

RIVER COMMUNITIES AND THE POLITICS OF WATER SAFETY: UNDERSTANDING  
WATER QUALITY DEBATES FOLLOWING THE GOLD KING MINE SPILL

By

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## ABSTRACT

In the aftermath of a major disaster, scientists often face a dilemma. On the one hand, scientists are tasked with answering urgent questions about environmental safety. On the other hand, disaster-related science is often contested as stakeholders grapple with uncertainties and unknowns, questions of responsibility and blame, and related post-disaster dynamics. This study explores this dilemma in the aftermath of the 2015 Gold King Mine spill in Colorado, USA, which occurred when a mine clean-up effort led by the U.S. Environmental Protection Agency accidentally spilled over 11 million liters of toxic acid-mine drainage into the Animas River. We ask *how* a river is declared “safe” after a large-scale water quality disaster such as this, *by whom*, and *based on what metrics*. Further, we examine how scientific claims about water safety were received in three different locations: the Colorado cities of Silverton and Durango, plus the sovereign Navajo Nation. We use the local newspaper in each location as a window into local disaster discourse and systematically analyze three months of media coverage after the spill. Drawing on a framework from Cash et al. (2003), we find that salience (relevance), credibility (scientific adequacy), and legitimacy (fair and unbiased information) were central to debates over water quality in Silverton, Durango, and Navajo Nation, respectively. In addition, we argue that science communicators must consider the strengths and limitations of relevant regulatory standards when they produce disaster science and that these limitations should be publicly acknowledged. After the Gold King Mine Spill, water quality standards did not address all the public’s concerns about river safety. Given projections that disasters are likely to increase in frequency and intensity with human influence on climate and the environment, it is increasingly important to examine the processes of disruption – and repair – that occur after these catastrophic events.

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## CHAPTER 1

### GENERAL INTRODUCTION

On August 5th, 2015, a team of contractors working for the U.S. Environmental Protection Agency (USEPA) accidentally released 11 million liters of polluted water from the Gold King Mine near Silverton, Colorado, USA. The toxic yellow-orange water traveled down the Animas River and into the San Juan River before ending in Lake Powell. Along the way, it flowed through the Colorado municipalities of Silverton and Durango, as well as the sovereign Navajo Nation. Following the Gold King Mine spill, several testers published scientific data to determine the safety of the Animas and San Juan rivers, including measurements such as metal concentrations and pH levels. The USEPA, who played a pivotal role in communicating water safety post-spill, published a considerable portion of these data. In the aftermath of the Gold King Mine spill, several parties contested the USEPA's data, citing confusion on how these data were collected and interpreted to mean "safe." Ultimately, this confusion regarding the USEPA's scientific interpretation and communication created debates on whether the Animas and San Juan Rivers were really safe again for usages such as irrigation and recreation after the USEPA said they were. The primary goal of this study is to examine the public debate about post-spill water quality in order to understand how regulators' claims about river safety were received and contested in Silverton, Durango, and the Navajo Nation.

We analyzed articles from three local newspapers from Silverton, Durango, and the Navajo Nation to gain an inside look into those communities' responses to water quality data. Through our research, we come to two main conclusions. First, the USEPA's communications about water safety were received differently by each community based on how salient (relevant), credible (scientifically adequate), and legitimate (fair and impartial) they were perceived to be.

In Silverton, the spill did not affect access to clean drinking water, rendering the USEPA's water quality testing and safety declarations irrelevant. In Durango, the USEPA's water safety communication failed because of shortcomings in scientific practice. Specifically, people in Durango expressed that the USEPA did not explain how their water quality data were collected nor did they interpret the results they published, causing questions on whether the water was truly safe, even after the USEPA said it was. In the Navajo Nation, the USEPA was not trusted as a communicator on water safety because people felt they would not be honest about the Gold King Mine spill's impact, due to mistrust in the U.S. Federal Government and the USEPA's direct role in the spill.

Second, we conclude that the standards used by the USEPA to determine water safety were limited in their ability to address concerns of the public. For example, the USEPA used baseline, or pre-event, water quality conditions to declare the Animas and San Juan Rivers safe for use again after the spill. However, these baseline conditions were already polluted before the spill due to chronic mining activities in the region. By relying on baseline conditioning as a measure of water safety, the USEPA normalized an already polluted river, highlighting the limitations of baseline conditions as a standard for water safety. Additionally, orange sediments deposited at the bottom of the river after the Gold King Mine spill caused concerns for water users, but the USEPA's water quality standards could not say whether these sediments were dangerous to touch. Ultimately, it was difficult to communicate water safety due to these limitations.

Based on these results, we offer practical takeaways for science communicators in post-disaster scenarios. We suggest that scientific information won't necessarily be trusted by non-scientists unless 1) scientific information and communication is tailored to different audiences

based on their geographical, cultural, and historical relationships to the impacted waters, 2) scientific data are collected in a way that is collaborative with partner agencies, and 3) the potential limitations of relevant regulatory standards are considered as scientific data are interpreted and are acknowledged when communicating scientific information to the public.

## CHAPTER 2

### RIVER COMMUNITIES AND THE POLITICS OF WATER SAFETY: UNDERSTANDING WATER QUALITY DEBATES FOLLOWING THE GOLD KING MINE SPILL

#### 2.1 Abstract

In the aftermath of a major disaster, scientists often face a dilemma. On the one hand, scientists are tasked with answering urgent questions about environmental safety. On the other hand, disaster-related science is often contested as stakeholders grapple with uncertainties and unknowns, questions of responsibility and blame, and related post-disaster dynamics. This study explores this dilemma in the aftermath of the 2015 Gold King Mine spill in Colorado, USA, which occurred when a mine clean-up effort led by the U.S. Environmental Protection Agency accidentally spilled over 11 million liters of toxic acid-mine drainage into the Animas River. We ask *how* a river is declared “safe” after a large-scale water quality disaster such as this, *by whom*, and *based on what metrics*. Further, we examine how scientific claims about water safety were received in three different locations: the Colorado cities of Silverton and Durango, plus the sovereign Navajo Nation. We use the local newspaper in each location as a window into local disaster discourse and systematically analyze three months of media coverage after the spill. Drawing on a framework from Cash et al. (2003), we find that salience (relevance), credibility (scientific adequacy), and legitimacy (fair and unbiased information) were central to debates over water quality in Silverton, Durango, and Navajo Nation, respectively. In addition, we argue that science communicators must consider the strengths and limitations of relevant regulatory standards when they produce disaster science and that these limitations should be publicly acknowledged. After the Gold King Mine Spill, water quality standards did not address all the

public's concerns about river safety. Given projections that disasters are likely to increase in frequency and intensity with human influence on climate and the environment, it is important to examine the processes of disruption – and repair – that occur after these catastrophic events.

## **2.2 Introduction**

On August 5th, 2015, a team of contractors working for the United States Environmental Protection Agency (USEPA) was working at the abandoned Gold King Mine in southwestern Colorado, USA, to mitigate polluted water draining from the mine. While excavating the old mine adit, the team accidentally released 11 million liters (the equivalent of 4-7 days of active drainage from the mine) of previously captured acid-mine drainage, or acidic water containing metals. The polluted water entered Cement Creek, a tributary of the Animas River (Figure 2.1). Acid-mine drainage has been a problem in the region since the 1800s. The Animas River headwaters, for example, are home to at least 5,400 mining features, including mine shafts, tunnels, and adits (Church et al., 2007). Silverton, in particular, is home to over 120 historic mine sites (Clark, 2021, p.5). However, acid-mine drainage often exists as a chronic but “invisible” problem. Essentially, the Animas River waters did not typically appear visibly contaminated outside of the Silverton region until the Gold King Mine spill occurred. Not only did the mustard-yellow Gold King Mine plume make visible a largely invisible problem, but it also affected communities on a multi-watershed scale over hundreds of kilometers. The Gold King Mine spill traveled down the Animas River and through several Colorado municipalities, including Silverton and Durango, before entering the San Juan River. It then traveled through the reservation lands of the sovereign Navajo Nation before ending up in Lake Powell.



**Figure 2.1.** Map depicting the path of the Gold King Mine Spill and the impacted cities and sovereign nation that are the focus of this study.

Approximately two weeks after the spill, on August 17<sup>th</sup>, the USEPA declared that the Animas and San Juan Rivers were safe for use again, citing water quality sampling data that indicated waters had returned to “pre-event” conditions. Despite these data being validated by several other sources, such as independent sampling done by La Plata County and the Navajo Nation EPA (NNEPA), the declaration of river safety was contested within the various communities and sovereign tribes affected by the spill. Here, we examine the debate over water quality after the Gold King Mine spill and the factors that contributed to public disagreement over the USEPA’s assurances that the river had returned to a “safe” state post-spill. This study is guided by the following research questions: (1) *How is a river declared “safe” after a water quality disaster, by whom, and based on what metrics?* (2) *How is post-spill water quality science debated within affected communities?* As disaster incidence and frequency is likely to

increase under a changing climate (IPCC 2022), it is imperative to examine debates over scientific information and safety following major disasters.

To address the questions outlined above, we utilize a well-known analytical framework by Cash et al. (2003), which outlines three primary characteristics as important in the production of science for public decision-making: salience, credibility, and legitimacy. Cash et al. specifically defines the term *salience* to mean relevance, *credibility* to mean scientific adequacy, and *legitimacy* to mean fairness and impartiality. In this study, we use local newspapers as windows into local discourse about the Gold King Mine spill. Within this community-level disaster discourse, we find the USEPA's scientific claims about post-disaster river safety and evaluate them using the criteria of salience, credibility, and legitimacy. Our analysis illuminates specific shortcomings in the agency's production and communication of water quality data. We argue that the USEPA's data and decision-making about river safety were not received as *salient* by Silverton residents, *credible* by Durango residents, and not *legitimate* by the Navajo Nation. These findings affirm the usefulness of Cash et al.'s categories. However, our analysis also reveals that there was more to the post-spill water quality debates in these communities than is captured by these criteria.

We argue that the very standards that the USEPA used to declare the river safe after the disaster contributed to public discord about river safety by 1) not acknowledging orange sediments that had been deposited at the bottom of the river by the spill and 2) normalizing an already polluted river by relying on "pre-event" conditions as a baseline for river safety. This study makes theoretical contributions to the literature on disaster science and practical contributions for science communicators. The theoretical contributions include building on the categories of salience, credibility, legitimacy as crucial elements of the production of science for

public decision-making to include attention to the regulatory standards by which disaster science is being interpreted. For practical takeaways for science communicators, we suggest that scientific information will not be inherently trustworthy to non-scientists unless 1) scientific communication is tailored to the different audiences based on their unique geographical, cultural, and historical relationships to the impacted waters, 2) scientific data are collected in a way that is collaborative with partner agencies, and 3) limitations to current regulatory standards are acknowledged when attempting to interpret and communicate scientific information.

## **2.3 Literature Review**

### **2.3.1 Science Communication: Salience, Credibility, and Legitimacy**

Scholars of science and policymaking have long pondered the relationship between scientific information and public decision-making. Within this literature, Cash et al. (2003) offer a now well-known analytical framework that outlines three key attributes of effective scientific knowledge production that seeks to inform public policy: *salience*, *credibility*, and *legitimacy*. According to Cash et al., scientific information that is seen by public stakeholders to be salient, credible, and legitimate is more likely to be used in public problem-solving processes (e.g., policymaking). *Salience* is the relevance of information to decision-makers. For example, after a water quality disaster, water quality data might not be salient, or relevant, to a certain community if they do not use water from the source in question. *Credibility* “involves the scientific adequacy of the technical evidence and arguments” (Cash et al., 2003). After a disaster, water quality data might not be seen as credible if proper scientific data collection methods were not followed. *Legitimacy* implies that stakeholders’ values and beliefs have been respected and that scientific information is fair and unbiased. Individuals or communities might not consider water quality data to be legitimate if they believe their knowledge, insights, and values have been disregarded.

Though all three attributes are key to effective science communication, scientists tend to focus on the credibility of information. The limited focus on credibility, while disregarding salience and legitimacy, can form mistrust in scientific information, and ultimately result in debates and contestation of scientific information (Cash et al., 2003). This framework is useful for examinations of disaster science, such as this one, because the relevance, quality, and perceived fairness of scientific information are sure to matter to members of the public as they make sense of socio-environmental harms after a disaster. Though the *salience, credibility, and legitimacy* framework has proven a useful tool, it has also received constructive critiques by science studies scholars. Breinar et al. (2022) suggests that more studies are needed to define additional criteria for quality knowledge production beyond *salience, credibility, and legitimacy*. For example, another study by Basta et al. (2021) identified additional criteria not addressed by Cash et al.'s framework, such as equity (fair inclusion of multiple stakeholders) and inclusiveness (heterogeneous participation) important for high-quality knowledge production and communication. Our research further expands these ideas on the limitations of Cash et al.'s framework by highlighting the shortcomings of scientific knowledge and communication beyond its salience, credibility, and legitimacy.

### **2.3.2 The Contestation of Post-Disaster Science**

According to Fortun and Frickel (2012, p. 11), disasters are “catastrophic events that disrupt eco-, political, and socio-cultural systems.” Scientists play an important role in disaster response. From data collection to communicating information to the public, people often turn to scientists for answers to clarify the uncertainties that a disaster can create (Machlis, 2019; Mayer 2014). However, scientific information is often publicly contested after a disaster for at least three major reasons. First, scientific credibility tends to be questioned in politicized

environments, like those resulting from major disasters. Previous studies have shown that in politicized environments, such as major disasters, scientific credibility is more likely to be called into question (Lupia, 2013). However, disasters also present a unique opportunity to enact political change and confront major environmental problems due to their often-politicized nature. Disasters can act as focusing events that call attention to environmental problems such as acid-mine drainage and can subsequently create a window of opportunity for furthering policy solutions (Birkland and DeYoung, 2012).

Second, mistrust of science, and scientists, has grown following technoscientific disasters. For example, public trust in nuclear experts declined in Japan following the Fukushima nuclear disaster (Ando, 2018). And third, social factors, such as trust in scientific organizations, influence trust in scientific information. Research has shown that trust in science is often dependent on the institutions conducting scientific research and those who are communicating it (Liu & Mehta, 2020). According to Renn and Levine (1991, p. 54), “both trust and confidence are necessary conditions for the assignment of credibility to a source.” In the absence of trust, scientific information is likely to be contested. Furthermore, individual identities and ideologies have been shown to influence trust in science (Gauchat, 2012). Many audiences do not assign credibility to scientists by default; rather, perceived expertise and common interests play a larger role in determining the credibility of scientists (Lupia, 2013; Suhay and Druckman, 2015). It is important to note that societal and political environments shape scientific communication (Akin and Scheufele, 2017, p. 26), which can have further implications on how communication is received.

Given the wide range of factors that contribute to trust in scientific information, or lack thereof, it is essential to tailor disaster response to individual and community needs. In addition,

it is important for scientists to disaggregate the broad category of “the public” and acknowledge stakeholders’ differing histories and needs. For example, research that attempts to address impacts on Indigenous communities after major disasters is inadequate if it does not consider the ongoing, disastrous impacts of colonization (Luft, 2016). Previous studies have shown that existing power dynamics within society lead to differential disaster impacts for Indigenous people (Bankoff, 2006). Such differential impacts were prominent after the Gold King Mine spill; though many consequences to commercial agriculture and tourism were quickly resolved, impacts to the Diné (Navajo) continue today (Clausen et al., 2023). For example, Diné livelihoods and cultural and spiritual activities were disrupted by the Gold King Mine spill, highlighting how Indigenous nations can especially be affected beyond economics by a major disaster (Van Horn et al., 2021). Another study by Teufel-Shone et al. (2021) emphasized that although financial harm was a concern for the Diné, participants in the study stressed concerns about the long-term cultural impacts of the Gold King Mine spill. The authors of the study present the following questions to convey concerns that the Diné had in the aftermath of the Gold King Mine spill: “How will the contamination impact the Diné people’s relationship with the rivers? Will the Diné people be able to continue their traditional subsistence patterns of farms and ranching? Will their children move away as they cannot continue the traditions? Will they become disconnected from family, the community, and traditions?” (Teufel-Shone, 2021). Community and Indigenous-centered studies such as this underscore the multi-dimensional impact of disasters and call attention to potential cultural losses that cannot be remediated through damage payments.

Furthermore, it is critical to consider historic factors that have contributed to a violent relationship between the U.S. Federal Government and the Diné people. From 1863-1864, the

Diné were forcibly relocated to an internment camp in present-day New Mexico known for its unlivable conditions and assimilation practices, in what is now known as the Long Walk (Laljani, 2020). Though the Diné eventually returned to a reservation established by the U.S. Federal Government on their ancestral homelands (though only a fraction of what they had occupied previously), The Long Walk is now recognized as an act of genocide that killed thousands of Diné people (Anderson, 2016; Laljani, 2020). In a more recent example of harm at the hands of the U.S. Federal Government, the Navajo Nation was mined by the U.S. Government for its uranium stores from the 1940s through the 1980s. Many uranium miners were Diné (Brugge and Goble, 2011), and many of them died of lung cancer (Panikkar and Brugge, 2008). Though scientific evidence linking incidences of lung cancer to uranium mining existed in the 1930s (Peller, 1939), the Diné miners were never informed of the potential health consequences of their occupation (Dawson, 1992). The environmental and health consequences of these activities remain a problem for the Navajo Nation. Today, many Diné rely on unregulated water sources contaminated by arsenic and uranium (Ingram et al., 2020) and elevated cancer rates continue to impact the reservation (Navajo Cancer Workgroup, 2018). Persistent health impacts to the Diné from mineral exploitation by the U.S. Federal Government exemplify Nixon's (2011, p. 2) concept of *slow violence*, which describes the health consequences suffered due to long-term, and often ignored, environmental pollution. Voyels (2015) coins the term *wastelanding* to describe the ways in which the U.S. Federal Government has deemed Indigenous lands as "deserted" and "barren," and subsequently turned them into "wastelands" targeted for resource extraction. Voyels grounds the concept of *wastelanding* in the U.S. Federal Government's exploitation of Navajo Nation lands for uranium mining.

### **2.3.3 The Trouble With Regulatory Standards and Disaster Science**

Prior to the adoption of regulatory standards for interpreting water quality, people primarily relied on senses such as taste and smell to assess water cleanliness and safety. However, this paradigm shifted in the early 20<sup>th</sup> century with technological advancements in chemistry and water treatment that led to the production of standardized limits for contaminants as core to water quality evaluation (Spackman, 2020). Environmental regulatory standards, such as the allowable contaminant levels set by regulators under the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA), further formalized the use of contaminant thresholds for water quality evaluation. Though such standards have been important for improving water quality and protecting public and environmental health in the U.S., they are also subject to critique. For example, water quality standards under the CWA and SDWA do not aim to remove all contaminants, but rather they identify acceptable pollution limits for them (Liborion, 2013). Subsequently, environmental standards effectively allow pollution to circulate in the environment, but with prescribed limits (Liborion et al., 2018).

More broadly, regulatory standards are produced via social processes and have multifaceted social implications – in other words, they are not neutral. Scientifically-based standards can act as barriers to public participation in regulatory processes by creating a hierarchal power structure that privileges and values the voice of technical experts over all others, which can ultimately obstruct activists from holding polluting industries accountable and creating healthier environments for their communities (Meesters et al., 2022; Ottinger, 2010). Environmental standards can also be manipulated through regulatory agency processes and loopholes. For example, Clifford (2022) outlines that the USEPA regulatory standards on air quality data to be excluded if it is deemed as “natural” or “exceptional.” Standards may also

contribute to the production of skewed understandings of pollution by prioritizing some exposure timeframes over others. For example, citizen-science air-quality data in Louisiana have previously been dismissed by regulatory agencies due to the timing of its collection; while air quality standards in the state are measured in 8-hour increments, citizen-science data are usually collected in 3 to 6 minute periods to capture the brief peaks in chemical exposure experienced by local communities (Ottinger, 2010). Standards may also be heavily influenced by cost avoidance strategies employed by industry (Liborion et al., 2018; Kleinman and Suryanarayanan, 2013). Relatedly, baseline conditions are often used as a default standard in environmental regulation because they are perceived to be a neutral point of comparison, though they often are not objective, either (Kinchy, 2019). Baseline conditions tend to assume a “natural” state independent of human intervention, which may not be the case, and they can change over time (Ureta et al., 2020). Subsequently, environmental degradation can become normalized as baseline conditions are used to establish a standard that is based on an already-degraded environment, whether by natural contamination, such as acid-rock drainage, or by human impact.

## **2.4 Methods**

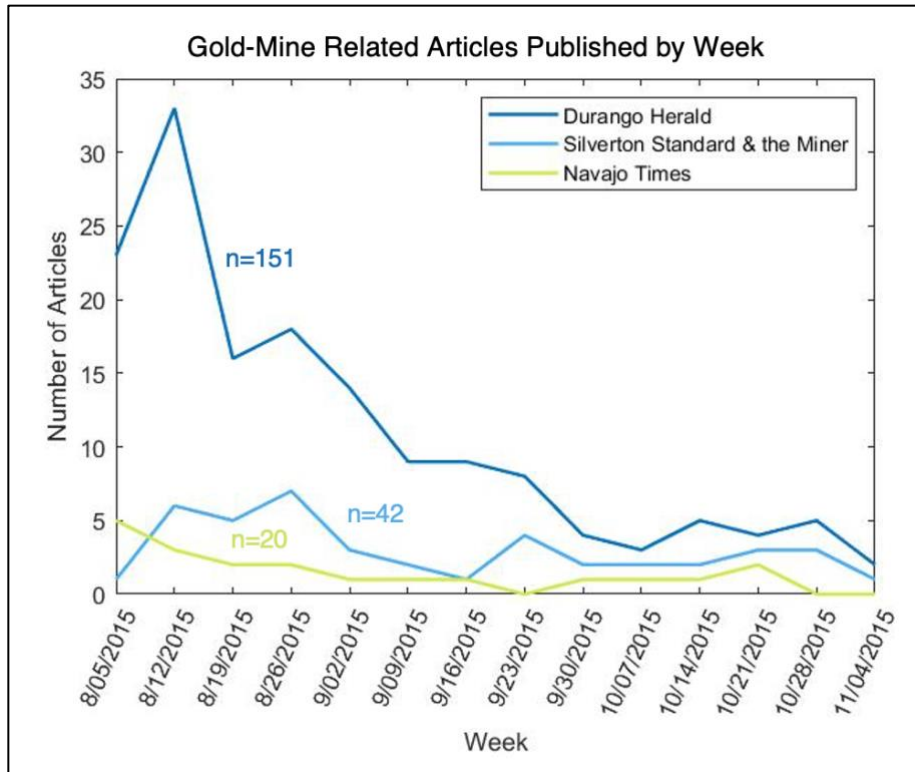
This study uses local newspaper articles (n=213) as windows into post-disaster community discourse. Local media play a critical role in making sense of disasters. In a reciprocal relationship, local media both shape and are shaped by community discourse. Most citizens gain scientific knowledge through mass media sources (Corbett & Durfee, 2004). Media play an important role in agenda-setting after a disaster by “focusing public attention on disaster-related issues and maintaining those issues on the public agenda” (McCombs & Valenzuela, 2020). Media sources can also shape discourses after a disaster by focusing on certain policy

problems and potential solutions and assigning blame and responsibility (Boykoff, 2011). The media can also shape how communities begin recovering from a disaster by contributing to a collective “social script” or narrative of the disaster and its resolution (Leitch & Bohensky, 2014). Additionally, media is shaped by locals by involving residents in pressing political issues (Kim et al., 2002). We used local newspapers to evaluate our research questions due to their reciprocal relationship with local communities and because they are an accessible window into local community discourse. It is important to note that newspapers are not a purely neutral source of information (Macnamara, 2005). However, by using local newspapers as a data source, we were able to identify issues unique to each community and begin to evaluate their complex views on water safety following the Gold King Mine spill, while also finding commonalities among them.

A content analysis, which is “a technique for gathering and analyzing the content of text” (Neuman, 2003), was conducted using local newspapers. Organized from upstream to downstream of the Gold King Mine, these newspapers were *Silverton Standard & the Miner*, *The Durango Herald*, and *Navajo Times*. It is important to note that other Tribal Nations and communities were impacted by the Gold King Mine spill, such as the Southern Ute Tribe and Farmington, New Mexico. However, we selected the three with the most extensive newspaper coverage to analyze in this study. We collected newspaper articles from the three months following the Gold King Mine spill (August 5 to November 5, 2015). The November 5<sup>th</sup> end date was selected due to limitations in the online availability of *Silverton Standard & the Miner*. Nevertheless, the decline in published articles by month three after the spill indicated that this period captured the immediate debate over river safety in the local press (Figure 2.2). The search term “gold king” was used to identify articles related to the Gold King Mine spill in the

NewsBank database for *The Durango Herald* and *Navajo Times*, and on the San Juan County Historical Society website, which archives digital copies of *Silverton Standard & the Miner*.

After removing repeat and irrelevant articles, the final sample was n=213.



**Figure 2.2.** Number of articles published by each newspaper weekly from August 5th, 2015, to November 5th, 2015.

An article content analysis strategy was developed to analyze the water safety debate following the Gold King Mine spill and formalized in a “codebook” available in the Appendix. The coding strategy was tailored to our specific research questions to help us gain insights from the newspaper articles we examined. It included general questions about how the public assigned responsibility for the spill, such as: “Is an explanation given for the cause of the spill? (0 for No, 1 for Yes),” and “If yes, how far back in time does the mine spill ‘origin story’ go? (1 for the immediate months/days leading up to the spill, through 4 for the century or more leading up to

the spill)". The coding strategy then zeroed in on the discourse around river safety. We developed a set of questions that teased out whether the river's safety was being debated, by whom, and how. For example, we asked questions such as, "Is the safety of the river's waters and/or the ecological health of the river mentioned? (0 for No, 1 for Yes)" and "Does the article specifically mention trust/distrust? (0 for No, 1 for Yes)." Qualitative questions were also included in our codebook to further develop our quantitative analysis. As an example, if an article mentioned trust/distrust, we then asked: "If yes, trust or distrust *by* whom, and trust or distrust *in* whom?" This was accompanied by a text box where the coder could briefly describe the trust/distrust dynamics.

To test the reliability of these methods, two coders evaluated a random set of articles representing 10% of the overall dataset and compared their results for discrepancies. This step is known in media research as establishing "intercoder reliability" (ICR). Intercoder reliability is a measure to determine the reliability of a coding tool by evaluating consistency between multiple coders (O'Connor & Joffe, 2020). Percent agreement was calculated for the overall dataset, as well as for each individual question, using the following formula:

$$\text{ICR} = (\text{total agreement})/(\text{total agreement} + \text{disagreement}) * 100 \quad (2.1)$$

Using this method, the average intercoder reliability across all codebook questions was determined to be 83%. Values between 75%-90% demonstrate acceptable agreement (Stemlar, 2004). When broken down by individual item, the intercoder reliability ranged from 100% on the high end to 68% on the low end. We chose to retain the data from our lowest-agreement question (the 68%) because coders' struggles to agree on this item mirrors the confusion that local readers

would have also faced when trying to determine river safety after the Gold King Mine spill. We will discuss the results of this question further in the results section.

In addition to our quantitative coding, we conducted a close reading of all of the articles and a qualitative analysis of their contents. Qualitative data were used to elaborate patterns that appeared in our quantitative data, and to bring nuance to those patterns. The qualitative assessment of the articles also allowed us to develop a timeline of post-spill events as they appeared in local media.

## **2.5 Case Study Background: Silverton, Durango, and the Navajo Nation**

Silverton, located in San Juan County, is a small high-alpine community with a population of 622 as of 2020 (US Census Bureau, 2020). Established in 1874 as a mining town, Silverton is situated at the headwaters of the Animas River Watershed, the farthest upstream site in this study when compared to Durango and the Navajo Nation (Figure 2.1). The area was originally inhabited by the Ute Tribe, with the Navajo, Comanche, Shoshone, and Apache also occupying the region (Clark, 2021, p. 31). Silverton has been of interest for USEPA Superfund designation since the 1990s due to ongoing acid-mine drainage resulting in poor water quality (USEPA, 2021). However, the town rejected Superfund designation prior to the Gold King Mine spill, citing concerns about the potential decline in property values and tourism with such a designation and favoring local interventions rather than those of the federal government (Olivarius-Mcallister, 2015). Silverton does not rely on the Animas River for its drinking water supply, obtaining it instead from Boulder Creek and Bear Creek (Esper, 2015).

Durango, located about 77 km south of Silverton and Situated in La Plata County (Figure 2.1), had a population of 19,071 as of 2020 (U.S. Census Bureau, 2020). Founded in 1880 to serve as a smelting location for the ores excavated around Silverton, Durango evolved into a

popular tourist and recreational destination by the early 1900s (City of Durango, n.d.). The primary source of drinking water in Durango is the Florida River, though the Animas River has been used as a secondary water source in times of need (City of Durango, n.d.). The Animas River is commonly used for recreation in Durango, with activities such as rafting, fishing, and boating being popular uses of the river (Clark, 2021, p.30). Importantly, the Animas River runs through the middle of the city of Durango, making it a highly visible amenity, a cultural touchstone, and a space where residents of Durango gather to recreate, rest, and connect with nature (McCormick, 2021, p. 136-142).

The Navajo Nation, located roughly 140 km southwest of Durango (Figure 2.1), existed for millennia prior to the westward expansion of European settlers and colonization. As of 2020, the Navajo Nation has a tribal enrollment of about 399,494 (Romero, 2021). Notably, the name Navajo originates from colonization, with Diné being the traditional name of the Navajo people (Clausen et al., 2023). Diné will be used throughout this article in lieu of Navajo, while Navajo Nation will be used as it is the current name of use for the sovereign Nation. The San Juan River runs through the northern portion of the reservation. The Diné use the San Juan River, of which the Animas River is a tributary, for irrigation. This area of the Navajo Nation has been referred to as the “bread-basket” of the reservation, highlighting the importance of farming and ranching for Diné farmers in the area (Clausen et al., 2023).

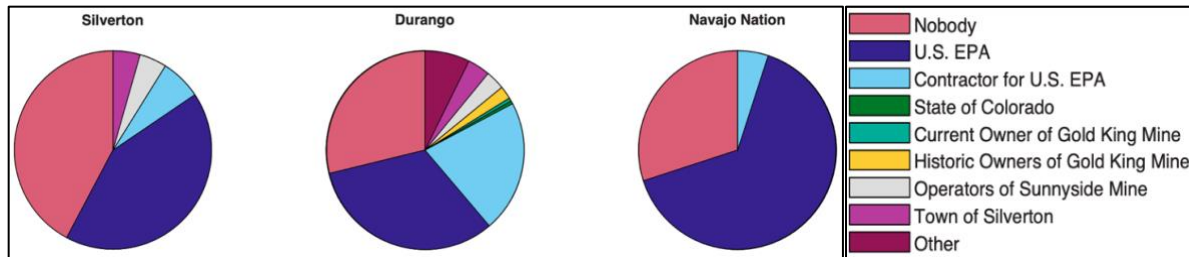
## **2.6 Results**

The ensuing results offer a comprehensive evaluation of the quantitative and qualitative data gathered through our content analysis. Below, we organize our results to correspond with each of our two research questions. We begin by discussing the USEPA’s role in declaring the Animas and San Juan Rivers safe after the Gold King Mine spill, and the standards used by the

agency to determine safety. We then discuss the ways that the USEPA’s water quality data were not viewed as salient to Silverton, credible to Durango, and legitimate to the Navajo Nation. The interdependence of salience, credibility, and legitimacy in science communication is important to acknowledge. However, the present case study is noteworthy for its demonstration of the failure of each of these criteria in the specific contexts of Silverton, Durango, and the Navajo Nation. Finally, we conclude our results by highlighting inadequacies in the regulatory standards used by the USEPA to declare water safety, which instigated confusion and debate over whether the rivers were truly safe.

### **2.6.1 How is a river declared “safe” after a water quality disaster, by whom, and based on what metrics?**

The USEPA largely received blame for causing the Gold King Mine spill when it occurred on August 5, though there were notable differences across communities in the extent of the blame that the USEPA received as compared to other actors, such as mine owners and operators or other government entities (Figure 2.3). Although the USEPA was often stated to be the primary instigator of the spill, they were also the primary water quality tester and science communicator after the spill, creating an awkward positioning that made their job of producing and communicating scientific information on water safety difficult from the start. Though the plume from Gold King Mine spill moved through the Animas and San Juan Rivers rather quickly, with the USEPA estimating the spill reaching Lake Powell by August 12<sup>th</sup> (USEPA, 2017), river reopenings were delayed to ensure waters were safe for use again. The USEPA declared both rivers safe for irrigation and recreation on August 17<sup>th</sup>, citing “risk screen analyses” and “pre-event” water quality conditions, which will be explained further at the end of this section.



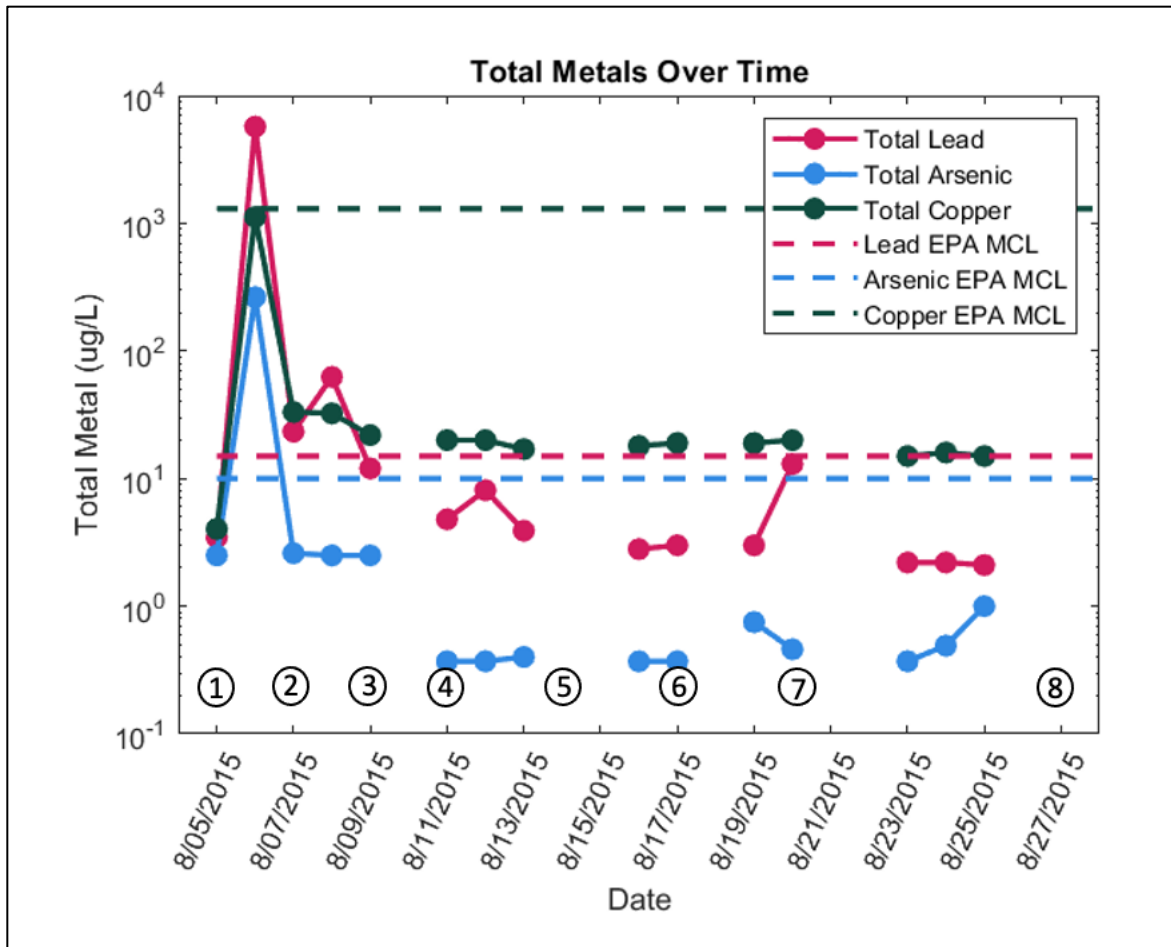
**Figure 2.3.** Percentage of different actors held responsible for the Gold King Mine spill by each community, according to their local news source. The USEPA was the actor blamed most often for the spill.

Several other water quality testers (Table 2.1, see p. 28) obtained results consistent with those of the USEPA; however, not all water quality testers released data at the same time. For example, then-Governor John Hickenlooper became the first to declare the Animas River safe during a public meeting on August 11<sup>th</sup> – a full 6 days before the USEPA made its announcement, and to the dismay of USEPA officials who were awaiting further testing before arriving at that conclusion. Hickenlooper’s declaration was based on water quality testing by the Colorado Department of Public Health and the Environment (CDPHE), which indicated that the river had returned to "pre-event" baseline conditions. A few days later, on August 14<sup>th</sup>, then-La Plata County Sheriff Sean Smith officially re-opened the Animas River for recreation based on preliminary water quality results from the CDPHE (Figure 2.4 on p. 24). The NNEPA did not declare the San Juan River safe for crop irrigation until the 20<sup>th</sup>, three days later than recommended by the USEPA (Figure 2.4). Despite the relatively speedy movement of the mine spill plume and consistency among local, state, federal, and tribal water quality results, there remained persistent debates over water safety within affected communities, and questions as to whether the Animas and San Juan Rivers were truly safe again for regular activities, such as recreation and irrigation. These debates will be discussed in more detail in the latter half of the results section.

After the Gold King Mine spill, USEPA scientists used a procedure they called “risk screening” to determine if water was safe for different uses of the Animas and San Juan Rivers (Benjamin, 2015). The screening standard that most commonly reported in local media was the “recreational screening level” for several dissolved heavy metals, including arsenic, cadmium, lead, and mercury. USEPA officials explained that they selected the recreational screening standard because it is a “conservative” measure that assumes an adult or a child ingests 2 liters of river water per day, four days per week, and over a 64-day period (USEPA, 2017). Importantly, the press did not relay information about other potential risk screening standards. For example, given the many different uses of the Animas and San Juan Rivers, one might imagine that recreational screening levels would be accompanied by risk screening levels specific to irrigation water or drinking water. Another type of standard that the USEPA did reference, however, were “pre-event” water quality conditions as a baseline for general safety. Once metal concentrations and pH levels had returned to pre-spill levels for several days in a row, the USEPA determined the Animas and San Juan Rivers were safe for reopening. Other water quality testers echoed the USEPA’s approach to water quality standards, turning to a combination of recreational screening levels and pre-event water quality as thresholds for deeming the Animas and San Juan rivers safe for use again. These included the CDPHE, La Plata County, and the Mountain Studies Institute.

There was one big problem that none of the water quality testing approaches were designed to handle, however: the layer of orange, heavy metal-laden sediments that blanketed the bottom of the river after the contaminant plume passed through. While testing data showed that metal concentrations in the river’s waters (i.e., “the water column”) returned to pre-event conditions rather quickly, they did not acknowledge the orange sediments on the riverbed. At the time of the Gold King Mine spill, no agreed-upon standards existed for regulating metals in

sediments or evaluating their potential health impacts to people (Olivarius-Mcallister, 2015), making sediment data difficult to interpret. This made the highly-visible orange sediment in the Animas River a major source of confusion for the public. For example, though La Plata County reopened its river for recreational use as of August 14<sup>th</sup>, it came with a health advisory. Specifically, the county urged the public to avoid any areas with orange sediments, and recommended washing with soap and water should they come into contact with the sediments (Butler and Marcus, 2015). Uncertainties in interpretation of the orange sediments, and their potential health impacts, were of particular concern in Durango, and will be discussed in more detail later in the results section.



1	Date of Gold King Mine spill
2	USEPA criticized for not warning downstream users of the spill coming until 24 hours later
3	USEPA releases initial water quality results (metals concentrations), but does not interpret
4	USEPA states they do not believe there is a risk to human health from the Animas River but that more days of water quality data are needed to be certain
5	La Plata County Sheriff opens Animas River in Durango for recreation and urban irrigation with a health advisory
6	USEPA says Animas and San Juan Rivers are safe for reopening for irrigation and recreation
7	NNEPA says San Juan River is safe for reopening for crop irrigation
8	Navajo Nation President Russell Begaye tries to open irrigation canals on Navajo Nation, but is vetoed by local farmers

**Figure 2.4.** Graph depicting total arsenic, copper, and lead over time compared to their respective USEPA MCL, or maximum allowable contaminant level for safe consumption, derived from post-Gold King Mine spill data collected by the USEPA. These contaminants were selected due to their frequent mention in our media sample. Note that gaps in the data are due to limitations in the dates that measurements were taken. The graph and chart highlight significant events and water safety debates post-spill. Data were collected from the Animas River in Durango, Colorado.

## 2.6.2 How is post-spill water quality science debated within affected communities?

### 2.6.2.1 Silverton: Saliency

According to Cash et al.'s framework, *saliency* is a key component in effectively influencing social responses to public problems. Here, we argue that the USEPA's water quality data were not relevant, or salient, to those of Silverton, who do not rely on drinking water from the Animas River. *Silverton Standard & the Miner* articles hardly addressed the Gold King Mine spill's impact on water sources; only 24% mentioned water impacts, compared to 47% of *The Durango Herald* articles, and 85% of *Navajo Times* articles. Furthermore, only 19% of *Silverton Standard & the Miner* articles mentioned the yellow color of the spill's plume, as compared to 49% of *The Durango Herald* articles, and 50% of *Navajo Times* articles, respectively. This discrepancy further suggests that residents of Silverton were not impacted by the spill in the ways that their downstream neighbors were. Therefore, conversations on water quality did not shape their post-disaster response.

Though water quality was not a major concern in Silverton, there was debate over several other topics, especially the intentions of the USEPA. After the Gold King Mine spill, Silverton's legacy-mining problem was cast into a national light by the abundant media coverage the disaster received. Impacts of abandoned mining became a political discussion on the federal, state, and local level. Affected stakeholders began discussing the issues of abandoned mining in the Silverton region and the subsequent consequences of acid-mine drainage on downstream neighbors and the environment. Silverton residents were suspicious of the USEPA and its previous interest in designating the area as a Superfund site for abandoned mine cleanup. Some believed that the USEPA caused the Gold King Mine spill on purpose to "force" Silverton into taking on Superfund status. One resident was quoted as saying, "...anybody who thinks this [the

Gold King Mine spill] was an accident is an idiot” (Taylor, 2015). Though some thought the USEPA caused the Gold King Mine spill intentionally, others simply accused the USEPA of negligence, claiming they were not qualified to address the region’s mining problems. One Silverton resident said, “I’m totally disgusted with the EPA. They have people here making decisions and taking action who are not remotely qualified to do so” (Zanomi, 2015).

### **2.6.2.2 Durango: Credibility**

The safety of the river was salient downstream in Durango, by contrast to Silverton. In *The Durango Herald* sample, 47% of articles mentioned water impacts, 49% mentioned the color of the contaminant plume, and 74% discussed the plume more generally, emphasizing the relevance of metal contamination for Durango residents post-spill. There, debates about water quality revolved more specifically around issues of scientific credibility. After the Gold King Mine spill, there existed confusion and debate within Durango pertaining to the safety of the Animas River and how it was being measured by the USEPA. At the time, Durango was in the middle of the economically busy season for the recreation industry. Much of Durango’s economy in August is dependent upon outdoor recreation and tourism, with the Animas River a focal point of these activities.

Despite several actors declaring the Animas River safe for reopening (Figure 2.4), a reluctance persisted among Durango residents to return to the water. A notable proportion of the articles published in *The Durango Herald* (34%) discussed the debates concerning water safety to some degree. Among this subset of articles, there was a prevalent sense of uncertainty regarding the scientific communication and interpretation of water quality data from the USEPA. Approximately 11% of the articles indicated that the safety of the Animas River was unknown, whereas 5% deemed it unsafe, 7% discussed river safety as actively being debated, and 11%

considered it safe. It is pertinent to highlight that this question had the lowest level of agreement in our intercoder reliability testing (68%; see Appendix), underscoring the confusion that coders—and, by extension, also *The Durango Herald* readers — experienced while trying to obtain a definitive answer from the local newspaper regarding the safety of the Animas River following the Gold King Mine spill.

The USEPA’s communication was a common topic of public critique after the Gold King incident. Central to these critiques were issues of scientific credibility. Specifically, there were questions raised in *The Durango Herald* regarding the transparency of the USEPA’s data, specifically how the USEPA collected its data. Durango stakeholders wanted to understand the USEPA’s methods so that others could copy them and evaluate them through additional testing. Furthermore, the USEPA was criticized for releasing water quality data without interpreting it, creating confusion over what the data meant in terms of safety. One notable quote from *The Durango Herald* highlights this lack of interpretation, stating, “I want to root for the [US]EPA to succeed in the wake of this accident, but the agency is making my job very difficult... The dribble of data released by public agencies has been incomplete and lacks the aquatic and human health context necessary to help us make heads or tails of it” (Olsen, 2015).

Another issue of particular concern was the orange sediments deposited in the Animas River after the Gold King plume had moved through. Many citizens continued to avoid recreating in the river even after the USEPA and several others had declared the waters safe (Table 2.1) due to confusion over the layer of orange sediment on the river bottom – namely, whether it would be harmful to people and animals if they stirred it up while wading and swimming in the river. Addressing uncertainties about the orange sediments, another quote read,

“Seriously? The water is safe, but don't get the sediment on you? How do children, dogs, tubers and so on get into the river without touching the bottom?” (Butler, 2015).

**Table 2.1.** Table showing some of the various entities involved in collecting scientific data on water quality following the Gold King Mine spill. Additional data may have been collected after the Gold King Mine spill; our table specifically reflects information provided in the local newspapers.

<b>Gold King Mine Spill Water Quality Testers</b>	
<b>Source</b>	<b>Data</b>
<b>Federal</b>	
USEPA	Dissolved metals, total metals, metals in sediments
USEPA Toxicologist Kristen Keteles	Dissolved metals, metals in sediments
US Geological Survey	Total discharge from Gold King Mine spill
<b>Tribal</b>	
Navajo Nation EPA	Dissolved metals, metals in sediments
Irvin Shaggy, Shiprock resident	Dissolved metals
<b>State</b>	
Arizona Department of Environmental Quality	Dissolved metals
Colorado Department of Parks and Wildlife	Fish survival
Colorado Department of Public Health and the Environment	Dissolved metals, pH
Colorado Division of Reclamation, Mining, and Safety	pH
New Mexico Department of Health	Dissolved metals
New Mexico Environment Department	"Water data"
<b>Local</b>	
Durango Utilities	pH
KOBTV, New Mexico News Station	Metal concentrations in water
La Plata County	Dissolved metals, metals in sediments
<b>NGO</b>	
Mountain Studies Institute	Insect survival
Scott Smith, Water Defense Fund	"Independent samples"

### 2.6.2.3 Navajo Nation: Legitimacy

After moving through Silverton and Durango via the Animas River, the Gold King Mine spill merged with the San Juan River and flowed into the Navajo Nation. While salience and

credibility were particularly relevant to Silverton and Durango, respectively, *Navajo Times* articles scrutinized the legitimacy of the USEPA as a voice of scientific authority on post-spill water safety. The intensity of the Navajo Nation's antipathy for the USEPA is visible in *Navajo Times'* framings of problems associated with the Gold King Mine spill. All articles examined from *Navajo Times* attributed blame for the disaster to some extent, with 65% of those articles blaming the USEPA explicitly (Figure 2.3). Of the 25% of articles that referenced trust, all of them mentioned mistrust the Diné had towards the USEPA and its data, specifically.

Although the USEPA said that the San Juan River was safe for crop irrigation as of August 17<sup>th</sup>, many Diné questioned the legitimacy of the agency and its scientific claims. USEPA water samples showed that metal concentrations in the San Juan River had returned to pre-event levels as of August 11<sup>th</sup>, and the USEPA stated that the river was safe for irrigation as of August 17<sup>th</sup>. However, the Navajo Nation insisted on conducting its own testing, citing mistrust in the USEPA's results. Then-Navajo Nation president Russell Begaye said, "We're not going to depend on the EPA... We're going to get our own answers" (Yurth, 2015). Independent testing conducted by the NNEPA eventually corroborated the findings of the USEPA, suggesting that the San Juan River was safe for crop irrigation when they were released on August 20<sup>th</sup>. A separate declaration regarding the safety of livestock watering would be announced on August 28<sup>th</sup>, specifically for large livestock such as horses and cows, but still excluding sheep and goats.

Despite consistency between the USEPA and NNEPA data on irrigation water quality, the results and safety declarations were not viewed as legitimate by the Diné. For example, farmers in Shiprock, a chapter of the Navajo Nation whose agricultural practices were largely disrupted due to the Gold King Mine spill, refused to open their canals for irrigation even after President Begaye decided to reopen them. The Shiprock farmers vetoed his decision, believing

that the president and the NNEPA were colluding with the Federal Government, as many remained suspicious despite the scientific evidence indicating that their water was safe. Subsequently, major crop loss occurred. Further highlighting deep-rooted fears of the Navajo Nation towards the USEPA and its intentions with the Gold King Mine spill, one quote from a Diné individual in *Navajo Times* read, “Didn't the federal government tell us uranium was safe before they started mining our precious land? Due to another fault of theirs, most of our people are suffering from cancer and many have passed from it” (Clark et al., 2015).

#### **2.6.2.4 Inadequacies of Standards**

The communication and interpretation of scientific information by the USEPA on water safety after the Gold King Mine spill faced notable challenges in terms of its salience, credibility, and legitimacy. Nonetheless, the inadequacies of these attributes only partially account for the debates about river safety in the communities downstream of the Gold King Mine, which played out long after scientific data from various sources indicated a return to pre-incident metal concentrations. In this regard, we suggest that the scientific standards employed by the USEPA and other agencies to declare water safety were inherently limited, which subsequently diminished the public’s confidence in the data. To properly address concerns with scientific information after a disaster, it is crucial to consider the limitations of the standards we use to determine what qualifies as “safe.”

After the Gold King Mine spill, the USEPA used standards for metals such as lead, arsenic, and copper to determine river safety. Once those contaminant levels had returned to pre-event conditions, the USEPA declared the Animas and San Juan Rivers “safe” for reopening. However, members of the public expressed concerns regarding the potential consequences the orange sediments, such as the toxicity of direct contact and the possibility of stirring them up and

creating harmful water conditions. Given the USEPA's standards based on metal concentrations from water sampling only, the orange sediments were effectively invisible to the question of water safety, highlighting an important inadequacy in scientific standards of what constitutes "safe" water.

A further inadequacy of scientific standards pertains to the use of pre-existing water-quality conditions as a measure of safety. Using "pre-event" or baseline conditions as a criterion for safety creates problems because these standards are often not objective (Kinchy, 2019). Furthermore, baselining assumes a "natural" state independent of human impacts (Ureta et al., 2020), which can work to normalize a contaminated environment. Though the USEPA declared the Animas and San Juan Rivers safe for reopening as of August 17<sup>th</sup>, the Gold King Mine was still actively draining over 2000 liters per day of polluted water as of August 24<sup>th</sup> (Romeo, 2015), underscoring how baseline conditions do not indicate the absence of pollution. In our case study, the Animas River has been impacted by acid-mine drainage and contamination for over a century, rendering reliance on baseline conditions as a scientific standard inherently problematic. While the USEPA's development and communication of scientific information was imperfect, it is imperative to recognize the inadequacies inherent in the criteria utilized to determine water safety after a disaster. Without addressing these underlying issues, scientific information is destined to falter, even if it satisfies Cash et al.'s (2003) criteria of being salient, credible, and legitimate.

## **2.7 Discussion**

Our research employed a media content analysis to investigate public debates about river safety in the aftermath of a major water-quality disaster. The motivation for this study was to examine the dilemma scientists face when interpreting and communicating scientific information

on water safety following a disaster, while recognizing the likelihood of an increasing frequency of disasters due to the persistent impacts of climate change. Specifically, we examined local newspaper coverage of the disaster in Silverton and Durango, Colorado, as well as the Navajo Nation, locations that were all affected by the Gold King Mine spill in different ways. Our analysis leveraged Cash et al.'s (2003) recommendations for the production of science for public decision-making, which highlights the importance of salience, credibility, and legitimacy in the making and communication of scientific claims.

Our results illuminate the USEPA's communication struggles in its attempt to declare the Animas and San Juan Rivers safe after the Gold King Mine plume had moved through them. These struggles go beyond the USEPA's obvious challenge of being the entity most frequently blamed for causing the mine spill itself. More specifically, the USEPA's communication was not salient to those living in Silverton. Rather than be concerned with the safety of the Animas River post-spill, many in Silverton were concerned with solutions moving forward, and fear of USEPA involvement in their town. Alternatively, river safety was highly prominent to Durango citizens, who were in the middle of the economically busy season for the recreation industry. However, despite assurances from the USEPA and other agencies that the Animas River was safe for reopening as of August 17<sup>th</sup>, Durango citizens questioned this interpretation of water-quality data. Citing fears of a persistent layer of orange sediment at the bottom of the river, lack of transparency regarding the USEPA's methods for water sampling, and the USEPA's lack of interpretation of water-quality results, there was a general hesitance in Durango to return to the river after the Gold King Mine spill.

We also find that, for the Navajo Nation, the USEPA was not seen as a fair, unbiased, and subsequently legitimate source of information on water health. The U.S. Federal

Government has caused significant harm to the Diné people, and many of these fears were conveyed in articles published in *Navajo Times* after the Gold King Mine spill. Mistrust of water-quality data was so deeply embedded among Diné farmers in the Shiprock region of the Nation that they chose to go against the recommendations of not only the USEPA, but also the NNEPA and then-Navajo Nation President Russell Begaye, ultimately opting not to open their irrigation canals for the rest of the growing season, resulting in major crop loss.

Though Cash et al.'s (2003) criteria of salience, credibility, and legitimacy explain part of the debates over water-quality after the Gold King Mine spill, there were underlying causes for mistrust in scientific data not captured by these factors. Our data illuminate the shortcomings of the regulatory standards used by the USEPA to determine water safety after the Gold King Mine spill. As previously noted, water sampling data collect only one piece of the hydrological consequences of a major acid-mine drainage event. Notably, USEPA regulations did not address the orange sediments that remained at the bottom of the Animas River after the plume moved through. The orange sediments were highly visible to the people in Durango, but they were not acknowledged in USEPA's water quality regulations. This lack of acknowledgment created a sense of confusion among those wondering if they could return to the river or not. By offering incomplete answers on the potential health consequences of these sediments, the USEPA created an uncertainty for communities that was difficult to overcome. Furthermore, relying on baseline river conditions as a criterion for declaring water safety normalizes an already-polluted environment. These inadequacies in water-quality standards introduce a broader concern on the effectiveness of determining water safety by using limited regulatory standards to interpret scientific data.

We contribute to the disaster social science literature by presenting a case study in which two municipalities and an Indigenous Nation are impacted by a water-quality disaster. We highlight how each corresponded to criteria established by Cash et al.'s (2003) analytical framework. We take our research a step further than Cash's criteria, however, by suggesting that the framework cannot explain concerns with scientific data that stem from the politics of legal environmental standards. Finally, we conclude our research with the following practical takeaways: scientific information will not inherently be trustworthy to non-scientists unless 1) scientific information, and subsequent communication, is tailored to reflect different communities and their unique geographical, cultural, and historical relationships to the impacted waters, 2) scientific data are collected in a way that is collaborative with partner agencies, and 3) the potential limitations to regulatory standards are considered as scientific data are interpreted and acknowledged when communicating scientific information to the public.

## **2.8 Conclusions**

A key takeaway from this study is that scientific information regarding water safety might not be inherently trustworthy to non-scientists after a water quality disaster. The aftermath of the Gold King Mine spill brought forth an abundance of scientific data aimed at addressing a crucial concern of affected populations regarding whether stream water is "safe." Despite the wealth of data from various entities such as the USEPA, federal, state and local agencies, and non-profit organizations, questions lingered on the validity of these safety claims. The spill underscores a fundamental question regarding trust in scientific information. Despite the USEPA's scientifically sound data that were consistent with those of other entities, significant doubts persisted about the water's safety. This case reveals that scientific criteria for sound scientific research do not necessarily translate into public trust in science. Though scientific

information can be useful in determining water safety after a major disaster, people and their perceptions of these data, and the entities communicating them, matter and must be acknowledged in disaster-recovery conversations.

Another important takeaway from our research on the Gold King Mine spill is the need to recognize the various stakeholders in different watersheds and communities within them when communicating and interpreting scientific information on a multi-watershed scale. The USEPA's post-disaster communication was limited in addressing community-specific needs, concerns, cultures, and histories that could have affected their response. Therefore, acknowledging these differences is crucial to effectively convey scientific information following a disaster.

Finally, our research shows that while salience, credibility, and legitimacy are essential components of scientific communication, it is imperative to recognize the limitations of current standards for determining water safety. The reliance on baseline conditions, which are already contaminated in the case of the Animas River, and the invisibility of polluted sediments from the Gold King Mine spill according to current standards created confusion among affected communities. Even if scientific communication satisfies the criteria of salience, credibility, and legitimacy, imperfect standards for interpreting data will inevitably lead to persistent skepticism of the scientific information presented. Therefore, it is imperative to address the limitations to current regulatory standards before interpreting and communicating scientific information.

## CHAPTER 3

### LIMITATIONS AND FUTURE WORK

#### **3.1 Limitations of this Study**

Though this study is a critical evaluation of water debates in communities impacted by the Gold King Mine spill, it is important to acknowledge its limitations. It is important to note that our media dataset only extended to three months after the Gold King Mine spill due to limitations in the online availability of *Silverton Standard & the Miner* articles. Though this three-month period captured the discourse in the immediate aftermath of the Gold King Mine spill, it does not capture the long-term discussions that occurred post-spill, which could offer additional insights into discourse beyond initial spill responses. It is also important to note that, though we chose to focus on Silverton, Durango, and the Navajo Nation, other communities were also impacted by the spill. Therefore, our study does not capture the discourse occurring in other places, such as the Southern Ute Tribe and Farmington, New Mexico.

#### **3.2 Future Work**

Future work efforts could consider conducting stakeholder interviews with those impacted by the Gold King Mine spill to gain additional insights into water quality debates on an individual level. Additionally, an examination of articles beyond the initial three-month period that we have analyzed could provide a more long-term outlook on water safety debates and subsequent outcomes of the Gold King Mine spill. Examining local media from other impacted communities could deliver useful insights into other water debates that occurred in the aftermath of the disaster. Finally, these data could be analyzed to incorporate the viewpoints of multiple

water quality testers who were involved in the Gold King Mine spill, extending beyond the USEPA. This analysis could provide additional insights into salience, credibility, and legitimacy, and expand the conversation of regulatory standards based on their unique perspectives.

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APPENDIX  
SUPPLEMENTARY MATERIAL

Below is the codebook we used to guide our research. The codebook was designed to capture both quantitative and qualitative data. Coders read newspaper articles closely and used questions from the codebook to gather data, which was recorded in Microsoft Excel sheets.

**Gold King Mine Spill Codebook Key**

*Note to selves: Read and code as literally as possible. Whenever in doubt, double check the text of the article. Ensure that you are reading the text itself and not between the lines.*

GKMS = Gold King Mine Spill

**Article Type:**

1. News
2. Opinion (letter to the editor, op-ed, editorial by newspaper's editorial board)
3. Other

**Is this story from a wire service rather than the local newspaper? (e.g., Associated Press (AP), Reuters)**

0. No
1. Yes

***RQ1: How is responsibility for the Gold King Mine Spill defined within each community? AND What similarities and differences exist, and if so, why? Do definitions of responsibility change over time in the aftermath of the disaster?***

**1a. Is an explanation given for the cause of the spill?**

1. No
1. Yes

**1b. If Y, how far back in time does the “origin story” go? (Code for 1 for all that apply):**

1. Immediate: Focus is narrowly on the *months, week(s), or days* leading up to the spill (summer 2015). Origin story emphasizes the work of the EPA contractor at the site and what went acutely wrong there.
2. Mid-Term: Focus is on the *decades* leading up to the spill (1970s+). For example, origin story may capture debates over Superfund designation dating to the early 2000s, or the modern environmental movement and its struggles to clean up abandoned mines via the Clean Water Act, Superfund/CERCLA, etc.
3. Longer-Term: Focus is on the *century+* leading up to the spill (1870+). For example, origin story may stretch back to the early days of the gold and silver booms

in the region or the General Mining Law of 1872 and its encouragement of mining activity without consideration of impacts.

4. Longest-Term: Focus is historically broadest (pre-1870). Origin story incorporates the history of indigenous peoples' contact with European-American settlers. For example, it may mention the first Euro-American expedition into the upper Animas (1861) and/or conflict between Utes and miners, or other ways that indigenous people have been impacted by Euro-American conquest, etc..

5. Other: (fill in as succinctly as possible)

**2a.** Who, if anybody, is assigned responsibility for the Gold King Mine Spill? In other words, who is blamed for the spill? (Code for 1 for all that apply):

1. Nobody
2. The U.S. EPA (the agency as coordinator of AMD clean-up or the specific On Scene Coordinator, who was on vacation the day of the blowout)
3. The contractor to the EPA that was working at the Gold King Mine (Environmental Restoration)
4. The U.S. Bureau of Land Management (landowner)
5. The U.S. Bureau of Reclamation (funder of AMD clean-up)
6. The U.S. federal government (general blaming of "the feds" without specificity of an agency)
7. The state of Colorado
8. The Colorado Division of Reclamation, Mining and Safety (or CO Department of Natural Resources, more generally)
9. Current owner of the Gold King Mine (Todd Hennis, Colorado Goldfields Inc.)
10. Historical owners or operators of the Gold King Mine
  - o (e.g., Olaf Arvid Nelson, Louisa Nelson, Cyrus Davis, Henry Soule, Willis Kinney, Gold King Consolidated Mine Co., Otto Mears, Gerber Minerals Corp, Gold King Mines Corp., Taylor Rand, Steve Fearn, etc.)
11. Current or historical owners or operators of the Sunnyside Mine
12. The City of Silverton
13. Other: (type in)
14. Multiple actors are blamed: (type in)

**3a.** Does the article mention that the spill has impacted water resources in the newspaper's source community? (I.e., Durango Herald mentions impacts to Durango water; Navajo Nation mentions impacts to Navajo water, etc.)

1. No
1. Yes

**3b.** If Y, what kind of impact(s) is/are mentioned for this community? (Code for 1 for all that apply)

1. Irrigation of crops and/or livestock (i.e., farming/ranching)
2. Irrigation of landscaping (e.g., watering lawns or parks)
3. Drinking water resources
4. Recreation (e.g., boating, fishing, children playing in water, etc.)
5. Ecological impacts (e.g., fish and other aquatic species)
6. Indigenous relationship to water (fill in):
7. Other (fill in):

***RQ2: How is the safety of the river's waters (to humans) debated within each community? Who is or is not entrusted to speak on water quality within each community, and why?***

**4a.** Does article mention color of river?

1. No
1. Yes

**4b.** If Y, what specific language does the article use to describe river color? (fill in)

**5a.** Does article mention the plume or dissolved metals?

1. No
1. Yes

**5b.** If Yes, what specific language does the article use to describe the plume? (fill in)

**6a.** Is the safety of the river's waters and/or the ecological health of the river mentioned? (Code for 1 and fill in by whom):

1. Not mentioned
2. Mentioned as unknown (not enough data/tests to determine if water is safe)
3. Mentioned and deemed unsafe (fill in by whom)
4. Mentioned and deemed safe (fill in by whom)
5. Mentioned as actively being debated (fill in by whom) (ex: data says it's safe, but someone else disagrees, is unsure, etc.)

**7a.** Does the article specifically mention trust or distrust?

1. No
1. Yes

**7b.** If the articles mentions trust/distrust, then by whom? in whom? (fill in)

**8a.** Does the article incorporate scientific data about water quality and/or the environmental impacts of the spill? (Note: It is not enough that testing is occurring; there must be results to report. Code "yes" if the article includes specific data (e.g. "lead concentrations are 0.08 ppm") OR if it generalizes the results (e.g., "water quality tests show normal levels of metals.")

1. No
1. Yes

**8b.** If yes, whose data are mentioned? (fill in)

**8c.** If yes, what data are mentioned? (fill in)

**9a.** Are any other ways of understanding the river and the quality of its waters (outside of scientific practices) mentioned? Might include lived experience, cultural storytelling, religion, gut instinct, etc. (Y/N)

1. No
1. Yes

**9b.** If yes, explain.

***RQ3: How are solutions to the spill defined by each community, and which solutions were codified in post-spill legal responses?***

**10a.** Does the article suggest potential solutions for the Gold King Mine spill and/or chronic acid mine drainage in the San Juans?

1. No
1. Yes

**10b.** If Y, what type of solution is offered, generally? (Code 1 for all that apply)

1. A technical solution based in engineering and/or science (e.g., build a wastewater treatment plant, do more research)

2. A policy solution based in policy or regulatory change (e.g., Superfund designation, reform of relevant laws, etc.)
3. A financial solution based in financially compensating losses *caused by the spill* (e.g., government payments for damages, public or private donations for those impacted by spill)
4. A legal solution based in legal action (e.g., lawsuits)
5. A market-based solution based in market principles (e.g., start mining again or recover profitable metals from acid mine drainage)
6. A power-based solution based in changes to existing power dynamics and/or authority, which primarily empower the U.S. federal government and the mining industry (e.g., give Native Nations more power and control over spill response and recovery; give local communities more power; reduce industry influence, etc.)
7. A cultural solution based in changing one's values (e.g., seeing the river as an entity worthy of protection)
8. Other (briefly explain)

**10c.** More specifically, if solutions are presented, what are they? (Fill in ALL solutions that are presented).

**11.** Any notable quotations? If yes, write in here.

**12.** List any notable events here.

Percent Agreement by Question													
1a.	1b.	2a.	3a.	3b.	4a.	5a.	6a.	7a.	8a.	9a.	10a.	10b.	Overall
96	77	78	96	72	100	75	68	96	87	96	96	69	<b>83</b>

**Table A.1.** Table showing calculated percent agreement by codebook question. It is important to note that questions with a percent agreement below 75% were excluded from our results, with the exception of 6a, which was kept due to its highlighting of the confusion coders experienced while trying to determine water safety after the Gold King Mine spill.