a 1.2 mile radius area discharge water ranging in temperature from 26 to 32°C (Mayer and Congdon 2008). The total spring discharge is about 36,000 af/y (Eakin 1964, Order 1169).

The flow estimate is from the long-term gage, Muddy River at Moapa (99416000). River flow at this gage is much larger than the sum of the measured discharges from the springs. Eakin (1964) presents a series of measurements, collected in 1963, which include the discernable spring orifices and river flows. That the river flows, including that at the gage, exceed the measured spring flows indicates that a substantial amount of flow, considered to be discharge from the Muddy River Springs, is actually seeps into the river. Johnson and Mifflin (2006), using data from earlier proprietary studies, suggest inflow from the carbonate to the alluvial aquifer equals 34 cfs and that the large springs discharge a total of 17 cfs through "carbonate-cemented conduits through the alluvial gravels (Johnson and Mifflin 2006, page 25). Eakin (1964) notes that the groundwater level from just east of the Arrow Canyon (west of Warm

Springs West) to the White Narrows is just ten feet or so below the ground surface. The natural discharge in this region therefore includes substantial evapotranspiration through riparian vegetation, estimated by Johnson and Mifflin (2006) to equal 4 cfs.

Most of the interbasin flow in the carbonate province occurs through carbonate rocks, but much of the groundwater storage occurs in the basin fill aquifer because of the high primary porosity. Carbonate aquifer flow is primarily through fractures caused by faulting and conduits caused by flow through the fractures dissolving carbonate rock. Primary porosity in carbonate rock is low, but the secondary porosity and conductivity, in the fracture and conduit zones, causes extremely productive zones (Dettinger et al., 1995). Wells constructed in one of these zones may produce high quantities of water with seemingly little head drop, as has been observed at various locations through the southern portion of the study areas (Mayer and Congdon, 2008, Nevada State Engineer Ruling 4542, Bunch and Harrill, 1984). Groundwater flow and storage in Coyote Springs and Muddy River Springs valleys is a good example of this.

Carbonate Aquifer Order 1169

The Nevada State Engineer issued the Carbonate Aquifer Order 1169 in 2002 to place into abeyance all applications for groundwater in six basins in southeast Nevada (Table 1) underlain by the carbonate aquifer until additional information had been collected regarding the effects of pumping from that aquifer in these basins. All six basins are in the southern portion of the White River Flow System (WRFS), which generally discharges to the Colorado River. Basically, the existing water rights in the area (Table 1) already were approximately equivalent to the known discharges from the WRFS. Order 1169 was the State Engineer's response to applications heard in a hearing held in July/August 2001.

Table 1: Tabulation of basins and current water rights in basins affected by Order 1169.

Basin	#	Total UG Rights in Order 1169
Coyote Spring	210	16,300
Black Mountain	215	10,216
Garnet Valley	216	3,380
Hidden Valley	217	2,200
Muddy River Springs	219	14,756
Lower Moapa Valley	220	5,813

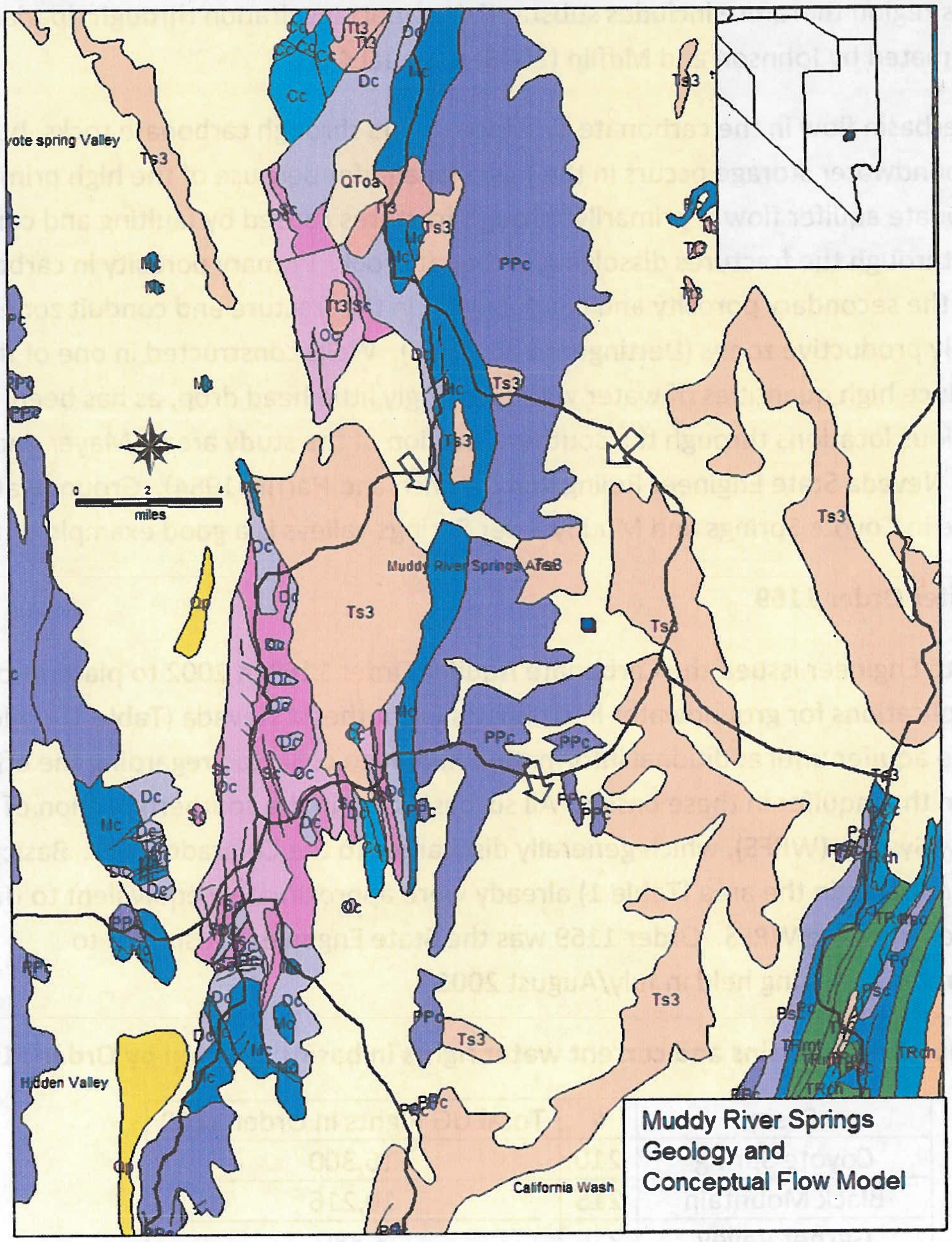

Figure 5: Geology and conceptual flow model of the aquifer system near the Muddy River Springs. Ts3 is volcanic rock, PPc, Mc, and Dc is carbonate rock. The formations west of the Muddy River Springs are the Arrow Canyon Range. The map show faults, but not near the Muddy River Springs because the fault did not appear on the surface. Source: Stewart and Carlson (1978), Stewart (1980).

STATE ENGINEERS OFFICE
2013 JUN 26 AM 10: 36
RECEIVED

Order 1169 required that a study that "must cover a 5-year minimum period during which at least 50% of the water rights currently permitted in the Coyote Springs Valley groundwater basin are pumped for a least 2 consecutive years" (Order 1169, p 6). The State Engineer recognized that the required pumping was not commencing and ordered the 2-year pump test to commence in October 2010 (Order 1169ao); it actually commenced November 15, 2010 and the NSE declared it complete as of December 31, 2012 (Order 1169ao). From May 2005 through March 2013, the total pumpage from Coyote Springs Valley has been 22,300 af (Figure 6). Over an almost 7 ½ year period which included the mandated pump test, the total pumpage from Coyote Spring Valley was just 18% of the total water right that would have been allowed to be pumped during that period, which is about 122,250 af.

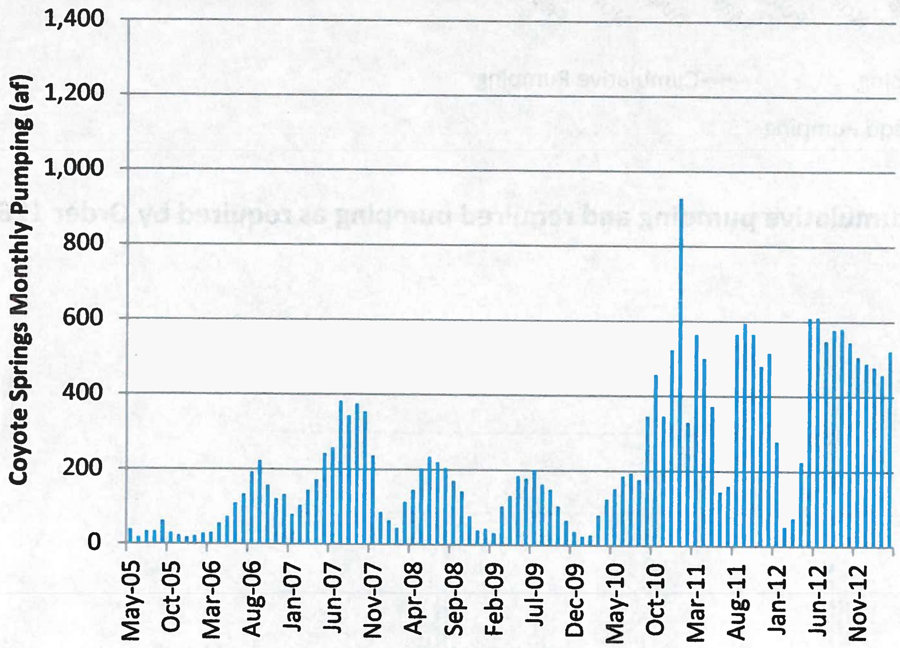

Figure 6: Monthly total pumping from Coyote Spring Valley.

During the period November 2010 through October 2012, there were 10,701 af pumped from Coyote Spring Valley, which is significantly less than the required 16,100 af or 8050 af/y for two years (Figure 7).

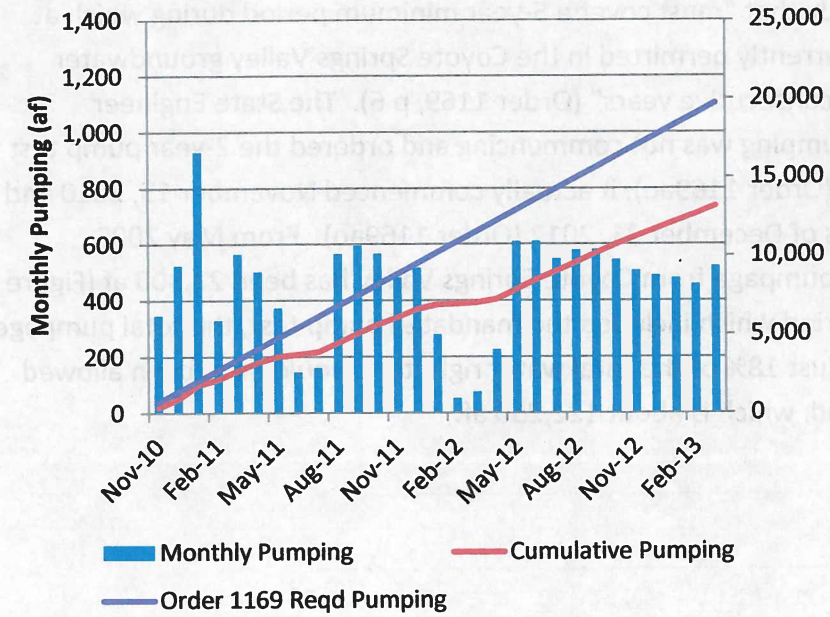

Figure 7: Monthly and cumulative pumping and required pumping as required by Order 1169.

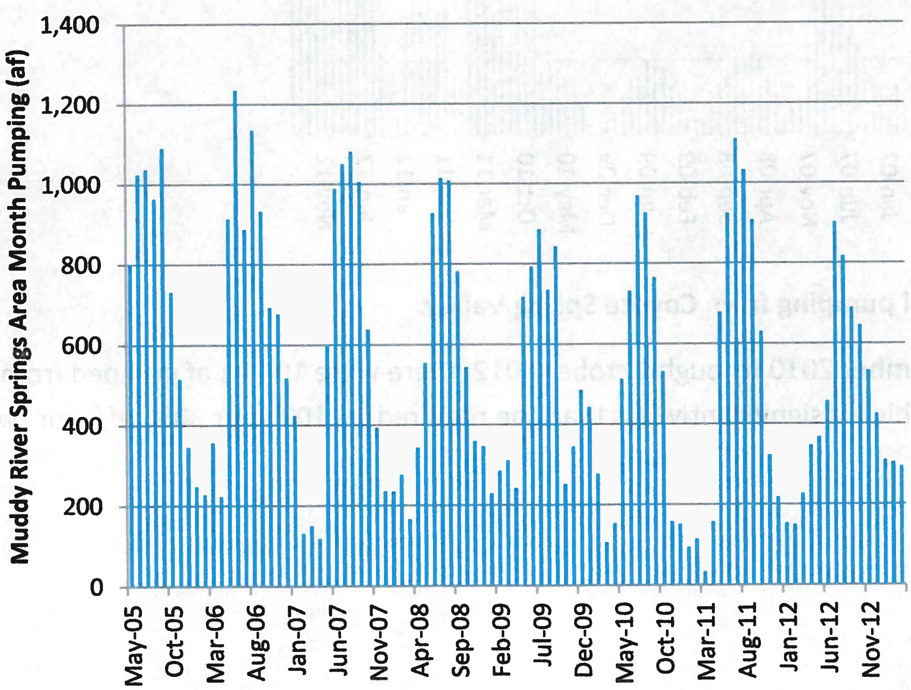

Figure 8: Monthly total pumping from the Muddy Springs Area.

STATE ENGINEERS OFFICE
2013 JUN 26 AM 10: 36
RECEIVED

Water Level Response

This memorandum considers the changes in water levels for two primary areas in the south end of the WRFS, Coyote Springs Valley and Muddy Springs Valley.

Coyote Springs Valley

The general slope of groundwater levels is from greater than 2200 ft amsl to about 1815 ft amsl near the point where the Muddy River Wash exits the valley and flows toward Arrow Canyon (Figure 1). Groundwater levels throughout the valley have been relatively stable when considered at a coarse scale since 1997 (Figure 9). Most of the wells have groundwater levels less than 1950 ft amsl with a cluster ranging from 1810 to 1835 ft amsl since 1997 (Figure 10). Those lower water level wells had decreasing groundwater levels from about 1998 until 2003 after which wet conditions allowed the groundwater level to mostly recover. Since 2005 they have been decreasing with an increase in the rate of water level decrease since pumping for the Order 1169 pump test commenced in 2010 (Figure 10). Several wells, including MX-5 and CSI-3 experience up-to-ten foot decreases due to intermittent pumping; in fact, MX-5 is the primary pumping well in Coyote Springs Valley.

The wells with higher groundwater levels, above 2000 ft amsl, are in the northern portion of the valley away from much of the pumping. Interestingly, water levels there have increased a few feet since the early 2000s (Figure 11). This indicates that stress from pumping in Coyote Springs Valley has not reached north to this area. The wells in Figure 11, CSVM-3 and -7, carbonate and basin fill wells, respectively, both have increasing water levels but the basin fill well (CSVM-7) is at least 40 feet higher than the carbonate well (CSVM-3). Similar observations hold for all of the wells in the north end of the valley.

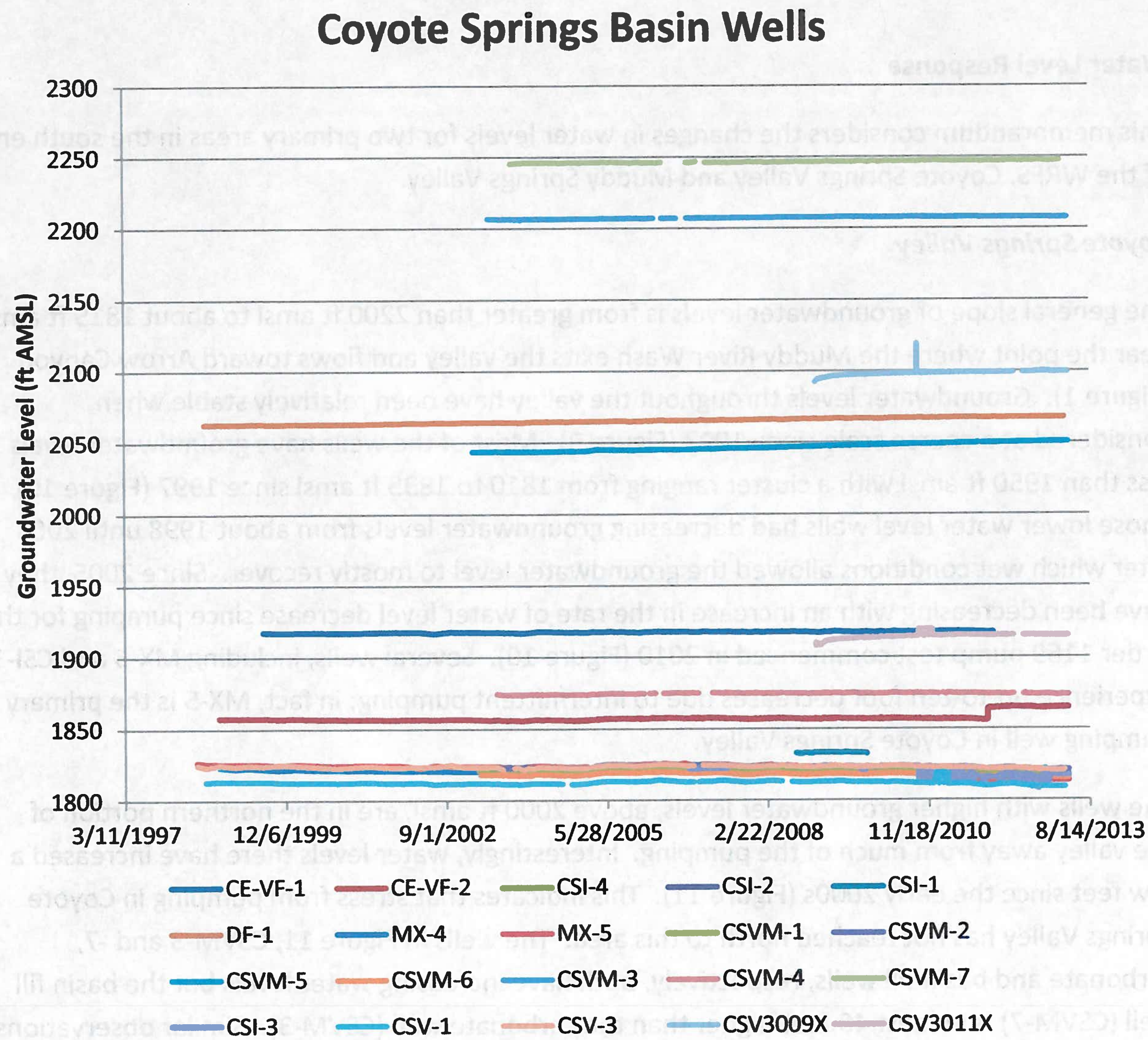

Figure 9: Groundwater level for monitoring and production wells in Coyote Springs Valley. See Figures 1 and 4 for their location, type, and completion.

STATE ENGINEERS OFFICE
2013 JUN 26 AM 10: 36
RECEIVED

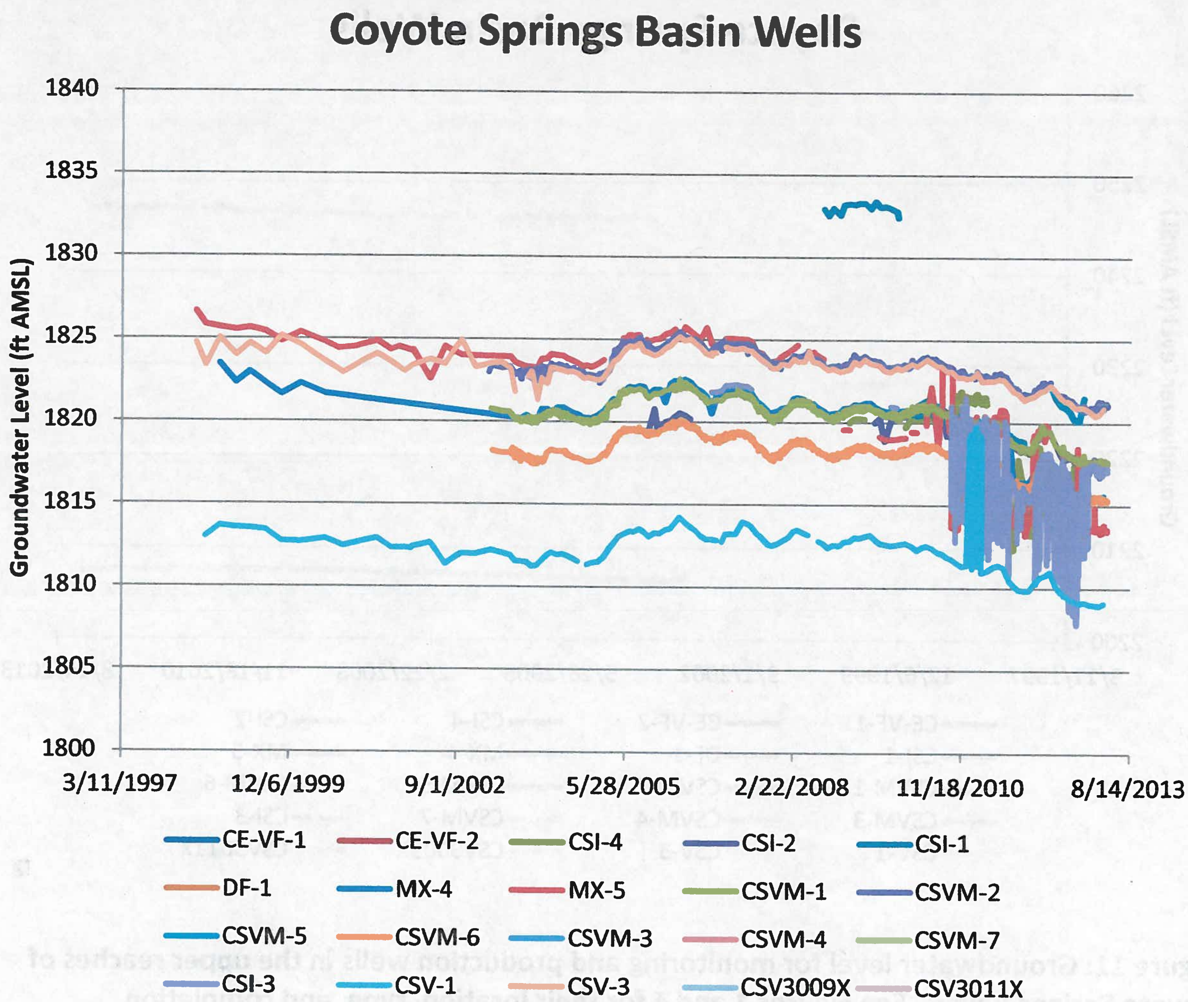

Figure 10: Groundwater level for monitoring and production wells in Coyote Springs Valley near the southeast portion where the valley flows into Muddy Springs Valley.. See Figures 1 and 4 for their location, type, and completion.

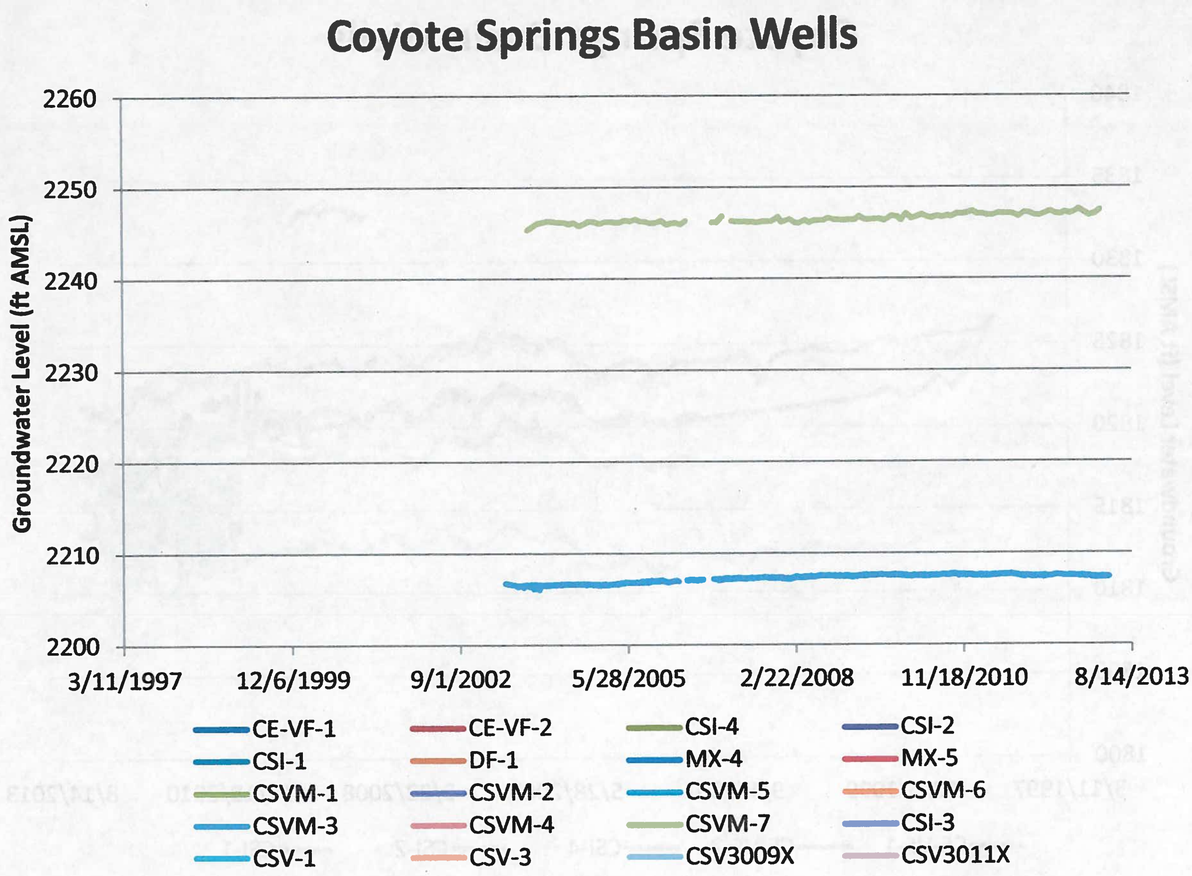

Figure 11: Groundwater level for monitoring and production wells in the upper reaches of Coyote Springs Valley. See Figures 1 and 4 for their location, type, and completion.

Muddy River Springs Area

Muddy River Springs Area and the Moapa Springs are downgradient of Coyote Springs Valley along the Muddy River wash that drains through Arrow Canyon. There are monitoring wells in both the basin fill and carbonate aquifers within the area. Groundwater levels have either remained steady or have decreased at wells within the area (Figure 12). However, groundwater levels at wells close to Moapa Springs have been mostly decreasing since about 1998. Carbonate wells EH-4 and EH-5B have been decreasing since the early 1990s, but they partly recovered in 2005 due to a wet year after which their decrease began again. The rate of water level decrease increased in 2010. Similar observations can be made for well CSV02, another carbonate well north of the springs (Figure 13). Well Lewis North and Boehmer are basin fill wells that have begun to decrease in the mid 1990s; however, the groundwater levels in these fill wells continues to decrease during the pump test, but not at an increased rate (Figure 13). Groundwater levels at the Abbot well, also completed in fill at the downstream end

STATE ENGINEERS OFFICE
2013 JUN 26 AM 10: 36
RECEIVED

of the valley, decreased about ten feet beginning in the mid 1990s to present with very little recovery around 2005, suggesting the wet conditions did not affect it.

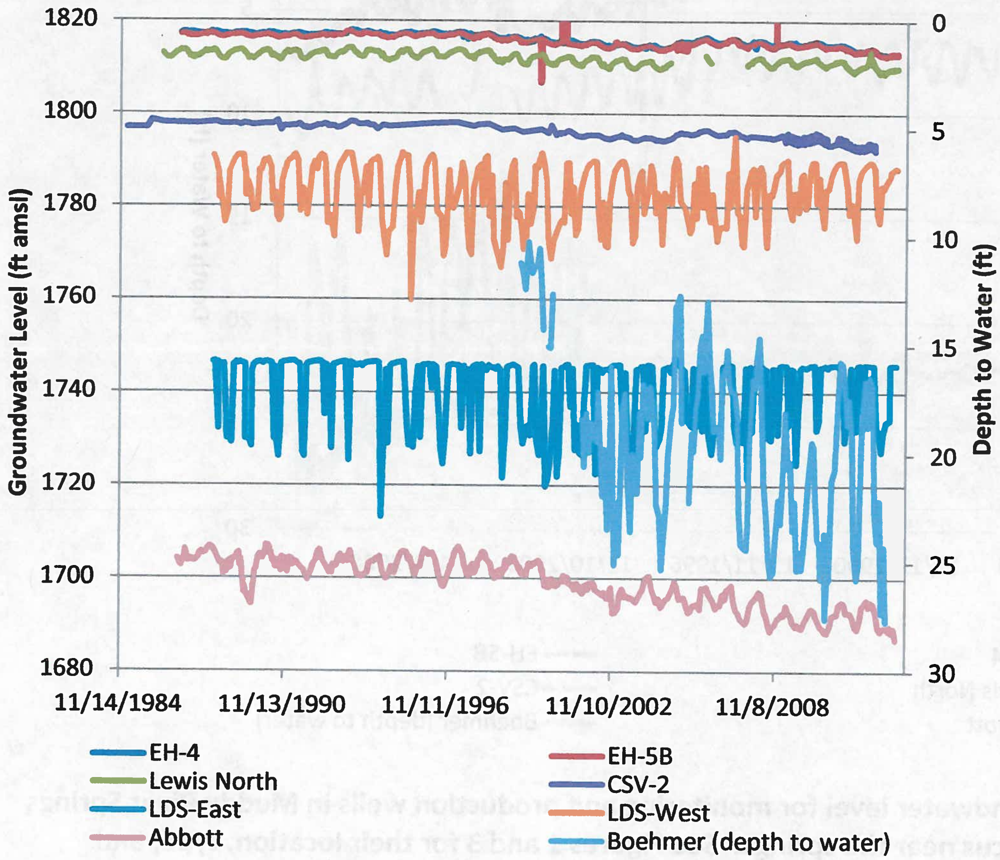

Figure 12: Groundwater level for monitoring and production wells in Muddy River Springs Valley. See Figures 1 and 3 for their location, type, and completion.

The summary for the Muddy River Springs Area is that groundwater levels for all wells have been decreasing since the mid 1990 with some recovery due to wet conditions from 2004 to 2005. During the 2010 to 2012 pump test period the rate of decline in carbonate wells increased.

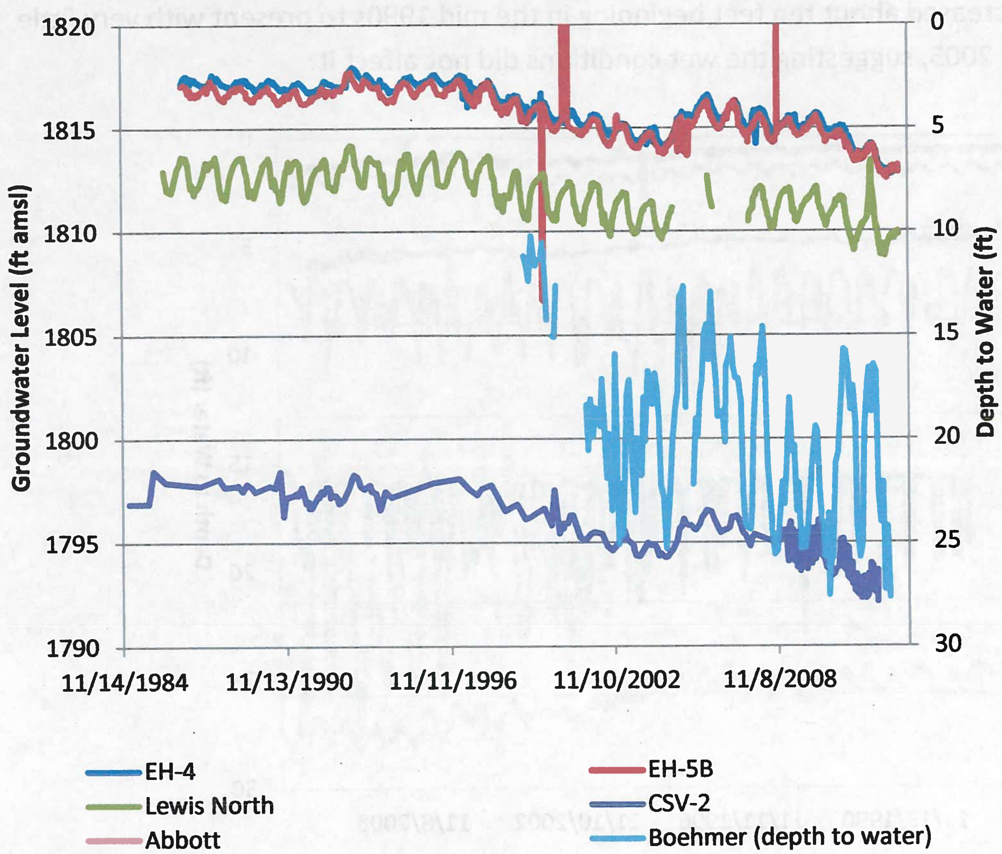

Figure 13: Groundwater level for monitoring and production wells in Muddy River Springs Valley with a focus near the springs. See Figures 1 and 3 for their location, type, and completion.

Spring Response

The most important feature in the area is the Moapa Springs, which is the upstream end of the perennial Muddy River. The average flow in that river, prior to any development, was about 36,000 af/y. Flows on the Muddy River below LDS Farm have many diversions, so the best way to monitor flows from the springs is to consider direct measurements. The cumulative flow from many of the gages began to decline in 1996. Even with a minor increase in 2007, the flows have decreased from the mid 8 cfs range to close to 7 cfs (Figure 14); prior to 1996, the records are unreliable due to an unmeasured diversion. Little change in flow rate appears to have occurred since 2009 or during the pump test period (Figure 14).

STATE ENGINEERS OFFICE
2013 JUN 26 AM 10: 36
RECEIVED

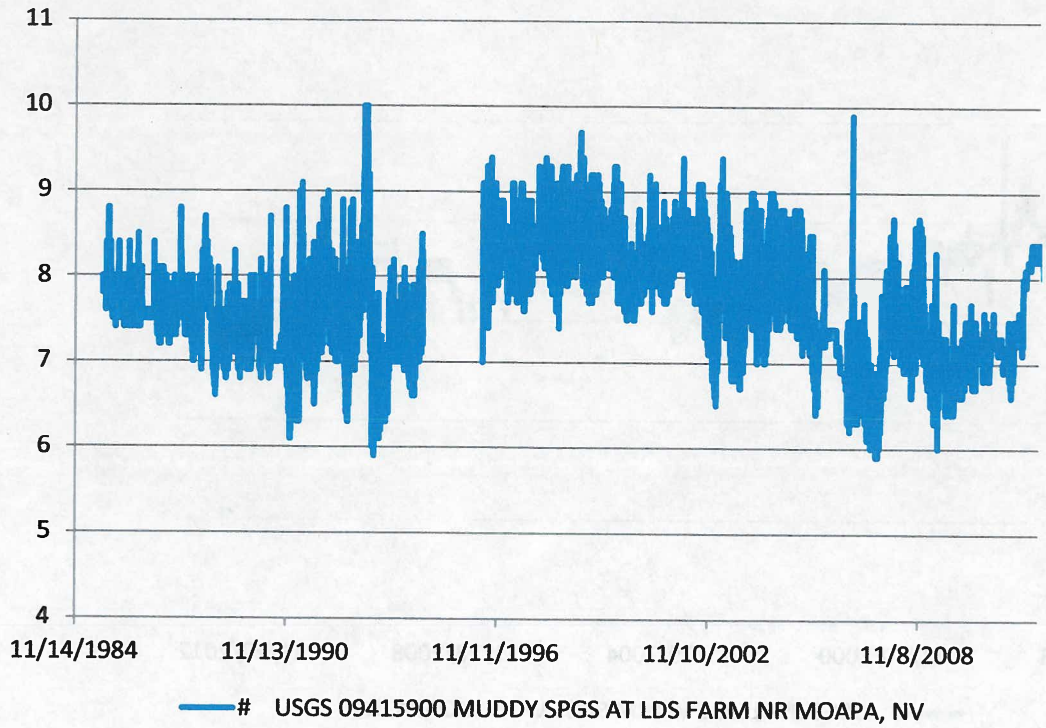

Figure 14: Flow rate downstream of many of the Moapa Springs.

The gage Warm Springs near Moapa is considered a trigger gage because it is at this gage that the Fish and Wildlife Service agreed to monitor the effects of pumping during the pump test (FWS, 2006). The highest trigger point, the flow rate at which the parties to the agreement agreed to meet to determine next steps, is 3.2 cfs. The flow at the gage has been decreasing since about 2009 (Figure 15) and most obviously during the pump test period (Figure 16). For a long period during 2012 and early 2013, the flow remained near 3.3 cfs, or just 0.1 cfs higher that the trigger point. This is the lowest flow recorded at this point since 1996 (Figure 15).

The reduction in discharge from the small Pederson Springs coincides with the low flows at the Warm Springs. The Pederson Springs flows springs had been relatively constant with seasonal fluctuation from 1996 through 2009 (Figure 17), but beginning with the pump test, their flow rates have decreased by more than 50 % (Figure 18); the flows at Pederson Springs near Moapa are less than a third of their value in early 2010 and show no sign of recovery as of April 2013.

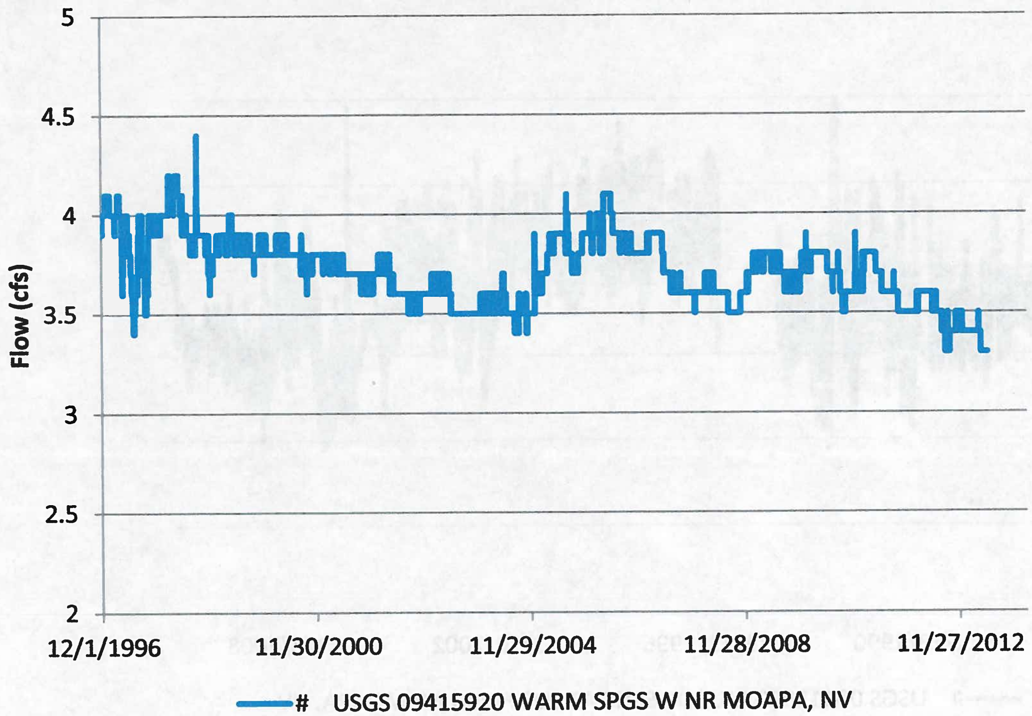

Figure 15: Flow rate at the trigger spring.

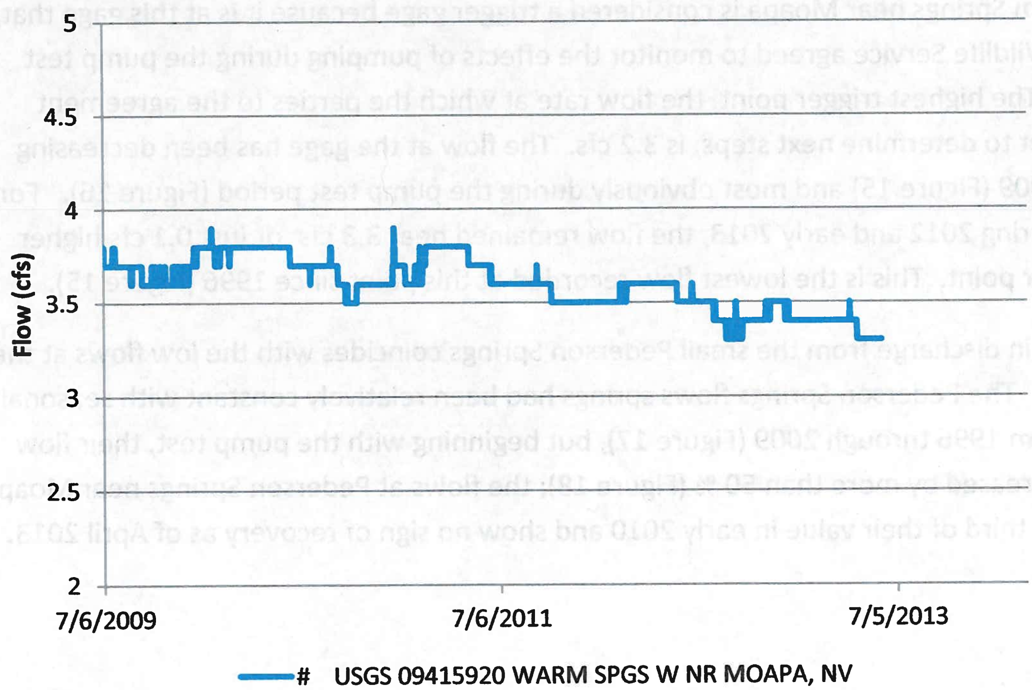

Figure 16: Flow rate at the trigger spring during the Order 1169 pump test.

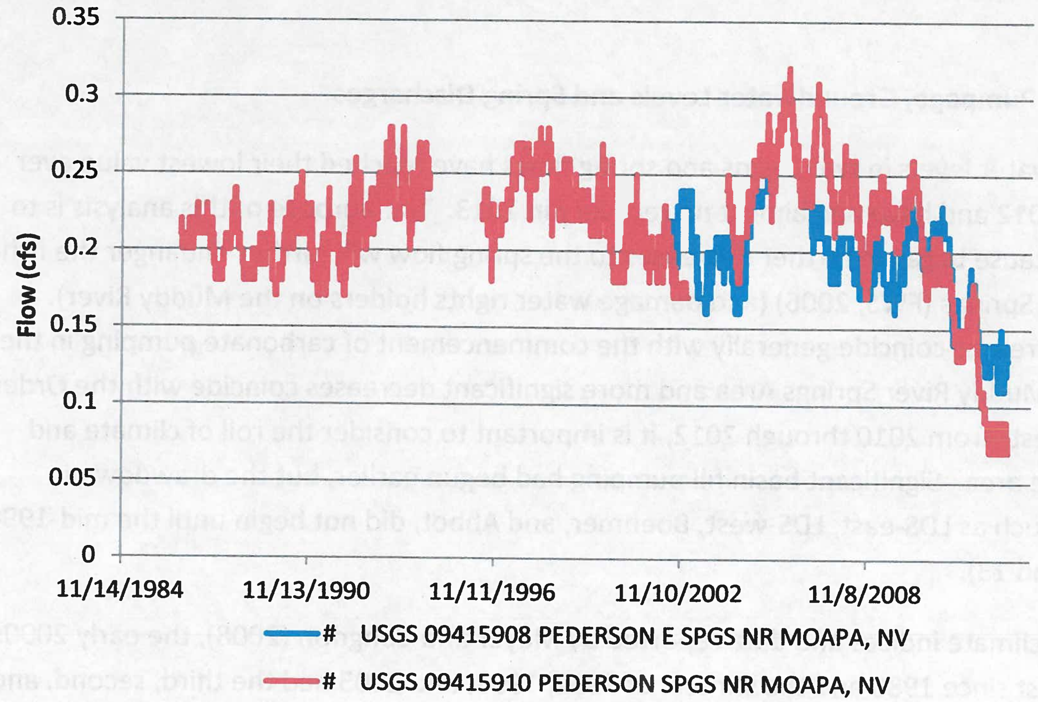

Figure 17: Flow rate at the Pederson Springs near Moapa, NV.

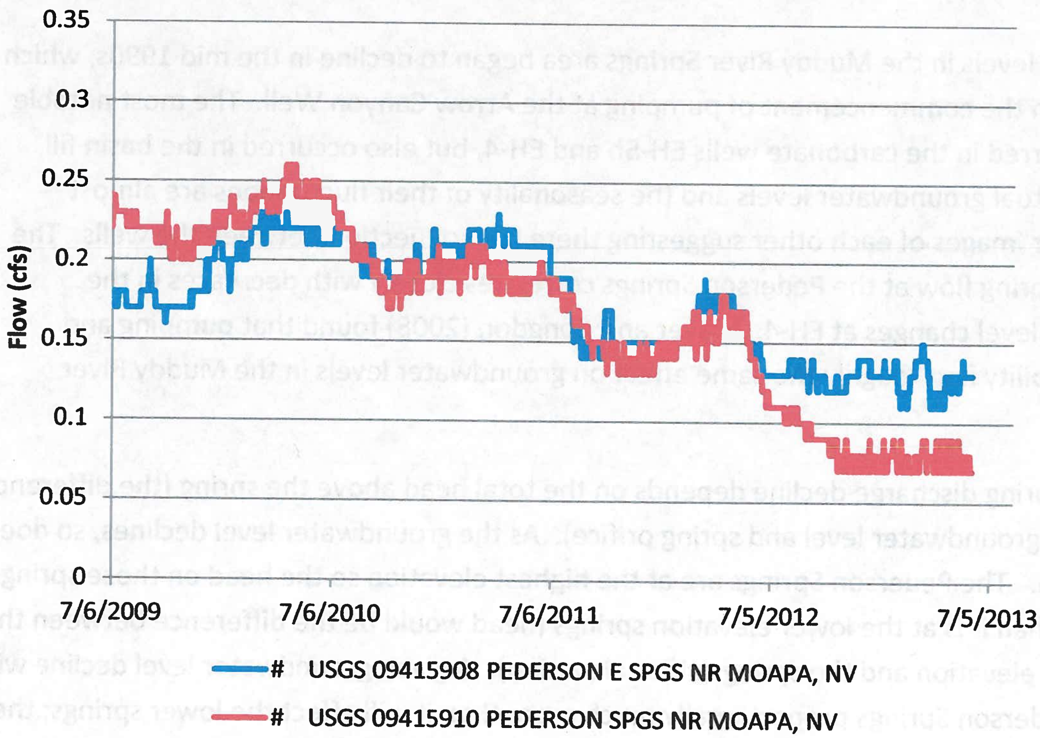

Figure 18: Flow rate at the Pederson Springs near Moapa, NV during the Order 1169 pump test.

Discussion of Pumpage, Groundwater Levels and Spring Discharges

Both groundwater levels in two basins and spring flows have reached their lowest value ever recorded in 2012 and have had almost no recovery in 2013. The purpose of this analysis is to consider the cause because further decreases to the spring flow will further endanger the fishes at the Moapa Springs (FWS, 2006) (and damage water rights holders on the Muddy River). While the decreases coincide generally with the commencement of carbonate pumping in the 1990s in the Muddy River Springs Area and more significant decreases coincide with the Order 1169 pump tests from 2010 through 2012, it is important to consider the roll of climate and drought in the area. Significant basin fill pumping had begun earlier, but the drawdown in those wells, such as LDS-east, LDS-west, Boehmer, and Abbot, did not begin until the mid-1990s (Figures 12 and 13).

According to climate indices and data reported by Mayer and Congdon (2008), the early 2000s were the driest since 1980 and the winters of 1992, 1993, and 2005 had the third, second, and highest precipitation totals since 1985. After 2005 the region primarily returned to drought conditions. The late 1990s were among the wettest years since 1980 (Mayer and Congdon 2008).

Groundwater levels in the Muddy River Springs area began to decline in the mid 1990s, which coincides with the commencement of pumping at the Arrow Canyon Well. The most notable declines occurred in the carbonate wells EH-5b and EH-4, but also occurred in the basin fill wells. The actual groundwater levels and the seasonality of their fluctuations are almost perfect mirror images of each other suggesting there is a connection between the wells. The decrease in spring flow at the Pederson Springs correlates closely with decreases in the groundwater level changes at EH-4. Mayer and Congdon (2008) found that pumping and climate variability had roughly the same effect on groundwater levels in the Muddy River Springs area.

The rate of spring discharge decline depends on the total head above the spring (the difference between the groundwater level and spring orifice). As the groundwater level declines, so does the discharge. The Pederson Springs are at the highest elevation so the head on those springs is likely less than it is at the lower elevation springs (head would be the difference between the groundwater elevation and the spring orifice elevation). A given groundwater level decline will affect the Pederson Springs proportionally much more than it will affect the lower springs; the spring discharge is a much larger proportion of the actual flow than it would be for a spring with more head on it.

RECEIVED
2013 JUN 26 AM 10: 36
STATE ENGINEERS OFFICE

The spring monitored for compliance with the stipulated agreement has a lower elevation and therefore presumably has more head. Well EH-4 has dropped from about 1817 to 1813 ft amsl since the mid-1990s during a period the discharge from the Warm Springs has dropped from about 3.9 to 3.3 cfs. If the relationship is linear, the spring would go dry if the groundwater level dropped 26 feet to about 1793 ft amsl. The datum for the spring is 1771 which suggests the water level would actually have to drop further than 26 feet and that the relationship between discharge and groundwater level at EH-4 is not exactly linear. This could be due to the fact that the monitored flow is the cumulative flow from springs above the measuring point. Well EH-4 is constructed in the carbonate aquifer and the spring discharges from the carbonate aquifer, so the well must be on the direct pathway to the spring.

The Arrow Canyon wells are completed in the carbonate aquifer and have been pumped since 1988 but much more extensively since 1998. Since 2000, there has been 28,735 af pumped from those wells (Figure 19). It was a significant portion of the total amount pumped in Muddy River Springs area (Figure 8 and Figure 19), although most of the pumpage other than from Arrow Canyon wells was from basin fill wells. Until the Order 1169 pump test, it was the largest withdrawal from the carbonate aquifer.

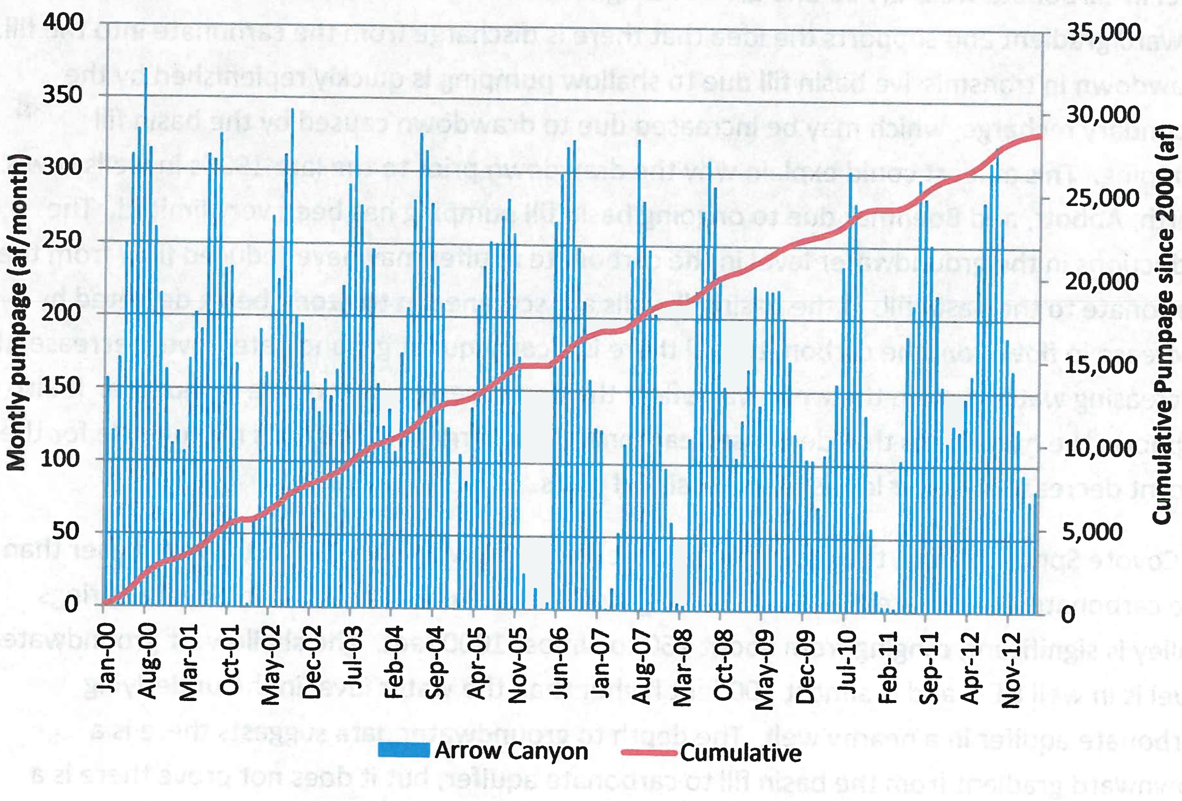

Figure 19: Monthly and cumulative pumping from the carbonate Arrow Canyon Well.

The Order 1169 pump test, although it did not even meet the pumping requirements specified in Order 1169, more than doubled the pumpage from the carbonate aquifer. Groundwater levels in the EH-5b and EH-4 wells declined more rapidly beginning almost coincidentally with the pump test (Figure 13). This suggests the pumping in Coyote Springs Valley has an additive effect with the pumping at Arrow Canyon, the pumping rate of which did not apparently decrease very much during the pump test (Figure 19), on the drawdown in the carbonate aquifer. Because of the linkage between the spring discharge and the groundwater level at EH-4 (and EH-5b), the Order 1169 pumping along with the Arrow Canyon pumping has caused most of the observed decrease in spring flow at the Moapa Springs. The drought has added to the effects, but without the pumping the declines would not have been that significant as can be observed considering the water levels in the early 1990s after an earlier period of significant drought.

The response of the basin fill wells is not indicative of the basin fill pumping, which in the Muddy River Springs area is substantial. Groundwater in the basin fill is likely secondary recharge of the water discharging from the various springs and discharge from the underlying carbonate aquifer into the basin fill, as suggested by Johnson and Mifflin (2006). That the water level in carbonate wells EH-5b and EH-4 are higher than the levels in the fill indicates there is an upward gradient and supports the idea that there is discharge from the carbonate into the fill. Drawdown in transmissive basin fill due to shallow pumping is quickly replenished by the secondary recharge, which may be increased due to drawdown caused by the basin fill pumping. This at least could explain why the drawdown prior to the late 1990s in wells Lewis North, Abbott, and Boehmer due to ongoing basin fill pumping has been very limited. The reductions in the groundwater level in the carbonate aquifer may have reduced flow from the carbonate to the basin fill. If the basin fill wells are screened in the zone being depleted by a decrease in flow from the carbonate and there is a consequent groundwater level decrease, the decreasing water level in the wells will reflect the decreased flow from the carbonate. It also supports the hypothesis that decreased carbonate discharge into the fill is responsible for the recent decrease in water levels in the basin fill wells.

In Coyote Springs Valley, the groundwater level in the fill was from 25 to 200 feet higher than in the carbonate in most areas. The depth to groundwater in both aquifers in Coyote Springs Valley is significant, ranging from about 160 to almost 1000 feet. The shallowest groundwater level is in well DE-1 and is almost 200 feet higher than the water level in the underlying carbonate aquifer in a nearby well. The depth to groundwater data suggests there is a downward gradient from the basin fill to carbonate aquifer, but it does not prove there is a hydraulic connection. The carbonate pumping did not apparently affect water levels in the basin fill, but due to the thickness of the fill aquifer it is possible that the groundwater levels throughout the fill would not change at one time and that the carbonate pumping actually causes a drawdown at depth and increases the gradient within the fill. The data as presented proves nothing about the connection. Due to the aridity of the basin, very little distributed recharge would be expected within the fill.

Groundwater Model of the Lower White River System

The National Park Service, Fish and Wildlife Service, and others have commissioned a groundwater model of the Lower WRFS (Tetra Tech 2012a and b). The purpose of the model is to estimate the future effects of developing all of the water rights in the basin.

Scenario 1 considers long-term pumping at the rates as occurred from 2009 through 2011 in the 13 basins, which means it considered part of the Order 1169 pump test. It shows the discharge rate from the Warm Springs decreasing to about 3 cfs after 1000 years. After about 50 years, it has reduced to about 3.7 cfs from an initial 3.9 cfs. This minor flow reduction occurred even though the reported drawdown is 1 to 2 and 2 to 5 feet after 10 and 50 years, respectively. These results suggest that the model underestimates the effect of pumping in Coyote Springs Valley. It also may reflect that the reported drawdown is not from the same layer as the simulated spring (reviewing the details of how the spring is simulated are beyond the scope of this memorandum).

Scenario 2 considers pumping all existing rights in the 13 basins, which includes pumping 16,100 af/y from Coyote Springs Valley. It also increases the pumping in the Muddy Springs area to 13,688 af/y from the 5964 af/y simulated in Scenario 1, so it is not possible to assign effects shown at the springs to pumping in either of the valleys. In this scenario, flow at the Warms Springs decreases to 3.0 cfs within 50 years, 2.0 cfs within 190 years, and essentially dries in 1000 years. Other springs have similar reductions, including the Pederson Springs which are dry within 50 years. The predicted drawdown after 50 and 200 years is 10 to 20 and 20 to 50 feet, respectively, which essentially verifies relation between drawdown and decreased discharge observed above.

The impacts from pumping Scenario 2 are due to pumping only the existing water rights in the basin. It would have been useful to simulate pumping only the amount from Coyote Springs Basin to more carefully examine the simulated connection between that valley and the springs. The effects of pumping Scenarios 3 through 7 are immense, with up to hundreds of feet of drawdown and springs going completely dry.

The effects of pumping from the carbonate aquifer on the spring flow may have been significantly underestimated because the model simulates drawdown expanding in many directions from the areas of pumping. In general, for Scenario 2, drawdown up to 100 feet covers much of the southwestern third of the model domain. The drawdown parallels the west boundary due to model boundary effects. Tetra Tech (2012b, p 62) claims this is due to "high transmissivity and low storativity of the carbonate aquifer". The reality may actually be that the model simulates the aquifer as a homogenous porous media across which the effects spread evenly in all directions. The aquifer due to its highly transmissive pathways would actually be very horizontally anisotropic which means that high transmissivity would occur only in one direction. It is also likely that the high transmissivity pathways end at the springs, due to a fault and termination of the carbonate rock which causes groundwater to surface in the springs.

Because of the horizontal anisotropy, it is likely that the volume from which groundwater can be removed from storage is much less than simulated in the model. It is therefore likely that the extent of the highly transmissive aquifer zone will be reached much sooner than simulated and that water levels in the Muddy Springs Area and the spring discharge will decrease more quickly than predicted by the model. The apparent additive effect of the Coyote Spring and Arrow Canyon pumping is substantial evidence that pumping from the carbonate aquifer in this area directly lowers the water table and is directly drawn from the Moapa Springs.

Conclusion

The purpose of the Order 1169 pump test was to stress the aquifer to determine whether to grant the water right applications that have been held in abeyance and to provide information as to what to do with all of the additional applications that have been filed since 1989. This memorandum did not summarize the applications but a brief compilation of the total amounts are provided in Tetra Tech (2012b).

Pumpage from Coyote Springs Valley during the Order 1169 pump test occurred at rates that are much less than half of the underground water rights already granted in Coyote Springs Valley. About a third of the total current underground water rights in Muddy Springs Valley were pumped at the same time. Just this small amount of pumping, in comparison with the total permits in the valleys, has caused significant drawdown in the carbonate aquifer of the Muddy River Springs basin. The drawdown is significant because it almost caused discharge from the Moapa Springs to decrease to a critical point. Continued pumping at those rates would have lowered the groundwater table in the carbonate aquifer further and caused the discharge from the springs to decrease further. It is apparent from the Order 1169 pump test data and from the predictions made using the groundwater model (Tetra Tech, 2012b) that full pumpage of even existing groundwater rights in these two valleys will cause the spring discharge to decrease to rates far insufficient for maintenance of the endangered species dependent on the Moapa Springs. Granting future water rights in these valleys will cause the spring discharge to drop even further below required rates, and may eventually dry the discharge from some or all of the springs, destroying endangered species habitat and harming downstream water rights on the Muddy River.

RECEIVED
2013 JUN 26 AM 10:36
STATE ENGINEERS OFFICE

The pump test has provided no data with which to consider water rights in the other valleys subject to the Order. Considering that there is little recharge to the basin fill and that the carbonate aquifer likely has highly conductive but limited transmissive zones, similar effects due to pumping from these valleys could be expected. There has been insufficient pumping from the carbonate aquifer in these valleys to know what discharge would be affected.

References

Bunch, R.L., and J.R. Harrill, 1984. Compilation of Selected Hydrologic Data from the MX Missile-Siting Investigation, East-Central Nevada and Western Utah. U.S. Geological Survey Open-File Report 84-702.

Eakin, T.E., 1964. Ground-Water Resources Reconnaissance Series Report 25, Ground-Water Appraisal of Coyote Spring and Kane Spring Valleys and Muddy River Springs Area, Lincoln and Clark Counties, Nevada. U.S. Geological Survey.

Eakin, T.E., 1966. A regional interbasin groundwater system in the White River area, southeastern Nevada. Water Resources Research 2(2):251-271.

Fish and Wildlife Service, 2006. Intra-Service Programmatic Biological Opinion for the Proposed Muddy River Memorandum of Agreement Regarding the Groundwater Withdrawal of 16,100 Acre-Feet per Year from the Regional Carbonate Aquifer in Coyote Spring Valley and California Wash Basins, and Establish Conservation Measures for the Moapa Dace, Clark County, Nevada. January 30, 2006. Reno, NV.

Harrill, J.R. and D.E. Prudic, 1998. Aquifer systems in the Great Basin Region and Nevada, Utah, and Adjacent States – Summary Report. Regional Aquifer-System Analysis – Great Basin, Nevada-Utah. U.S. Geological Survey Professional Paper 1409-A.

Johnson, C., and M. Mifflin, 2006. The AEM and regional carbonate aquifer modeling. Ground Water 44(1): 24-34.

Mayer, T.D., and R.D. Congdon, 2008. Evaluating climate variability and pumping effects in statistical analyses. Ground Water 46(20):212-227

Stewart, J.H. 1980. Geology of Nevada: Nevada Bureau of Mines and Geology Special Publication 4. Nevada Bureau of Mines and Geology, Reno NV

Stewart, J.H., and J.E. Carlson, 1978. Geologic map of Nevada: Nevada Bureau of Mines and Geology Map, scale 1:500,000.

Tetra Tech, Inc., 2012a. Development of a Numerical Groundwater Flow Model of Selected Basins within the Colorado Regional Groundwater Flow System, Southeastern Nevada, Prepared for National Park Service, U.S. Fish and Wildlife Service, and Bureau of Land Management. Louisville, CO.

Tetra Tech, Inc., 2012b. Prediction of the Effects of Groundwater Pumping in the Colorado Regional Groundwater Flow System, Southeastern Nevada, Prepared for National Park Service, U.S. Fish and Wildlife Service, and Bureau of Land Management. Louisville, CO.

GREAT BASIN WATER NETWORK

PO Box 75
Baker, NV 89311

June 25, 2013

Jason King, State Engineer
Nevada Division of Water Resources
901 South Stewart St. #2002
Carson City, NV 89701

Dear Mr. King:

We appreciate the invitation by Deputy State Engineer Rick Felling at the February 2013 NWRA conference in Reno to submit comments on the pump test results from implementing Order #1169 in Coyote Spring Valley and 5 other basins in southeastern Nevada.

Based on the results of Dr. Tom Myers' review and analysis of the pump test results, it seems clear that even pumping less than 50% of existing groundwater rights in Coyote Springs Valley caused a decrease in spring flows to critical levels for the endangered Moapa Dace in the Muddy River Springs basin, and appeared certain to cause serious adverse impacts on senior water rights in downgradient basins had the test pumping continued. In view of this stark demonstration of the regional groundwater system's limits, we urge the State Engineer to deny all pending applications in Coyote Springs Valley and in the rest of the 6 basins comprising the lower portion of the White River Flow System (WRFS) in southeastern Nevada. We also urge the State Engineer to take administrative actions in Coyote Springs and, where appropriate in the other 5 basins, to reduce existing water permits to sustainable levels.

Dr. Myers' review of the pump test and other data clearly shows the link between groundwater pumping in these valleys and spring discharges. It also supports the conclusion that full pumping of existing underground water rights will unacceptably decrease spring discharges in the Muddy River Springs basin. GBWN believes that any additional pumping of the WRFS, including pumping in Cave, Dry Lake and Delamar basins, will exacerbate the problem of decreasing spring flows and eventually dry up of springs in the downgradient basins.

Even before the full completion of Order #1169's five-year pump test period, and without pumping an amount of groundwater close to the intended 50% of the existing water rights in Coyote Spring Valley for at least 2 consecutive years, the pump test results show clear decreases in spring discharges at Moapa Warm Springs to within 0.1 cfs of the trigger point of 3.2 cfs set in the MOU agreed to by the US Fish and Wildlife Service. Spring flows lower than 3.2 cfs were recognized as insufficient to maintain the endangered Moapa Dace.

Thank you for considering our comments and Dr. Myers' attached Technical Memorandum: "Comments on Carbonate Order 1169 Pump Test Data and the Groundwater Flow System in Coyote Springs and Muddy River Springs Valleys, Nevada."

Sincerely,

Abby Johnson /s/

Abby Johnson, Chair
Great Basin Water Network

Attachment - Dr. Myers's TM

RECEIVED
2013 JUN 26 AM 10: 36
STATE ENGINEERS OFFICE