



# AGRICULTURAL WATER QUALITY PROGRAM

## 2019 Groundwater Monitoring Summary



# Executive Summary



## Introduction

The Ag Water Quality Program (AWQP) is responsible for monitoring state waters in Colorado for the presence/absence of agrichemicals. Work in 2019 included groundwater sampling in the following regions:

- ❑ Unconfined quaternary deposits of the San Luis Valley in the Rio Grande River Basin (RGRB) and alluvial and quaternary deposits in parts of the South Platte River Basin (SPRB).
  - ❑ Both regions sampled historically by AWQP
  - ❑ Expansion of coverage and density in both areas in 2019
  - ❑ Samples analyzed for nearly 100 pesticide compounds and inorganic nutrients, including nitrate-N ( $\text{NO}_3\text{-N}$ ) and orthophosphate. New sites in the SPRB analyzed for dissolved metal content.

The need for expanded coverage and density was amplified in the AWQP's [Long-Term Monitoring and Strategy Plan - 2019-2029](#) which was completed in June of 2019. This plan included a revision of a prioritization model and map using intrinsic factors like depth to groundwater, soil texture, presence of irrigated or dryland agriculture, as well as historical AWQP water quality results. Along with the map showing areas needing more coverage in the SPRB, the Lost Creek Groundwater Management District had expressed interest in collaborating with AWQP for conducting some water quality analysis in their basin in 2019. So of 86 total sites sampled in SPRB, 46 were new and 28 of those were from the Lost Creek and Kiowa-Bijou Designated Basins that had received very little attention prior to 2019. For the RGRB, attempts to collaborate with the U.S. Geological Survey for sampling a network of their monitoring wells did not materialize, so AWQP had to fill in coverage gaps with 13 new domestic or commercial use wells in 2019 for a total of 49 sampled in the region.

## RGRB Results

The median ( $\text{NO}_3\text{-N}$ ) of < 1.8 parts-per million (ppm) seen since 2009 increased only slightly to 2.5 ppm in 2019.

- ❑ Likely a result of the addition of new sites in higher priority areas.

Expanded coverage in 2019 showed additional areas in the aquifer with levels above naturally occurring (~2.5 ppm), but the number of wells above the U.S. EPA drinking water maximum contaminant level (MCL) for  $\text{NO}_3\text{-N}$  of 10.0 ppm remains very low for the region at only 10% of sites.

- ❑ Majority of sites above the MCL lie between Center, CO and Mosca, CO; the maximum  $\text{NO}_3\text{-N}$  of 41.6 ppm is from a well about 3 miles west of Mosca.

A total of 29 pesticide detects were seen in 18 wells for a 36% detection frequency which is typical for the region. The major metabolites of the herbicide metolachlor – metolachlor-ethane sulfonic acid (MESA) and metolachlor-oxanilic acid (MOA) accounted for 96% of total detects. The single remaining detect was of the herbicide aminopyralid.

- ❑ Median concentrations for all three pesticides is < 0.7 parts-per-billion (ppb)

MESA and MOA detection has been the most prevalent and most consistently detected pesticide compounds since 2009 in most of the shallow groundwater areas in the state where metolachlor use is occurring.

## SPRB Results

Samples collected in this region are compared in separate groups. These are: Weld County Long-Term (WCLT) monitoring well network; Lost Creek (LC); Kiowa-Bijou (KB); and other locations in the SPRB (Other). The median ( $\text{NO}_3\text{-N}$ ) is 8.9 ppm for all SPRB samples while the WCLT, LC, KB, and Other had 15.9, 10.5, 5.3, and 6.5 ppm, respectively. No one area was significantly higher/lower than any other.

- ❑ Results seen for LC were surprising when considering the area is mostly mapped as moderate or low for monitoring priority.
- ❑ WCLT median for 2019 is slightly lower than the median of 20 ppm (1992-2018) which takes into account all wells sampled.
  - ❑ Frequency of wells exceeding the EPA MCL in WCLT is only 59% in 2019 compared to 70% from 1992-2018.
  - ❑ 11 WCLT monitoring wells that have been sampled annually, since 1996, show a downward trend in median  $\text{NO}_3\text{-N}$  that is statistically significant.
- ❑ A smaller set of seven WCLT wells having consistently detected dissolved orthophosphate since 2012; show a marked decrease in concentration from 2018 and 2019.

Pesticide detection for SPRB continues to show a diversity of compounds (26) and a high number of detects (176) which are similar to results seen from prior years. When comparing detection frequency across the different areas, it is clear that the presence of pesticide compounds in LC and KB is less prevalent compared to WCLT and Other. This difference is probably due to a combination of lower pesticide usage in the LC and KB areas along with greater depth to groundwater.

- ❑ The most commonly detected pesticide compounds were MESA and MOA in the SPRB which has been the typical pattern for the region since 2009
- ❑ When considering all detects of atrazine, metolachlor, and their common degradates (five additional compounds), 70% of detects in 2019 are accounted for. This is very similar to the 65% that these compounds have accounted for of the 3,200+ detects statewide since 2009.

Results for dissolved metals provided a few notable observations for the KB and LC samples.

- ❑ Previous water quality work by other groups showed some occurrence of elevated nitrate and sulfate in the LC and AWQP observations in 2019 agree.
- ❑ Half of the 16 sites in LC were above the U.S. EPA MCL for  $\text{NO}_3\text{-N}$  but only a few wells were near or above 2,000 ppm for sulfate. Elevated sulfate can be problematic for stock watering. Sulfate also has a secondary U.S. EPA drinking water MCL of 250 ppm – a non-regulatory, mostly aesthetics standard – which the majority of all sites in KB and LC exceeded in 2019.
- ❑ Water is considered 'very hard' if hardness measures above 180 ppm (as  $\text{CaCO}_3$ ) and 86% of sites in KB and LC in 2019 exceeded this level.
- ❑ Only two wells had compromised water quality due to selenium (U.S. EPA drinking water MCL of 0.05 ppm) although, since neither well is utilized for drinking water by humans, health risk is minimal.

## Conclusion

Overall, groundwater quality results for agrichemicals discovered in 2019 were unremarkable and fit the patterns seen in the RGRB and SPRB historically. The exception is the improved coverage and density of samples in the LC and KB areas where results provide brand new insight to water quality impacts. The elevated nitrate concentrations discovered in LC were unexpected given the mostly low to moderate monitoring priority designation the AWQP had applied to the areas in its updated 2019-2029 Monitoring Strategy and Plan. These new data verify that the accuracy in some areas like LC is subpar when only intrinsic factors are considered and the true potential risk to water quality impact may be underestimated. As a whole, observed pesticide detects were within expectations for areas of intense irrigated agriculture overlaying shallow groundwater. Metolachlor breakdown products continue to be the most commonly detected as has been the case since 2009.

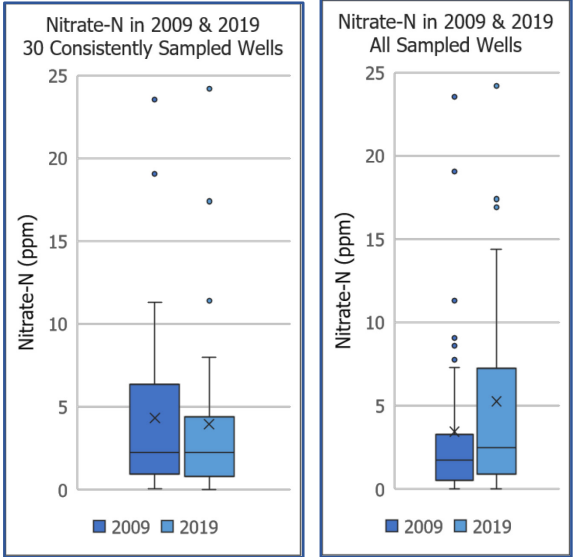
The following pages contain graphical summaries of field and laboratory results for groundwater sampling conducted by the AWQP in 2019. The pages are optimized for legal paper size and a landscape layout for printing.

Please feel free to contact [AWQP](#) with any questions or concerns. For your convenience, all data discussed and shown is available for download on AWQP's online database – [erams.com/co\\_groundwater](https://erams.com/co_groundwater). Additional program information and all published documents can be found and downloaded from [here](#).

# REGION: RIO GRANDE RIVER BASIN - SAN LUIS VALLEY (SLV)

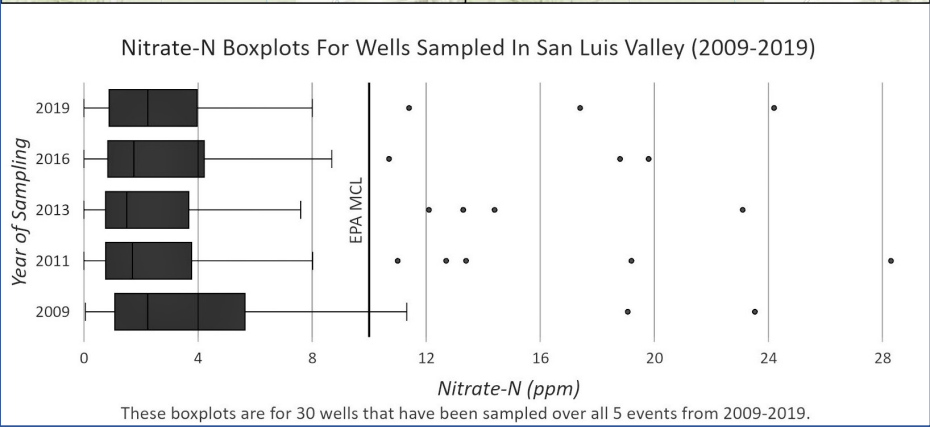
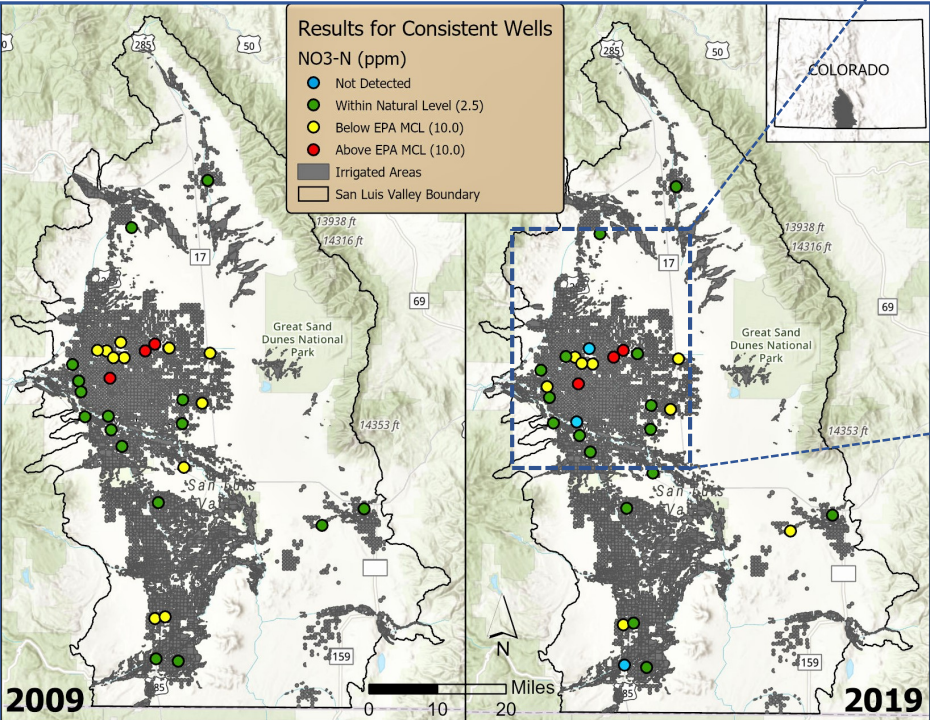
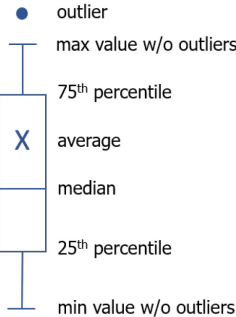
## 2019 MONITORING SUMMARY

- 49 wells (mostly domestic use) sampled in September/October – 13 new sites
- Reached five sampling events on 30 wells (2009, 2011, 2013, 2016, 2019)



### Nitrate Results

2019 median nitrate-N ( $\text{NO}_3\text{-N}$ ) of 2.5 mg/L or parts-per-million (ppm) is similar to prior years when looking at the 30 consistently sampled wells. However, the addition of 13 new sites stretches the boxplot upward mostly due to sites being intentionally targeted to areas that were likely to encounter elevated  $\text{NO}_3\text{-N}$ .



GIS Basemap Imagery Sources: ESRI, HERE, Garmin, FAO, NOAA, USGS, ©OpenStreetMap contributors, Airbus DS, USGS, NGA, NASA, CGTAR, N Robinson, NCEAS, NES, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

### 2019 Site Expansion

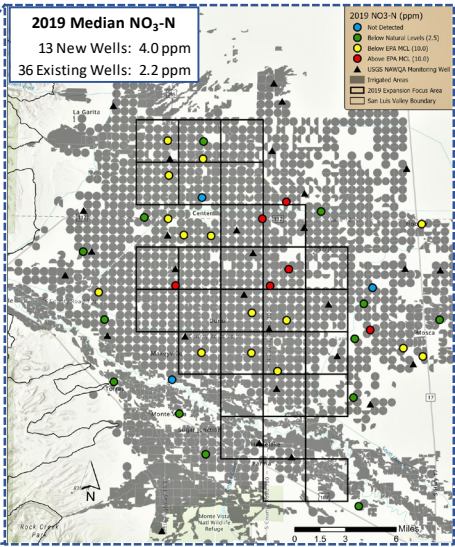
Laboratory capacity in 2019 allowed for some expanded sampling in the SLV. This effort focused on filling in areas where a U.S. Geological Survey monitoring well network has not been sampled since 2007. Future sampling efforts will continue to fill in sampling gaps within the SLV to obtain a more uniform density across its irrigated areas.

### Pesticide Results

97 pesticide compounds screened for in 2019 at CDA's laboratory.

Other than in 2009 when results from a third-party lab had reporting limits 10X to 100X lower, reporting levels have typically been 0.1-0.5  $\mu\text{g/L}$  or parts-per-billion (ppb).

Since 2009, results show the metolachlor-ESA (**MESA**) and -OA (**MOA**) metabolites accounting for 91-100% of annual total detects in the San Luis Valley unconfined aquifer.

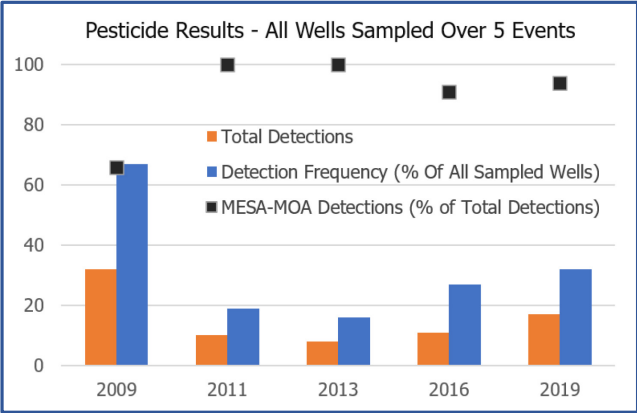


### Concentration Median All Pesticide Detects

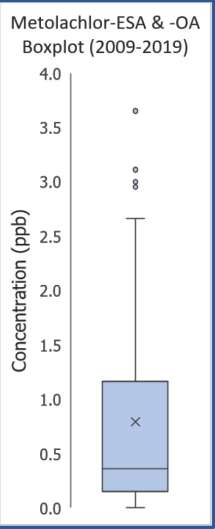
2019 < 0.5 ppb  
2009-2016 < 0.2 ppb

### Number of Different Pesticides Detected

2019: 3  
2009-2016: 12



AWQP Online Database: [www.erams.com/co\\_groundwater](http://www.erams.com/co_groundwater)





# REGION: SOUTH PLATTE RIVER BASIN

## 2019 MONITORING OVERVIEW

### Sampling & Analysis Logistics

- 86 sites sampled in this region in 2019
  - Domestic use and monitoring wells
  - New sites added in previously unsampled areas
- Samples were screened for 97 pesticide compounds, nitrate, and orthophosphate
  - New sites saw expanded inorganic and dissolved metals analysis by a 3<sup>rd</sup> party lab
- Sampling of Weld County Long-Term monitoring wells occurred in June-July to align with timing of 25+ years of annual sampling events on the network
- Sampling of new wells occurred in August-September

### Designated Groundwater Basin

Simply stated, groundwater not hydraulically connected to stream discharge and therefore not considered or required in the fulfillment of decreed surface water rights outside of the basin. Currently, eight such basins exist in Colorado.

### 2019 Collaborative Partnerships

- Worked with Todd Denning, Lost Creek Groundwater Management District, to obtain samples in the Lost Creek Basin. This is one of the first groundwater quality surveys of the shallow, alluvial groundwater in the basin.
- Ryan Bailey, professor at Colorado State University, provided access to several monitoring wells in Weld County.
- Central Colorado Water Conservancy District provided access to monitoring wells in the Box Elder watershed for improved coverage in moderate to higher priority areas of the region.

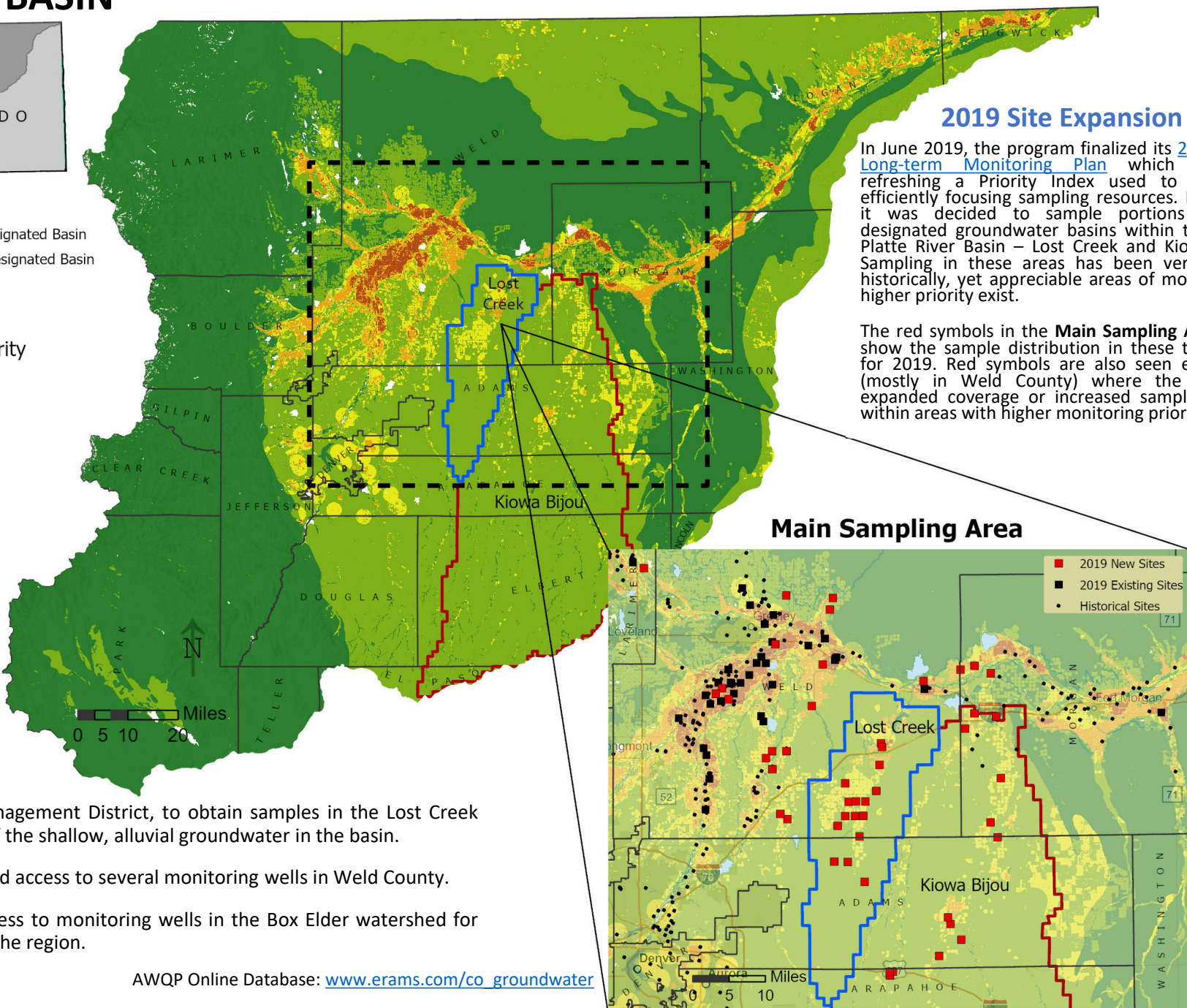


- Lost Creek Designated Basin
- Kiowa-Bijou Designated Basin
- County

### Priority Index

#### Monitoring Priority

- Lowest
- Lower
- Moderate
- Higher
- Highest



### 2019 Site Expansion

In June 2019, the program finalized its [2019-2029 Long-term Monitoring Plan](#) which included refreshing a Priority Index used to assist in efficiently focusing sampling resources. For 2019, it was decided to sample portions of two designated groundwater basins within the South Platte River Basin – Lost Creek and Kiowa-Bijou. Sampling in these areas has been very limited historically, yet appreciable areas of moderate to higher priority exist.

The red symbols in the **Main Sampling Area** map show the sample distribution in these two areas for 2019. Red symbols are also seen elsewhere (mostly in Weld County) where the program expanded coverage or increased sample density within areas with higher monitoring priority.



# REGION: SOUTH PLATTE RIVER BASIN

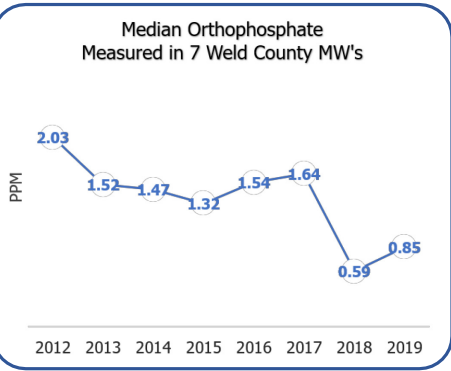
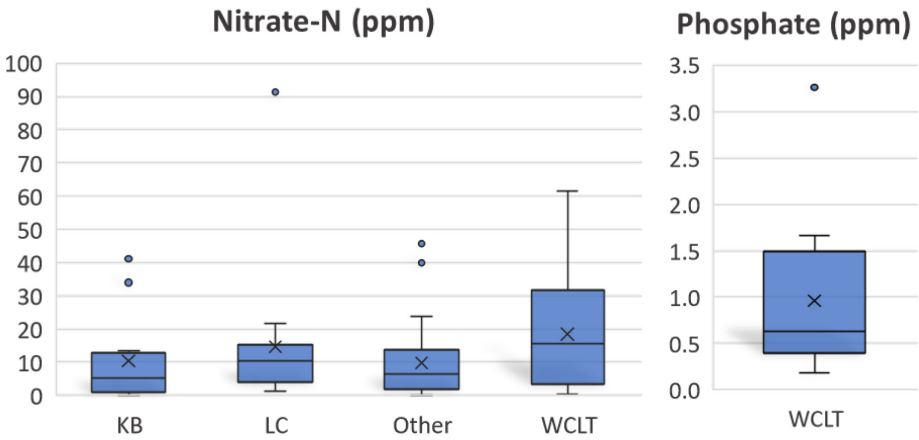
## 2019 RESULTS: NITROGEN & PHOSPHORUS

### LC & KB Notes

- ❑ Kiowa-Bijou (KB) saw 38% and Lost Creek (LC) 56% of sampled wells with measured nitrate-N ( $\text{NO}_3\text{-N}$ ) exceeding the U.S. EPA Maximum Contaminant Level (MCL) of 10.0 ppm.
- ❑ Median  $\text{NO}_3\text{-N}$  for LC and Weld County Long-Term (WCLT) are above the MCL, but KB and other SPRB sites (Other) are 5.3 and 6.5 ppm, respectively.
- ❑ While wells with elevated nitrate seem to be evenly distributed across the sampled LC area, there is evidence of a slight gradient present from low to high as you move from south to north in KB.

### Weld County MW Network Notes

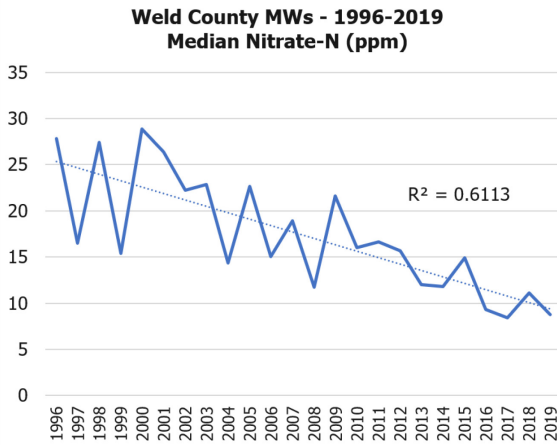
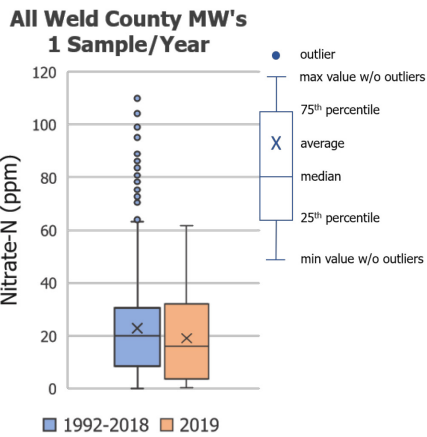
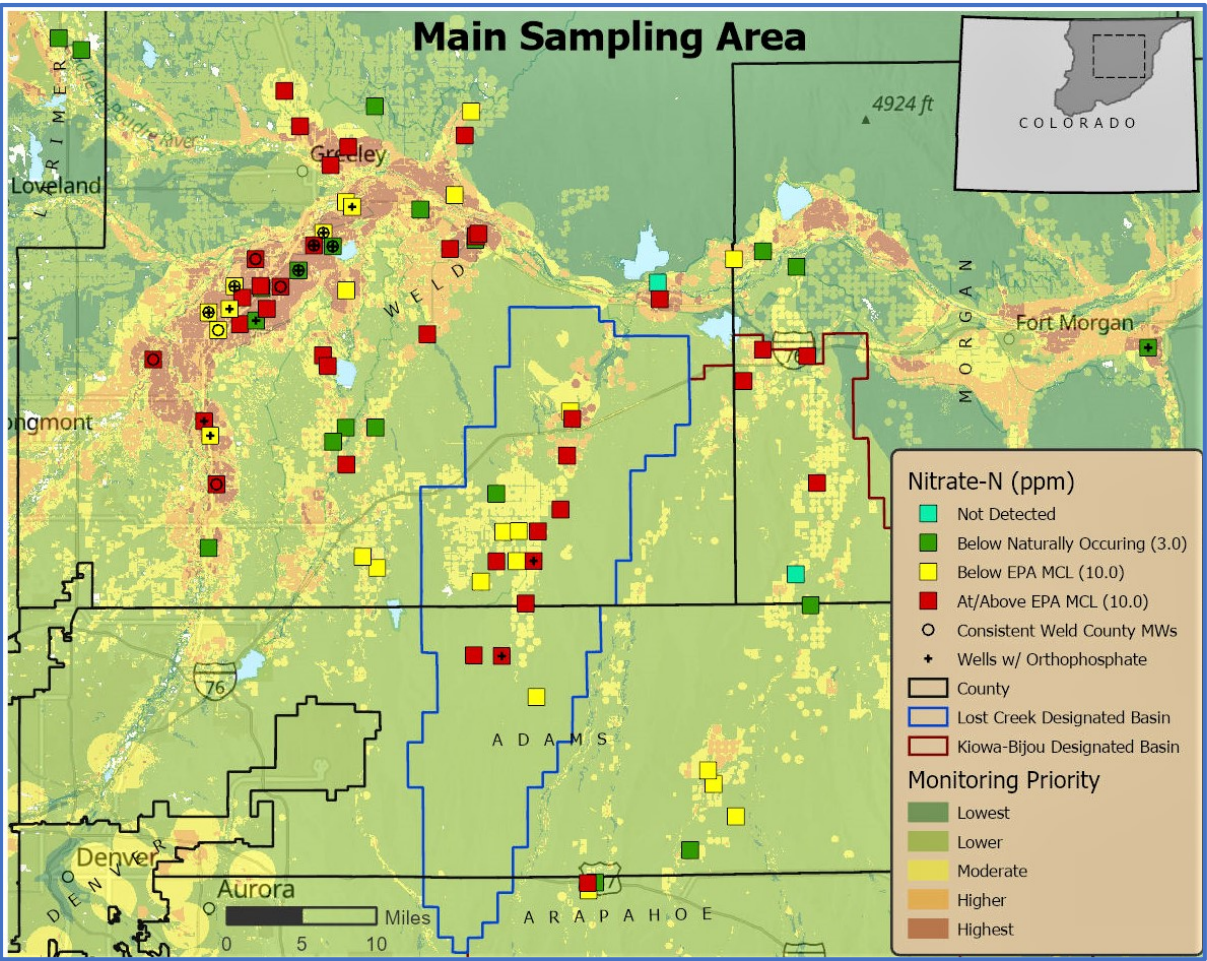
- ❑ Nitrate seen in WCLT monitoring wells in 2019 remains similar to that seen in prior years and higher than other sampled areas in the SPRB.
- ❑ Review of monitoring wells (MW's) consistently sampled since 1996 ('O' symbol on map) shows evidence of a statistically significant downward trend in  $\text{NO}_3\text{-N}$  concentration.
- ❑ Most new MW's sampled in 2019 fit their location in the monitoring priority model well; however, there were less wells above the MCL for  $\text{NO}_3\text{-N}$  compared to historical results.



### Orthophosphate

- ❑ Seven WCLT MW's have consistently detected this compound since 2012 when the program began reporting, but over the last two years the median concentration has dropped
- ❑ In 2019, other WCLT and LC wells ('+' symbol in map) saw detections
- ❑ This compound is not regularly detected in groundwater like nitrate, but conditions can arise where other mineral concentrations and soil adsorption capacity is unable to prevent leaching to groundwater.

Time Period	Concentration (ppm)		Number Samples	Relative to EPA STD	
	Median	Range		% Below	% Above
1992-2007	19.9	8.5-29.4	268	29%	71%
2008-2018	20.3	8.7-31.6	257	28%	72%
2019	15.9	3.6-31.8	29	41%	59%





# REGION: SOUTH PLATTE RIVER BASIN

## 2019 RESULTS: PESTICIDES

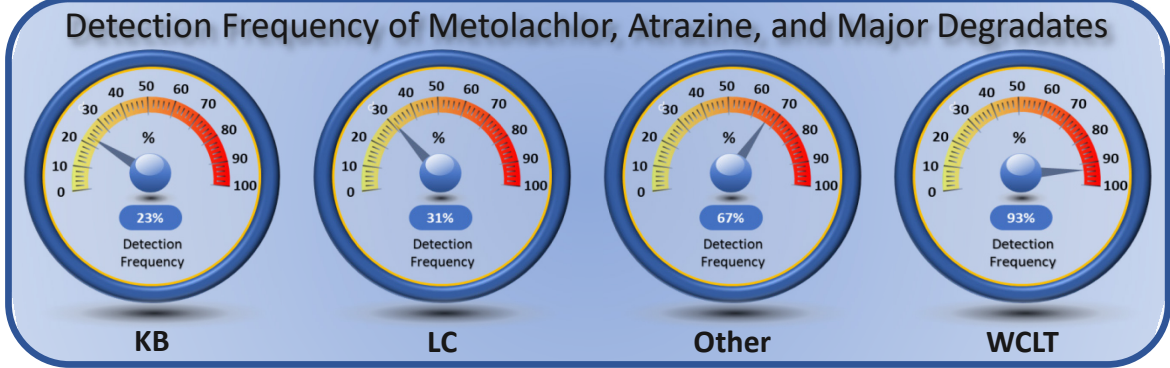
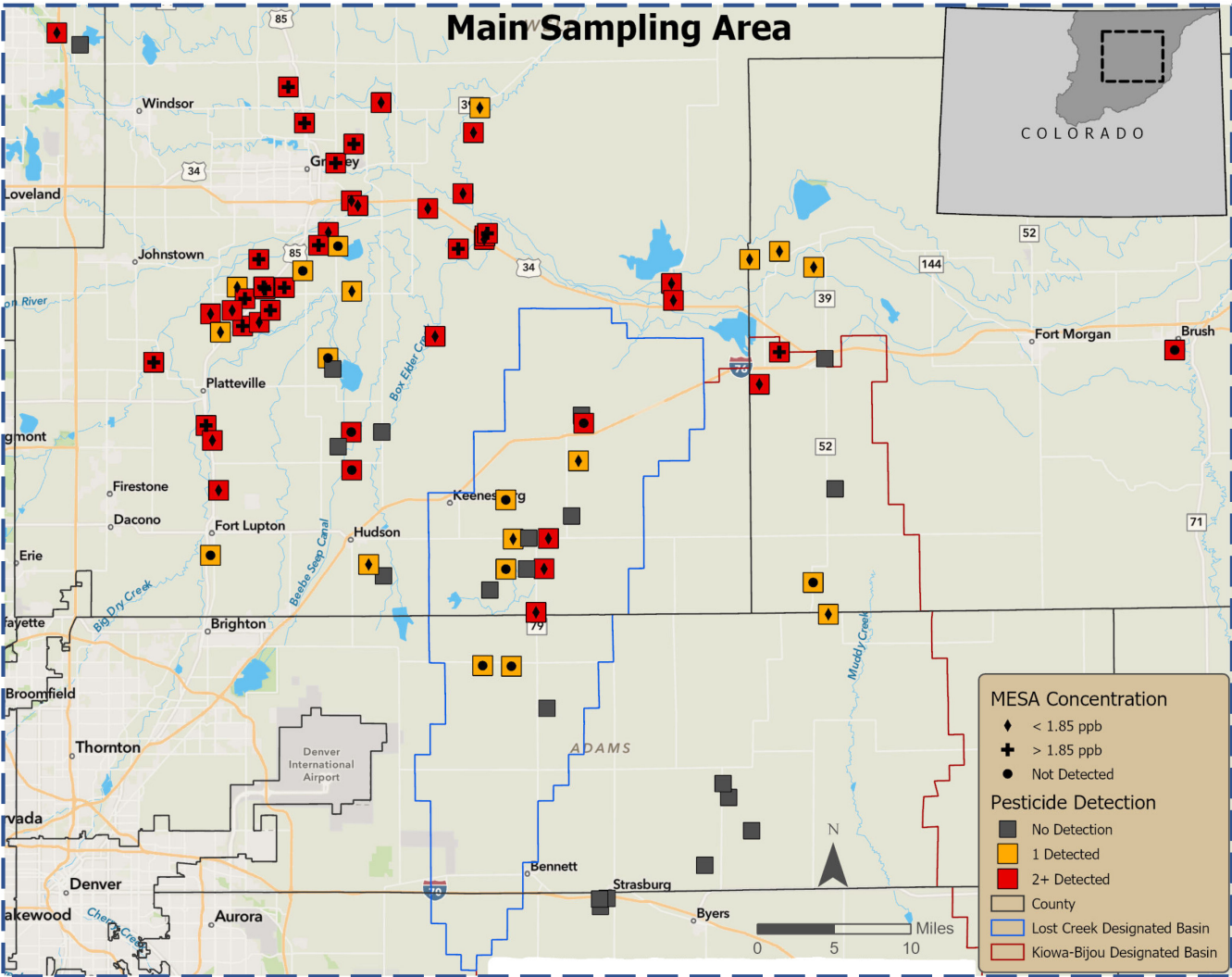
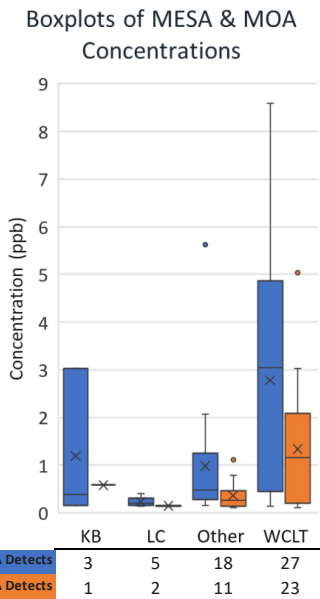
- 77% of the 86 sites sampled in 2019 saw one or more of 26 different pesticide compounds
  - The most non-detect locations were seen in Kiowa-Bijou (KB) and Lost Creek (LC)
  - Of 66 sites with pesticide detection, only 1/3 detected a single compound
  - Weld County Long-Term (WCLT) and other SPRB sites (Other) had 19 and 17 detected pesticide types, respectively
- Overall, detected levels averaged 1.04 µg/L or parts-per-billion (ppb) and have a median of 0.35 ppb with no locations at levels exceeding established U.S. EPA drinking water standards

Pesticide Results				
Area	# Samples	Detection Frequency	Total Detects	Average Well Depth (ft)
KB	13	33%	8	82*
LC	16	63%	18	87
Other	27	81%	54	39
WCLT	30	100%	96	24

\* A well sampled at the southern end of Main Sampling Area, near Strasburg, is in the much deeper Laramie-Fox Hills Aquifer of the Denver Basin which is below the Kiowa-Bijou Designated Basin and is therefore excluded from average well depth calculation.

### Types & Concentration of Detected Pesticides

Groundwater Type	# Pesticide Types	Concentration (ppb)	
		Median	Range
Designated Basin	9	0.21	0.11 - 3.03
South Platte Alluvial	24	0.38	0.04 - 8.58



- Detection of the herbicide metolachlor, or more commonly its major degradates – metolachlor-ethane sulfonic acid (MESA) & -oxanilic acid (MOA) – accounts for 55% of the 176 total detects seen in 2019
  - Further inclusion of atrazine and its three major degradates screened for by the program (desethyl-, desisopropyl-, and hydroxy-atrazine) finds 70% of total detects accounted for in 2019
- The lower detection frequency seen in KB and LC is likely a factor of less usage due to fewer acres of crops where these pesticides are used, but average well depth compared to WCLT and Other also factors in
- These compounds, by far, are the most frequently detected pesticides where the program samples in Colorado and account for 65% of the 3,275 detections seen since 2009



# REGION: SOUTH PLATTE RIVER BASIN

## 2019 RESULTS: OTHER WATER CHEMISTRY IN DESIGNATED BASINS

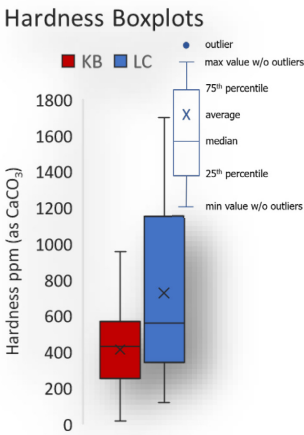
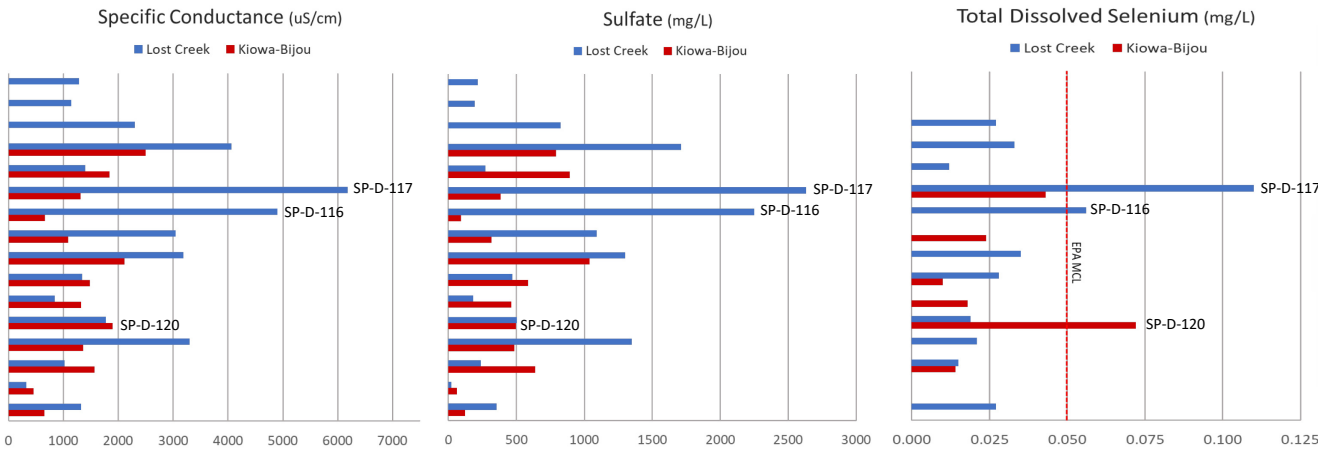
- ❑ A Colorado Geological Survey report titled *Lost Creek Basin Aquifer Recharge and Storage Study* (published in December 2011) provides a brief water quality summary to compare 2019 results against.
  - ✓ Compiled results of 132 samples collected from various efforts between 1944-2011
  - ✓ 35% of samples with specific conductance over 1000 uS/cm
  - ✓ Evaluation of major ion proportions showed little evidence of gradients in the basin
  - ✓ Sulfate and nitrate highlighted as water quality concerns in Lost Creek
    - Most samples exceed 500 mg/L or parts-per-million (ppm) of sulfate with a few exceeding 1000 ppm



Old community hall in Leader, CO (Kiowa-Bijou Basin)

### 2019 Observations

- ❑ Two Lost Creek (LC) wells, SP-D-116 (lawn use only) & SP-D-117 (stock watering use), have sulfate above 2,000 ppm and total dissolved selenium above 0.05 ppm. Another well in Kiowa-Bijou (KB), SP-D-120 (commercial use) also tested above 0.05 ppm for selenium but had much lower sulfate.
  - ✓ Elevated sulfate can cause a nervous system disease in cattle – **polioencephalomalacia or PEM**
  - ✓ The majority of sites in both LC and KB contain sulfate above 250 ppm which can compromise taste and odor of drinking water
  - ✓ The U.S. EPA drinking water standard for selenium is 0.05 ppm - prolonged exposure to elevated selenium content can result in fingernail or hair loss, numbness to extremities, or circulation problems
- ❑ 86% of all sites between KB & LC measured above 180 ppm for hardness – ‘Very Hard’ water can cause significant issues with plumbing and, when used for irrigation, can contribute to salinization of soils over time



## Lost Creek & Kiowa-Bijou 2019 Sulfate and Selenium Results

