NEVADA DIVISION OF WATER RESOURCES

Basin Status Assessment Map Series

November 2023

Introduction:
The following series of maps provides a basin-scale display of various indicators related to groundwater supply conditions in Nevada. These maps were collectively prepared by the Division of Water Resources to address common questions about areas in the state where groundwater problems exist. The first five maps each focus on a specific indicator of potential groundwater problems or risk, while the final map combines all five indicators weighted equally. It is important to note that these maps are entirely data-driven and rely on publicly available baseline data. No subjective or qualitative assessments were made regarding the data.

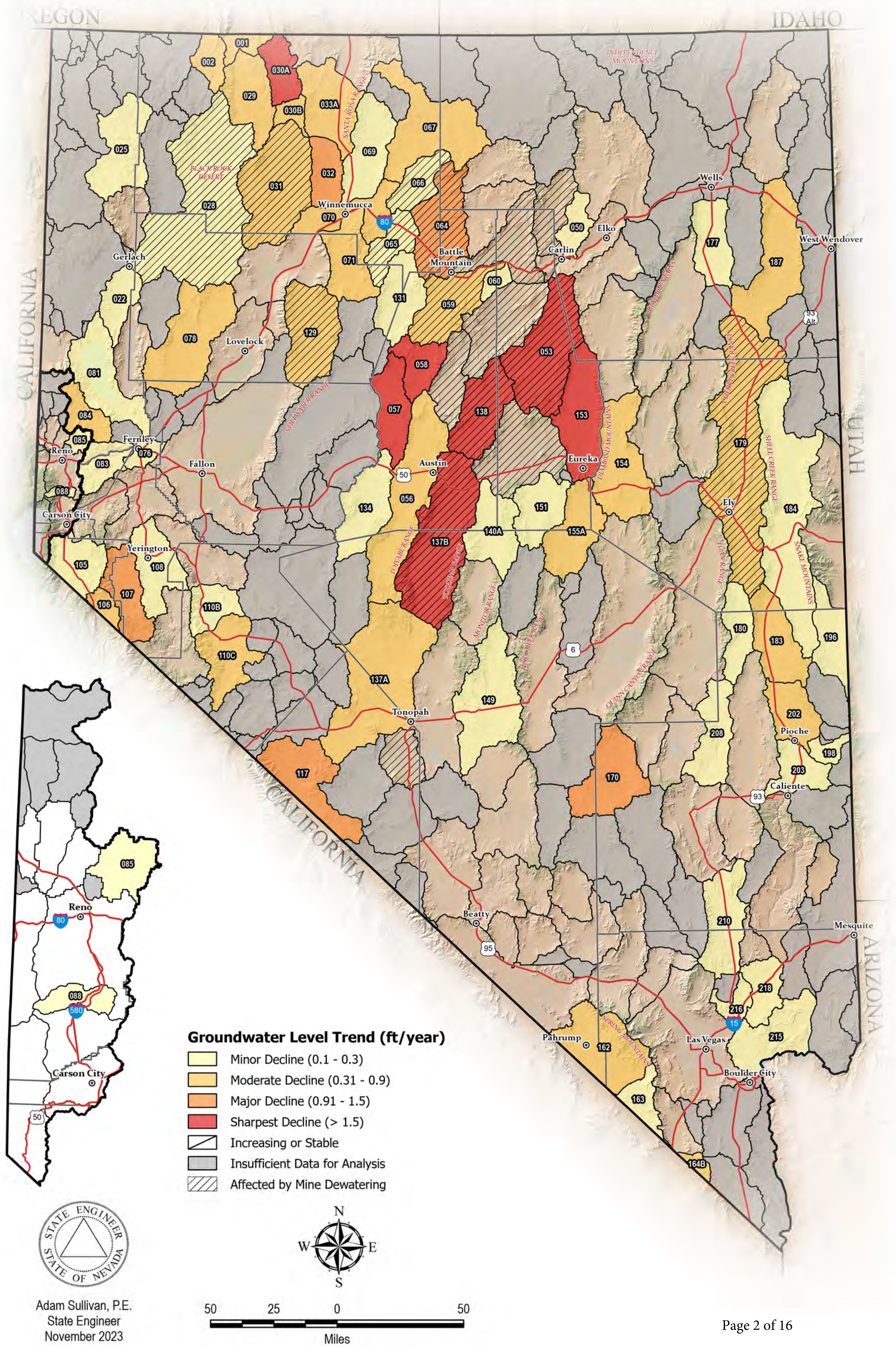
Map Explanations and Future Updates:
To address potential questions or uncertainties, each map is accompanied by a one-page explanation detailing the map's meaning, derivation, and limitations. These maps may undergo updates in the future as more data become available, any errors are corrected, or new variables or data presentation methods emerge.

Purpose and Limitations:
These maps are intended for public communication and general awareness of long-term vulnerability to groundwater shortage. They do not necessarily indicate any current shortage or imply any immediate administrative actions. The five indicators displayed here were selected because they represent common concerns and have data available to display in map format; this is not a comprehensive presentation of all variables that may indicate groundwater problems. Some groundwater issues may not be represented, or they may occur at a much more localized level or at a larger regional scale than what these basin-scale maps depict. Furthermore, since the maps are solely derived from Nevada groundwater data, issues that span state boundaries are not represented here.

Further Investigation and Action:
For a comprehensive understanding of groundwater problems in specific areas or related to particular water rights, and to determine appropriate actions to address these issues, further investigation beyond the scope of these indicator maps is required.

BASIN GROUNDWATER LEVEL TRENDS, 1984-2021

NEVADA DIVISION OF WATER RESOURCES - 2023 BASIN STATUS ASSESSMENT



NDWR Basin Indicators – Groundwater Level Trends

- **What does it mean?**

Excessive pumping removes groundwater at a faster rate than it is replenished, causing a decline in groundwater levels that can result in economic and environmental stress. This map shows hydrographic basins in Nevada with declining groundwater levels, shaded with graduated colors to indicate the degree of the water level decline. Basins with declining water levels that are impacted by mine dewatering operations are indicated with hatch lines. Basins with grey area have insufficient data to assign a trend to a basin.

- **How was it derived?**

The map is based on The Nature Conservancy's (TNC) groundwater level trend analysis for wells across Nevada, completed as part of the Stressor and Threat Assessment of Nevada Groundwater Dependent Ecosystems (2022). Data used for the analysis was limited to the years 1984-2021 and came from NDWR and USGS databases. For each well with at least five years of data, TNC calculated the Sen's slope, which represents the change in groundwater levels over time (feet/year). Sen's slope is a nonparametric slope estimate that uses the median slope of all paired combinations of points in a hydrograph.

Using the TNC dataset, the rate of groundwater level decline at the basin scale was then determined by calculating the median of the Sen's slopes for the wells in each basin containing at least four wells. Basins with declining groundwater level trends (in this case, negative slopes greater than 0.1) are symbolized on the map with graduated colors using manually-adjusted breaks. No further analysis was conducted in basins with increasing and stable groundwater level trends.

Some of the wells in the TNC dataset are in the vicinity of mine sites where dewatering is occurring or has occurred. Mine dewatering can temporarily impact groundwater levels. For basins affected by mine dewatering, the declines illustrated in the map may not be indicative of a basin's long-term trend due to a much greater density of groundwater level monitoring in the vicinity of the mines affecting the overall trend. As a result, the map indicates basins where temporary dewatering activity is known to impact water levels. Affected basins were identified using the Nevada Division of Environmental Protection and Nevada Division of Water Resources list of mines and associated basins with historic and active mine dewatering activities. Mines with existing or projected pit lakes with surface area greater than 10 acres were considered.

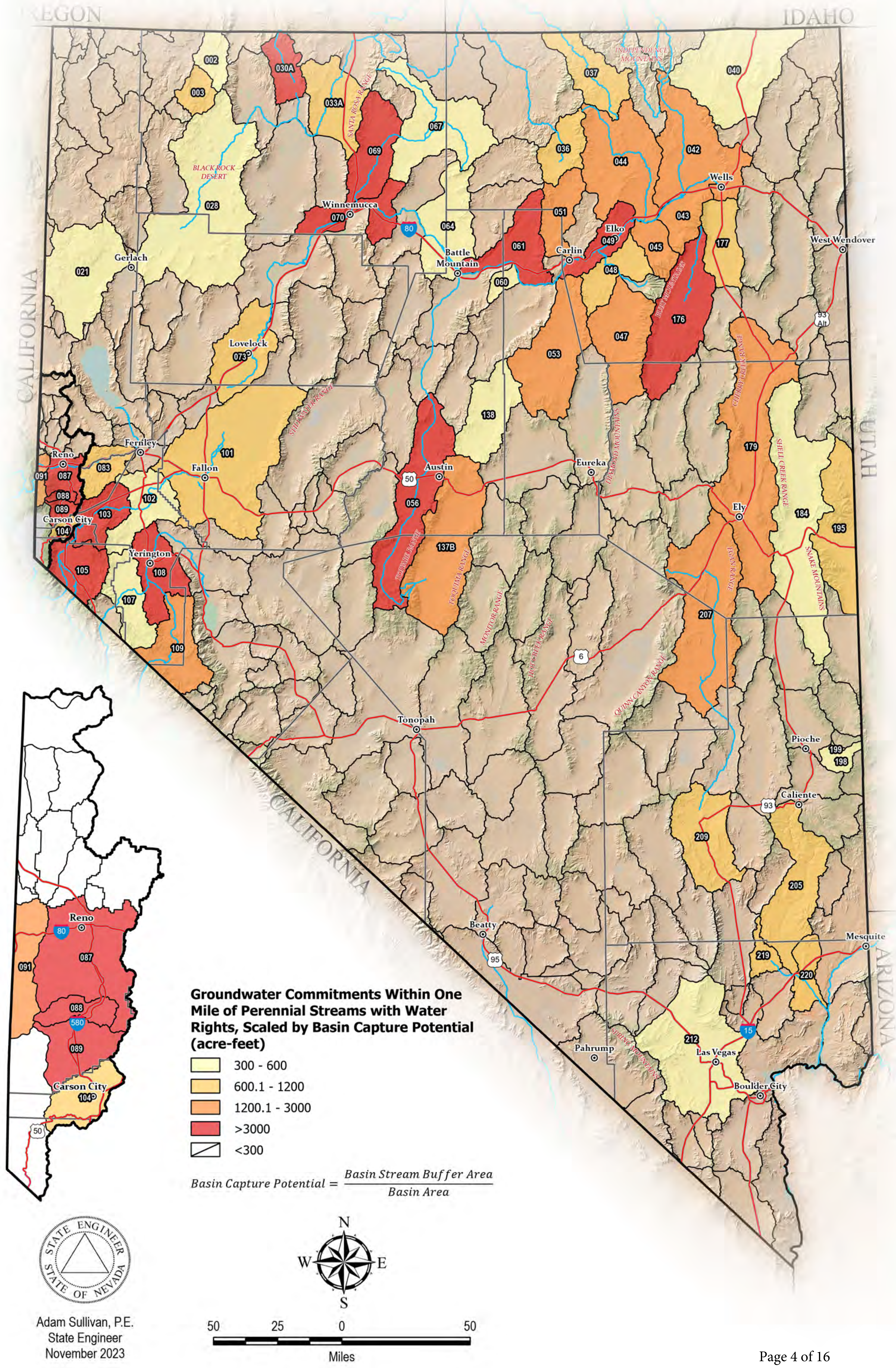
- **What are the limitations?**

The distribution and density of measured water levels varies across Nevada's landscape, possibly skewing basin-wide median water level trends. Basins with limited measurements were excluded from this analysis and should not be assumed to have stable water levels. Trends were analyzed by TNC for all wells with at least five years of data during the study period, but groundwater level patterns in some wells are not a good representation of long-term trends (e.g., mine monitoring wells, recharge wells).

Variations in water level patterns within a basin cannot be seen in this basin-scale display; however, well-specific data are available at water.nv.gov/WaterLevelData.aspx and waterdata.usgs.gov/nv/nwis/gw. TNC has made their trend analysis data available as well, including via a mapping application.

POTENTIAL CAPTURE OF SURFACE WATER RIGHTS BY GROUNDWATER PUMPING

NEVADA DIVISION OF WATER RESOURCES - 2023 BASIN STATUS ASSESSMENT



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November 2023

NDWR Basin Indicators – Potential Capture of Surface Water Rights by Groundwater Pumping

- **What does it mean?**

  This map shows hydrographic basins in Nevada with the greatest likelihood of groundwater pumping conflicting with surface water rights. The graduated colors indicate the relative potential for surface water capture by groundwater pumping. The units of the map are acre-feet and represent the total permitted groundwater duty within proximity of water righted streams scaled to the stream capture potential for each basin. Stream capture is the reduction in streamflow caused by groundwater pumping. Stream capture potential is a measure of a hydrographic basin's potential for stream capture to occur.

- **How was it derived?**

  The map is based on analysis of quantity of groundwater rights within proximity of water righted streams normalized by the capture potential of each hydrographic basin.

  Streams with water rights were estimated by taking all streams in the USGS National Hydrography Dataset (NHD) classified as 'perennial' streams – meaning the stream flow duration is continuous throughout most of any given year. The 'perennial' streams were then clipped to unconsolidated sediments as defined by Maurer and others, 2004 to represent streams in valleys and alluvial slopes which is where most surface water rights are used for irrigation and where most groundwater points of diversion are located.

  The stream dataset was then given a 1-mile-wide buffer and clipped to basin boundaries for a total buffer width of two miles to create stream buffer polygons. Basin Stream Capture Potential (unitless) was then computed for each hydrographic basin by dividing the total stream buffer area within a basin by the total area of the basin (see Figure 1 for example). Potential capture of surface water rights by groundwater pumping was then calculated by summing the total groundwater rights within the stream buffer area of a basin and multiplying by the respective Basin Capture Potential. For groundwater sites with Total Combined Duties (TCD), the TCD was divided equally among all points of diversion within the TCD group.

- **What are the limitations?**

  An assumption was made that all NHD classified perennial streams within basin fill in Nevada are fully or nearly fully appropriated and are connected with groundwater. The assumption that all perennial streams are connected with groundwater may or may not be correct, but it is likely that if perennial streams are not connected, it is because they are disconnected due to groundwater pumping. There is also uncertainty associated with NHD classifications of stream reaches which may at times over-represent perennial classifications especially across alluvial slopes (alluvial fans).

  An assumption was made that streams in the mountains (or consolidated rock units) would be less susceptible to capture from groundwater pumping due to most mountains having limited pumping as well as consolidated rock material having lower permeability.

  A one-mile buffer was chosen based on criteria that groundwater pumping within one-mile of a stream will source approximately 50 percent of pumping from stream capture after 50 years based on a conservative estimate of aquifer properties (Transmissivity of 250 ft^2/d and Specific Yield of 0.15). In most areas with groundwater development, transmissivity is likely greater than this and thus capture would be greater.

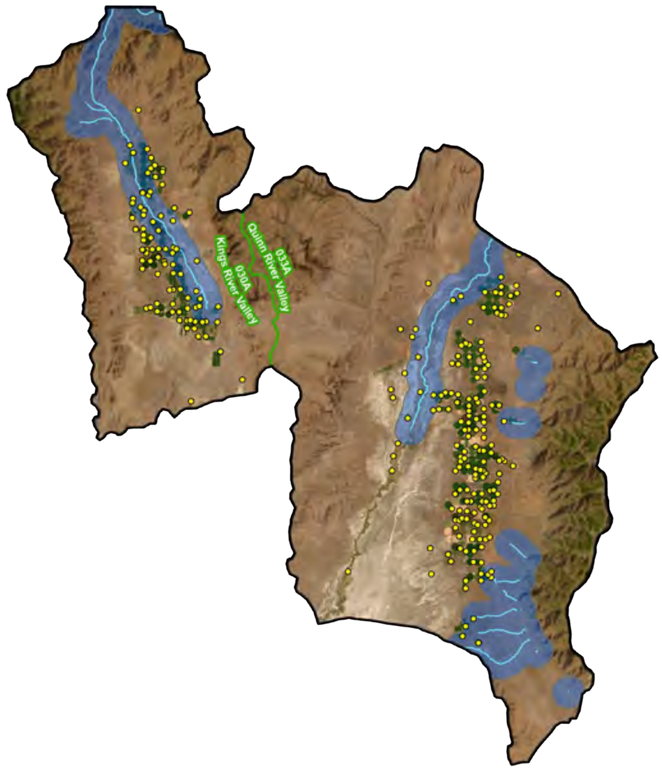
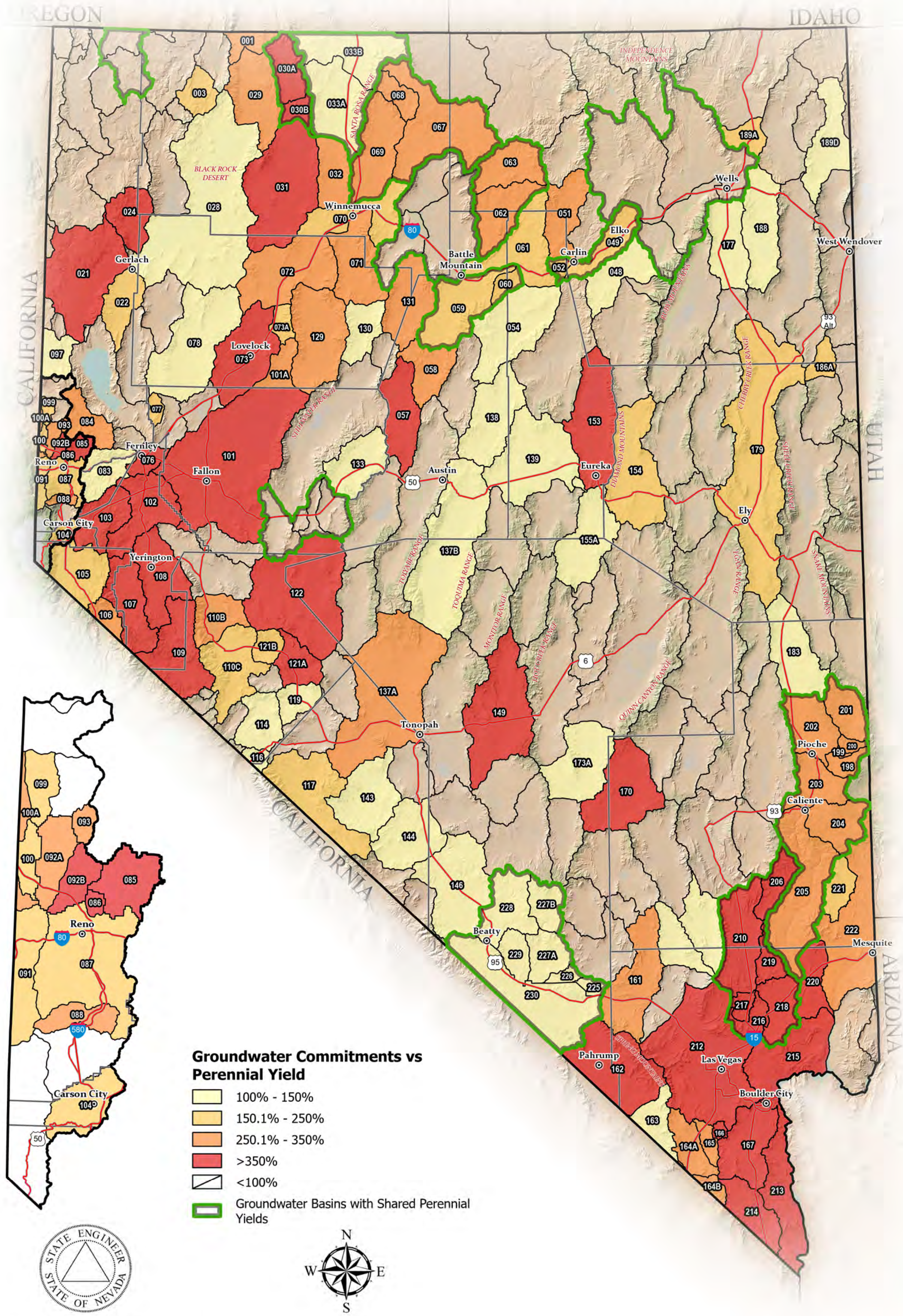


Figure 1. Cropped image of data underlying potential capture of surface water rights for Quinn River Valley (Basin 033A) and Kings River Valley (Basin 030A). This figure shows perennial streams (blue lines) with 1-mile buffers (blue polygons) intersecting water rights (yellow points). Kings River Valley has a greater quantity of underground water rights within the 1-mile buffer area of King's River as compared to Quinn River Valley.

GROUNDWATER COMMITMENTS VS. PERENNIAL YIELD

NEVADA DIVISION OF WATER RESOURCES - 2023 BASIN STATUS ASSESSMENT



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NDWR Basin Indicators—Groundwater Resource Commitments Compared to Perennial Yield

- **What does it mean?**

  This map compares the maximum amount of potential groundwater pumping under existing rights to the amount that can be supported in the long-term. The total amount of actual pumping is often much less than the total commitments. The graduated colors shown here for each hydrographic basin indicate the unitless ratio of groundwater commitments to perennial yield.

- **How was it derived?**

  Groundwater Committed is the sum of all permitted, certificated, decreed, reserved, relinquished, revocable, unadjudicated vested claims, domestic well use commitment, and the groundwater reserve per NRS 533.0241.Water right duties are generated from the NDWR Permit Database, which is capable of adjusting for total combined duties of groundwater rights.[1] Estimates of domestic wells come from the NDWR Well Log Database.[2] The maximum withdrawal from a domestic well is two acre-feet annually (afa) (NRS 534.180); thus, the domestic well contribution to the commitment is the number of domestic wells times two.

  The perennial yield can be defined as the maximum amount of groundwater that can be withdrawn each year over the long term without depleting the groundwater reservoir. Estimates of perennial yields commonly originate from USGS water budget studies that were published in Water Resource Bulletins and Reconnaissance Series Reports, and findings within State Engineer rulings.

  For this display, basins with combined perennial yields are each assigned the full amount of the perennial yield and the total of all commitments within the group. Thus, the ratio of commitments to perennial yield will be the same across the entire group of basins. In other basins without clear values for perennial yield, the number used here is the best representation available for the amount of groundwater that can be withdrawn annually over the long term.

- **What are the limitations?**

  Perennial yield estimates are the primary guideline for evaluating the availability of groundwater in a basin, but they should not be taken as a highly precise or uniform representation of a basin's groundwater supply. Other variables such as the location of pumping and the hydrogeologic setting of the basin can have a strong influence on groundwater availability over time. In some locations, a basin's water supply may be in a much more stable condition than suggested by this map. For instance, perennial yield may be very small compared to the volume of aquifer storage

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[1] Some water rights are limited by a permit term restricting their total combined duty (TCD) to less than the sum of the individual permit duties. For example, two wells may be permitted to pump 100 afa by a water right for each of them, but the terms of the permits may limit them to a total combined duty of 100 afa.

[2] GIS inventories of domestic wells conducted in Hydrographic Basin 212, the Las Vegas Artesian Basin, results in a more accurate accounting of the number of domestic wells; therefore, this value is used instead of the estimate from well logs.

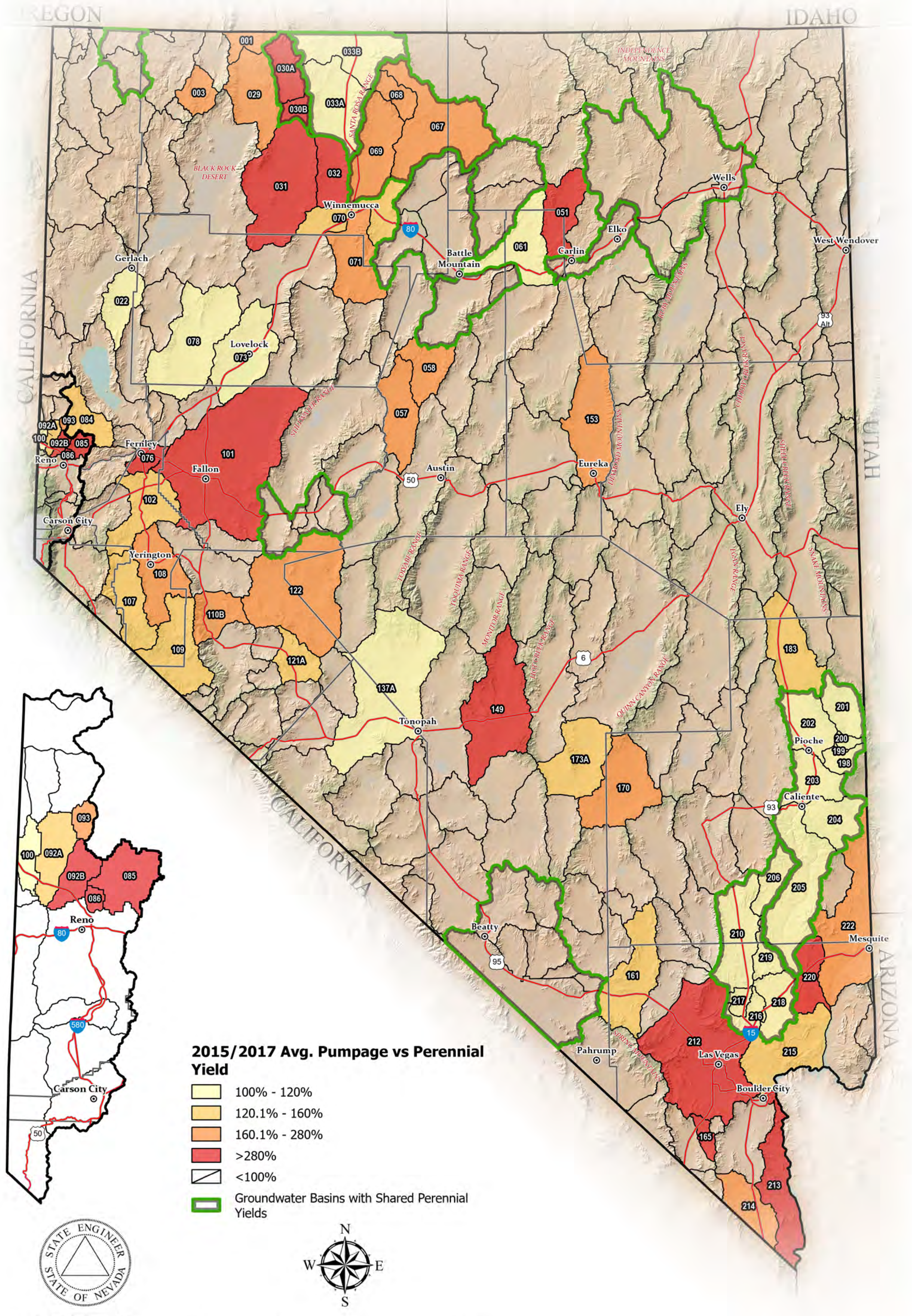
with only localized drawdown impacts (e.g. basin 149) or surface water inflow may dominate the basin water budget (e.g. Basin 101).

Perennial yield is not uniformly available for each administrative groundwater basin. In some basins there is no published perennial yield, or it's been published as a range, or the maximum amount of groundwater that can be withdrawn is based on a system yield or other metric. In others, published reports do not include separate perennial yield values for each administrative basin, but only for the group of adjacent basins. Updates to the perennial yield estimates may be adopted as time allows and further data become available.

Domestic well commitments may be overestimated because relinquishments filed in support of domestic wells are counted in addition to the query of domestic well logs as described here.

BASIN PUMPAGE VS. PERENNIAL YIELD

NEVADA DIVISION OF WATER RESOURCES - 2023 BASIN STATUS ASSESSMENT



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- **What does it mean?**

  This map compares current groundwater pumping to the amount that can be supported in the long-term. If pumping exceeds perennial yield, groundwater levels are anticipated to decline and steady-state conditions will not be achieved. The graduated colors indicate the ratio of pumpage to perennial yield (as a percent) for each hydrographic basin in Nevada.

- **How was it derived?**

  Annual groundwater pumpage is estimated as the average between 2015 and 2017 values published in NDWR inventories. 2015 and 2017 are the most recent statewide pumpage inventories and represent pumping conditions in a drought year (2015) and a wet year (2017). Domestic pumpage is included in this analysis by taking the number of domestic wells within each basin and with few exceptions[1], multiplying by 1.0 acre-foot per year.

  The perennial yield can be defined as the maximum amount of groundwater that can be withdrawn each year over the long term without depleting the groundwater reservoir. Estimates of perennial yields commonly originate from USGS water budget studies that were published in Water Resource Bulletins and Reconnaissance Series Reports, and findings within State Engineer rulings.

  For this display, basins with combined perennial yields are assigned the full amount of the perennial yield and the total of all pumping within the group. Thus, the ratio of pumping to perennial yield will be the same across the entire group of basins. In other basins without clear values for perennial yield, the number used here is the best representation available for the amount of groundwater that can be withdrawn annually over the long term.

- **What are the limitations?**

  Perennial yield estimates are the primary guideline for evaluating the availability of groundwater in a basin, but they should not be taken as a highly precise or uniform representation of a basin's groundwater supply. Other variables such as the location of pumping and the hydrogeologic setting of the basin can have a strong influence on groundwater availability over time. In some locations, a basin's water supply may be in a much more stable condition than suggested by this map. For instance, perennial yield may be very small compared to the volume of aquifer storage with only localized drawdown impacts (e.g. Basin 149) or surface water inflow may dominate the basin water budget (e.g. Basin 101).

  Perennial yield is not uniformly available for each administrative groundwater basin. In some basins there is no published perennial yield, or it's been published as a range, or the maximum amount of groundwater that can be withdrawn is based on a system yield or other metric. In others, published reports do not include separate perennial yield values for each administrative basin, but only for the group of adjacent basins. Updates to the perennial yield estimates may be adopted as time allows and further data become available.

  An additional limitation is statewide pumpage is not based on most recent pumpage but based on average of 2015 and 2017 pumpage. In many basins, annual pumpage can fluctuate greatly because of supplemental use of groundwater to primary surface water supplies, such as in Mason Valley (Basin 108) and Smith Valley (Basin 107), change in mining operations, or conjunctive use of groundwater and surface water, such as in Truckee Meadows (Basin 087). Estimation of statewide pumpage is a major effort for NDWR and has only been done for a few select years.

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[1] Lake Tahoe Basin (Basin 90) estimates domestic well usage as 0.4 acre-feet per year for each well. Pahrump Valley (Basin 162), Mesquite Valley (Basin 163), and Amargosa Desert (Basin 230) estimate domestic well usage as 0.50 acre-feet per year for each well.

DOMESTIC WELL USAGE VS. PERENNIAL YIELD

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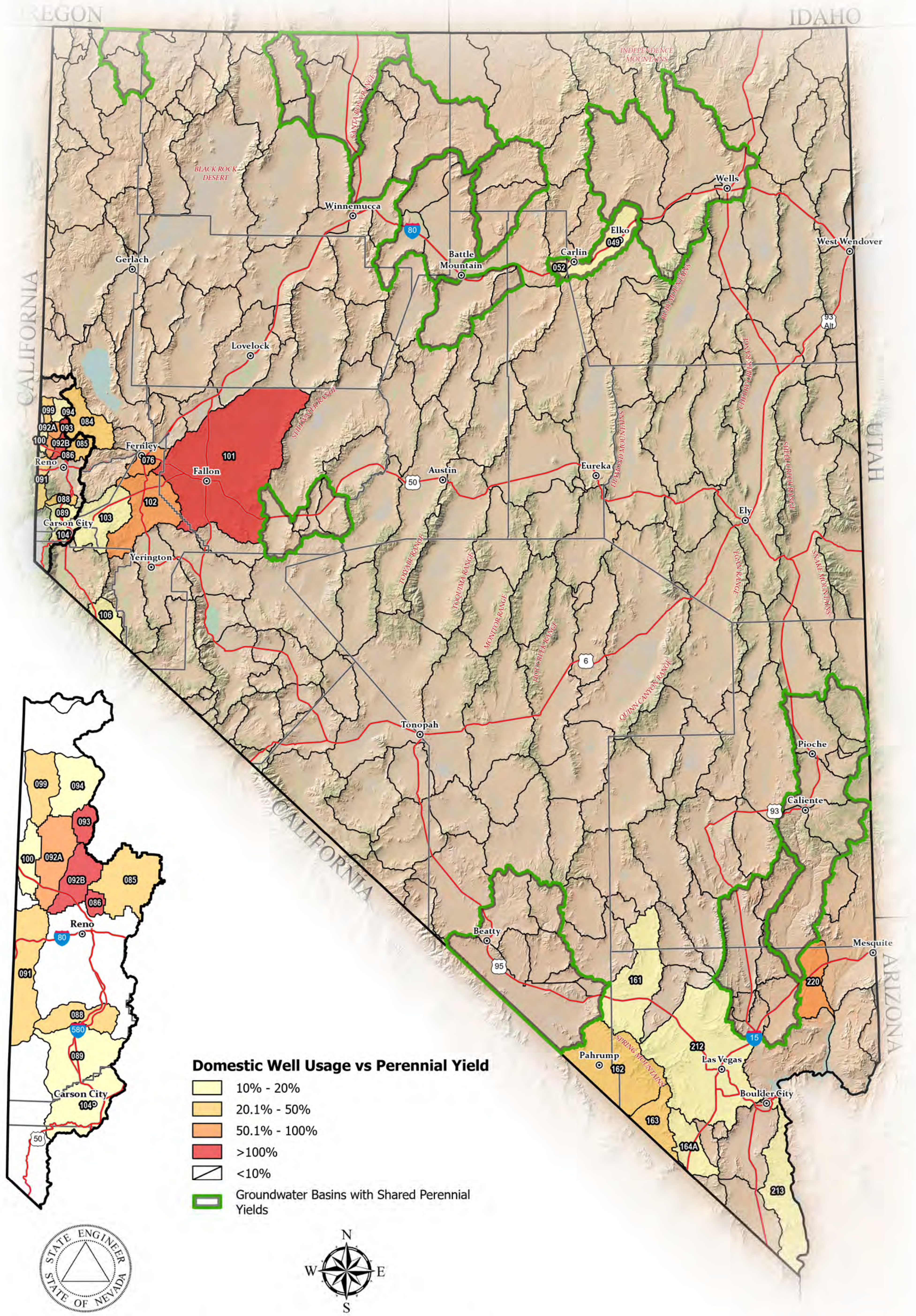

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NDWR Basin Indicators—Domestic Well Use Estimates Compared to Perennial Yield

- **What does it mean?**

  This map shows the estimated annual groundwater pumping from permit-exempt domestic wells compared to the perennial yield of the basin. Where domestic well usage is a substantial proportion of the basin water budget, there is a unique challenge for water management because domestic wells have specific protections including exemption from the requirement to hold a water right.

- **How was it derived?**

  The number of active domestic wells in each basin was derived from a query of the NDWR well log database. Active domestic wells were counted by summing the number of new wells and redrilled wells and subtracting the number of plugged wells.[1] This process is repeated for every basin. An estimated annual usage is then assigned to each well. With few exceptions[2] a value of 1.0 acre-foot per year is estimated to be used by each well. The estimate of 1.0 acre-foot, or the lesser value in certain basins, is based largely on visual estimates when considering all domestic well use in a basin.

  The perennial yield can be defined as the maximum amount of groundwater that can be withdrawn each year over the long term without depleting the groundwater reservoir. Estimates of perennial yields commonly originate from USGS water budget studies that were published in Water Resource Bulletins and Reconnaissance Series Reports, and findings within State Engineer rulings.

  For this display, basins with combined perennial yields are each assigned the full amount of the perennial yield and the total of all domestic wells within the group. Thus, the ratio of domestic wells usage to perennial yield will be the same across the entire group of basins.

- **What are the limitations?**

  The NDWR well log database is imperfect due to missing records, records containing errors, or domestic wells that were drilled without filing the required documentation. Apart from the Las Vegas Valley Basin, domestic wells are not individually inventoried to validate the accuracy of the number of active domestic wells in a basin. There are also circumstances where a well was originally drilled for a purpose other than domestic use and later converted to a domestic well, which would not be accounted for in this analysis.

  Because domestic well use is generally not metered nor reported, the usage assigned for this analysis is an estimate and not necessarily representative of each individual domestic well's use.

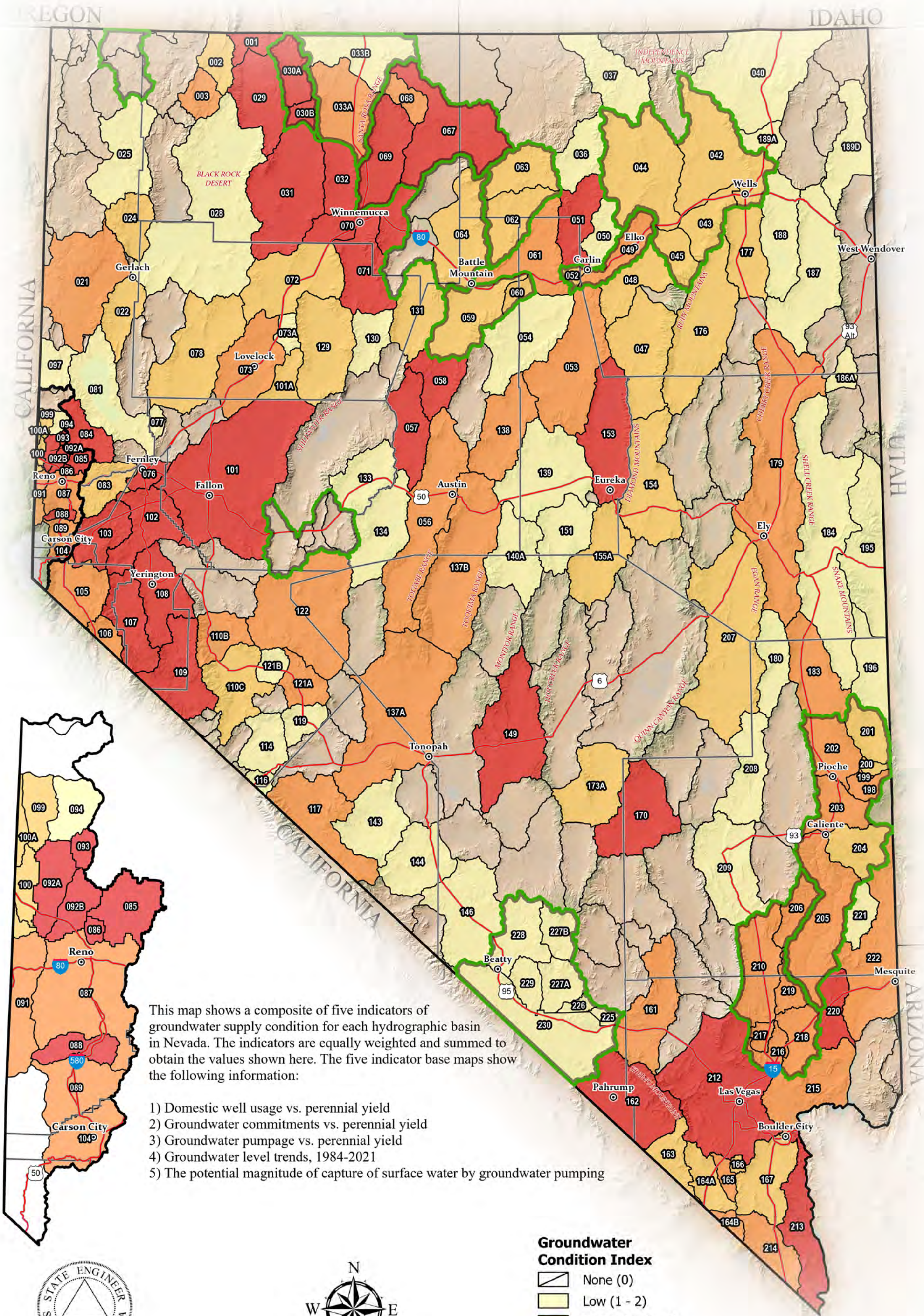
[1] The lone exception to this methodology is the Las Vegas Valley (Basin 212) which derives an estimate from a GIS inventory of active domestic wells. The number used for this analysis was obtained from the 2022 pumpage inventory report for Basin 212.

[2] Lake Tahoe Basin (Basin 90) estimates domestic well usage as 0.4 acre-feet per year for each well. Pahrump Valley (Basin 162), Mesquite Valley (Basin 163), and Amargosa Desert (Basin 230) estimate domestic well usage as 0.50 acre-feet per year for each well.

Perennial yield estimates are the primary guideline for evaluating the availability of groundwater in a basin, but they should not be taken as a highly precise or uniform representation of a basin's groundwater supply. Other variables such as surface water inflow that dominates the basin water budget (e.g. Basin 101), or the location of pumping or the hydrogeologic setting of the basin can have a strong influence on groundwater availability over time. Updates to the perennial yield estimates may be adopted as time allows and further data become available.

2023 BASIN STATUS ASSESSMENT

NEVADA DIVISION OF WATER RESOURCES



This map shows a composite of five indicators of groundwater supply condition for each hydrographic basin in Nevada. The indicators are equally weighted and summed to obtain the values shown here. The five indicator base maps show the following information:

1) Domestic well usage vs. perennial yield
2) Groundwater commitments vs. perennial yield
3) Groundwater pumpage vs. perennial yield
4) Groundwater level trends, 1984-2021
5) The potential magnitude of capture of surface water by groundwater pumping

Groundwater Condition Index

- None (0)
- Low (1 - 2)
- Moderate (3 - 4)
- High (5 - 7)
- Very High (8 - 16)
- Groundwater Basins with Shared Perennial Yields

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NDWR 2023 Hydrographic Basin Status Assessment Map

- **What does it mean?**

  The main purpose for this map is to combine the array of indicators shown on the previous five maps onto one composite map to help provide a groundwater basin condition summary. The graduated colors represent the sum of indicators from each of the five maps. These maps show the following for each of Nevada's Hydrographic Basins:

  1) Domestic well usage vs. perennial yield
  2) Groundwater commitments vs. perennial yield.
  3) Groundwater pumping vs. perennial yield.
  4) Groundwater level trends, 1984-2021
  5) The potential magnitude of capture of surface water by groundwater pumping.

- **How was it derived?**

  This map is based on a composite score derived from each of the 5 basin indicator maps. Each category from each map was assigned a numeric value of 1 for low classification (light yellow color), 2 for moderate classification (light orange color), 3 for high classification (orange color), or 4 for very high classifications (red color). The numeric value for each indicator from each hydrographic basin from the 5 maps was then added together for the composite score. The composite scores were then classified with the final assessment breakout being as follows:

  Water Resource Condition Index

  - None (0)
  - Low (1 - 2)
  - Moderate (3 - 4)
  - High (5 - 7)
  - Very High (8 - 16)

- **What are the limitations?**

  The five indicators in this basin assessment were selected because they represent common public concerns and have sufficient data available to display in map format. This composite map is just an aggregate of the five different indicators and is not an exhaustive investigation of groundwater conditions or a comprehensive presentation of groundwater problems. Limitations associated with each of the five indicator maps are summarized on the separate map descriptions.

  The five indicators are equally weighted in this composite display. Alternatively, the indicators could be weighted differently to display the relative importance of different metrics on overall groundwater condition. Variable weighting of the different indicators requires some subjective interpretation and was not part of this basin status assessment.

  One further limitation is that many of the hydrographic basins are shared with bordering states. Only data from Nevada is represented in this analysis and doesn't account for what may be occurring in the adjacent side of the shared hydrographic basins.