# Heavy Metal Contamination in New Mexico Soils after 2015 Gold King Mine Spill

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An historical context to the Gold King Mine during days of gold production *(right):* *Photo credit to Denver Public Library/Western History Collection/X-61017, via: http://www.denverite.com/look-gold-king-mine-history-environment-12776/*

## Introduction

- On August 5, 2015, Environmental Protection Agency (EPA) contractors accidentally destroy a plug at the entrance to the Gold King Mine (GKM)
- Approximately 3,000,000 gallons of acid mine waste water containing elevated heavy metals are released into Cement Creek, a tributary of the Animas River

Figure 1: A picture showing the waste flow nearly two weeks after the initial blowout at the Gold King Mine *(right).* Photo by Geoff Liesik of Desert News: http://www.hcn.org/issues/48.7/silvertons-gold-king-reckoning/silverton-animas-goldking-jpg/image

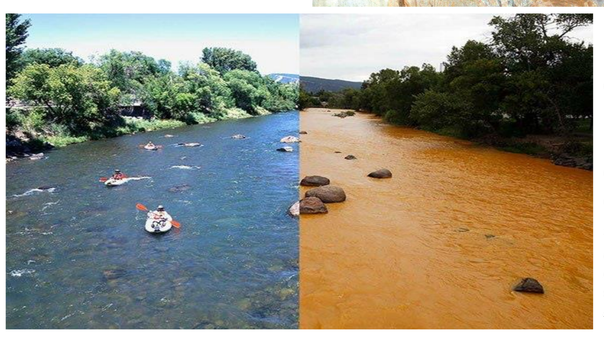


Fig 2: A glimpse of the Animas River pre- and post-GKM contamination event on August 5, 2016 *(left):* *Photo credit from http://ecowatch.com/wp-content/uploads/2015/08/3million_650.jpg*

- Animas River joins San Juan River to the south in Farmington, New Mexico, continues to Navajo Nation, Utah, and Arizona before joining Colorado River
- The Animas/San Juan Rivers feed irrigation ditches to thousands of farms along its path

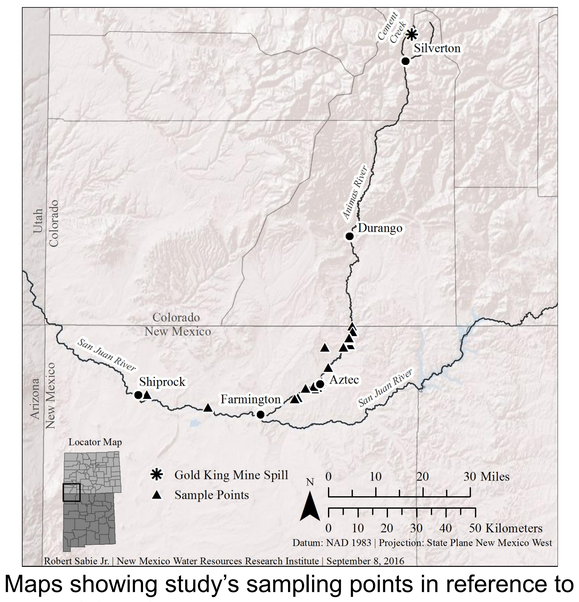



Fig 3: Maps showing study's sampling points in reference to the GKM point source (above). GIS mapping performed by Robert Sabie

## Long-term Research Question:

- Is metal contamination from upstream mining districts impacting irrigation ditch sediments along Animas/San Juan Rivers?

## Short-term Research Questions:

- Is metal concentration consistent across irrigation ditch sediments?
- Where and how many samples must be analyzed to effectively evaluate metal contamination in ditches?

Fig 4: Animas/San Juan River water diverted for agricultural irrigation of forage crops, grains, high value horticultural crops. These irrigation ditches also feed into subsistence farming plots *(left)*. *Photo by K.A. Lombard*

## Materials and Methods

- Irrigation ditches closed before the waste plume passed. The soil in these ditches was sampled in 13 irrigation ditches and provide "baseline" levels of metals.
- Soil samples were collected at three depths along transects perpendicular to ditches using EPA method 5035 (*Figure 5*)
- Soils were air dried, sieved and acid digested using EPA methods 3051A, followed by ICP-OES analysis (EPA 200.7)
- Paired t test were conducted for metal concentrations between parallel ditch position within one ditch to one depth.

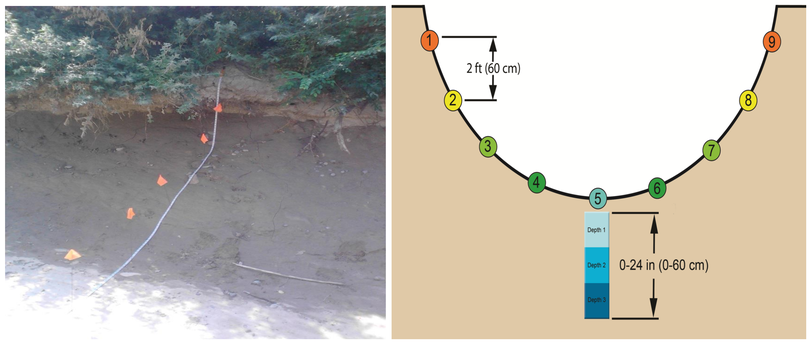
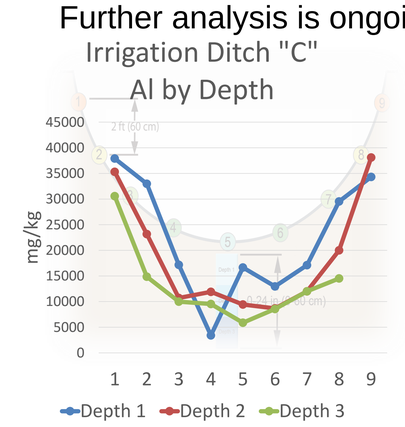
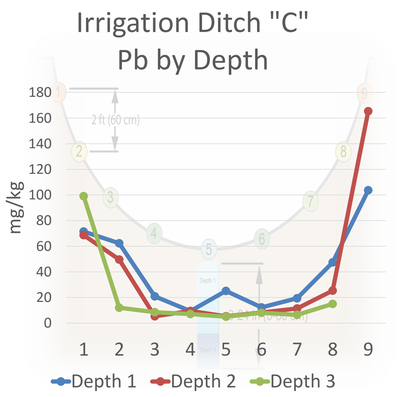



Fig 5: Sampling technique: *Photo and figure by Dr. K.A. Lombard*

## Results

- Although we consider the 2015 closed ditch samples as "baseline," the appearance of As, Al, Pb in variable concentrations suggests historical (e.g., 1978 Sunnyside Mine breach) and active/ongoing mine drainage from dozens of closed mines located in the Silverton, CO mining district may have impacted these ditches previously.
- From initial analysis, Pb, Al, and As appear highest in surface layer of ditch sediment compared to the center points (Fig 6).
- Sample points located across from one another within one ditch analyzed were not significantly different in metals concentration.
- No significant difference in metal concentration with depth (0-60 cm) was found (data not shown)
- Current analysis is on one of thirteen ditches sampled. Further analysis is ongoing.



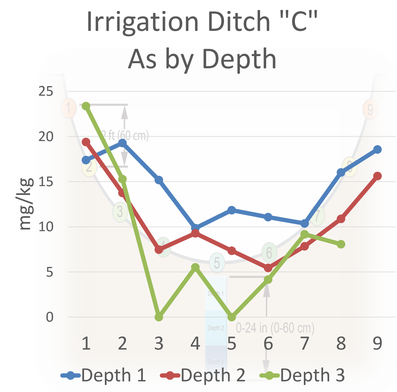




Fig 6: Graphical tracking of each Aluminum (Al), Arsenic (As), and Lead (Pb) across a ditch transect.

## Implications

- Potential to minimize sampling points when doing future emergency response analysis
- Heavy metal content of irrigation ditch sediment in mining areas may be a threat to agricultural and human health
- Considerations of historical metal loading due to legacy mining and previous contamination events as impacting irrigation ditches warrants long-term monitoring of agricultural infrastructure/fields and testing several research questions.

**Acknowledgements**

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