

Groundwater Injury

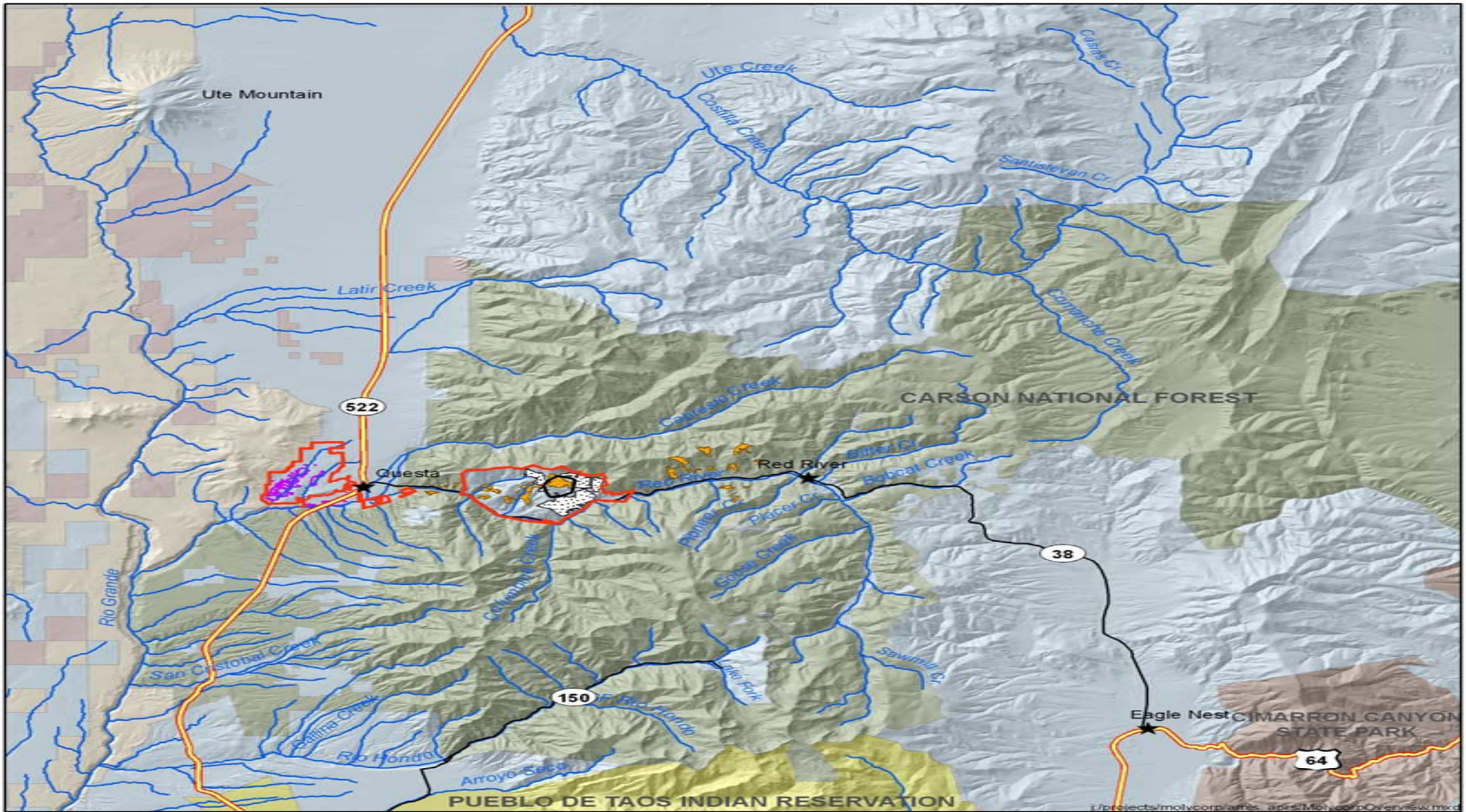
Presentation Overview

- ▶ Separation of site into functional areas
- ▶ Key data sources
- ▶ Site overview and hydrology
- ▶ Site groundwater chemistry data overview
- ▶ Conceptual injury approach

Functional Areas

- ▶ Mine site
 - Pit
 - Rock piles
 - Underground workings
 - Scars
- ▶ Alluvial areas
- ▶ Tailings

- ▶ Trustees concerned about all areas



- ★ Town
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- ▨ Mine rockpile
- Hydro scar
- BLM
- US Forest Service
- Tribal land
- Private
- State of New Mexico
- State Fish and Game



Key Data Sources: Mine Site

- ▶ SPRI (1995) Progress Report on the Geology, Hydrogeology, and Water Quality of the Mine Area
- ▶ Slifer for New Mexico Environment Department (1996) Red River Groundwater Investigation
- ▶ Abshire for USEPA (1998) Report on Hydrological Connection Associated with Molycorp Mining Activity, Questa, New Mexico
- ▶ New Mexico Office of the Natural Resource Trustee (1999) Geochemistry of the Red River Stream System Before and After Open-Pit Mining, Questa Area, Taos County, New Mexico

Key Data Sources: Mine Site

- ▶ Robertson GeoConsultants (2000) Water Balance Study for Questa Mine, New Mexico
- ▶ Robertson GeoConsultants (2000) Progress Report: Questa Mine Rock Pile Monitoring and Characterization Study
- ▶ Robertson GeoConsultants (2000) Interim Background Characterization Study, Questa Mine, New Mexico
- ▶ Vail Engineering (2000) Analysis of Acid Rock Drainage in the Middle Reach of the Red River, Taos County, New Mexico

Key Data Sources: Mine Site

- ▶ Souder, Miller & Associates (2000) 1999 Hydrogeologic Investigation
- ▶ USGS (2003) Historical Ground-Water Quality for the Red River Valley, New Mexico

Key Data Sources: Tailings Area

- ▶ SPRI (1995) Discussion of Geology, Hydrogeology, and Water Quality of the Tailings Area
- ▶ Robertson GeoConsultants (1998) Questa Tailings Facility – Revised Closure Plan

Key Data Sources: Mine and Tailings Areas

- ▶ Various presentations for the RI/FS

Key Data Sources: Database

- ▶ URS Molycorp Database, V. 8.1 dated 8/31/04
 - Most current version?
- ▶ Sources of data in database
 - Historic Data Review Chart
 - How to link chart with chemistry samples?
 - Report_key (primary key)
 - No direct relationships

Contaminant Sources

- ▶ Rock piles: ~800 acres
 - Without scars: ~675 acres
- ▶ Open pit: ~300 acres
 - Without scars ~190 acres
- ▶ Underground workings: ~440 acres
 - Without scars, rock piles and open pit: ~230 acres
- ▶ Tailings: ~640 acres

Mine Contaminant Sources

- ▶ Acid rock drainage and leaching of contaminants from:
 - Waste rock dumps
 - Disturbed soils
 - Pit surfaces and underground workings
- ▶ Oxidation and leaching of oxidation products and other contaminants from tailings facilities

Site Hydrology

- ▶ Site elevation ranges from 7,580 to 10,812 ft (orographic effect on precipitation)
- ▶ Estimates of annual precipitation at mill site range from 12 to 16 inches
- ▶ Rainfall rates at other stations in NM above 10,000 ft are as high as 24 inches
- ▶ Robertson GeoConsultants estimate groundwater recharge is 1 inch
- ▶ Other estimates from base flow in the Red River

Site Hydrology

- ▶ Mine Site hydrogeologic units
 - Alluvium
 - Gradient: 0.002 to 0.06
 - Hydraulic conductivity: 20 to 2,000 ft/day
 - Colluvium
 - Gradient: 0.2 to 0.35
 - Hydraulic conductivity: 0.1 to 2 ft/day
 - Bedrock
 - Gradient: 0.2 to 0.5
 - Hydraulic conductivity: 0.001 to 0.08 ft/day

Site Hydrology

- ▶ Tailings area hydrogeologic units
 - Upper and basal alluvial aquifer
 - Hydraulic conductivity: 0.01 to 10 ft/day
 - Basal volcanic aquifer
 - Hydraulic conductivity: 100 to 1,000's ft/day
- ▶ Generally small vertically downward gradient
- ▶ Flow in both aquifers to south/southwest
- ▶ Fractures are conduits for flow

Site Groundwater Chemistry

- ▶ Molycorp Database
- ▶ Groundwater Data Query Criteria
 - MEDIUM_TYPE = "GW" Or "SP" Or "WM"
 - DATA_FLAG="R" removed

Preliminary List of Analytes

Aluminum

Cadmium

Chromium

Cobalt

Copper

Iron

Lead

Manganese

Molybdenum

Nickel

Sulfate

Zinc

Conceptual Chemistry Data Analysis Approach

- ▶ What?
 - Substances
- ▶ Where?
 - R, M, T designations
 - Which wells/sites?
- ▶ When?
 - Pattern over time
 - Consistent, spill event
- ▶ To what degree?

Water Quality Standards

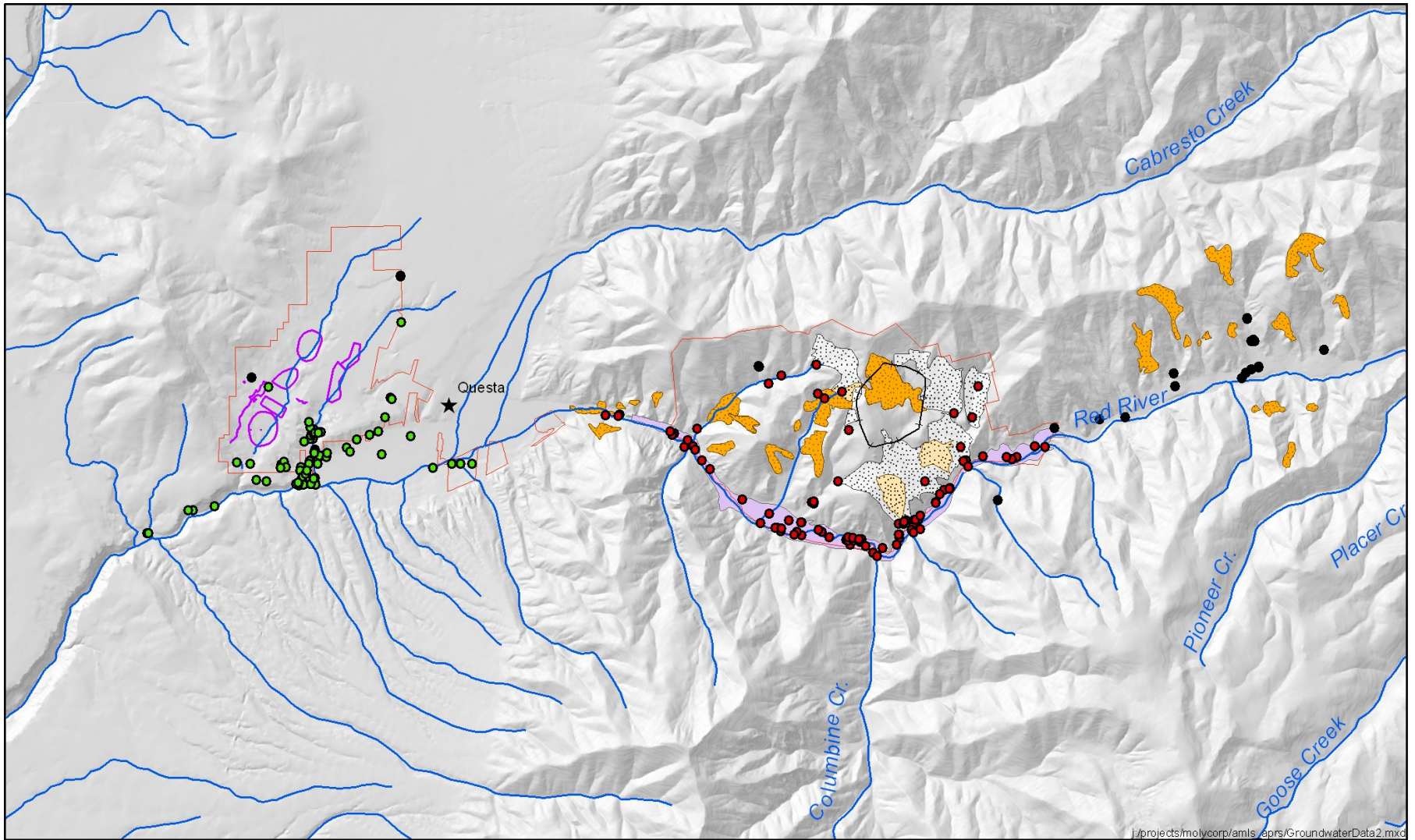
- ▶ New Mexico State Standards
- ▶ 20.6.2 NMAC, New Mexico Water Quality Control Commission Regulations
 - 20.6.2.3103 Standards for groundwater
- ▶ Other standards
 - EPA drinking water standards

Baseline Conditions – Initial Impressions

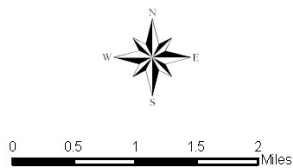
- ▶ Reference sites as designated in database
- ▶ Some exceedences of selected analytes at reference sites
 - Al, Co, Fe, Mn, Ni
- ▶ Other contaminants not exceeding at reference sites
 - Cd, Cr, Cu, Pb, Mo, Zn
- ▶ Further investigation of reference locations

Mine and Tailings – Initial Impressions

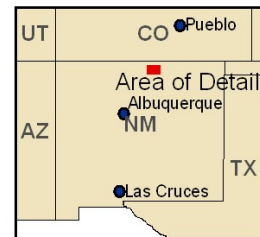
- ▶ Mine sites
 - Exceedences of all selected analytes except Mo (very low % of samples exceeded)
 - Most analytes exceeded more frequently than at reference sites
- ▶ Tailings sites
 - Most analytes do not exceed standards
 - Some exceedences of Mo, Mn, Fe
 - Appropriate reference?

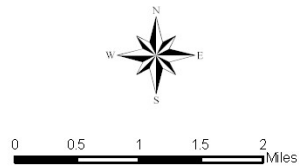
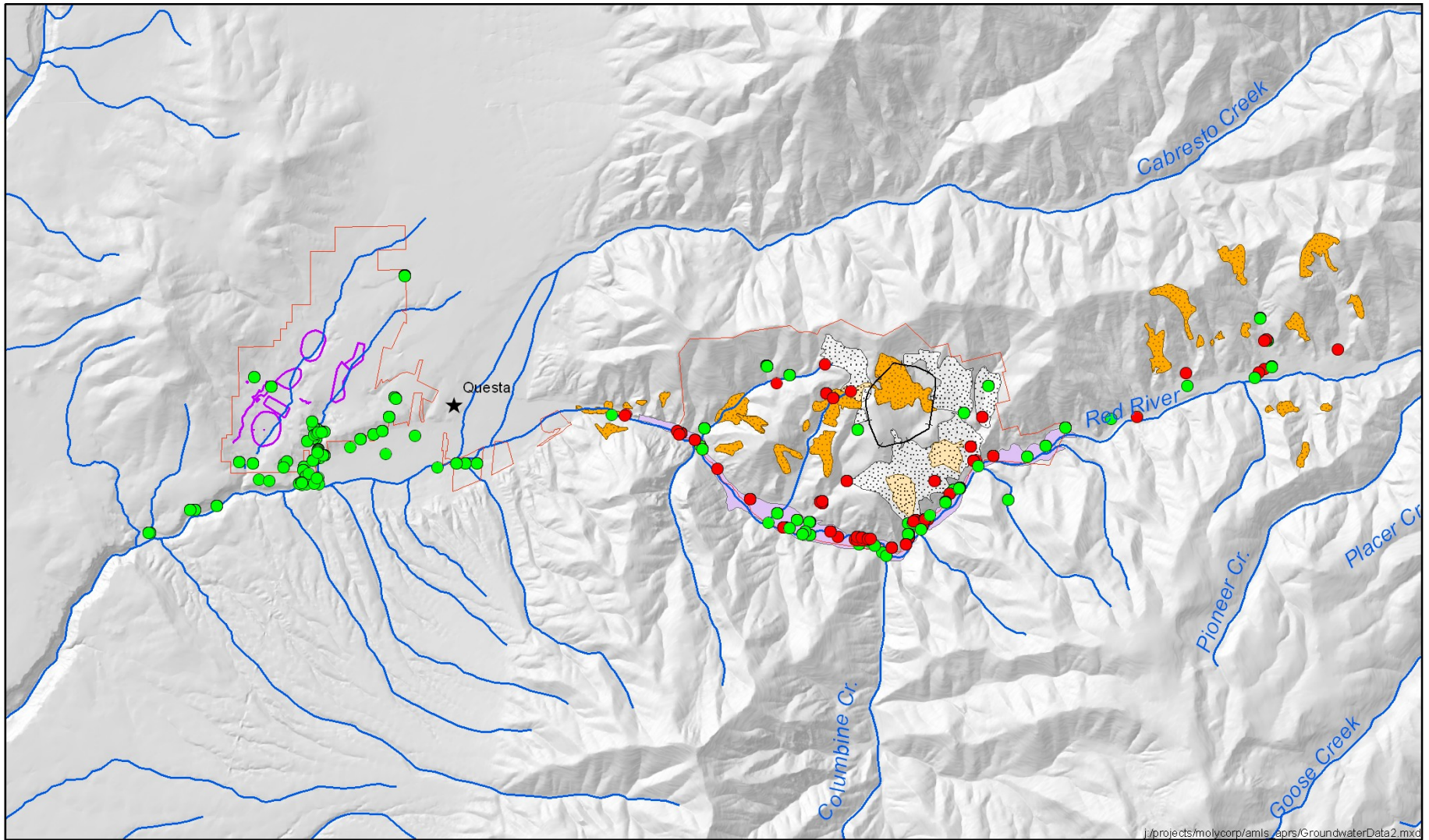


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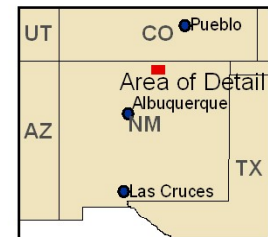


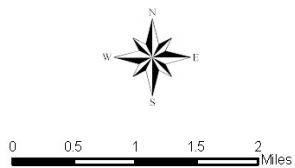
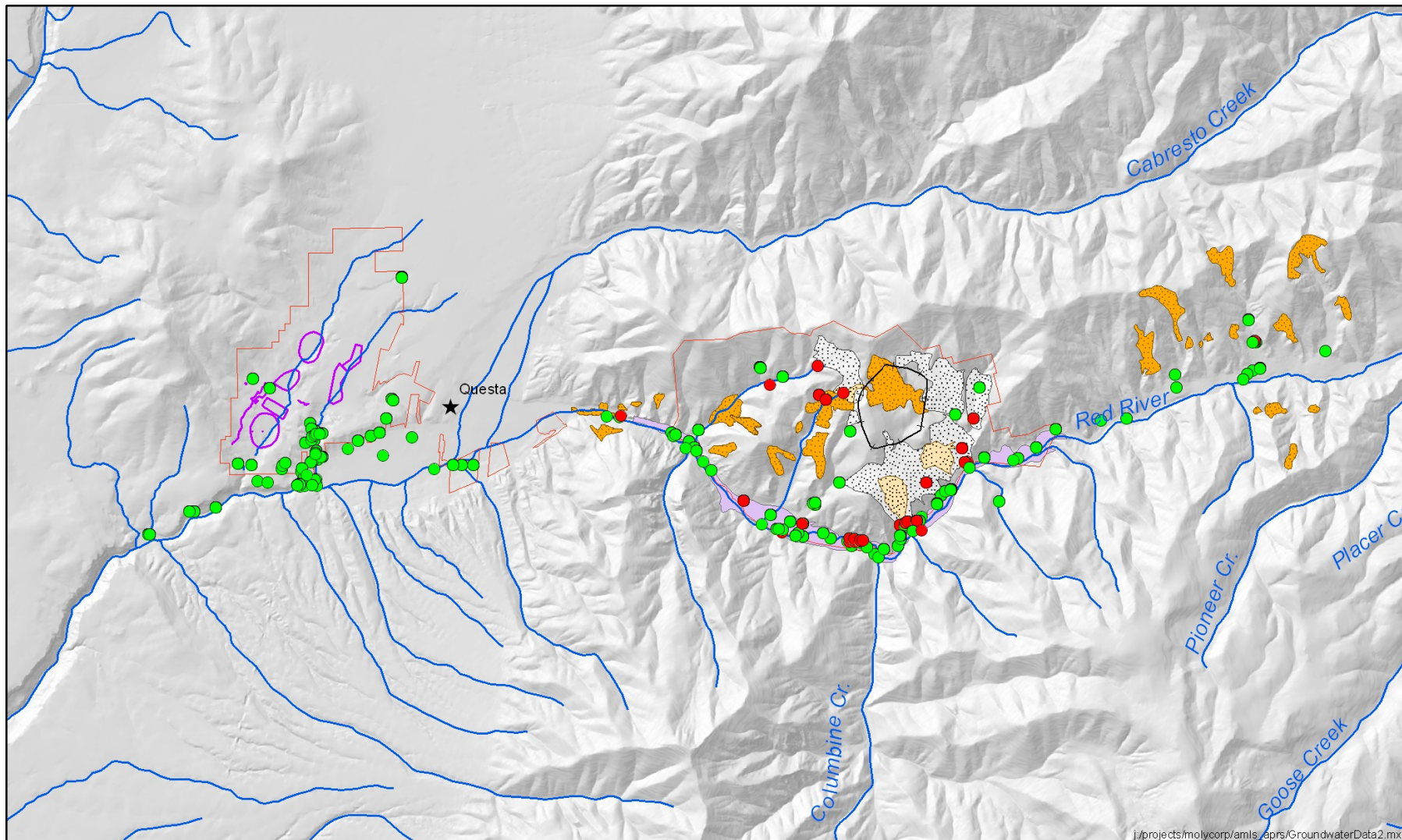
- ★ Town
- Reference
- Mine
- Tailing
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- Alluvium deposit
- Hydro scar
- Mine rockpile



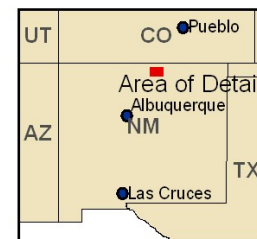


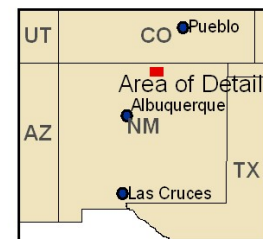
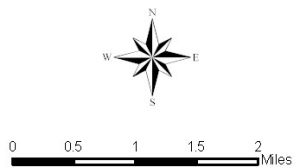
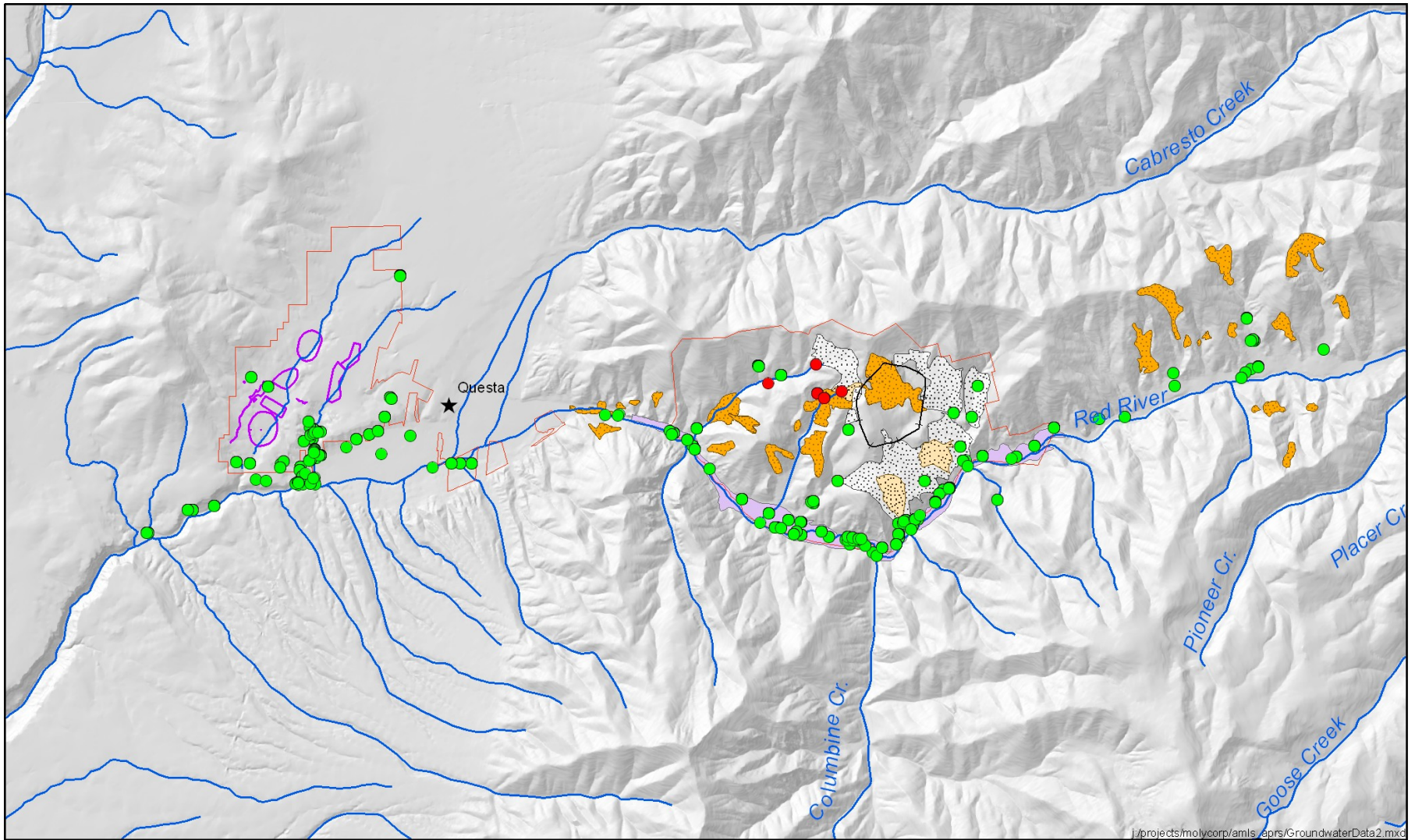
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| ★ Town | — Larger stream | ■ Alluvium deposit |
| GW Aluminum | — Mine boundary | ■ Hydro scar |
| ● Standard not exceeded | — Open pit boundary | ■ Mine rockpile |
| ● Standard exceeded | — Tailings ponds | |

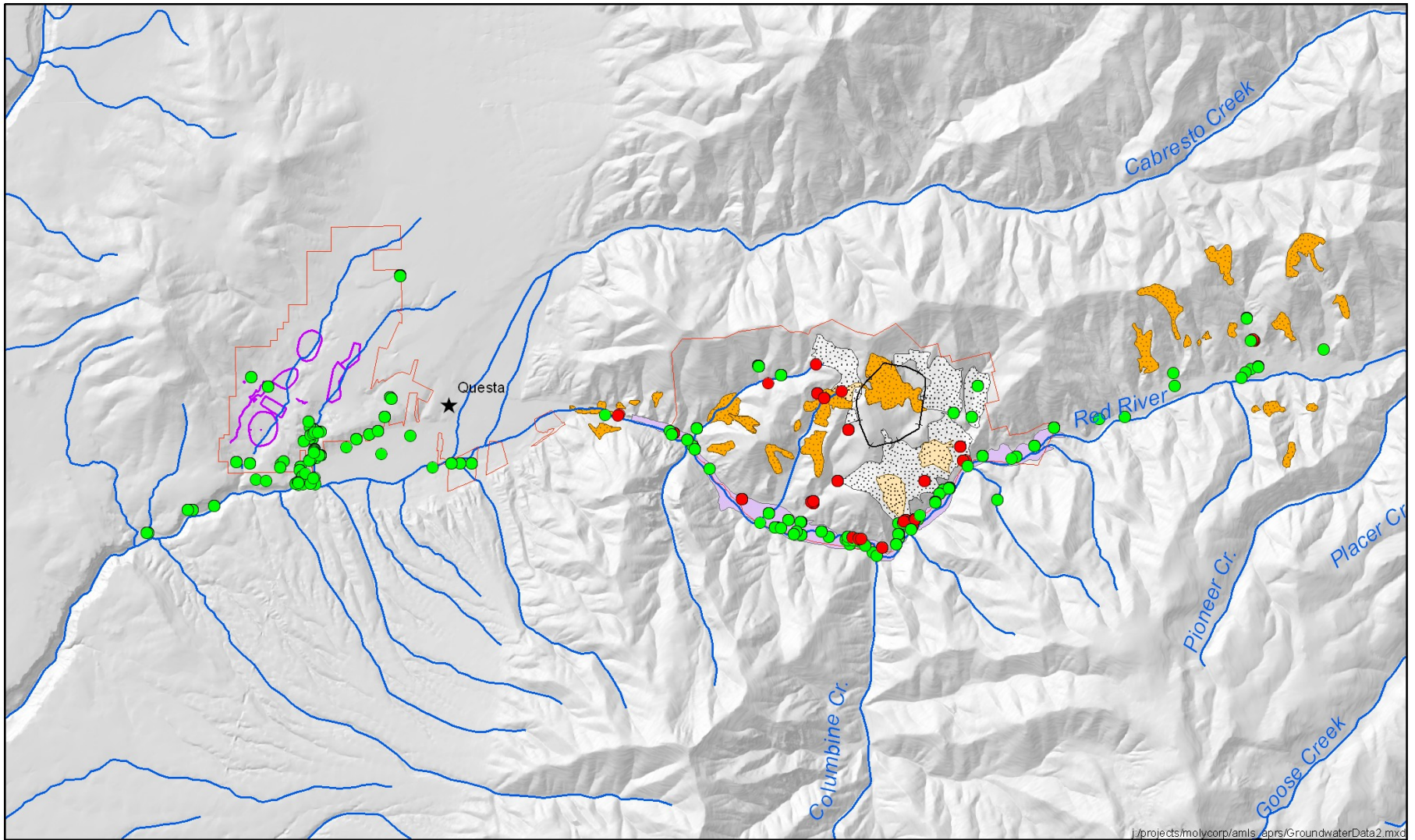




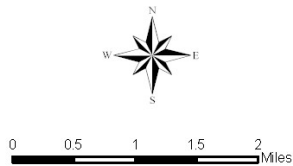
- ★ Town
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- GW Cadmium
- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile



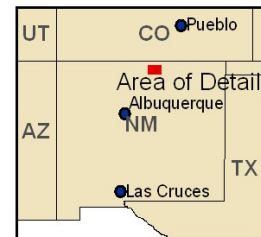


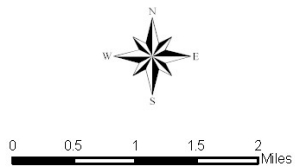
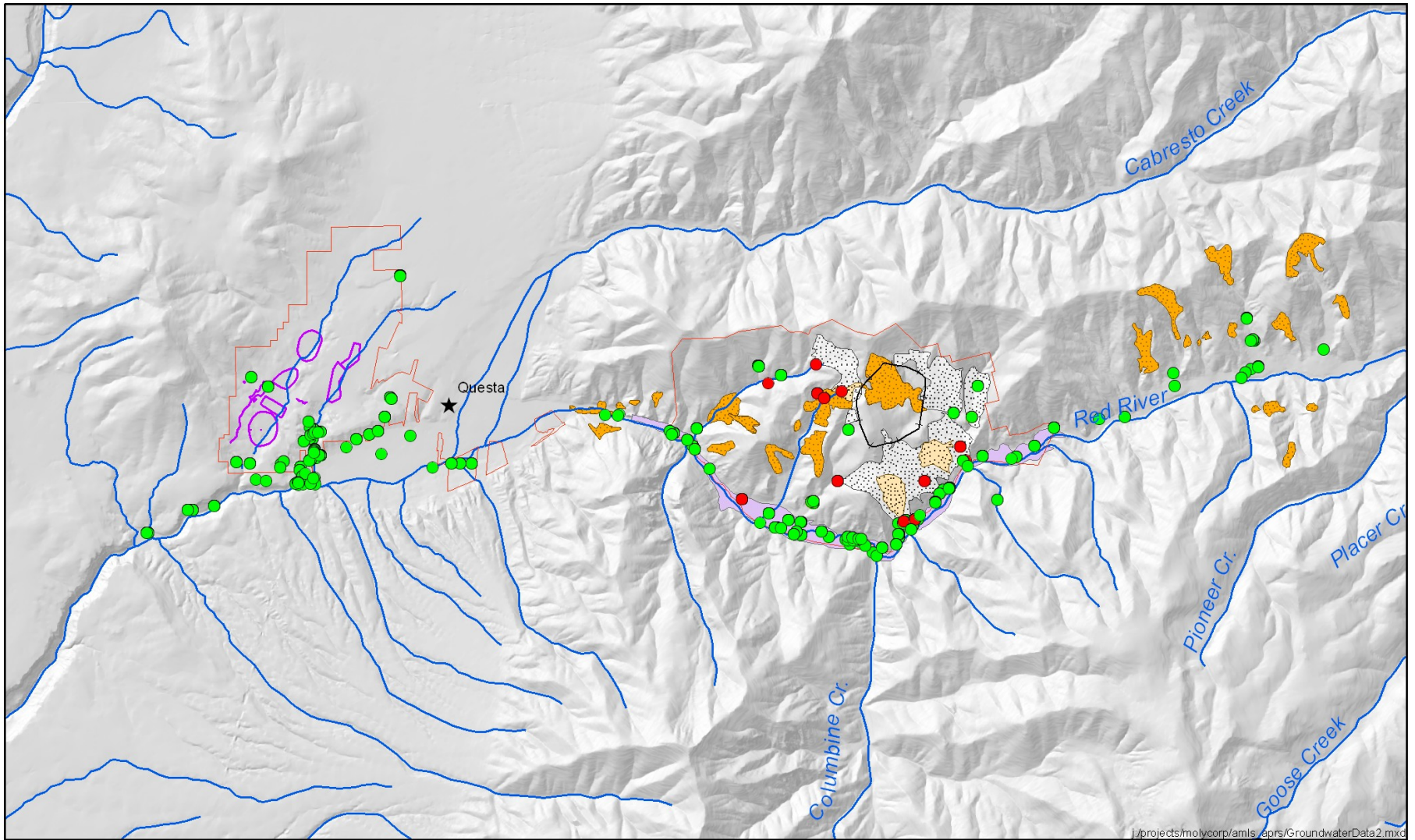


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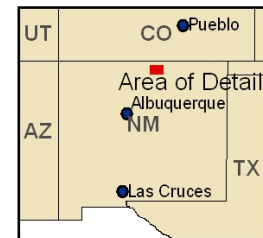


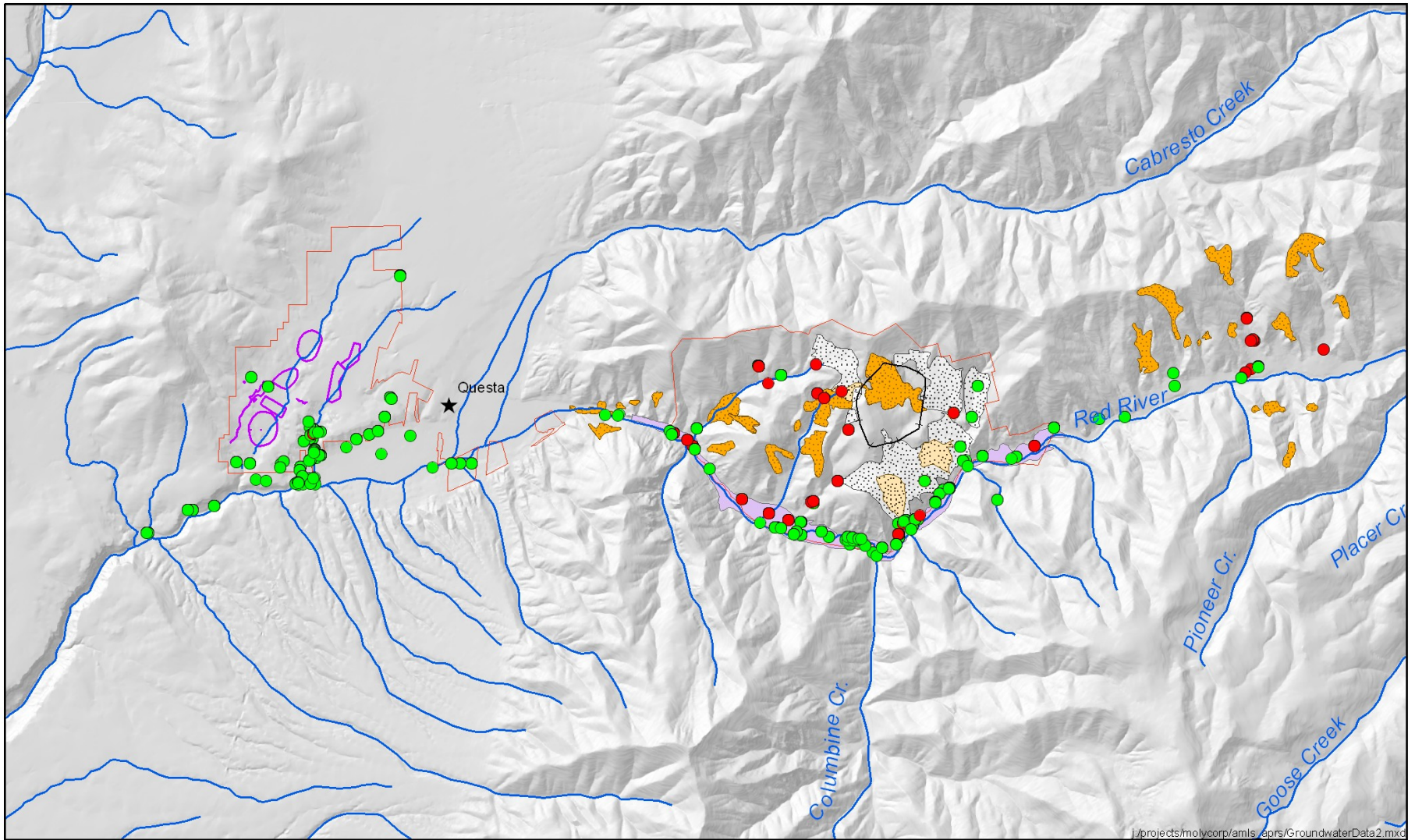
- ★ Town
- Larger stream
- Mine boundary
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- Tailings ponds
- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile



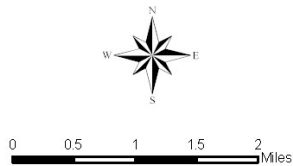


- ★ Town
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile

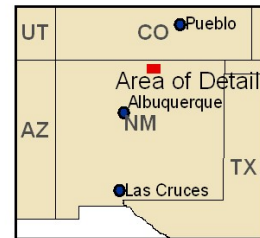


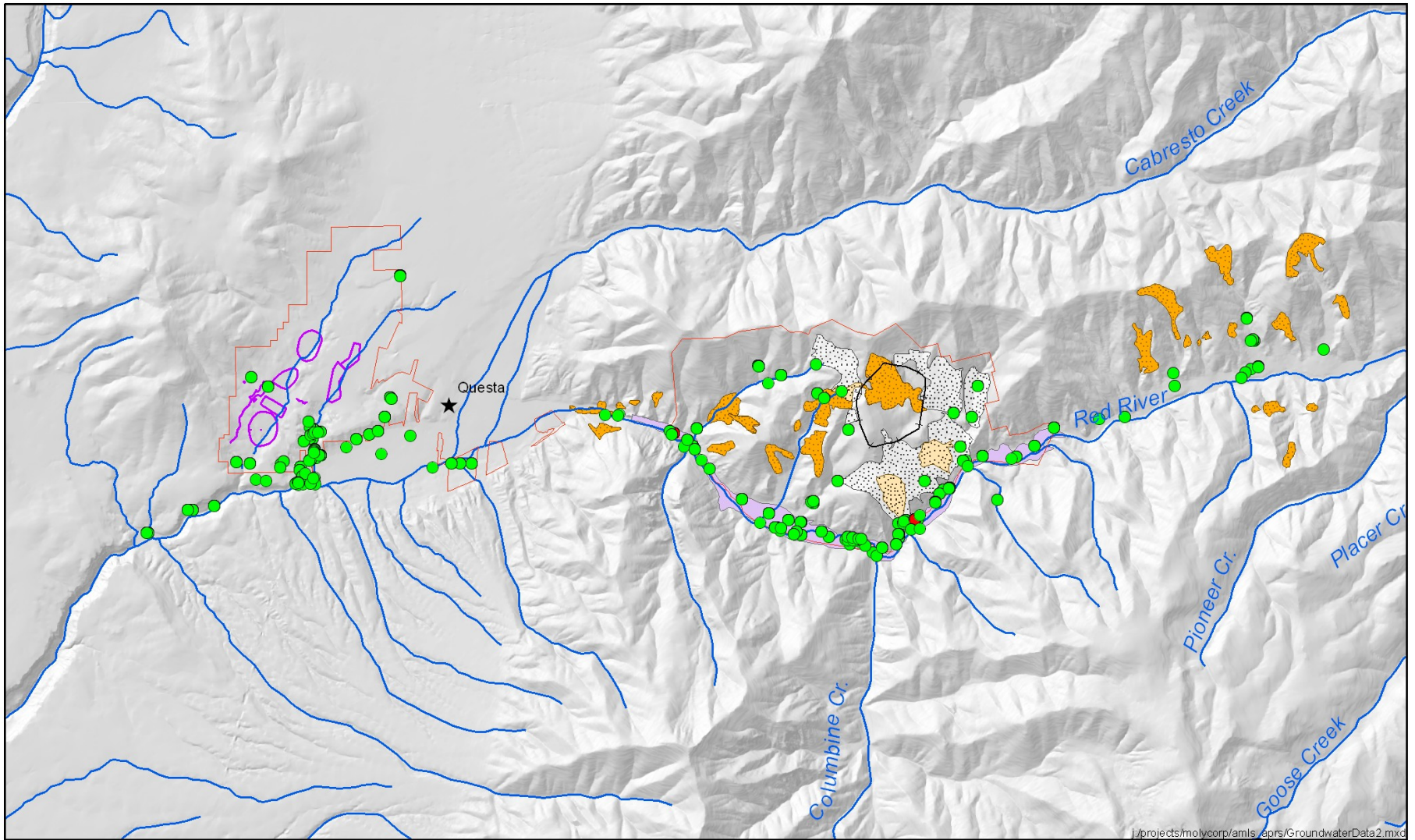


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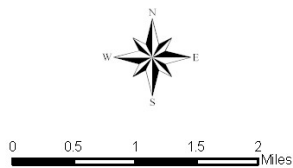


- ★ Town
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile

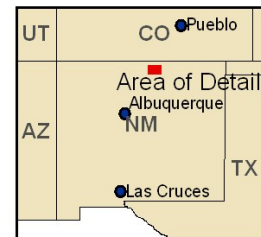


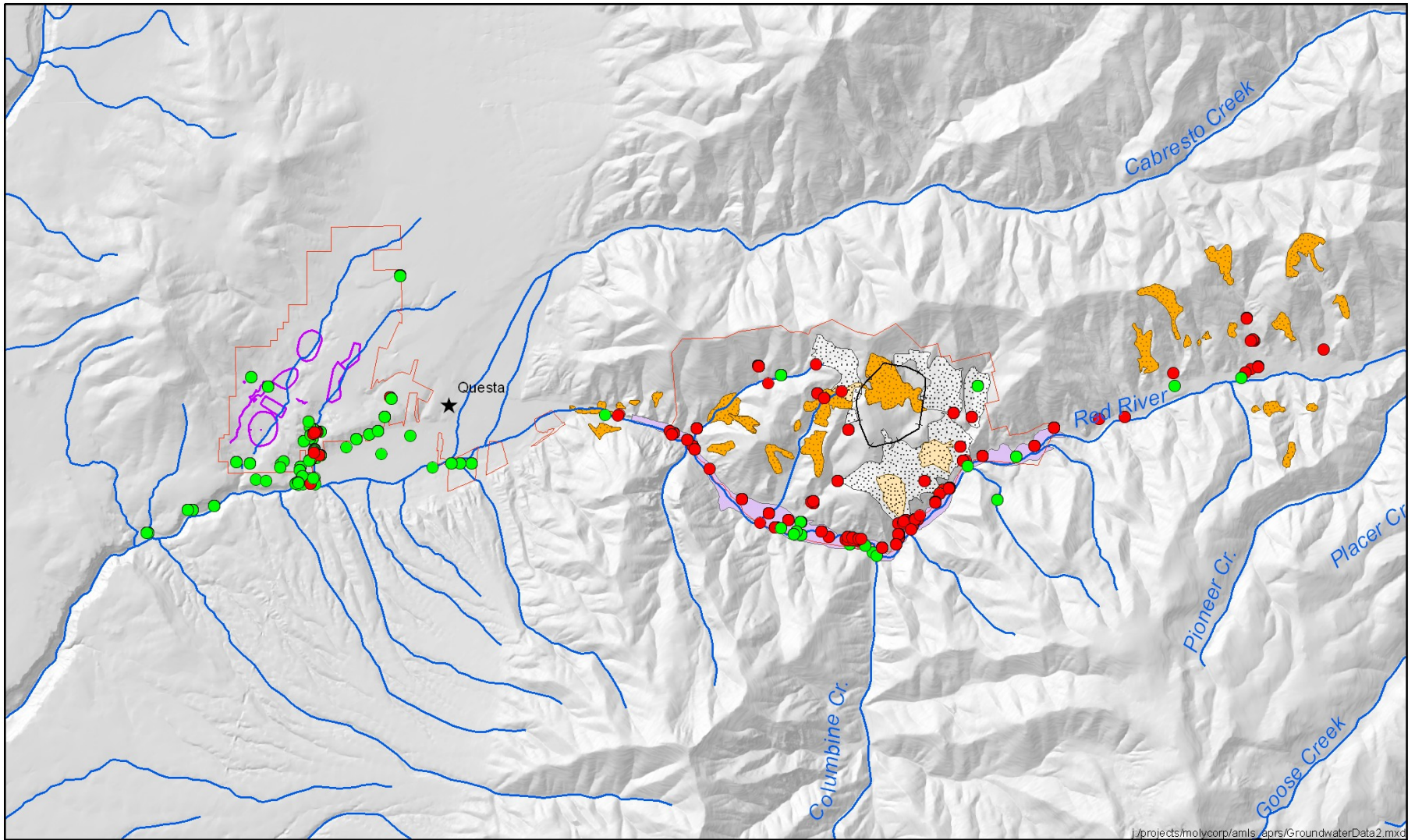


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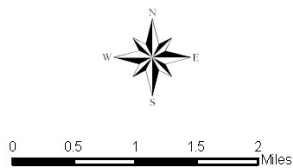


- ★ Town
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile

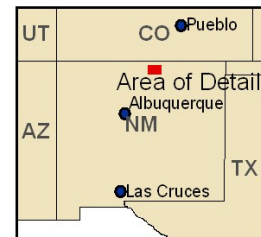


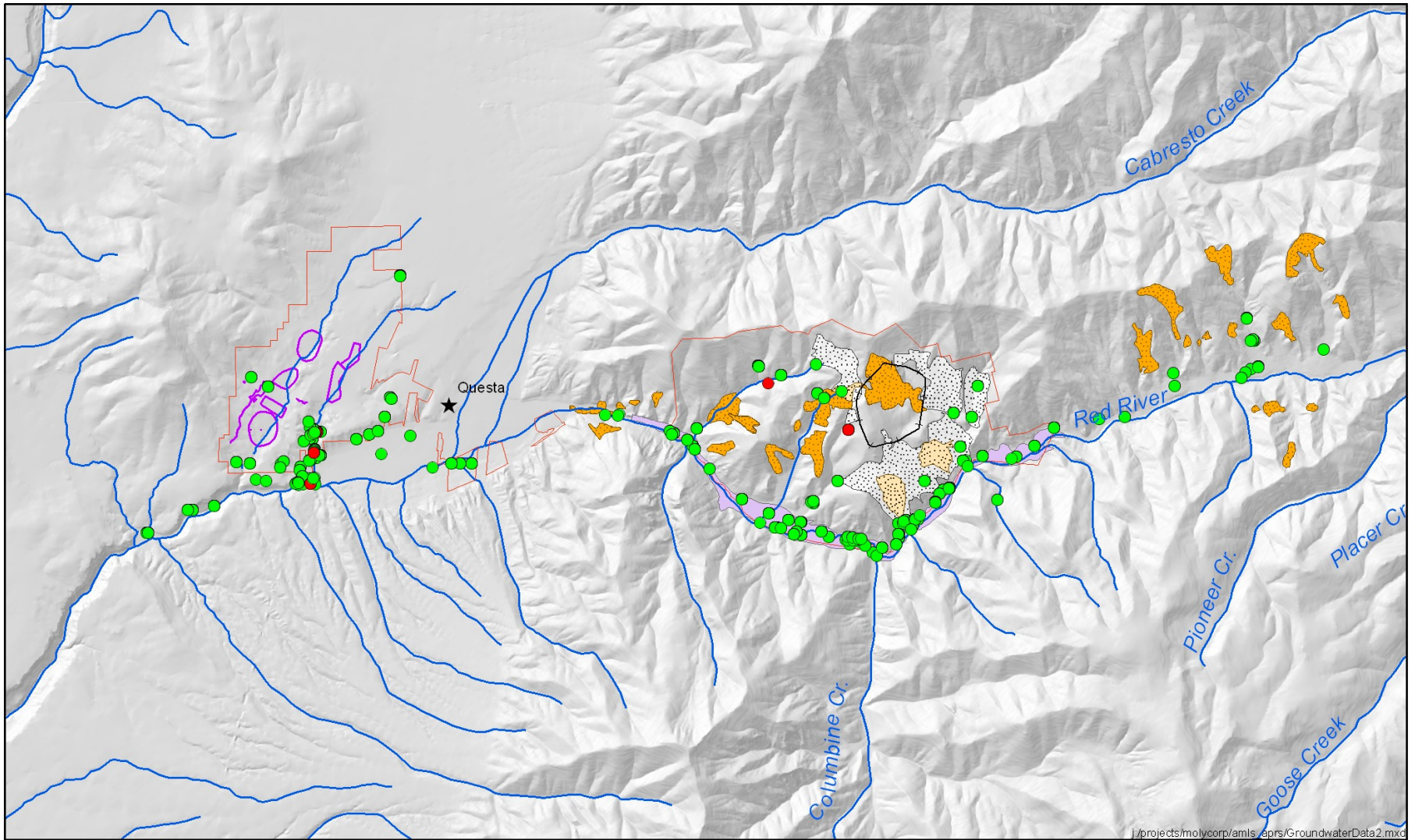


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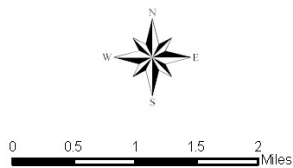


- ★ Town
- Larger stream
- Mine boundary
- Open pit boundary
- Tailings ponds
- GW Manganese
- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile

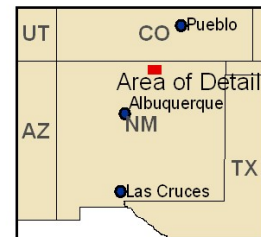


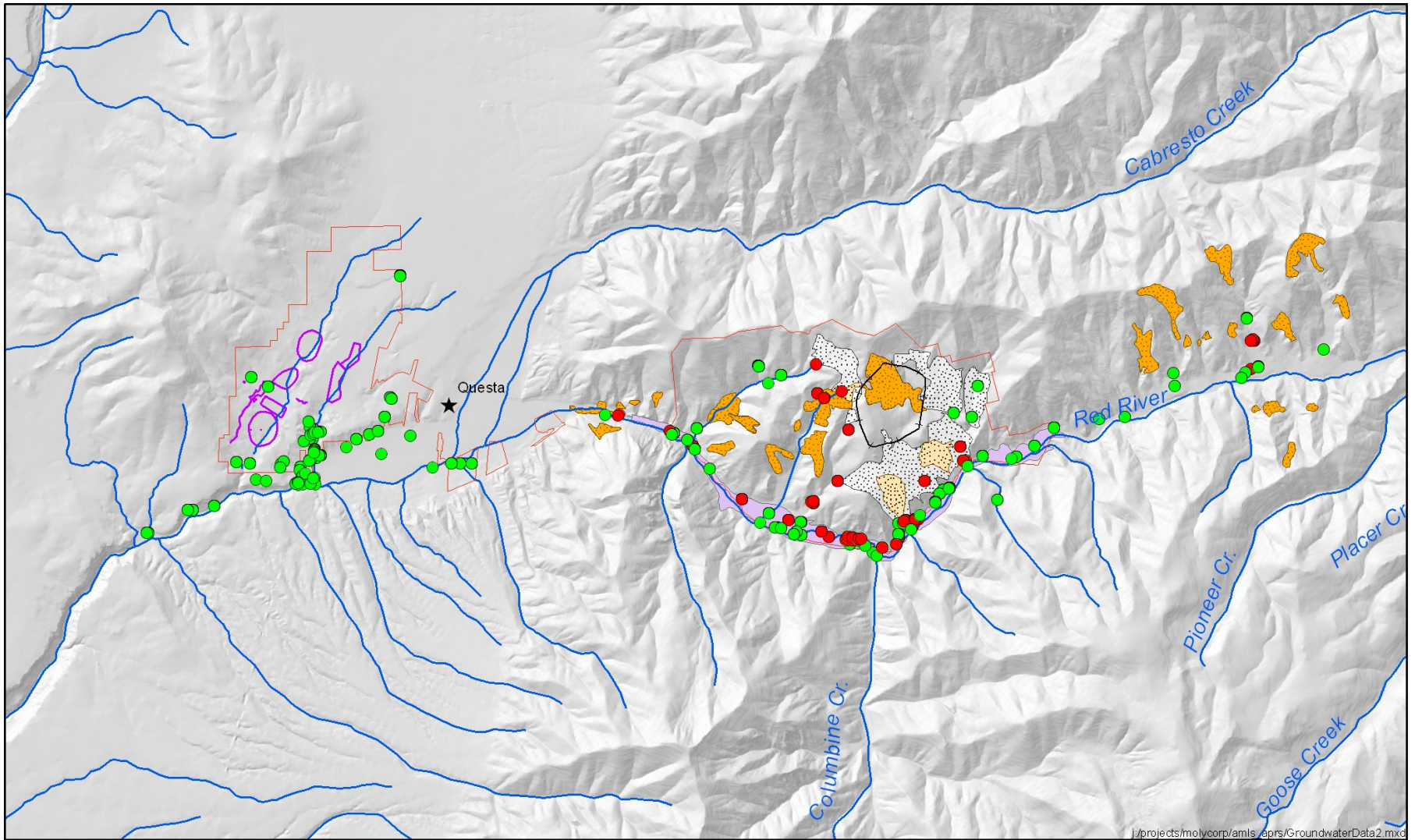


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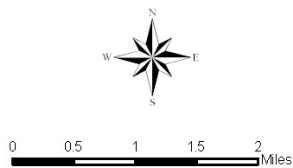


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|-------------------------|---------------------|--------------------|
| ★ Town | — Larger stream | ■ Alluvium deposit |
| GW Molybdenum | — Mine boundary | ■ Hydro scar |
| ● Standard not exceeded | — Open pit boundary | ■ Mine rockpile |
| ● Standard exceeded | — Tailings ponds | |

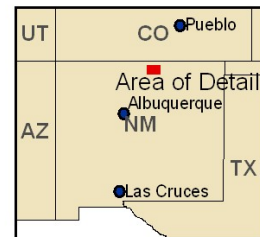


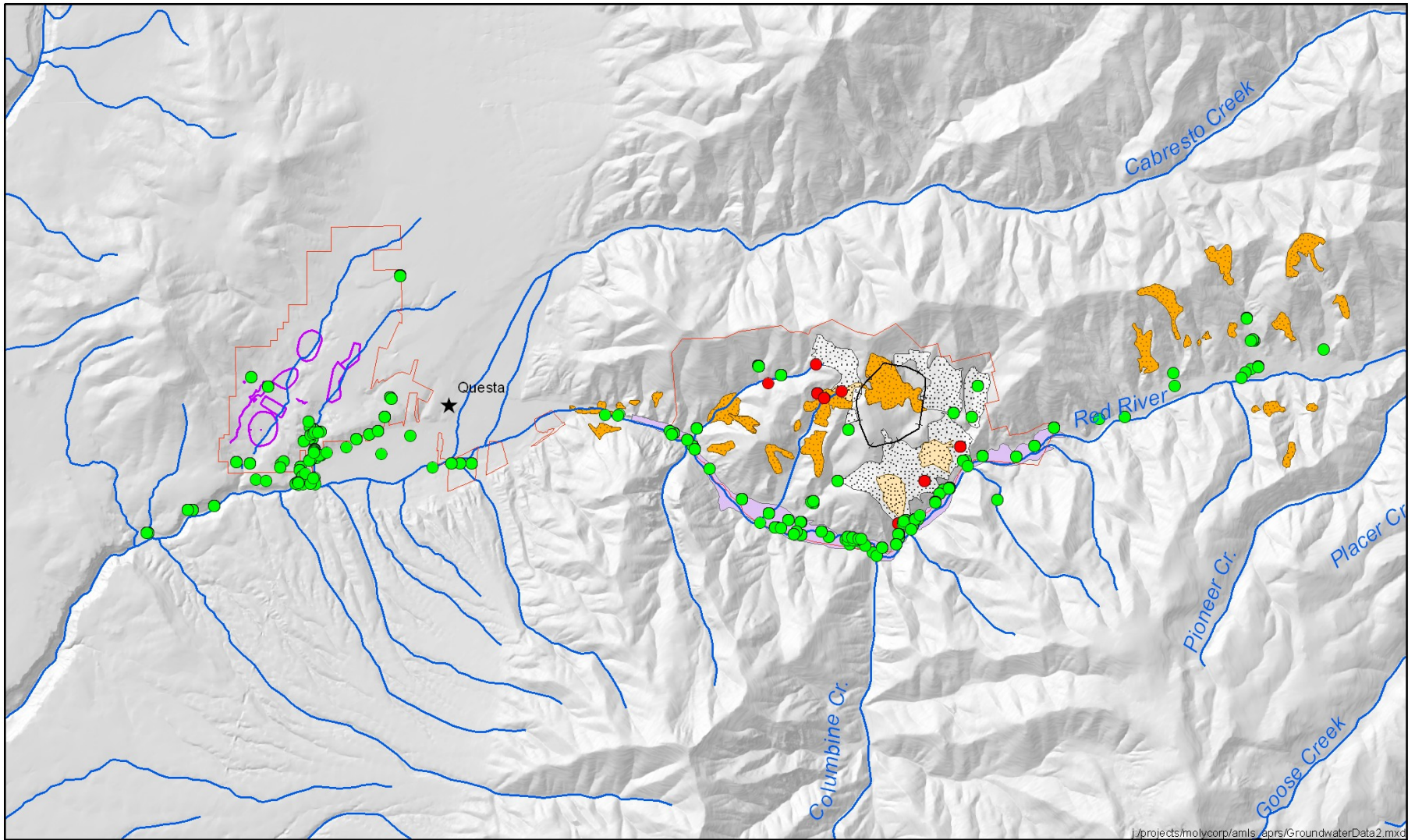


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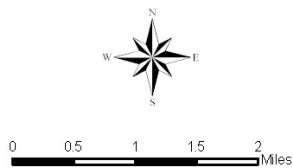


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- Hydro scar
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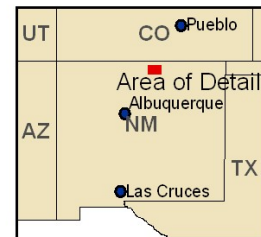




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- ★ Town
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- Standard not exceeded
- Standard exceeded
- Alluvium deposit
- Hydro scar
- Mine rockpile



Next Steps

- ▶ What?
 - Look at more substances?
- ▶ Where?
 - Narrow down problem locations (to sampling site level)
 - Investigate vertical extent of contamination
- ▶ When?
 - Define temporal extent
- ▶ To what degree?
 - Quantify degree of injury

Approach to Determining Injury

- ▶ Injury level relative to baseline
 - Degree of exceedence?
- ▶ Temporal Variation
- ▶ Spatial Variation
- ▶ Estimated volume x degree exceedence x time?
 - How to calculate volume?
 - simple methods
 - complex methods
- ▶ Discounted acre-foot-years