Gold King Mine

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Figure 5. Miners working inside a cut-and-fill stope, Gold King (mine # 111; circa 1899, Silverton Standard folio, 1904) This rare view inside a stope was staged for promotional purposes, but the photo shows hand drilling on a stope hanging wall and ore being cobbed with a hammer while an engineer studies samples. Miners are working off a fill pil while timbers support mined-out area above.

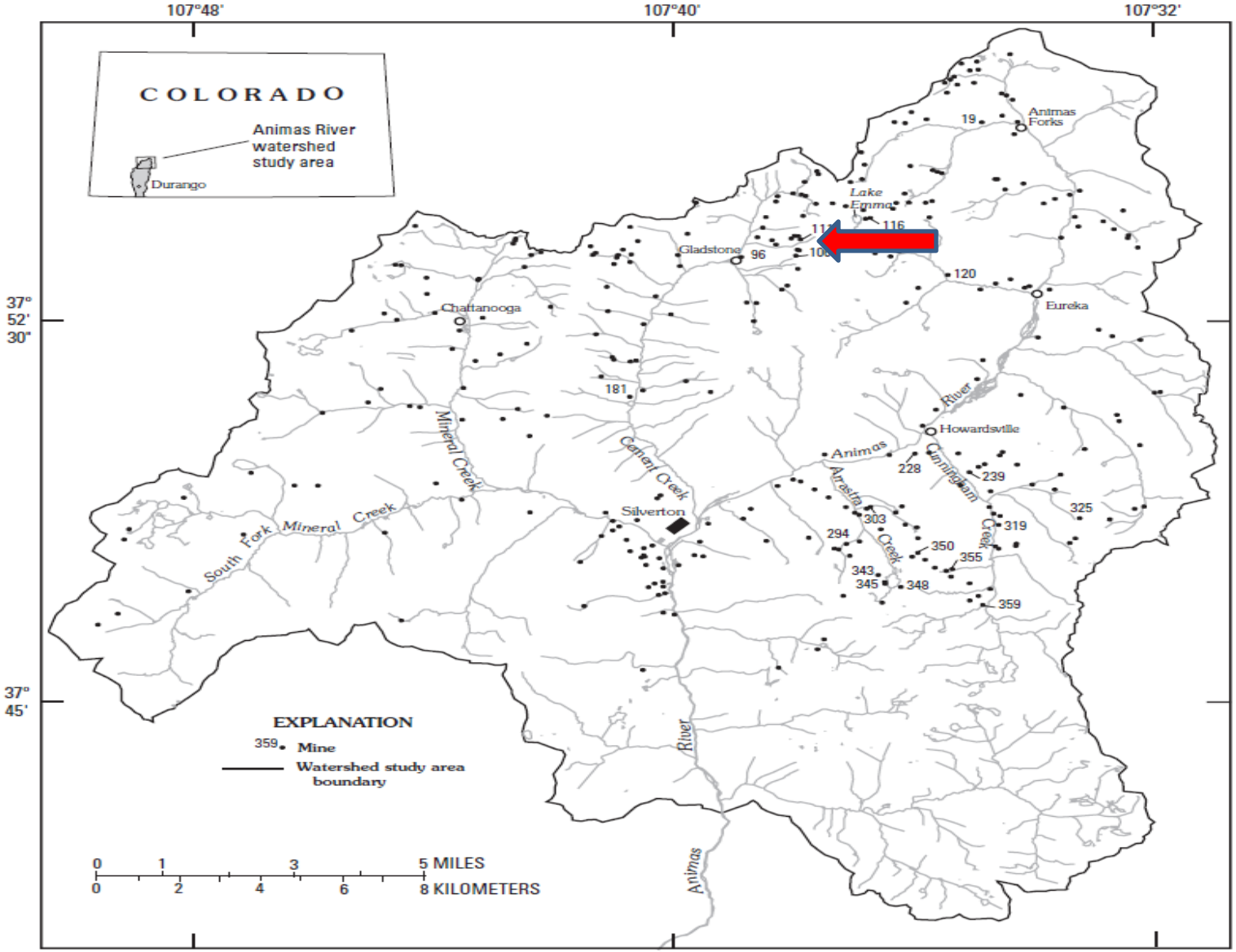


Figure 1. Locality map of mines, Animas River watershed study area (Church, Mast, and others, this volume, Chapter E5). Mine sites referred to in this chapter are: Frisco tunnel (site # 19), Gold King Mill level tunnel (site # 96), Lead Carbonate (mine # 106), Gold King (mine # 111), Sunnyside (mine # 116), Terry tunnel, Sunnyside (mine # 120), May Day (mine # 181), Little Nation (mine # 228), Old Hundred mine, mill level (site # 239), Unity tunnel of the Silver Lake (mine # 294), Little Giant (mine # 303), Pride of the West mine, # 1 level (mine # 319), Buffalo Boy (mine # 325), Silver Lake mine, # 1 level (mine # 343), Iowa (mine # 345), Royal Tiger (mine # 348), North Star (mine # 350, later a part of the Shenandoah-Dives mine, 1700 level), Shenandoah-Dives mine, 900 level (mine # 355), and Highland Mary mine, # 7 level (mine # 359).

from USGS, Church et al., 2007

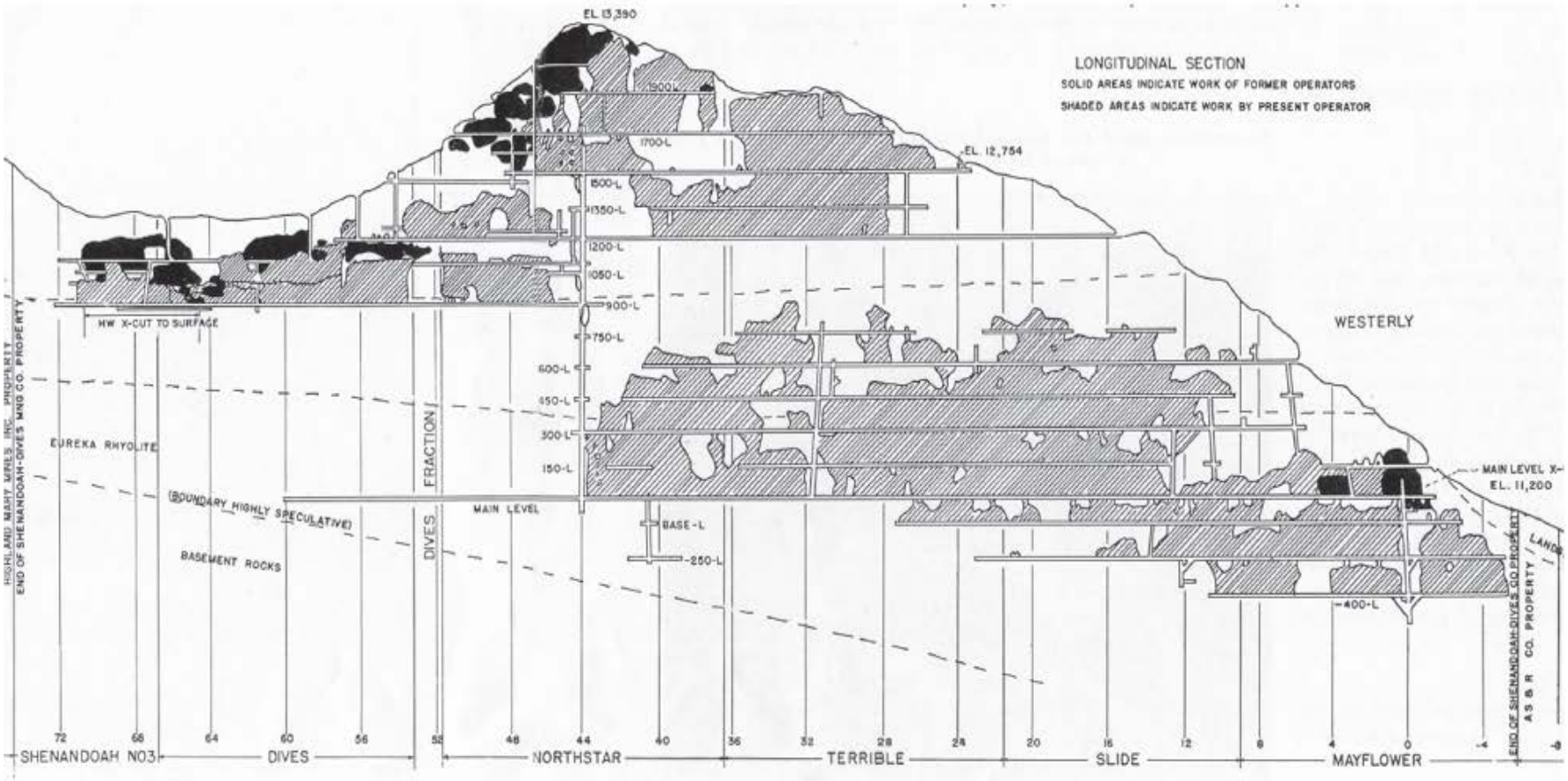


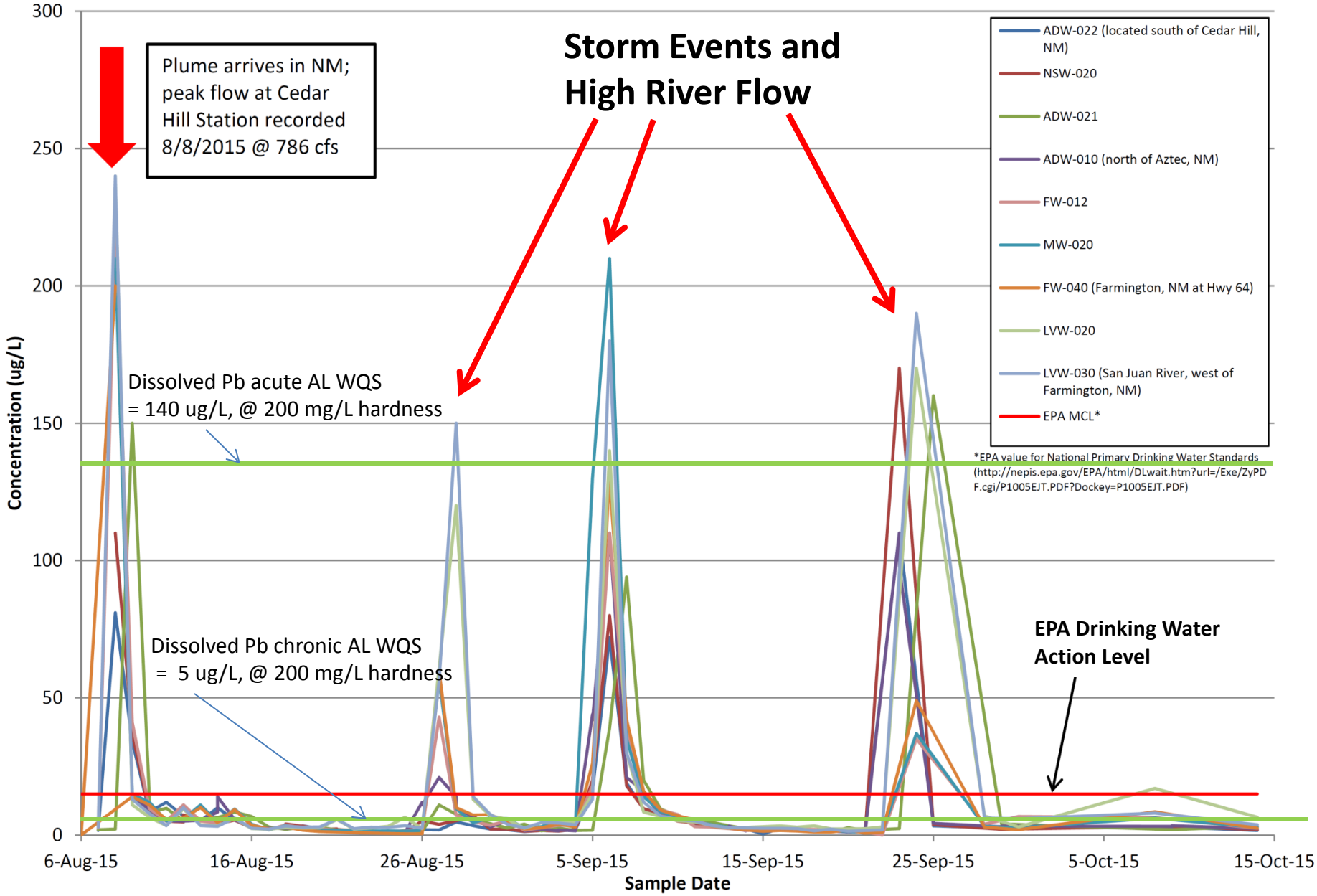
Figure 21. Cross section of Shenandoah-Dives mine in 1950 (Chase, 1952). This cross section view of the Shenandoah-Dives (mine # 355) shows 1880–1925 mined-out areas in black and 1926–1950 stoped areas in shaded gray diagonal lines. The figure graphically shows the difference in size and extent of the mined area removed during the latter "modern" period, when air drills and power equipment were used, relative to that achieved using earlier hand methods. Map shows mining over a vertical extent of 2,500 ft and horizontal extent of 7,600 ft.

from USGS, Church et al., 2007

Figure 5.—Historical photograph of the Gold King Mine Level 7 taken prior to the mine closing in 1923. Note the drainage flow down the side of the waste-rock dump.

from U.S. Dept. of Interior, Bureau of Reclamation, Tech. Evaluation, Oct, 2015

Total Lead in the Animas and San Juan Rivers
New Mexico



Metal reactions with changes in pH

<u>Approximate Heavy Metal precipitation zone</u>

	Fe (III)	Al	Cu	Zn
pH	3.5	4.5	5.5	6.5
	soda	*acid rain*	*coffee*	*saliva*

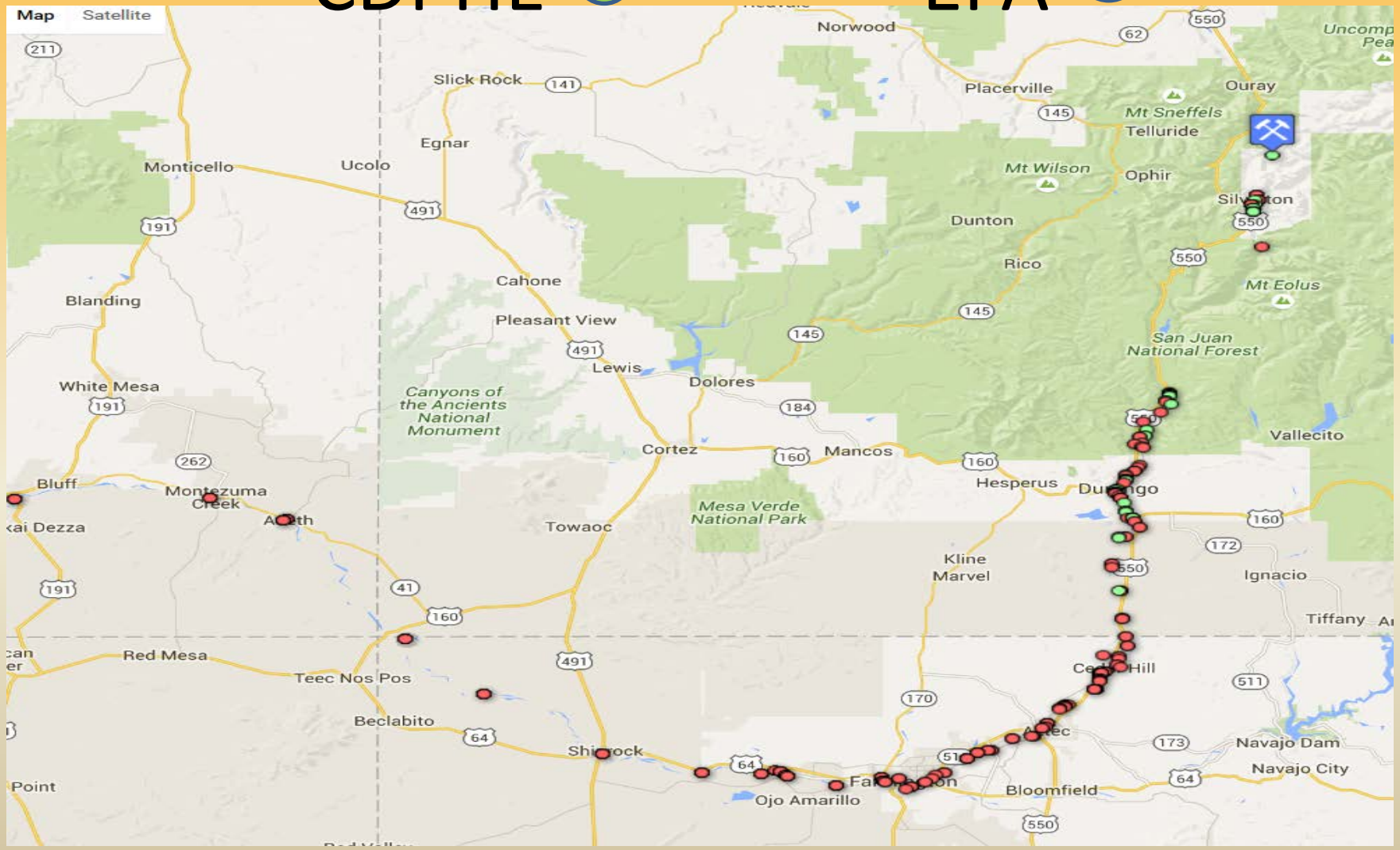
At Aztec, the pH was ~7.9 SU as the plume passed and between 8.2 and 8.7 SU in the hours/days that followed.

Slam Bar, Animas River Sediment Sampling, Sept. 2015

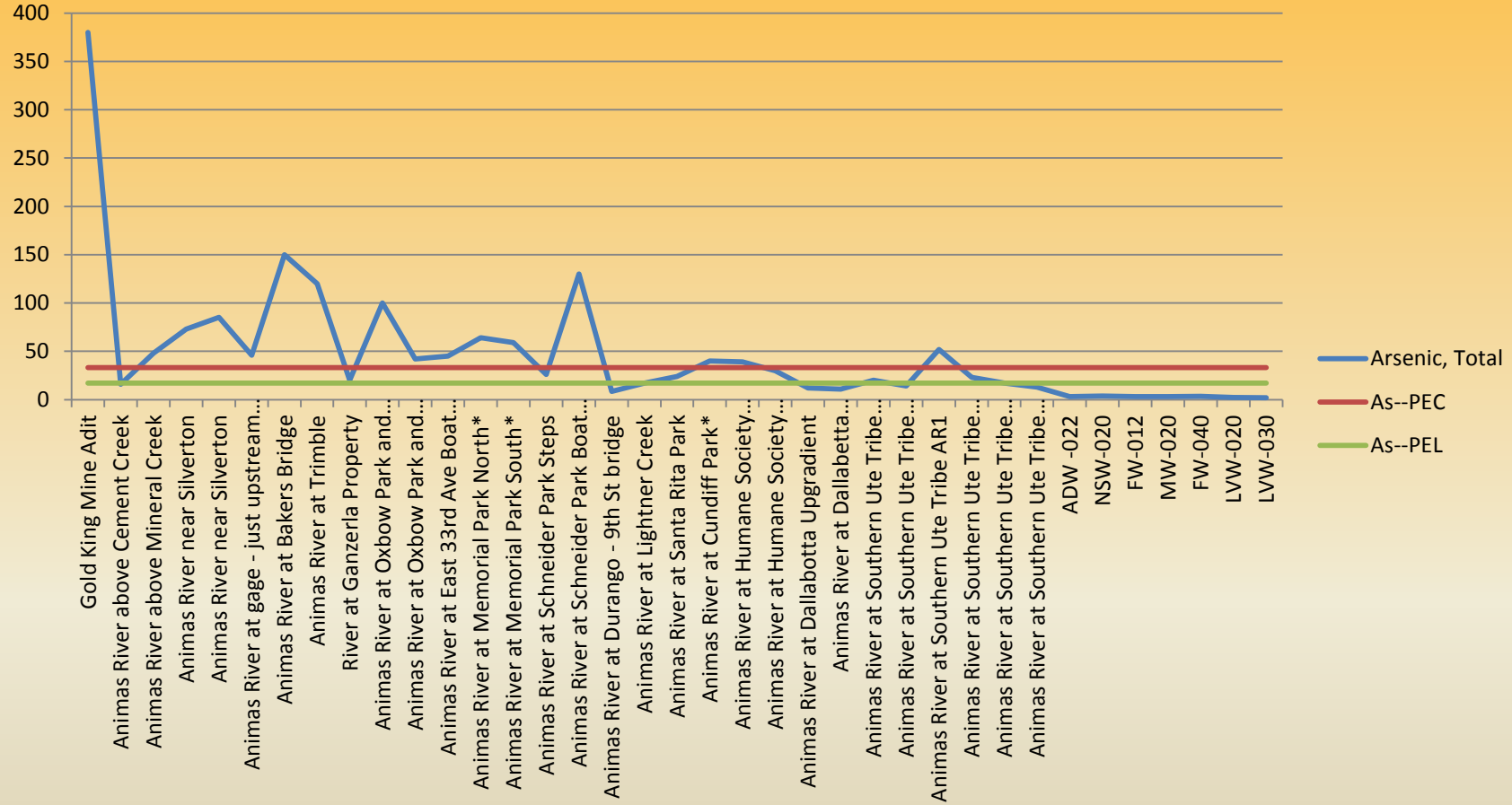
Sediment Sampling, Animas River near Cedar Hill, Sept. 2015

CDPHE and EPA Sediment Sampling Stations, Animas and San Juan Rivers

CDPHE- EPA-



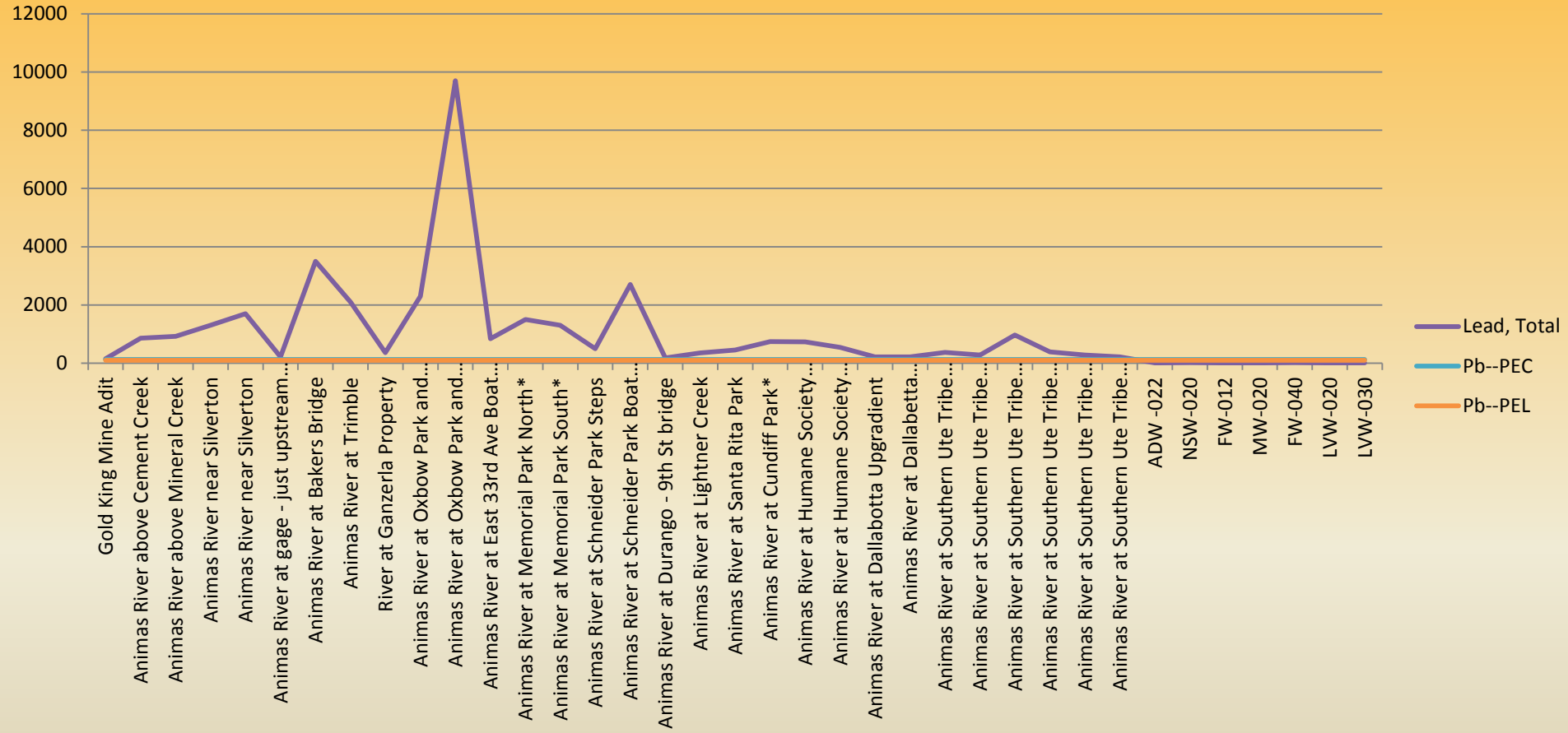
Arsenic mg/Kg



CO data from CDPHE 8/11--18/2015
NM data from EPA 8/29/2015

EPA Screening Level = 4200 mg/Kg
from Aug 11, 2015 calculation

Lead
mg/Kg



CO data from CDPHE 8/11--18/2015
NM data from EPA 8/29/2015

EPA Screening Level = 20,000 mg/Kg
from Aug 11, 2015 calculation

Determining "Background" for sediment in the Upper Animas Valley

- Given the extensive history of mining in the Valley, how can "background" sediment concentrations be determined?
- USGS (2005)
  - Determine pre-mining baseline, in deposit-related trace elements in streambed sediment that pre-date mining
  - Use pre-mining fluvial deposits in old stream terraces
  - Use lead isotopes (ex: ^{206}Pb is the product of ^{238}U decay) to separate modern from historic sediment
    - $^{206}Pb/^{204}Pb$ (since ^{204}Pb has no parent)

Background sediment sampling sites, Upper Animas Basin, from Church, et al., Chapter E12, Professional Paper 1651, USGS, 2005
(Gold King Mine is shown with arrow)

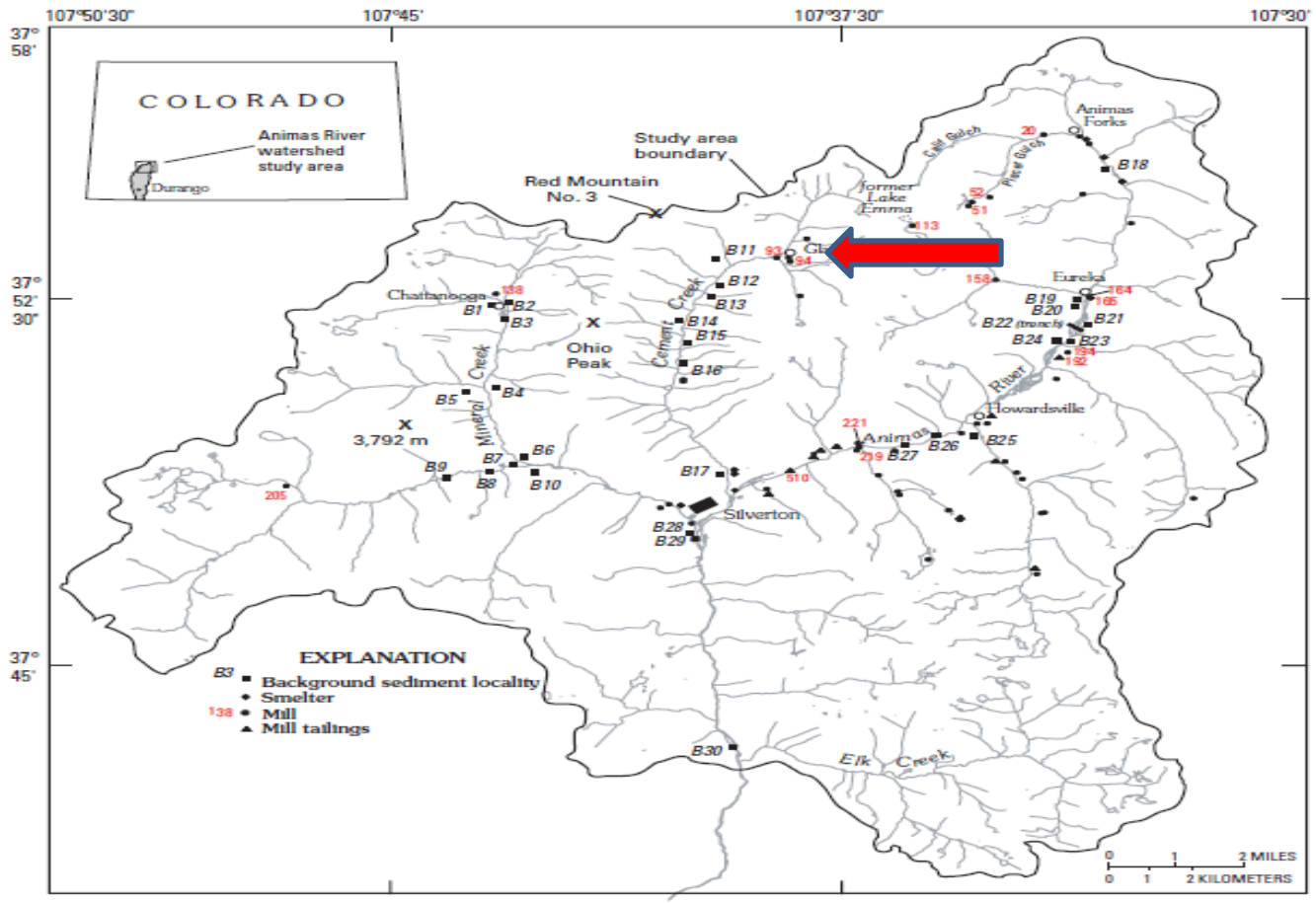


Figure 4. Sample localities of stream terraces sampled, some of which are used here to determine premining geochemical background in streambed sediment in the various basins of the Animas River watershed study area. Other sites are used to determine the present-day composition of contaminants in the watershed (table 1). Mills discussed in text are from Church, Mast, and others (this volume): Bagley Mill (site # 20); Hanson Mill (site # 51); Mastodon Mill (site # 52); Mogul Mill (site # 93); Gold King Mill (site # 94); Sunnyside-Thompson Mill (site # 113); Silver Ledge Mill (site # 138); Sunnyside Mill # 1 (also known as the Midway Mill, site # 158); Sunnyside Eureka Mill (site # 164); Sunnyside Mill # 2 (site # 165); Kittimack Mill and tailings (site # 194 and 192); Silver Lake Mill # 2 (site # 219); Mayflower Mill (site # 221); and the active Sunnyside tailings pond # 4 at the Mayflower Mill (site # 510).

Determining "Background" for sediment in the Upper Animas Valley --Findings--

- Animas River at and 10 miles above confluence with Mineral Creek
  - Cu >40X "crustal abundance" or background
  - Pb >100X
  - Ag >50X
  - Zn >20X
  - Cd >40X
  - Mn >10X
  - As >8—15X

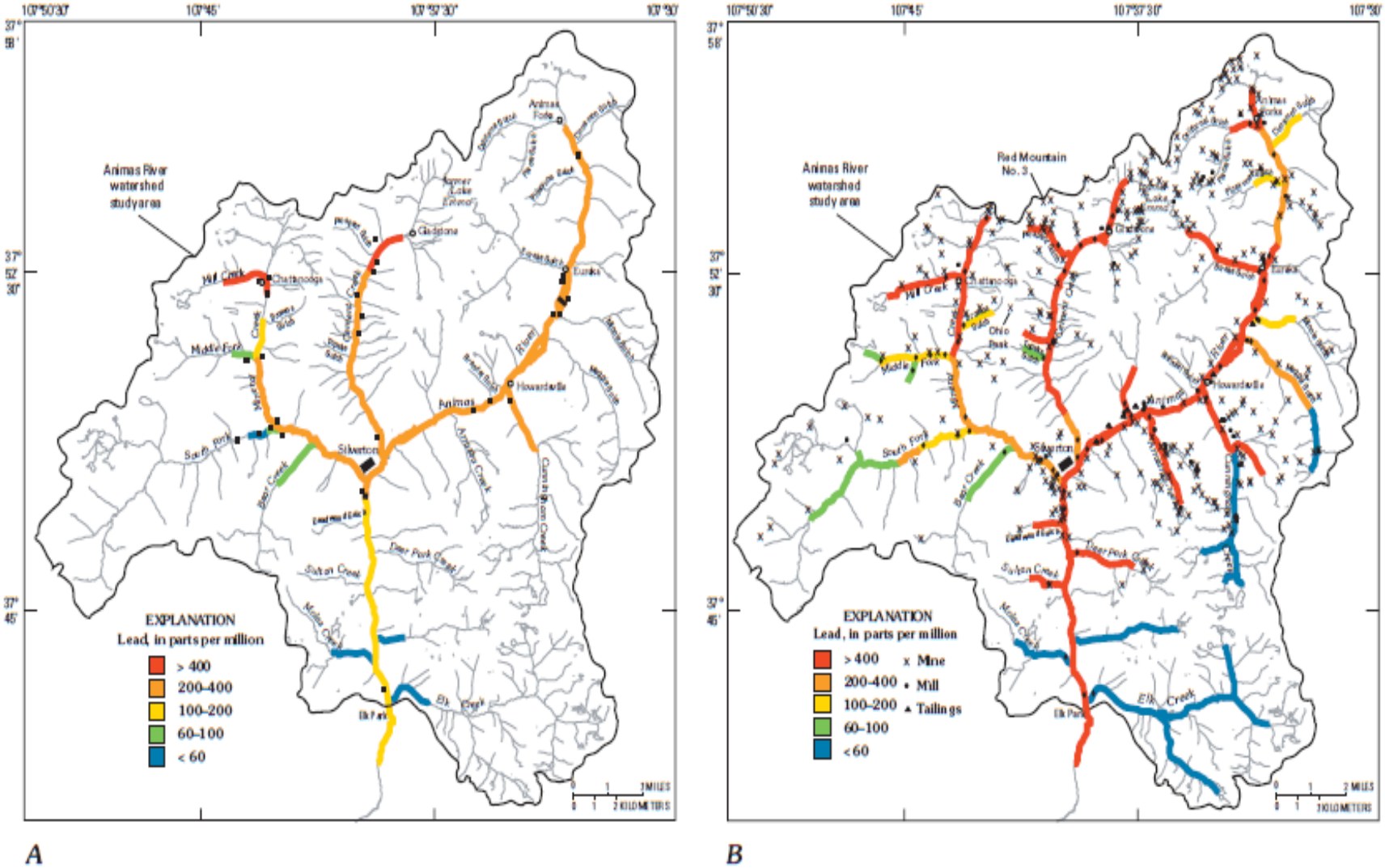


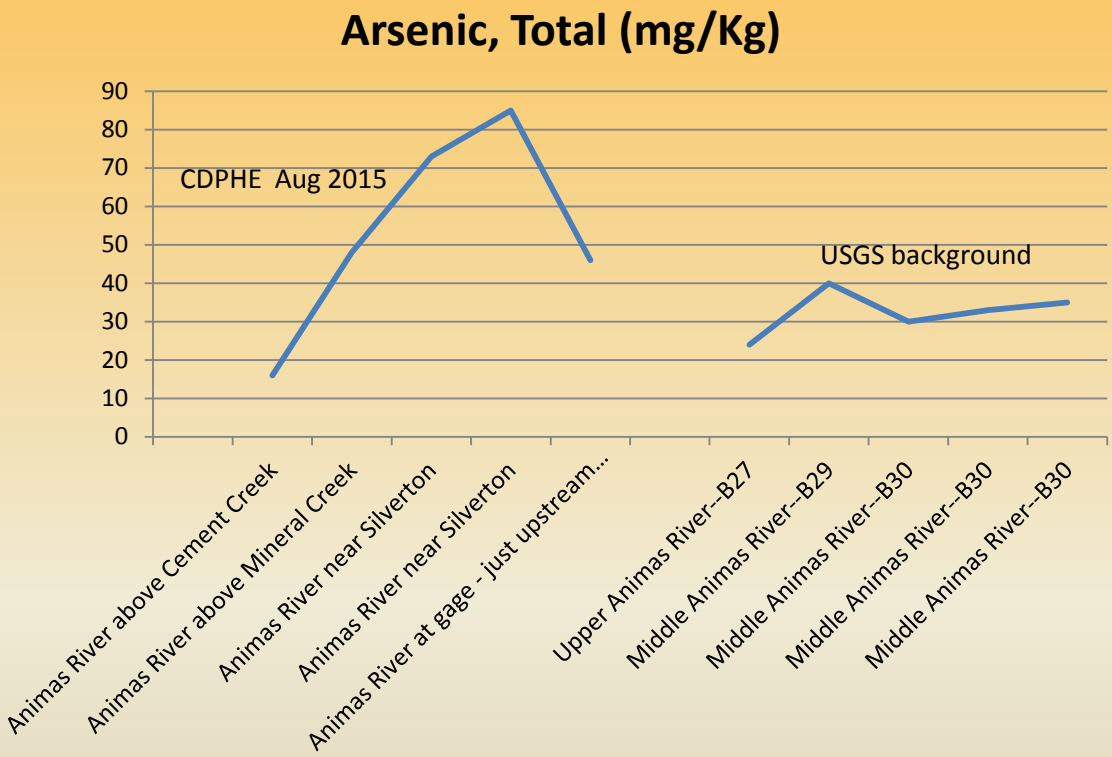
Figure 27. Concentration of lead from total-digestion data from *A*, sediment from premining terrace deposits (dot, sample locality), and *B*, modern streambed sediment. Premining geochemical baseline data from table 2. Lead concentrations were elevated in the premining geochemical baseline, but do not have the lead isotopic signature of the ores. Lead enrichment in modern streambed sediment is substantial, often approaching 1,000 ppm. Every stream reach affected by historical mining is contaminated by lead. This contamination can be traced downstream from Silverton for more than 100 mi (Church and others, 1997).

from Church, et al., Chapter E12, Professional Paper 1651, USGS, 2005

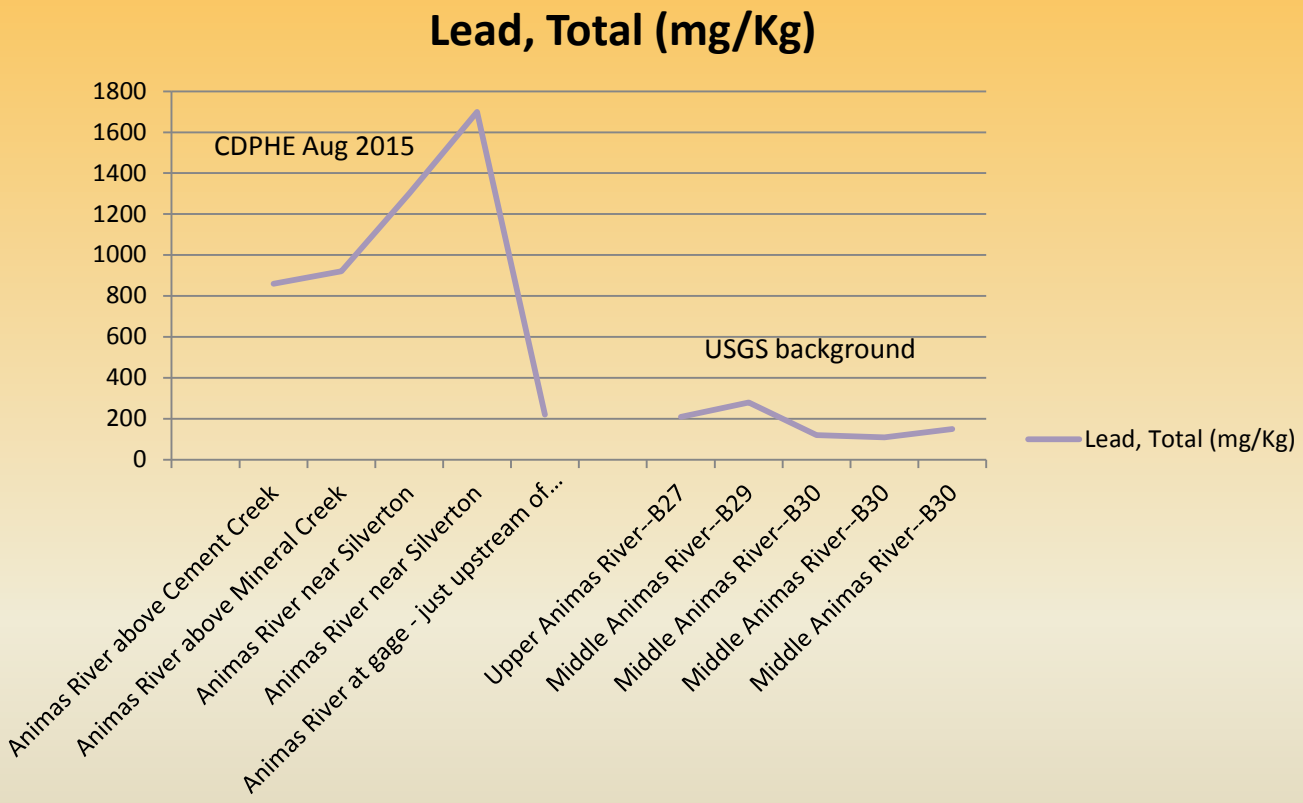
Determining "Background" for sediment in the Upper Animas Valley --Findings--

- Pb isotopic data provide "unequivocal evidence of the effect of historical mining on the three major streams of the Animas River watershed …"
- Deposit-related trace element data indicate principal contributor of 2.5×10^6 tons is tailings, from Sunnyside Eureka Mill.
- Pre-mining concentrations for Pb and Zn in the Animas River btw Eureka and Elk Park >threshold quality criteria (TEC and PEC, from MacDonald et al., 2000)
  - Pb > criteria in Cement and Mineral Creeks
  - Cu, Cd and Ag < criteria in all streams

Comparison of Sediment in the Upper Animas to Background



Comparison of Sediment in the Upper Animas to Background



Interim Conclusions

- GKM is one of >5400 mine sites in the Upper Animas Valley
  - Lack of controls is prevalent
- WQ impacts are not new
  - 1902, 1947, 1949, 1974, 1978
- pH and Turbidity spikes in the first hours
  - Low level metals increases
- Sediment likely impacted for some metals
  - Difficult but not impossible to separate pre- from post-mining
  - Impact from GKM??

Questions?

San Juan
BACKCOUNTRY
4x4 JEEP TOURS
JEEP & ATV Rentals
970-387-5565
1119
GOLD MINE TOURS
FOR RENT
* C-B RADIOS
* PICNIC GAMES
* COOLERS
BICYCLE RENTAL
SHUTTLE SERVICE
SMOKE FREE
ATVs FOR SALE
JEEPS FOR SALE