Mamm Creek Field Area
Garfield County, Colorado
Water Quality Data, Reports and Reviews

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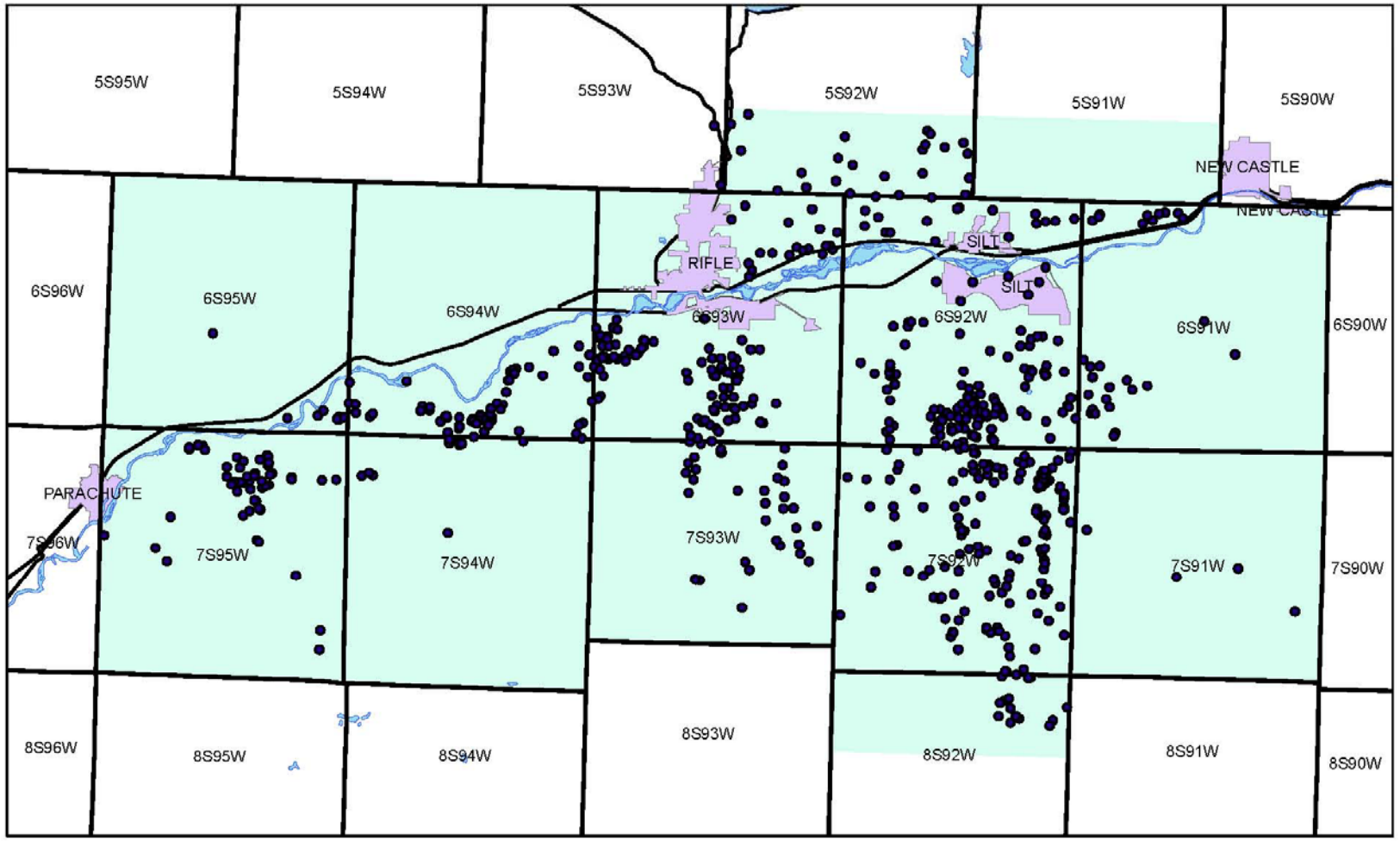
Water Quality Data

- COGCC water quality database
- Other public sources (*i.e.* USGS)

Mamm Creek Area Water Sample Locations



Legend

- Water Sample Locations
- Study Area
- Highways
- Cities
- Water features

0 1.5 3 6 9 12 Miles

WellLocateMammCreek.mxd 6/30/09 CJS

Water Quality Reports

- URS Phase 1
- SSPA Phase II
- Thyne Review of Phase II
- SSPA Evaluation of Thyne Report

Thyne Report Executive Summary

- *1 – The water quality data is sufficient to establish the range of natural background chemistry and delineate the impact of petroleum activities. Impacts from petroleum activity are not currently present at levels that exceed regulatory limits. The impacts are mainly elevated methane and chloride in groundwater wells.*

Thyne Report Executive Summary

- *2 - There is a temporal trend of increasing methane in groundwater samples over the last seven years that is coincident with the increased number of gas wells installed in the Mamm Creek Field. Pre-drilling values of methane in groundwater establish natural background was less than 1ppm, except in cases of biogenic methane that is confined to pond and stream bottoms. The cases of biogenic methane can be readily identified by stable isotopic characterization of the methane. The isotopic data for the methane samples show the most of the samples with elevated methane are thermogenic in origin.*

Thyne Report Executive Summary

- *3 - Concurrent with the increasing methane concentration there has been an increase in groundwater wells with elevated chloride that can be correlated to the number of gas wells. Chloride is derived from produced water.*

Thyne Report Executive Summary

- *4 - The increasing methane and chloride will not trigger regulatory action since there is no regulated limit on methane and the majority of chloride values are below regulatory limits, however, as more gas wells are drilled the chloride value may reach the regulatory limit.*

- "*COGCC has defined impact to wells as that which exceeds the Federal or State standards*" Thyne Silt presentation

- *"COGCC has defined impact from petroleum activity as concentrations of BTEX and methane that exceed regulatory limits"* Thyne Silt presentation

Are There Regulatory Action Levels for Methane in Groundwater, Surface Water or Drinking Water in Colorado?

No.

Has the COGCC Staff and the Commission Taken Actions Based on Presence of Thermogenic Methane in Water Produced from Domestic Wells?

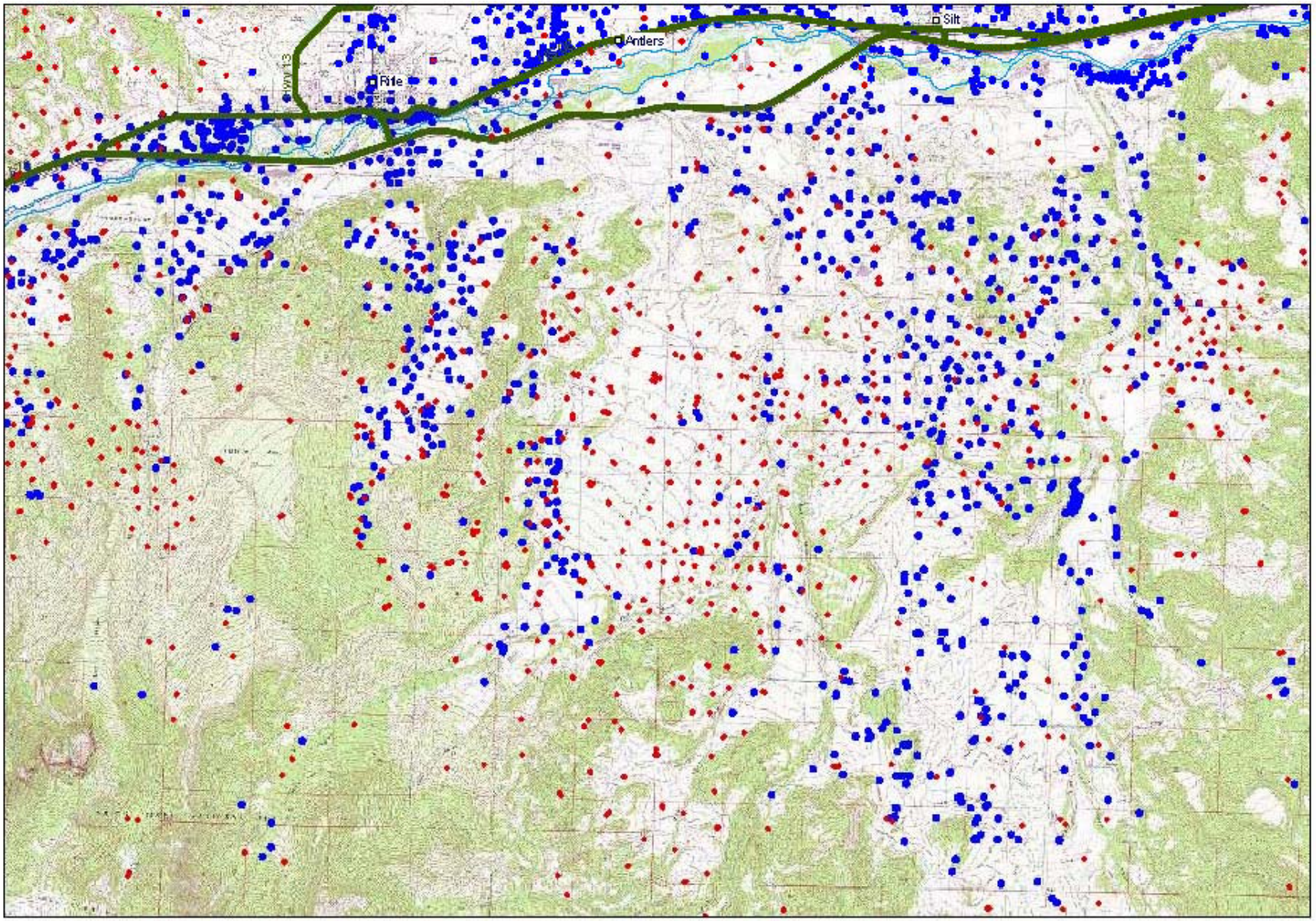
Yes

Thyne Report Executive Summary

- *5 - Currently the only monitoring mechanism to evaluate the impact of gas well drilling and gas production to groundwater quality is the existing domestic water wells and surface water bodies.*

  The number of water wells (<200) and their spatial distribution is inadequate to monitor and locate potential source of contamination from the more than 1400 potential point sources (gas wells and produced water pits). There are only a few cases where COGCC has been able to identify gas wells as point sources of the observed more widespread increase in impact (West Divide Creek seep and the Amos well).

Water Well and Oil and Gas Locations



SCALE 1 : 100,561

1 0 1 2 3

MILES

N

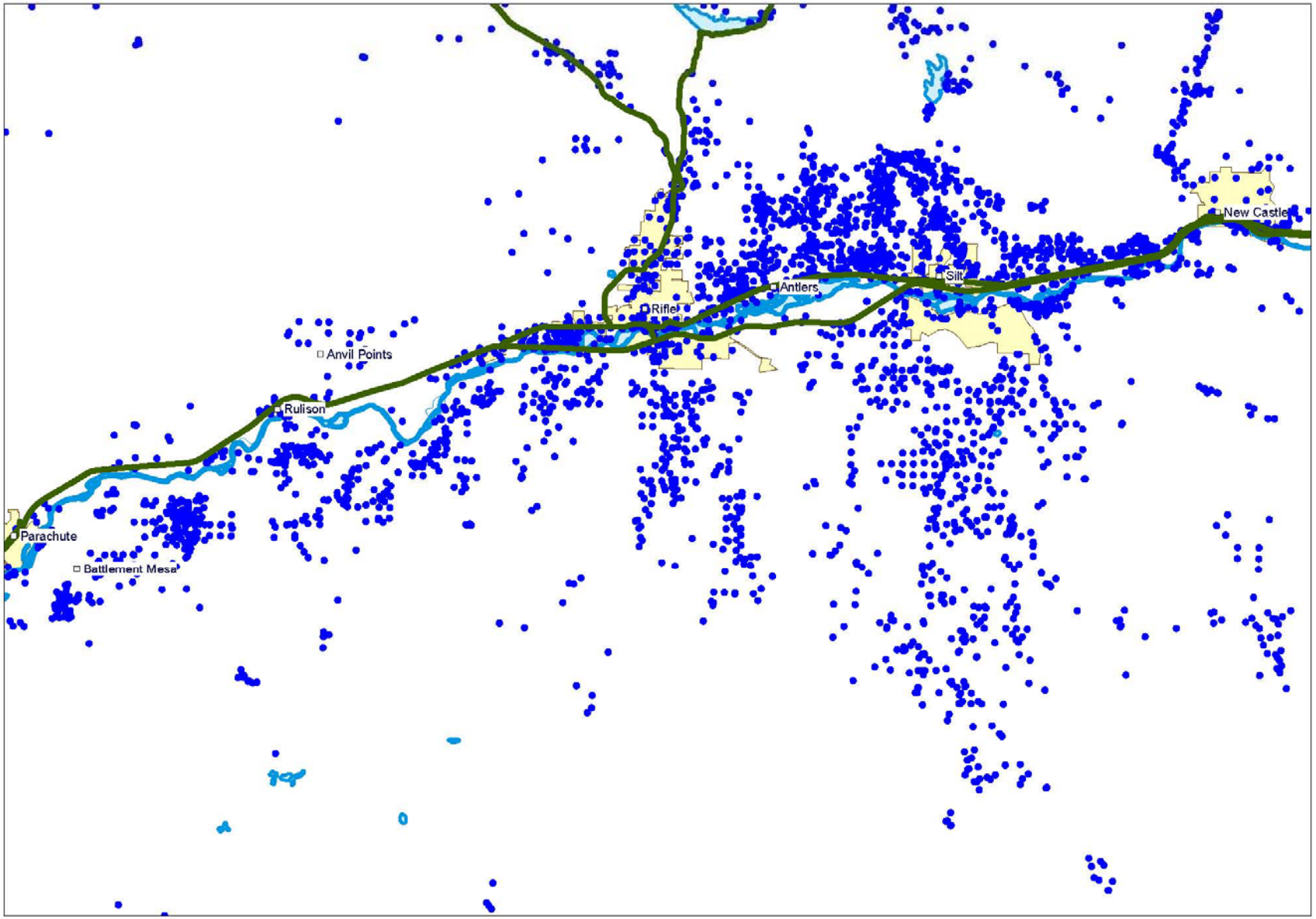
- Approximately 1100 water well permits in the study area as shown in the Thyne report.
- Approximately 2400 O&G wells permitted in the study area as shown in the Thyne report.

SSPA Evaluation of Thyne Report

- COGCC staff pulled data from the Thyne report study area and some data from surrounding area for evaluation.

- Approximately 4000 water well permits in the expanded area.
- Approximately 6000 O&G wells permitted in the expanded area.

Water Well Permit Locations



SCALE 1 : 192,776

2 0 2 4 6

MILES

N

O&G Well Locations