Overview

Among the primary concerns expressed by the public during the scoping period for the Resolution Copper Mine EIS were the potential risks posed by mine operations to public health and well-being. These included the potential for toxic air emissions, contamination of groundwater and surface water, tailings storage facility failure, increased risk of wildfire, and increased potential for accidental spills or releases of hazardous chemicals or other pollutants. This section addresses, in three parts, tailings facility and pipeline safety, fire risks, and the potential for releases or public exposure to hazardous materials. Air emissions issues are analyzed in Section 3.6, Air Quality, and the potential for mine-related contamination of water sources is assessed in Section 3.7.2, Groundwater and Surface Water Quality.

3.10 Public Health and Safety

3.10.1 Tailings and Pipeline Safety

3.10.1.1 Introduction

During scoping, the public expressed concern for the potential failure of a tailings embankment as well as the potential for failure of the copper concentrate and tailings pipelines. Some commenters cited recent high-profile tailings facility failures in Brazil and British Columbia as examples of the possible consequences.

Tailings storage facilities represent a long-term source of risk to public health and safety that extends well beyond the operational life of the mine. Catastrophic failures are one type of risk. In these cases, the tailings embankment can fail either because of a design or foundation flaw, a failure in construction, errors in operation, natural phenomena like earthquakes or floods, and often combinations of these factors. While the tailings themselves are solid particles, the material stored behind the embankment is a mixture of tailings solids and water. With a catastrophic failure of a tailings embankment, the tailings material stored in the facility behaves like a liquid. Massive amounts of tailings materials can spill from the facility and flow downstream for long distances, even hundreds of miles.[58]

A tailings embankment failure is similar to other high-consequence, low-probability events, such as catastrophic wildfires, hazardous material spills, or 1,000-year floods. The likelihood of these events happening is low and given their nature it is not possible to predict when or how they might occur. However, they do occur, and when they occur the impacts can be severe.

Bowker (2019) cataloged 254 failures of tailings facilities worldwide occurring between 1915 and 2019, with 121 categorized as serious or very serious,[59] and at least 46 events resulting in loss of life. In the recent past, since 2000, Bowker documents the occurrence of 32 serious or very serious failure events, of which 18 resulted in loss of life.[60] More than 100 of the failures between 1915 and 2019 were in the United States, with about a quarter of them serious or very serious; the last serious failure in the United States was in Kentucky in 2017, which also resulted in loss of life. Bowker also documents a number of known tailings failures in the vicinity of the project, including Pinto Valley (1997, classified as a serious failure), Ray Mine (four failures between 1972 and 2011, including one classified as serious in 1993), and Magma Mine itself (1991, classified as a minor failure).

A tailings embankment failure has immediate consequences to those in the vicinity and

58. Note that this refers primarily to slurry tailings facilities (like Alternatives 2, 3, 5, and 6). Alternative 4 is a filtered tailings facility and would likely react differently during a failure; this difference is described in this section.

59. The researchers based this designation on loss of life, high release volume (more than 100,000 cubic meters), or long travel distance.

60. Concerning recent high-profile events, the dataset includes the Mount Polley (British Columbia, 2014) and Fundão (Brazil, 2015) failures, as well the much-publicized failure of the tailings facility in Brumadinho, Brazil, in January 2019.

living downstream, including loss of life, destruction of property and infrastructure, and destruction of entire ecosystems (aquatic or terrestrial). Once the tailings stop moving downstream, long-term consequences from a catastrophic failure continue through the contamination of large geographic areas, compromised water supplies, economic disruption, and displacement of large numbers of people.

Aside from catastrophic failures, tailings storage facilities can represent other long-term risks to public health and safety, including the potential for groundwater contamination from tailings seepage, erosion of material into downstream waters, and windblown dust. While tailings facilities gradually drain over time, becoming less susceptible to failure, the potential risks can last for many decades after closure. One study identified that roughly 80 percent of tailings facility failures occur in active facilities and 20 percent occur at closed facilities (Strachan and Van 2018).

The concentrate and tailings pipelines are also potentially susceptible to failure. Failures can occur from pipe damage due to geotechnical hazards such as rockslides or ground subsidence, from hydrologic hazards such as scour or erosion, seismic hazards, human interference, or even lightning. Failures of these types of pipelines are not generally tracked, because the consequences of tailings pipeline failures are substantially less severe than a tailings embankment failure. The petroleum industry is the only source of published information on the frequency of pipeline failures. Natural gas or petroleum pipelines run at much higher pressures than those planned for the tailings and concentrate pipelines and the contents are more immediately hazardous (flammable), but they still represent a useful estimate of the type and frequency of pipeline failures.

For the petroleum industry, the frequency of failures in the United States has been estimated as 16 gas or petroleum pipeline failures per year, out of roughly 500,000 miles of pipeline (Porter et al. 2016). This can be looked at in other ways as well. The research translates to roughly 0.03 failures per year per 1,000 miles of pipeline (Porter et al. 2016) for a 30-mile tailings pipeline, the risk of failure in any given year would be about 0.1 percent. Other research has found that the failure rate is substantially lower for large-diameter pipelines and decreases with the amount of soil cover (European Gas Pipeline Incident Data Group 2015). This research also indicates that the most common failure types are pinhole leaks and holes, and the least common failure type is a complete rupture of the pipeline (European Gas Pipeline Incident Data Group 2015).

Besides the potential magnitude of a release, pipeline failures are substantially different from embankment failures. Pipelines are monitored with pressure sensors and can shut down immediately upon a rupture being detected, leading to relatively localized releases that can likely be readily cleaned up. Pipeline risk also decreases to zero after closure, unlike the tailings embankment which can still represent a risk decades after closure.

The tailings and pipeline safety analysis in the DEIS addresses three public safety and natural resource protection commitments of the Forest Service:

1. To disclose risks and the potential magnitude and type of downstream impacts from a hypothetical tailings embankment failure;
2. To disclose risks and potential impacts associated with a failure of the tailings or copper concentrate pipelines; and
3. To ensure that the design of any tailings storage facility built on Federal land meets all expectations for safety, including a minimum requirement to adhere to National Dam Safety Program guidelines.

3.10.1.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for tailings and pipeline safety consists of all downstream areas that could be affected in the event of a partial or complete failure of the tailings embankment, as shown in figure

3.10.1-1, including human and natural environments, as well as the water bodies that could be impacted by a pipeline rupture or spill.

Analysis Techniques

A number of approaches are available to assess the risk of failure of a tailings storage facility, as well as the downstream effects of a failure. These techniques can be used to inform the decision process and to help analyze the potential differences between alternatives.

There are two basic steps frequently used to understand the potential size and extent of a failure.

- First, a risk-based design approach can be used to assess the inherent risks in a given design. One common tool is a failure modes and effects analysis (FMEA). The purpose of conducting a risk-based design process is to identify potential ways an embankment could fail (modes), the type of failure (whether the tailings act as a fluid or a solid), and also to develop design and operational strategies to mitigate the risk.
- Second, in the event a failure were to occur, a breach analysis (also known as a runout analysis or inundation analysis) can be used to assess the potential downstream impacts of where the tailings would travel, how far, and how fast.

The Forest Service is using both of these steps in the NEPA process. For the DEIS, the Forest Service is using a worst-case assumption that a full breach would occur and that the tailings would act like a fluid as they ran out, with resulting catastrophic impacts. This type of analysis does not consider controls or design features that would be employed to prevent this type of failure or limit potential damage; these features are identified and discussed in “Summary of Applicant-Committed Environmental Protection Measures” in section 3.10.1.4. For the DEIS, a failure modes analysis has been conducted using the DEIS designs for each of the tailings storage facility alternatives. A breach analysis has also been conducted using a simple empirical technique based on a database of past failures. For more discussion of techniques evaluated by the Forest Service, see Newell and Garrett (2018c).

FAILURE MODES AND EFFECTS ANALYSIS

When tailings facilities fail, they fail for specific reasons, or often a combination of reasons related to design (design flaws, design oversights like unknown foundation conditions, or deviation from planned design), operations (improper pond management or tailings deposition practices), and environmental triggers (seismic events, extreme precipitation). In general, these are known as “failure modes.” There is no such thing as a “typical” facility failure, as each situation is the result of a specific failure mode or combination of failure modes.

An industry-standard step in the design of a tailings facility is to conduct an FMEA:

> Failure modes and effects analysis (FMEA) is a technique that considers the various fault (or failure) modes of a given element and determines their effects on other components and on the global system. It is an iterative, descriptive and qualitative analytical methodology that promotes, based on the available knowledge and information, the systematic and logical reasoning as a means to improve significantly the comprehension of the risk sources and the justification for the decisions regarding the safety of complex systems, namely dams. Without requiring mathematical or statistical frameworks, it intends to assure that any plausible potential failure is considered and studied, in terms of: *what can go wrong? How and to what extent can it go wrong? What can be done to prevent or to mitigate it?* (dos Santos et al. 2012) (emphasis in original)

Resolution Copper has conducted a failure modes assessment for each tailings facility design (Klohn Crippen Berger Ltd. 2019a; Pilz 2019), identifying all potential failure modes, and identifying the design feature

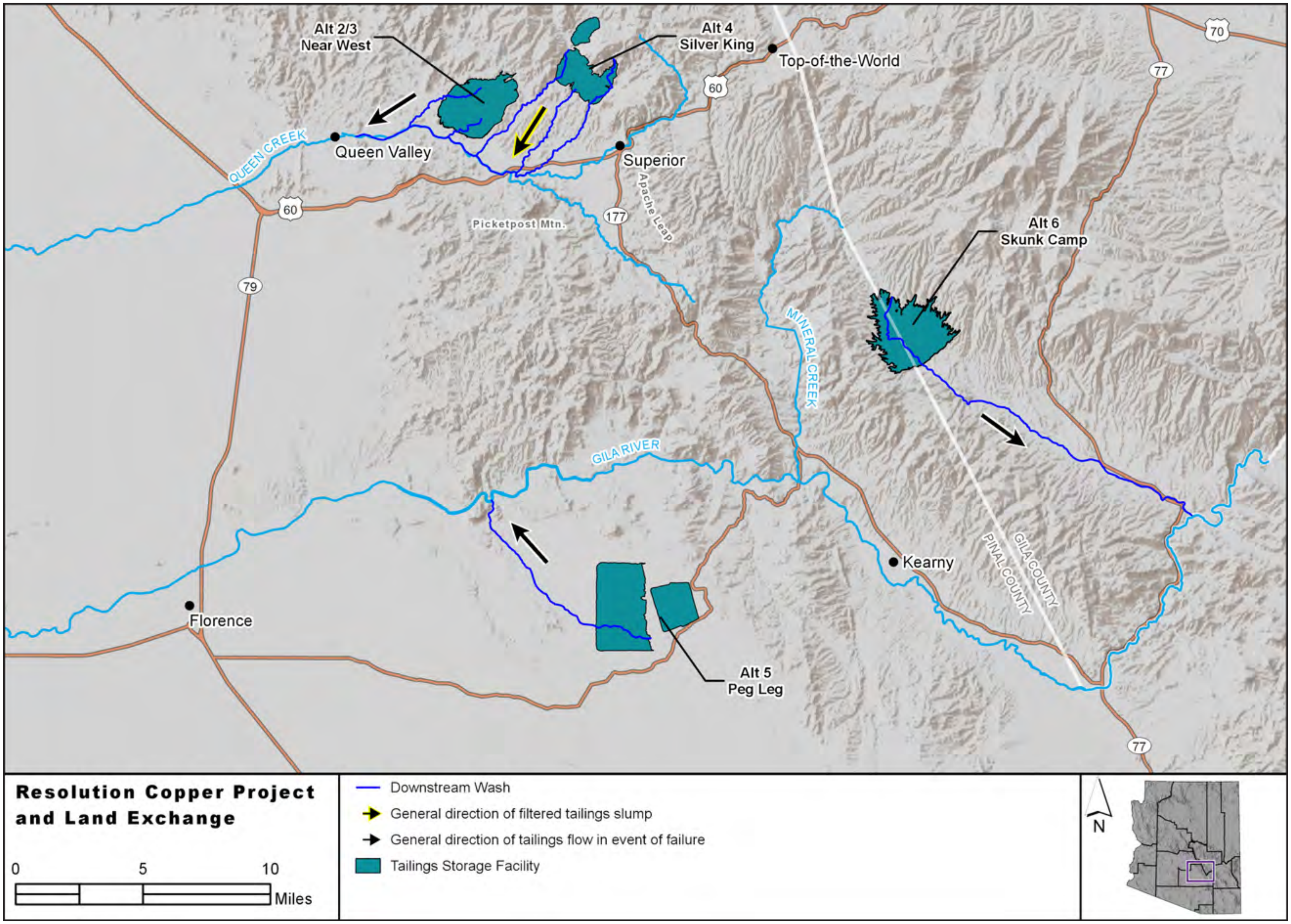

Figure 3.10.1-1. Overview of tailings safety analysis areas

to address each risk, in line with best industry practice, international design standards, and Federal and State regulations. The Forest Service reviewed the failure modes assessment, found it appropriate for the level of alternative design, and has included a discussion of the work in "Summary of Applicant-Committed Environmental Protection Measures" in section 3.10.1.4.

BREACH ANALYSIS

A breach analysis is used to model a tailings storage facility failure, including the volume of tailings released and how far it would run downstream. Some methods require no site-specific information except for basic facility design (such as embankment height or total facility volume). These methods include the empirical, rheological, and energy balance methods. Other methods use numerical modeling with the incorporation of detailed site-specific information. See Newell and Garrett (2018c) for further information on these techniques.

For the DEIS, the Forest Service has chosen the following empirical method to disclose the effects of a failure. As noted in the following text, this approach likely represents a worst case. It does not consider embankment type, design features used to specifically address failure modes, foundation conditions, operational approaches, or real-world topography.

Rico Empirical Method

Empirical methods use the known, available characteristics of historical tailings facility failures in order to estimate the characteristics of a failure at a hypothetical future tailings facility. Empirical methods are often based on limited data, perhaps only the basic geometry of the facility (embankment height, total volume), rather than specific embankment design details and foundation conditions. This approach was introduced by Rico et al. (2007), who relied on a database of 29 known tailings facility failures worldwide that occurred between 1965 and 2000. This empirical method was updated in 2018 by Larrauri and Lall (2018) to include additional known failures, for a total of 35 worldwide tailings facility failures between 1965 and 2015. The Larrauri and Lall dataset includes the two largest and most recent failures (at the time): Mount Polley Mine in British Columbia in 2014, and Fundão in Brazil in 2015.

These researchers developed two statistical relationships. The first relationship predicts the volume of material released during a failure based on the total facility volume. Fundamentally this approach comes down to a basic equation that shows historic releases have on average released about 33 percent of the total facility volume. The second relationship predicts the maximum travel distance downstream based on the release volume and the embankment height.

There are substantial limitations to the empirical approach:

- The largest facility in the dataset is 74 million cubic meters,[61] compared with 1,000 million cubic meters (upon buildout) for the planned Resolution Copper facility. For this project, the extrapolation goes well beyond the bounds of the original dataset; this represents an uncertainty since larger facilities may or may not react like smaller facilities.
- Specific embankment construction methods are not factored into the empirical equations. Of the 35 facilities included in the Larrauri and Lall estimates, 24 used an upstream construction method, one used modified centerline (matching Alternatives 2 and 3), and none used centerline (matching Alternatives 5 and 6) (Bowker 2019). The empirical dataset is therefore not representative of the specific design proposed by Resolution Copper. The Resolution Copper facility would have a fundamentally different type of embankment than most of the previous failures (instead of an upstream embankment, Alternatives 2 and 3 use a modified-centerline, and Alternatives 5 and 6 use a centerline embankment).

61. The most common unit of volume used in the literature on tailings releases is cubic meters, or millions of cubic meters. For ease and consistency, these same units are being used in this section.

- The dataset extends as far back as 1965 and may have been designed to lower factors of safety or higher acceptable levels of risk; the Resolution Copper facility would be designed to modern standards (described in more detail in "Relevant Laws, Regulations, Policies, and Plans" in section 3.10.1.3).
- The empirical estimates are based solely on embankment height or facility volume and take no account of operational methodologies, topography, or actual failure mode.

While recognizing these limitations, the Forest Service has selected the empirical method as the most reasonable method for the DEIS to inform the NEPA process and assess differences between alternatives. The level of current design and site-specific information is sufficient to use the empirical method, and the downstream effects reflect the real-world conditions experienced during other failures.

3.10.1.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

The regulations and policies that guide the design, construction, operation, and closure of tailings storage facilities come from a variety of sources. Some guidance is required to be met, such as the requirements of the National Dam Safety Program, Arizona State Mine Inspector's office, or Arizona APP program, while other guidance is followed voluntarily as part of industry best practices. What is considered acceptable in the design of a tailings storage facility is evolving as the industry and government respond to a number of recent and widely publicized catastrophic tailings failures. In this section, the Federal, State, and industry design standards are summarized, as well as recent proposals for better risk-based tailings design methods; ultimately, the design proposed by Resolution Copper is shown to meet the most stringent of these standards.

RECENT FAILURES

Post-failure investigations by independent industry experts were conducted in the Mount Polley (2014) and Fundão (2015) tailings failures. Both of these events are discussed here because they provide useful examples of the chain of events that can lead to a catastrophic failure, and because they underscore the need for stringent design requirements, regulatory oversight, and governance. In January 2019, another tailings embankment failure in Brazil at the Córrego do Feijão facility resulted in the estimated deaths of over 300 people. The post-failure investigation for this catastrophe is likely to take a year or more to complete, and at this time little is known about the cause of the Córrego do Feijão failure.

Mount Polley Failure (2014)

The Mount Polley investigative panel considered a wide range of potential failure modes that could have contributed to the failure (Mining and Mineral Resources Division 2015). Ultimately, the panel determined that the primary reason for the failure was the lack of understanding of the foundation conditions and how the increasing embankment height would change the foundation behavior. Specifically, the site characterization undertaken below a secondary embankment used to help impound the tailings prior to construction failed to identify the nature of glacial lakebeds in the subsurface, and therefore the design did not take into account the complexity of the foundation materials. As the embankment height increased, the geological unit in question changed properties and became susceptible to "undrained loading," which means that under the great load of the tailings, this geological unit compressed and developed excess pore pressure, reducing the shear strength. These were factors that are well known and studied in soil mechanics but were not understood or applied correctly in the design process.

An additional aspect of the design that contributed to the failure was the use of a steep slope on the downwards face of the embankment (1.3:1). The original design criteria for the embankment called for a 2:1 slope, but that slope had not yet been achieved due to a lack of available rock fill material until later in the life of the tailings facility. The panel concluded that the embankment likely would not have failed if the 2:1 design slope had been achieved.

Although not a cause of the failure, the primary factor in the severity of the failure was the excess amount of water stored in the facility. When the failure occurred, permitting was still underway to allow treatment and discharge of the excess stored water downstream.

In summary, the Mount Polley failure resulted from the following:

- shortcomings in site characterization,
- inadequate design resulting from the flawed site characterization,
- inadequate construction resulting from temporary deviations from the original design due to logistical issues (availability of waste rock),
- logistical delays with the discharge of excess water from the facility, which increased the severity of the consequences of failure, and
- failure of regulatory oversight for adherence to design and operational parameters.

The Mount Polley failure released 21 to 25 million cubic meters of pond water and tailings. The failure of the embankment took place suddenly without any warning signs and became uncontrollable in less than 2 hours. Polley Lake (just upstream of the breach), Hazeltine Creek, and Quesnel Lake were impacted by the debris flow, and the discharge of water from Polley Lake was blocked by the tailings plug left behind (Golder Associates Ltd. 2015; Mining and Mineral Resources Division 2015). The tailings release impacted about 5 to 6 miles of Hazeltine Creek before entering Quesnel Lake. There was no loss of human life.

At the immediate discharge location, tailings were estimated to be 11 to 12 feet thick. Along Hazeltine Creek, the debris flow scoured some areas to bedrock (estimated 1.2 million cubic meters of material lost) and tailings deposits covered other areas (estimated 1.6 million cubic meters of material deposited). Authorities estimated that Quesnel Lake received almost 19 million cubic meters of tailings, eroded material, and discharged water. The discharge completely destroyed the aquatic habitat in Hazeltine Creek. It also affected the water quality in Quesnel Lake and Polley Lake through increased turbidity and copper content. Initial assessments within the first year after the release found relatively little permanent or ongoing impact on aquatic life or terrestrial life, but studies continue (Golder Associates Ltd. 2015).

Fundão Failure (2015)

The Fundão investigative panel determined that a chain of decisions made during operations ultimately led to the failure of the embankment (Fundão Tailings Dam Review Panel 2016). First, damage to the original starter dam resulted in a change of design that allowed for an increase of saturation in the facility beyond the original plans. Second, a series of unplanned deviations in the facility construction resulted in deposition of fine-grained tailings at unintended locations, and the subsequent raising of the embankment above these tailings. This unintended deposition was a result of a design flaw—an inadequate concrete structure below the embankment that prevented the original design from being implemented—but also a deviation in tailings and water management over several years, in which water was allowed to encroach much closer to the crest of the embankment than originally planned.

The stresses placed on the fine-grained materials underlying the embankment caused them to shift, ultimately weakening the embankment to “a precarious state of stability” (Fundão Tailings Dam Review Panel 2016). Ninety minutes before the failure a series of small earthquakes occurred, and these seismic shocks triggered the failure. The panel was careful to note that while the seismic event was the trigger mechanism, it was not the ultimate cause of the failure.

In summary, the Fundão failure resulted from the following:

- deviations from the original design that allowed greater saturation in the facility;

- deviations in the location of planned tailings deposition caused by an unexpected problem with a foundation structure;
- deviations in the location of planned tailings deposition caused by deviations from tailings and water management criteria;
- a seismic shock that triggered the failure of the already compromised embankment; and
- failure of regulatory oversight for adherence to design and operational parameters.

The Fundão embankment failure released 32 million cubic meters of tailings. The failure of the embankment took place suddenly, within 2 hours of the triggering earthquakes. The United Nations estimated that the tailings release ultimately traveled 620 km downstream, following the Gualoxo and Doce Rivers, to reach the Atlantic Ocean. The town of Bento Rodrigues was immediately downstream of the facility; over a dozen people lost their lives, an estimated 600 families were displaced, and the drinking water supply to over 400,000 people was disrupted (GRID-Arendal 2017). The tailings destroyed an estimated 3,000 to 4,000 acres of riparian forest and destroyed substantial aquatic habitat.

Both of these failures (and others) involved a combination of design, construction, and operational factors, specifically the role of water, that contributed to the final outcome. Industry best practice is evolving to understand that each of these issues must be managed in an overall management plan or system that reviews the design and construction process throughout the life of the facility to prevent such future incidents.

EVOLVING INDUSTRY DIRECTION TOWARD AN INTERNATIONAL STANDARD ON TAILINGS STORAGE FACILITIES

In 2018, Dr. Norbert Morgenstern delivered a lecture to the Brazilian Geotechnical Congress on the topic of Geotechnical Risk, Regulation and Public Policy (Morganstern 2018). Dr. Morgenstern noted that the recent high-profile failures have occurred "at locations with strong technical experience, conscientious operators and established regulatory procedures." As part of that lecture, Dr. Morgenstern proposed a system for Performance-Based Risk-Informed Safe Design (PBRISD), construction, operation, and closure of tailings storage facilities. He further urged the International Council on Mining and Metals (ICMM) to support this proposed system and to facilitate its adoption in practice. In addition, Dr. Morgenstern praised The Mining Association of Canada's (MAC's) "Guide for the Management of Tailings Facilities" (Mining Association of Canada 2019) and noted the guide's influence on "governance protocols needed to ensure safe tailings management from the conceptual stages through to closure."

The ICMM is an international organization representing 27 signatory mining and metals companies, including Rio Tinto and BHP, partners in Resolution Copper. The ICMM also represents 36 associations, including the MAC and the National Mining Association. Through these members, the ICMM delivers best practice guidelines and industry standards.

Following the 2014 tailings failure at the Mount Polley Mine in British Columbia, MAC launched a comprehensive internal and external review of their Tailings Guide. The resulting recommendations included "a risk-based ranking classification system for non-conformances and have corresponding consequences." The recommendations also asked that guidance on risk assessment methodology be included. MAC noted that the resulting third edition of the Tailings Guide "is another step in the continual improvement process for tailings management, moving toward the goal of minimizing harm: zero catastrophic failures of tailings facilities, and no significant adverse effects on the environment and human health" (Mining Association of Canada 2019). Of note, the current edition includes a risk-based approach, "managing tailings facilities in a manner commensurate with the physical and chemical risks they may pose." The revised guidance specifies: (1) regular, rigorous risk assessment; (2) application of most appropriate technology to manage risks on a site-specific basis (best available technology); (3) application of industry best practices to manage risk and achieve performance objective (best available performance); and (4) use of rigorous, transparent decision-making tools to select the most appropriate site-specific combination of best available technology and location for a tailings facility.

In February 2019, and in response to the recent Brumadinho tailings embankment failure in Brazil, the ICMM announced that it would establish an independent panel of experts to develop an international standard for tailings facilities (International Council on Mining and Metals 2019b). According to ICMM, this standard is expected “to create a step change for the industry in the safety and security of these facilities.” The details of the standard are expected to include (1) a global and transparent consequence-based tailings facility classification system with appropriate requirements for each level of classification; (2) a system for credible, independent reviews of tailings facilities; and (3) requirements for emergency planning and preparedness.

In support of developing an international standard, ICMM’s response to the Brumadinho failure also announced that the supporting guidance would include PBRISD, as recommended by Dr. Morgenstern, a conformance guide for ICMM’s tailings governance framework, and a critical controls management framework (International Council on Mining and Metals 2019a). The fundamental principle of a PBRISD tailings management system is accountability, achieved only by multiple layers of review, recurrent risk assessment, and performance-based validation, from construction through closure (Morganstern 2018).

Further to ICMM’s initial announcement, in March 2019, they announced they would co-convene the independent review along with the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI) (International Council on Mining and Metals 2019c). This partnership will encourage more broad acceptance of the eventual international standard, while still requiring commitment to it by ICMM’s member companies. The independent review is anticipated to conclude by the end of 2019.

FEDERAL REQUIREMENTS FOR TAILINGS FACILITY DESIGN

Regulatory jurisdiction over a tailings embankment and facility depends largely on the location. If the tailings facility is located fully or in part on Federal land administered by the BLM or Forest Service, then tailings design and safety are analyzed and approved as part of the review process for the mining plan of operations, and a bond is required for any reclamation requirements associated with the tailings embankment. Mineral regulations specifically give the Forest Service the ability to regulate tailings: “All tailings, dumpage, deleterious materials, or substances and other waste produced by operations shall be deployed, arranged, disposed of or treated as to minimize adverse impact upon the environment and forest surface resources” (36 CFR 228.8(c)).

The BLM’s mining regulations require the “prevention of unnecessary or undue degradation” (43 CFR 3809), in addition to the applicable considerations for surface use and occupancy (43 CFR 3715). This gives the BLM the authority and ability to regulate tailings storage facilities on BLM-administered land. This would apply to Alternative 5 – Peg Leg.

While neither BLM nor Forest Service guidance contains prescriptive[62] requirements for how tailings embankments must be constructed, the Federal Emergency Management Agency (FEMA) has developed the National Dam Safety Program, which includes standards that are applicable to structures constructed on Federal land. This includes tailings embankments. The National Dam Safety Program provides a conceptual framework that includes requirements for site investigation and design, construction oversight, operations and maintenance, and emergency planning, as outlined in table 3.10.1-1 (Federal Emergency Management Agency 2004, 2005, 2013).

The Forest Service would require that the Resolution Copper tailings storage facility adhere to National Dam Safety Program guidelines, if

62. For the purposes of this discussion, a “prescriptive” design requirement is one where a specific technique or value is dictated by the guidance, rather than a conceptual or qualitative objective. For example, FEMA standards for “factor of safety” are non-prescriptive: “Factors of safety should be appropriate to the probability of the loading conditions . . . ,” whereas APP standards for factor of safety are prescriptive: “Static stability analyses should indicate a factor of safety of at least 1.3.”

Table 3.10.1-1. Overview of key requirements of National Dam Safety Program and comparison with other guidance

National Dam Safety Program Process/ Components	Specific FEMA Guidance	Arizona BADCT Guidance	Rio Tinto (2015)	ICMM (2016)	CDA (2014)	MAC (2017)	ANCOLD (2012)	MEM (2017)	USACE (2002, 2004)
Site Investigation and Design									
Hazard classification	III.B.1.a (FEMA 93) FEMA 333				X		X	X	
Selection of inflow design flood	III.B.1.b-c (FEMA 93) FEMA P-94	E.3.2, E.3.3, E.3.4			X		X	X	X
Selection of the hydraulic capacity of embankment	III.B.1.d (FEMA 93)	3.5.4.2; E.3.5			X		X		X
Seismic investigations	III.B.2.a-d (FEMA 93)	3.5.3.3; E.2.4.6					X		
Selection of design earthquake	III.B.2.e-f (FEMA 93) FEMA 65	3.5.3.3; E.2.4.3			X		X	X	X
Geotechnical aspects									
Site-specific exploration	III.B.3.a-b (FEMA 93)	3.5.3.2; E.2.3					X		X
Geotechnical design	III.B.3.c (FEMA 93)	3.5.3.3			X		X		X
Foundation treatment to ensure stability, control seepage, and minimize deformation	III.B.3.d (FEMA 93)	3.5.4.1			X		X		X
Embankment design parameters									
Site-specific design	III.B.5.a (FEMA 93)	3.5.3					X		X
Material evaluation	III.B.5.b (FEMA 93)	E.2.3					X		X
Seismic design	III.B.5.d.1 (FEMA 93)	3.5.4.4; E.2.4.3; E.2.4.6			X		X	X	X
Stability/factors of safety	III.B.5.d.2 (FEMA 93)	3.5.4.4; E.2.4.3; E.2.4.5			X		X	X	X
Settlement and cracking	III.B.5.d.3 (FEMA 93)	E.2.4.3					X		X
Seepage control	III.B.5.d.4 (FEMA 93)	3.5.4.3			X		X		X
Zoning to ensure stability and seepage control	III.B.5.d.5 (FEMA 93)								X
Erosion protection	III.B.5.d.6 (FEMA 93)						X		X
Construction management									
Inspection	III.B.3.f (FEMA 93)		X	X		X	X		X
Reevaluation of design	III.B.5.f (FEMA 93) III.C.2 (FEMA 93)		X				X		X
Construction quality assurance and testing	III.C.4 (FEMA 93)		X			X	X	X	X
Operations and maintenance									

continued

Table 3.10.1-1. Overview of key requirements of National Dam Safety Program and comparison with other guidance *(cont'd)*

National Dam Safety Program Process/ Components	Specific FEMA Guidance	Arizona BADCT Guidance	Rio Tinto (2015)	ICMM (2016)	CDA (2014)	MAC (2017)	ANCOLD (2012)	MEM (2017)	USACE (2002, 2004)
Develop written operating and maintenance procedures	III.D.1.b-c (FEMA 93)	3.5.4.5	X	X	X	X	X	X	X
Periodic inspection	III.D.2.a-b (FEMA 93)	3.5.4.6	X	X	X	X	X	X	X
Instrumentation	III.B.3.e (FEMA 93) III.B.5.e (FEMA 93) III.D.2.c (FEMA 93)						X		X
Correction of deficiencies	III.D.2.d (FEMA 93)		X	X		X	X	X	X
Emergency Planning	III.A.1.f (FEMA 93) III.B.1.e-f (FEMA 93) III.D.3 (FEMA 93)								
Determine failure modes	III.D.3.b.1 (FEMA 93)								X
Inundation maps or breach analysis	III.D.3.b.2-3 (FEMA 93)				X		X	X	
Response times	III.D.3.b.4 (FEMA 93)								
Emergency action plan	III.D.3.c-d (FEMA 93)		X	X	X	X	X	X	X
Other aspects									
Use of outside review	III.A.6 (FEMA 93)		X	X	X	X	X	X	
Risk-based design	III.A.1.g (FEMA 93) 2.3.6 (FEMA P-94)		X	X	X	X	X	X	
Closure/Post-closure design	*	3.5.5	X	X	X	X	X	X	
Accountability	*		X	X	X	X		X	
Change management and documentation	*		X	X		X		X	X

Sources: Rio Tinto (2015); International Council on Mining and Metals (2016); CDA = Canadian Dam Association (2014); Mining Association of Canada (2017); ANCOLD = Australian National Committee on Large Dams Inc. (2012); MEM = Ministry of Energy and Mines (2017); U.S. Army Corps of Engineers (2002) and U.S. Army Corps of Engineers (2004)

Notes:

FEMA 93 = Federal Guidelines for Dam Safety, April 2004

FEMA 333 = Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams, April 2004

FEMA P-94 = Selecting and Accommodating Inflow Design Floods for Dams, August 2013

FEMA 65 = Federal Guidelines for Dam Safety, Earthquake Analyses and Design of Dams, May 2005

* While components of the National Dam Safety Program standards touch on these topics, they are not handled in great specificity or detail.

built on Federal land. This is included in the “Adherence to National Dam Safety Program Standards” part of the “Mitigation Effectiveness” section as a required mitigation on Federal land.

STATE REQUIREMENTS FOR TAILINGS FACILITY DESIGN

The APP program administered by the ADEQ contains prescriptive requirements for tailings embankments. While focused on protecting aquifer water quality, the APP program requires that tailings storage facilities are designed to meet the standards of Best Available Demonstrated Control Technology (BADCT). The BADCT guidance provides specific recommended geotechnical criteria for static stability and seismic stability of tailings embankments, including minimum design earthquake magnitude, factors of safety for various loading conditions, and maximum deformation under seismic loading (see Section 3.5 – Tailings Impoundments, in Arizona Department of Environmental Quality (2004)).

The Forest Service cannot ultimately approve a plan of operations that violates an applicable law or regulation. Eventually the issuance of an Aquifer Protection Permit by the ADEQ to Resolution Copper would demonstrate to the Forest Service that the project complies with applicable Arizona laws and regulations. For the purposes of the DEIS, it is therefore assumed that APP prescriptive BADCT requirements must be met. The overlap of the Aquifer Protection Permit BADCT requirements with the National Dam Safety Program requirements is shown in table 3.10.1-1.

INDUSTRY BEST PRACTICES

The mining industry has adopted a number of industry standards and best practices that are equally or more restrictive than the requirements of either the National Dam Safety Program or the APP program. These are shown in comparison to the National Dam Safety Program and APP program in table 3.10.1-1 (Australian National Committee on Large Dams Inc. 2012; International Council on Mining and Metals 2016; Mining Association of Canada 2017; Ministry of Energy and Mines 2017; Rio Tinto 2015; U.S. Army Corps of Engineers 2002, 2004).

There are number of concepts in these documents that represent industry best practices that are not strongly represented in the National Dam Safety Program or APP program standards. These include the following:

- *Risk-based design.* FEMA standards allow for risk-based design as an option (see for example FEMA P-94, Section 2.3.6, Risk-Informed Hydrologic Hazard Analysis), but do not require it, as these techniques were still evolving and yet to be widely used when FEMA’s primary guidance was developed. A risk-based design approach can be used to “fine-tune” design parameters, but only when appropriate and within certain bounds.
- *Design for closure.* FEMA standards are largely silent on the issue of closure and post-closure of tailings facilities, instead focusing primarily on the design, construction, and operation of embankments.
- *Accountability.* FEMA standards require qualified personnel be used, but do not specify a single individual accountable for the design, construction, or management of the tailings storage facility.
- *Change management.* FEMA includes various requirements for documentation; however, industry best practices include a strong focus on managing and evaluating deviations from the original design, construction, or operation plan.
- *Independent review.* One common feature in many of the industry best practices listed here is the use of independent technical review by an outside expert or panel of experts. Resolution Copper has employed an Independent Technical Review Board (ITRB) to review the tailings design, drawing

on professionals with recognized expertise in tailings design and management[63] (Resolution Copper 2017). The ITRB has made a number of specific comments on design considerations for liquefaction, seismic loading, design factors for seismic and flood risk, and seepage controls.

APPROPRIATENESS OF RESOLUTION COPPER PROPOSED DESIGN

Many of the design standards that Resolution Copper must comply with, particularly those of the National Dam Safety Program, are narrative and non-prescriptive in nature. Key design parameters that are prescriptive and readily comparable between guidance documents are shown in table 3.10.1-2. The designs developed by Resolution Copper meet the most stringent of these standards, whether required (National Dam Safety Program or Aquifer Protection Permit program) or solely industry best practice.

Existing Conditions and Ongoing Trends

DOWNSTREAM COMMUNITIES

The tailings alternatives are located upstream of population centers in central Arizona that could be affected in the event of a failure. Communities in the approximate flowpath are shown in table 3.10.1-3, for roughly 50 miles downstream.[64] For Alternatives 2 and 3, the hypothetical flowpath of a tailings release is assumed to follow Queen Creek, through Whitlow Ranch Dam, through the community of Queen Valley, through urban development in the East Salt River valley, and eventually onto the Gila River Indian Community. For Alternative 5, the hypothetical flowpath is assumed to follow Donnelly Wash to the Gila River, and then downstream through Florence and eventually onto the Gila River Indian Community. For Alternative 6, the hypothetical flowpath is assumed to follow Dripping Spring Wash to the Gila River toward Winkelman, Hayden, and Kearny.

DOWNSTREAM WATER SUPPLIES

The tailings facilities are also upstream of substantial water supplies in central Arizona, both community potable water systems and agricultural irrigation districts, as shown in table 3.10.1-4. In the event of a tailings failure, water supplies would be at risk from destruction of infrastructure and potential contamination of surface water and groundwater sources.

DOWNSTREAM WATERS AND HIGH-VALUE RIPARIAN AREAS

Riparian Areas Downstream of Tailings Storage Facility

High-value riparian ecosystems exist downstream of all of the tailings alternative locations. These include the following:

- Queen Creek at Whitlow Ranch Dam (downstream of Alternatives 2, 3, and 4). Perennial flow occurs in Queen Creek at Whitlow Ranch Dam, which is the outlet for subsurface flow in the Superior Basin. Approximately 45 acres of riparian vegetation have grown up behind Whitlow Ranch Dam, supported by flowing surface water and shallow groundwater. There is a dense understory. Saltcedar dominates the woody vegetation, although other riparian tree species are also present,

63. The four members of Resolution Copper’s ITRB are David Blowes, Ph.D. (University of Waterloo), David A. Carr (Registered Geologist), Richard Davidson (Professional Engineer), and Norbert Morgenstern, Ph.D. (Professional Engineer; Professor Emeritus, University of Alberta; Chair of the Mount Polley Independent Expert Engineering Investigation and Review Panel; Chair of the Fundão Tailings Dam Investigation Panel).

64. While the empirical estimates discussed in section 3.10.1.4 indicate that tailings could go farther than 50 miles in the event of a catastrophic failure, this analysis focuses on communities in the East Salt River valley and along the Gila River that would be within 50 miles of the tailings storage facility alternative, that have the highest likelihood of being impacted if a catastrophic failure were to occur.

Table 3.10.1-2. Comparison of key design criteria against requirements of National Dam Safety Program, Aquifer Protection Permit program, and industry best practices

	Downstream Slope	Minimum Factor of Safety (Static)	Minimum Factor of Safety (Dynamic or Seismic)	Design Earthquake	Inflow Design Flood	Independent Review	Breach Analysis and Emergency Planning
FEMA National Dam Safety Program (Required)	No specific requirement	1.5	1.2	Maximum Credible Earthquake (for high-hazard dam)	Probable Maximum Flood (for high-hazard dam)	No specific requirement	Determine failure modes; prepare inundation maps; time available for response; develop emergency action plans
Aquifer Protection Permit program BADCT (Required)	No specific requirement	1.3 to 1.5	1.0 to 1.1	Maximum Credible Earthquake (for risk to human life)	Probable Maximum Flood (for risk to human life)	No specific requirement	No specific requirement
Industry best practices	No steeper than 2H:1V (Ministry of Energy and Mines 2017)	1.5 (Ministry of Energy and Mines 2017) 1.3 to 1.5 (Australian National Committee on Large Dams Inc. 2012)	1.0 to 1.2 (Australian National Committee on Large Dams Inc. 2012)	2,475-year return period (Ministry of Energy and Mines 2017) 10,000-year return period up to Maximum Credible Earthquake (Canadian Dam Association 2014) 10,000-year return period up to Maximum Credible Earthquake (Australian National Committee on Large Dams Inc. 2012)	1,000-year return period up to Probable Maximum Flood (Canadian Dam Association 2014) 975-year return period, with 72-hour duration (Ministry of Energy and Mines 2017) 100,000-year return period up to Probable Maximum Flood (Australian National Committee on Large Dams Inc. 2012)	Required by most industry standards	Emergency action plans required by most industry standards; inundation maps required by Australian National Committee on Large Dams Inc. (2012), Canadian Dam Association (2014), and Ministry of Energy and Mines (2017)

continued

Table 3.10.1-2. Comparison of key design criteria against requirements of National Dam Safety Program, Aquifer Protection Permit program, and industry best practices *(cont'd)*

	Downstream Slope	Minimum Factor of Safety (Static)	Minimum Factor of Safety (Dynamic or Seismic)	Design Earthquake	Inflow Design Flood	Independent Review	Breach Analysis and Emergency Planning
Resolution Copper design	Alternative 2 has a 4H:1V slope, and Alternatives 3, 5, and 6 all have a 3H:1V slope	1.5	1.2	Maximum Credible Earthquake Analysis indicates Maximum Credible Earthquake is equivalent to 10,000-year return period. The 10,000-year design earthquake is based on a mean value; the 95th percentile of the 10,000-year event was also considered.	Probable Maximum Flood, 72-hour duration	Use of ITRB to oversee tailings design process	Not yet completed. This would be a required step for the preferred alternative based on site-specific information and design.
Comparison of Resolution Copper criteria to guidelines	Slope is less steep than the most stringent prescriptive standard	Static factor of safety meets the most stringent prescriptive standard	Dynamic factor of safety meets the most stringent prescriptive standard	Design earthquake meets the most stringent prescriptive standard	Design flood meets the most stringent prescriptive standard	Review by ITRB is consistent with the industry standard	Not yet met, but would be met for preferred alternative

Table 3.10.1-3. Communities and populations within 50 miles downstream of proposed tailings facilities

	Alternatives 2 and 3 – Near West Location	Alternative 4 – Silver King Location	Alternative 5 – Peg Leg Location	Alternative 6 – Skunk Camp Location
Nearest downstream residence	0.3 miles	4.5 miles	Directly adjacent	4 miles
Other points of interest		Boyce Thompson Arboretum = 3.7 miles		
Major communities				
1–10 miles downstream	Queen Valley CDP (654)	Queen Valley CDP (654)		Dripping Springs CDP (165)
11–20 miles downstream	San Tan Valley CDP (90,665)			
21–30 miles downstream	Town of Queen Creek (33,298) Town of Gilbert (232,176)		Town of Florence (26,066) Blackwater CDP [Gila River Indian Community] (1,653)	Town of Winkelman (262) Town of Hayden (483)
31–40 miles downstream	City of Chandler (245,160)		Sacaton Flats Village CDP [Gila River Indian Community] (457)	Town of Kearny (2,249)
41–50 miles downstream	Lower Santan Village CDP [Gila River Indian Community] (395) Stotonic Village CDP [Gila River Indian Community] (379) Sweet Water Village CDP [Gila River Indian Community] (152)		Sacaton CDP [Gila River Indian Community] (2,338) Upper Santan Village CDP [Gila River Indian Community] (391) Lower Santan Village CDP [Gila River Indian Community] (395) Stotonic Village CDP [Gila River Indian Community] (379) Sweet Water Village CDP [Gila River Indian Community] (152)	
Estimated population within 50 miles	*602,879*		*31,831*	*3,159*

Source: ACS 2013–2017 5-year Estimates: Total Population (U.S. Census Bureau 2018).

Note: CDP = Census designated place

Table 3.10.1-4. Water supplies in central Arizona within 50 miles downstream of proposed tailings facilities

Water Supply	Population/ Acreage Served	Source of Water	Downstream of Alternatives
Community Water Systems			
Queen Creek Water Company	74,842	Groundwater (wells within 2,000 feet of Queen Creek)	Alternatives 2 and 3
Town of Gilbert	247,600	Surface water (SRP, CAP); Groundwater (wells directly adjacent to Queen Creek)	Alternatives 2 and 3
Apache Junction (Arizona Water Company)	57,647	Groundwater (wells 10–11 miles from Queen Creek)	Alternatives 2 and 3
Superior (Arizona Water Company)	3,894	Groundwater (wells 3–4 miles from Queen Creek)	Alternatives 2 and 3
Central Arizona Project	~850,000	Delivery of surface water to over a dozen downstream contract holders, including systems serving Tucson, Florence, Marana, Coolidge, and Casa Grande	Alternatives 2, 3, 5, and 6
Diversified Water Utilities	3,868	Groundwater (wells directly adjacent to Queen Creek)	Alternatives 2 and 3
Queen Valley Domestic Water Improvement District	1,000	Groundwater (wells directly adjacent to Queen Creek)	Alternatives 2 and 3
City of Chandler	247,328	Surface water (SRP, CAP); Groundwater (wells 1–2 miles from Queen Creek)	Alternatives 2 and 3
Johnson Utilities	62,158	Groundwater (wells 1–2 miles from Queen Creek)	Alternatives 2 and 3
Town of Florence	14,880	Groundwater (wells directly adjacent to Gila River)	Alternative 5
Johnson Utilities – Anthem at Merrill Ranch	7,028	Groundwater (wells 1–2 miles from Gila River)	Alternative 5
Gila River Indian Community – Casa Blanca/Bapchule	2,603	Groundwater (well locations unknown)	Alternative 5
Gila River Indian Community – Sacaton	5,307	Groundwater (well locations unknown)	Alternative 5
Winkelman (Arizona Water Company)	468	Groundwater (wells within 1,000 feet of Gila River)	Alternative 6
ASARCO Hayden Operations	779	Groundwater (wells directly adjacent to Gila River)	Alternative 6
Town of Hayden	870	Groundwater purchased from ASARCO	Alternative 6
Town of Kearny	2,070	Groundwater (wells directly adjacent to Gila River)	Alternative 6
Major Irrigation Districts			
New Magma Irrigation and Drainage District	~27,000 acres	Groundwater; CAP	Alternatives 2 and 3
Queen Creek Irrigation District	~16,000 acres	Groundwater; CAP	Alternatives 2 and 3
San Tan Irrigation District	~3,000 acres	Groundwater; CAP	Alternatives 2 and 3
San Carlos Irrigation and Drainage District	~50,000 acres	Surface water (Gila River); CAP; Groundwater	Alternatives 5 and 6

including cottonwood and willow. This area is important to birding and outdoor recreation. Endangered southwestern willow flycatchers have been documented in this habitat in ongoing surveys conducted by Resolution Copper; endangered western yellow-billed cuckoo have not been detected during surveys, but the habitat is appropriate for the species.

- Gila River between Dripping Spring Wash and Ashurst-Hayden Dam (downstream of Alternatives 5 and 6). This reach of the Gila River is generally perennial, though flow is regulated by releases from the San Carlos Reservoir upstream. A riparian gallery exists along substantial portions of this reach, dominated by saltcedar, with some mesquite, cottonwood, willow, and wet shrublands (Stromberg et al. 2005). This reach of the Gila River includes critical habitat for the endangered southwestern willow flycatcher and proposed critical habitat for the threatened western yellow-billed cuckoo and northern Mexican gartersnake, and is habitat for a number of native species (desert sucker, Gila longfin dace, Sonoran sucker, roundtail chub), amphibians (lowland leopard frog), reptiles (desert tortoise, box turtle), and bats (pallid bat, pale Townsend's big-eared bat, and California leaf-nosed bat). Recreational activities along this stretch of the Gila River include hiking, birding, and camping, particularly along the Arizona Trail, which crosses the Gila River downstream of Kearny. Additionally, the abandoned town of Cochran, Arizona and the associated coke ovens are accessible from this stretch of the Gila River.
- Approximately 7.5 miles of the Gila River from Dripping Spring Wash to the town of Winkelman was studied by the BLM, according to the Wild and Scenic Rivers Act, and was determined to be suitable for addition to the National Rivers System in 1997, with a "recreational" classification. The outstandingly remarkable values identified in the area are scenic, fish, and wildlife habitat. This river segment includes two developed recreation sites, providing access to the river for wildlife, viewing, fishing, hunting, camping, and picnicking (Bureau of Land Management 1994a).
- A number of wetland[65] areas are associated with the Gila River (downstream of Alternative 5). A large wetland complex has developed along the Gila River Indian Community's MAR-5 managed aquifer recharge project, located near Sacaton, Arizona. The community is planning to enhance this area with the development of the Gila River Interpretive Trail and Education Center.

Riparian Areas Crossed or Paralleled by Tailings and Concentrate Pipelines

Copper Concentrate Pipeline and Tailings Pipelines for Alternatives 2, 3, and 4

The copper concentrate pipeline route from the West Plant Site to the filter plant and loadout facility crosses a number of ephemeral washes that are tributary to Queen Creek: Silver King Wash, Rice Water Wash, Potts Canyon, Benson Spring Canyon, and Gonzales Pass Canyon. All contain some amount of xeroriparian habitat in linear strands along the drainage, typically mesquite, palo verde, ironwood, and desert shrubs in concentrations greater than found in the uplands. The width of xeroriparian habitat crossed by the pipeline varies, from roughly 50 feet to 500 feet wide. The copper concentrate pipeline route also parallels an ephemeral portion of Queen Creek upstream of Whitlow Ranch Dam, which has a well-developed xeroriparian community.

The tailings pipeline route to Alternatives 2 and 3 also crosses Silver King Wash, Rice Water Wash, and Potts Canyon, and the tailings pipeline route to Alternative 4 crosses Silver King Wash. Similar xeroriparian habitat exists at these crossings.

65. In this section, a number of references are made to wetland or riparian areas. The intent is to identify physical features on the landscape with high value for habitat, recreation, aesthetics, and other uses. These references to wetlands should not be construed to mean that these are jurisdictional waters of the U.S., as regulated under Section 404 of the Clean Water Act. That designation would be made by the USACE when appropriate.

Alternative 5 Tailings Pipeline – West Option

The west option for the tailings pipeline route for Alternative 5 crosses a number of ephemeral washes with similar xeroriparian habitat as that described earlier. These include Silver King Wash (tributary to Queen Creek), Cottonwood Canyon (tributary to Queen Creek), and Donnelly Wash (tributary to Gila River). Silver King Wash and Cottonwood Canyon vary in width from 100 to 500 feet; Donnelly Wash is a wider, braided wash with a width of roughly 1,000 feet.

The pipeline route also parallels Reymert Wash (tributary to Queen Creek) for roughly 2 miles; the xeroriparian corridor along this reach of the wash is generally 50 to 100 feet wide.

Where the pipeline route crosses Queen Creek it would be underground, installed using either trenching techniques or horizontal directional drilling. At this location, the stream is ephemeral, approximately 1,000 feet wide, with braided strands of xeroriparian vegetation.

Where the pipeline route crosses the Gila River it would be underground, installed using trenching techniques or horizontal directional drilling. At this location, the river is perennial, approximately 1,300 feet wide, and supports both aquatic habitat and hydroriparian vegetation as described previously.

Alternative 5 Tailings Pipeline – East Option

The eastern option for the tailings pipeline route for Alternative 5 crosses several ephemeral washes, including Zellweger Wash and Walnut Canyon, both tributaries to the Gila River, with similar xeroriparian habitat as that described earlier. Walnut Canyon has a riparian reach designated as part of the White Canyon ACEC. Important resources values in this area are outstanding scenic, wildlife, and cultural values.

Where the pipeline route crosses Queen Creek it would be underground, installed using either trenching techniques or horizontal directional drilling. At this location, the stream is ephemeral and approximately 400 feet wide; however, nearby the pipeline route also crosses an unnamed tributary that receives effluent from the Superior Wastewater Treatment Plant. Thick hydroriparian vegetation is supported along this wash, and the streamflow feeds a perennial reach of Queen Creek located a few hundred feet downstream.

The pipeline route also parallels a portion of upper Arnett Creek for about 2 miles, near SR 177. Arnett Creek in this area is largely ephemeral with xeroriparian habitat, but portions of Arnett Creek downstream of this location have perennial flow.

Where the pipeline route crosses the Gila River it would be underground, installed using trenching techniques or horizontal directional drilling. At this location, the river is perennial, approximately 1,000 feet wide, and supports both aquatic habitat and hydroriparian vegetation.

Alternative 6 Tailings Pipeline – North Option

The north option for the tailings pipeline route for Alternative 6 crosses several ephemeral washes tributary to Queen Creek, including Conley Springs Wash and Yellowjack Wash. Some xeroriparian vegetation is associated with these washes, but sparse due to the steep and rocky terrain. Queen Creek lies about 2 miles downstream of the pipeline crossings, and is generally intermittent in this area, but with some hydroriparian vegetation adjacent to the channel (cottonwood, sycamore, ash, walnut). The pipeline route also crosses Queen Creek itself in this same area.

The pipeline route crosses Devil’s Canyon (underground) upstream of where perennial flow first occurs. Within a few miles downstream Devil’s Canyon is characterized by perennial flow, flowing springs, deep pools, and a closed-canopy hydroriparian corridor (ash, sycamore, alder), with associated aquatic habitat. Near here the pipeline route crosses Rawhide Canyon, an ephemeral wash tributary to Devil’s Canyon, with relatively sparse xeroriparian habitat.

The pipeline route crosses both Lyons Fork, a tributary to Mineral Creek, and then parallels Mineral Creek for over 3 miles. Mineral Creek has perennial flow in this area, relatively dense hydroriparian vegetation (cottonwood, willow, sycamore, ash), and aquatic habitat.

Alternative 6 Tailings Pipeline – South Option

The south option for the tailings pipeline route for Alternative 6 is identical to the north route once the route crosses Devil's Canyon. The south option crossing at Devil's Canyon (currently planned as a pipe bridge, but potentially underground) is farther downstream than the north route, in an area with perennial flow and associated riparian and aquatic habitat. Before reaching Devil's Canyon, the pipeline route crosses several ephemeral washes on Oak Flat, including Oak Creek and Hackberry Canyon, both tributary to Devil's Canyon.

Near Superior, the south pipeline route follows the same route as the Alternative 5 east pipeline route, crossing Queen Creek, the unnamed wash with perennial flow from the wastewater treatment plant, and then paralleling Arnett Creek for several miles.

INFRASTRUCTURE

In addition to population centers, water supplies, and high-value riparian areas, a number of important transportation or water supply structures are downstream of the tailings facilities. These include the following:

- Whitlow Ranch Dam. Whitlow Ranch Dam is a flood control structure located on Queen Creek, immediately downstream of Alternatives 2 and 3. The dam was built in 1960 to reduce the risk of flood damage to farmland and developed areas including the communities of Chandler, Gilbert, Queen Creek, and Florence Junction, as well as the former Williams Air Force Base (now Phoenix-Mesa Gateway Airport). The USACE evaluated the structure in 2009 and rated it as inadequate (due to foundation seepage and piping), but with a low probability of failure (U.S. Army Corps of Engineers 2012b). The capacity of Whitlow Ranch is approximately 86 million cubic meters (Maricopa County Flood Control District 2018); the ability of the dam to retain or detain a tailings release from Alternatives 2 or 3 would depend on the specific size of a failure.
- East Salt River valley canals and flood control. Three major distribution canals are downstream of the flowpath of a hypothetical tailings release from Alternatives 2 or 3. The Eastern and Consolidated Canals pass through the communities of Chandler and Gilbert and are part of the SRP distribution system. The Roosevelt Canal is part of the Roosevelt Conservation District and parallels a major flood control structure, the East Maricopa Floodway. This floodway is essentially an urbanized extension of Queen Creek; the ability of the floodway to retain or detain a tailings release would depend on the specific size of a failure.
- Central Arizona Project aqueduct. The CAP aqueduct transports water from the Colorado River, through Lake Pleasant north of Phoenix, and then transits the East Salt River valley. The aqueduct crosses Queen Creek near the communities of Queen Creek and San Tan Valley; flows from Queen Creek bypass the canal using a syphon system. The canal is raised and tends to block overland flow along much of its length; the ability of the canal levee to retain or detail a tailings release would depend on the specific size of a failure. The CAP canal also crosses the Gila River near Florence, but unlike the Queen Creek crossing, the flows from the canal are routed below the Gila River. The aqueduct continues through Pinal County and provides water as far south as Tucson and Green Valley.
- Arizona Water Company infrastructure. The potable water pipeline serving the town of Superior is located within the MARRCO corridor and would be downstream of a potential tailings release from Alternatives 2 or 3. This system serves approximately 4,000 people.
- Ashurst-Hayden Dam, Northside Canal, Florence Casa Grande Canal. These water diversion structures are located east of Florence and form the headworks to divert water from the Gila River for irrigation, including to the San Carlos Irrigation and Drainage District.
- U.S. Route 60. U.S. 60 crosses Queen Creek near Florence Junction. This highway forms one of only a few regional connection between the Phoenix metropolitan area and the

communities of the central Arizona highlands (Globe–Miami) and the White Mountains of eastern Arizona (Show Low, Pinetop-Lakeside, Springerville).

- U.S. Route 77. U.S. 77 crosses the Gila River near Winkelman and Dripping Spring Wash near its confluence with the Gila River. This highway forms the main regional connector for the areas between Tucson and Globe, connecting to the Upper Gila valley at Safford and the White Mountains northeast of Globe.
- U.S. Route 79. U.S. 79 crosses the Gila River near Florence. This highway forms the main regional connector for the agricultural areas between Tucson and the East Salt River valley.
- Christmas, Shores, and Winkelman Campgrounds. These are improved recreational facilities located adjacent to the Gila River and important for water-based recreation activities.

3.10.1.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Alternative 1 – No Action

Under the no action alternative, the tailings facility would not be constructed, pipelines would not be built, and there would be no risk to public health and safety associated with potential failure of a tailings embankment or pipelines.

Impacts Common to All Action Alternatives

EFFECTS OF THE LAND EXCHANGE

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources. However, nothing related to the tailings storage facilities is associated with the Oak Flat Federal Parcel, and the land exchange would not have an effect on public health and safety in this regard.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. Section 3003 of the National Defense Authorization Act specifies that any land acquired by the United States is withdrawn from all forms of entry, appropriation, or disposal under the public land laws, location, entry, and patent under the mining laws, and disposition under the mineral leasing, mineral materials, and geothermal leasing laws.

Specific management of mineral resources on the offered lands would be determined by the agencies, but in general when the offered lands enter Federal jurisdiction, mineral exploration and development would not be allowed. Given these restrictions, no or little tailings-related activity would be expected to occur on the offered lands.

FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mining plan of operations (Shin 2019). No standards and guidelines were identified applicable to management of tailings from a safety perspective. See process memorandum (Shin 2019) for additional details.

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to enhance tailings safety. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures for tailings and pipeline safety include those outlined in the tailings design documents (Golder Associates Inc. 2018a; Klohn Crippen Berger Ltd. 2018a, 2018b, 2018c, 2018d, 2019d), the Tailings Corridor Pipeline Management Plan (AMEC Foster Wheeler Americas Limited 2019), the Concentrate Pipeline Corridor Management Plan (M3 Engineering and Technology Corporation 2019b), and the GPO (Resolution Copper 2016d).

Tailings Storage Facility Design and Operational Measures

The following measures that enhance the safety of the tailings storage facility have been incorporated into the tailings design:

- use modified centerline (Alternatives 2 and 3) or centerline embankment (Alternatives 5 and 6) for NPAG;
- use full downstream embankment for PAG tailings (Alternatives 5 and 6);
- perform thickening of both PAG, NPAG, and NPAG overflow tailings (Alternatives 2, 3, 5, and 6), and additional ultrathickening of NPAG tailings (Alternative 3);
- segregate PAG tailings into smaller separate cells (Alternatives 5 and 6); and
- use filtered tailings (Alternative 4).

A failure modes analysis has already been completed to identify all potential failure modes and to align them with design measures appropriate to address those modes (Klohn Crippen Berger Ltd. 2019a; Pilz 2019). The design measures are aligned with international best practice and Federal and State regulations. Resolution Copper has identified both preventative measures to minimize the potential for failure, and reactive measures if problems are seen to develop. These are considered applicant-committed environmental protection measures and are summarized in table 3.10.1-5.

Pipeline Design and Operational Measures

A failure modes analysis was also completed for both the concentrate and tailings pipelines. The analysis informed the following design measures for both the tailings and concentrate pipelines that enhance the safety of the pipelines:

- Install pipe bridges for concentrate pipeline over Queen Creek outside the ordinary high-water mark of that drainage.
- For tailings pipelines that cross Devil’s Canyon and Mineral Creek, pipeline corridors would pass beneath and outside the ordinary high-water mark.
- Fabricate and test all pipelines in corridors for concentrate, tailings, and water in accordance with the requirements of American Society of Mechanical Engineers (ASME) standards or equivalent for quality assurance and quality control purposes.
- Locate pressure indicators on non-buried pipelines intermittently along water, tailings, and concentrate pipelines. Flow indicators would be placed near the tailings pumps and at the end of the line. A leak detection system would connect via fiber-optic cable to the control room at the West Plant Site and the control room at the tailings facility if a separate facility exists.
- Pipelines would be buried where feasible, given the geological setting, and where buried they would be appropriately wrapped.

Table 3.10.1-5. Applicant-committed environmental protection measures addressing key failure modes, during both design and operations

Failure Mode	Preventative Controls	Responsive Actions (if problems develop)
Failure through foundation. Certain types of geological materials can exhibit problematic behavior due to the stress of supporting millions of tons of material, including consolidation, liquefaction, or bedding plane weaknesses.	Removal of materials (design); use of shear keys (design); thorough site investigation (design); slope flattening (design); monitoring of pore pressure and deformations (operations).	Construct berms (operations); move water pond farther from embankment (operations).
Slope failure through tailings. These failures occur when the tailings or tailings embankment loses strength, caused by increased pore pressures that reduce strength and lead to liquefaction. Failure can be triggered by either static (i.e., a gradual increase of stress as the facility grows) or seismic means.	Use of modified-centerline or centerline embankments (design); quality assurance/ control during construction to confirm density requirements (operations); monitoring of pore pressure and deformations (operations); minimize perforations (pipes) through embankments (operations).	Flatten embankment slopes (operations); maintain water pond farther from embankment (operations).
Failure through internal erosion or piping. Flow developing within the embankment or foundation can wash out fine particles, gradually leading to voids and a vicious cycle of greater flow and greater washout. Controlling movement and loss of fine particles using filter materials is a key design element.	Facility beach length and structure (design); inclusion of filter materials (design); quality assurance/control during construction to confirm proper placement of materials (operations).	Placement of filters on downstream slope (operations); movement of pond away from embankment (operations); modify spigotting or tailings deposition to reduce hydraulic gradients (operations).
Failure by overtopping. When water accumulates in the pond behind the embankment and exceeds the crest height, water flowing over the top can erode the downstream face of the embankment.	Design for adequate freeboard (Probable Maximum Flood); pond storage and management requirements (design); armoring of downstream slope (design); monitoring of water levels and maintain sufficient beach width (operations).	Maintain adequate embankment freeboard (operations); construction of emergency spillways (operations); pumping (operations); emergency embankment raising (operations).
Failure through surface erosion. Erosion of material from the downstream embankment, not only by directly causing a breach, but also by causing the downstream slope to become steeper than designed.	Repair of erosion channels (operations); stormwater control (design); armoring or use of riprap (design); regular maintenance of erosion controls (operations).	Emergency repairs of eroded material (operations).

- Sacrificial anodes would be installed at determined intervals on the buried concentrate pipelines and select sections of tailings pipelines.
- Shut-off valves would be located at booster pump stations.
- Double containment would be used on the concentrate pipeline at major stream crossings and it would be routed through sleeves underneath major crossings. Tailings pipelines would be sleeved under major crossings. Expansion loops would be incorporated along the pipeline corridor.
- A minimum of 3.3 feet of horizontal and vertical separation would be used between pipelines and existing utilities or infrastructure.
- The tailings pipeline would be concrete and high-density polyethylene (HDPE) and non-pressurized for Alternatives 2 and 3, designed to flow approximately 50 percent full. The tailings pipelines to Alternatives 5 and 6 would likely be carbon steel and pressurized.
- The concentrate pipeline would be schedule 40 steel with an HDPE protective lining.
- Aboveground concentrate and tailings pipelines would be contained in a secondary containment ditch where possible and painted with an epoxy coating to prevent degradation.

In addition, a number of operational pipeline measures have been identified:

- Development of a tailings pipeline operations manual to summarize inspections and maintenance protocols (Operations, Maintenance, and Surveillance).
- Resolution Copper would have equipment available and/or contractors readily available on-site for pipeline repair. The pipeline access road would provide access to the full length of the line.
- There would be daily patrols along the pipelines to look for leaks; containment spills, sediment build-up, and breaches; drainage sediment build-up, blockages, and wash-outs; access road erosion and damage; pipe bridges and over/underpass damage; landslides; third-party interference; and other potential hazards.
- The Operations, Maintenance, and Surveillance manual would be followed for immediately investigating, reporting, and implementing a response plan for suspected leaks from the tailings pipeline. Aberrations in flow rate, pump operation, and pressures would trigger investigations and emergency response if needed.
- A tailings pipeline spill prevention and response plan (pipeline management plan) would be prepared.
- The operating concentrate pipeline would contain pressure dissipation stations consisting of control valves, block valves, and ceramic orifice plate chokes. This control system would keep the normal pipeline operating pressure below 500 psig (pounds per square inch gauge) and would lower the pressure to an acceptable level at the filter plant and loadout facility.

DESCRIPTION OF HYPOTHETICAL TAILINGS BREACH

The Forest Service requires that the tailings storage facility design, construction, and operations adhere to National Dam Safety Program standards, as well as the APP program BADCT standards. This minimizes the risk for a catastrophic failure of the tailings storage facility. Adherence by Resolution Copper to the applicant-committed environmental protection measures, including industry best practices, further reduces the risk both by proactively providing robust design and containment measures, and by identifying operational steps that can be taken in reaction to a developing problem.

However, overall risk is the combination of both the probability of a failure and the consequences of that failure. While a tailings storage facility or pipeline failure is not reasonably foreseeable, the following

Table 3.10.1-6. Empirical estimates of a hypothetical failure

Distance to:	Alternatives 2 and 3 – Near West Location*	Alternative 4 – Silver King Location (filtered)†	Alternative 5 – Peg Leg Location	Alternative 6 – Skunk Camp Location	For Comparison: Actual Mount Polley Failure‡	For Comparison: Actual Fundão Failure‡
Calculated release volume (million cubic meters)	243 (136–436)	220	243 (136–436)	243 (136–436)	23.6	45
Calculated downstream distance traveled (miles)	277 (85–901)	~1–2.5	209 (65–669)	268 (83–868)	4.4	398

Source: Larrauri and Lall (2018). Calculations can also be run at https://columbiawater.shinyapps.io/ShinyappRicoRedo/.
Note: Values shown reflect the median predicted result; values in parentheses indicate the range defined by the twenty-fifth and seventh-fifth percentiles.
Key parameters: Total facility volume at buildout = 1 billion cubic meters; Embankment height: Alt 2 (520 feet/158 m); Alt 3 (510 feet/155 m); Alt 5 (310 feet/94 m); Alt 6 (490 feet/148 m).
Mount Polley and Fundão comparisons taken from Bowker (2019).
* Alternative 3 modeled as Alternative 2
† Alternative 4 uses filtered tailings and the empirical method is not applicable. A 220 million cubic meter release was modeled using the USGS LaharZ model instead.
‡ The Mount Polley release represented 32 percent of the total facility volume; the Fundão release represented 82 percent of the total facility volume.

discussion of a hypothetical tailings storage facility or pipeline failure provides a basis to compare the inherent risk in the tailings alternative locations and designs.

Estimated Magnitude and Downstream Effect

Table 3.10.1-6 summarizes the predicted volume released in a hypothetical tailings failure, and the downstream distance traveled, based on the empirical method (Larrauri and Lall 2018; Rico et al. 2007). The downstream distance traveled would roughly represent the downstream distance to the Colorado River, near Yuma, Arizona.

The filtered tailings (Alternative 4) would likely fail in a different manner than the slurry tailings alternatives (Alternatives 2, 3, 5, and 6). As described in table 3.10.1-6, rather than running out as a liquid, the tailings would slump in a relatively localized area.

There are a number of possible failure modes for filtered tailings. Identifying the most likely failure mode relies on whether the tailings are likely to experience liquefaction. The primary factors that would trigger liquefaction of tailings are material porosity and density, moisture content, fines content, static loading (the weight of the tailings themselves), and seismic loading (earthquakes). Generally, the dewatering requirements for practical filtered operations dictate fairly low moisture content; this is necessary for handling, transporting, and placing the tailings in the storage facility. The low moisture content necessary to handle tailings physically like this (estimated for Alternative 4 as 11 to 14 percent), represents a low potential for liquefaction. A filtered tailings facility that maintains drained conditions is expected to fail as a slump or landslide (rotational or wedge shape) with no flow of tailings downstream, regardless of whether the failure is triggered by static or seismic loading. Tailings release from a filtered tailings facility would be localized instead of flowing long distances (Witt et al. 2004).[66]

Similar to assessing the failure modes for tailings embankments for slurry tailings facilities, an FMEA could be conducted on a filtered tailings facility to assess whether undrained failure modes could occur. An undrained condition would require that a phreatic surface (i.e., water table) develop within the tailings mass itself. Under these conditions, the part of the tailings below the water table could experience liquefaction, while the part of the tailings above the water table would fail in a slump or landslide. Unlike the slurry tailings alternatives, as designed Alternative 4 would not have substantial amounts of water present and how an undrained scenario could develop is not clear. Defining a scenario under which the drainage would not occur and create a water table condition would likely require a combination of multiple factors, which could be identified during an FMEA-type of analysis.

Estimated Chemistry of Released Liquid

In the event of a failure, the materials potentially released downstream would include NPAG tailings (and associated water in the pore space), PAG tailings (and associated water in the pore space), and any standing water in the recycled water pond.

The potential effects of tailings on water quality are described in section 3.7.2 for stormwater and seepage. Water released during a potential failure would have similar characteristics, as shown in table 3.10.1-7. In the event of a release, concentrations above surface water quality standards would be anticipated for a number of metals, including cadmium, copper, nickel, selenium, silver, and zinc. Alternative 5 has the highest concentrations of cadmium, nickel, and notably copper.

Estimated Chemistry of Released Solids

The solid tailings material deposited downstream once water drains away would also pose a contamination concern. As shown in table 3.10.1-8, concentrations of metals in remnant tailings materials would be above Arizona soil remediation levels for several constituents, including arsenic and copper, and require active cleanup to prevent further degradation of groundwater or surface water.

An accidental release because of a pipeline rupture would also pose similar concerns, whether a tailings pipeline or concentrate pipeline, as shown in table 3.10.1-8.

Alternative 2 – Near West Proposed Action

TAILINGS STORAGE FACILITY DESIGN

Tailings Embankment and Facility Design

The same design and safety standards apply to any tailings embankment (see table 3.10.1-2), regardless of whether the embankment has an upstream, modified-centerline, centerline, or downstream construction. However, even though the design standards are the same, there are still inherent differences between embankment types that can factor into the long-term probability of failure.

The majority of historic events that inform our understanding of when and how tailings facilities fail were constructed using the upstream method, in which the tailings themselves form part of the structure of the embankment. When designed and operated properly, these tailings facilities can be as safe as embankments constructed using modified-centerline or centerline methods.

However, based on expert investigation of historic failures, usually a failure is the result of a chain of events that might include improper characterization of the foundation and understanding of how foundation

66. The USGS Lahar flow inundation zone simulation program (referred to as LaharZ) was used to estimate the runout zone from a potential failure of the filtered tailings (Schilling 2014). A failure angle of 10 degrees was assumed based on an estimate of the residual shear strength of the tailings in the event of saturation and/or lack of buttressing; this parameter changes with saturation levels and would change, depending on the failure modes defined in a refined FMEA.

Table 3.10.1-7. Potential for water contamination in the event of a tailings facility or pipeline failure

	Alternative 2 Released Water (mg/L)*	Alternative 3 Released Water (mg/L)*	Alternative 5 Released Water (mg/L)*	Alternative 6 Released Water (mg/L)*	Surface Water Standard for Most Restrictive Use (Gila River or Queen Creek)†	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)†
Antimony	0.0114	0.0118	0.0056	0.0036	0.030	0.747
Arsenic	0.00092	0.00141	0.001853	0.00003	0.030	0.280
Barium	0.015	0.015	0.018	0.019	98	98
Beryllium	0.00124	0.00179	0.004552	0.00003	0.0053	1.867
Boron	0.85	0.44	0.331	0.27	1	186.667
Cadmium	0.016	0.015	0.0082	0.005	0.0043	0.2175
Chromium, Total	0.092	0.078	0.0364	0.030	1	–
Copper	0.199	0.199	4.604	0.194	0.0191	0.0669
Fluoride	2.4	2.4	3.3	2.9	140	140
Iron	0.001734	0.001727	0.008108	0.001717	1	–
Lead	0.0028	0.0021	0.00174	0.0009	0.0065	0.015
Manganese	2.23	2.23	2.182	0.63	10	130.667
Mercury	–	–	–	–	0.00001	0.005
Nickel	0.255	0.272	0.312	0.066	0.1098	10.7379
Nitrate	8.4	8.1	3.8	2.6	3,733.333	3,733.333
Nitrite	–	–	–	–	233.333	233.333
Selenium	0.346	0.349	0.149	0.113	0.002	0.033
Silver	0.079	0.073	0.030	0.026	0.0147	0.0221
Thallium	0.0058	0.0065	0.0022	0.0018	0.0072	0.075
Uranium	–	–	–	–	2.8	2.8
Zinc	3.56	3.03	1.69	1.17	0.2477	2.8758

* Results shown for all alternatives are based on predicted chemistry of “lost seepage,” for year 41 representing full buildout of the facility (Eary 2018a, 2018b, 2018c, 2018d, 2018e).

Notes: Dash indicates no results available for this constituent, or no standard applies to this constituent.

Shaded cells indicate the potential for concentrations to be above water standards.

† See appendix N, table N-5, for more detail of applicable standards.

Table 3.10.1-8. Potential for contaminated material to be left in the event of a tailings facility or pipeline failure

	Copper Concentrate Material (mg/kg)*	Tailings Material (mg/kg)*	Arizona Soil Remediation Levels†
Antimony	2.2–13.3	0.18–0.71	31
Arsenic	**11.4–1,180**	**2.0–20.9**	10
Barium	20–70	120–360	15,000
Beryllium	0.05	1.62–3.53	150
Boron	–	–	16,000
Cadmium	6.56–28.1	0.09–0.24	39
Chromium, Total	28–77	36–68	120,000
Copper	**>10,000**	**781–3,288**	3,100
Fluoride	–	–	3,700
Iron	–	–	–
Lead	39.1–161.5	22–258	400
Manganese	5 - 35	20–902	3,300
Mercury	–	–	23
Nickel	32.1–71.2	17.4–45.5	1,600
Nitrate	–	–	–
Nitrite	–	–	–
Selenium	154–205	6–22	390
Silver	29–100	0.41–3.12	390
Thallium	0.17–4.57	0.29–0.82	5.2
Uranium	1–3.7	1.7–3.5	16
Zinc	1,620–5,460	17–181	23,000

Notes: Dash indicates no results available for this constituent, or no standard applies to this constituent.

Shaded cells indicate the potential for concentrations to be above soil standards.

* Tailings and concentrate material values are based on whole rock analysis performed on simulated whole tailings and concentrate for four master composites (MC-1, MC-2, MC-3, MC-4) (MWH Americas Inc. 2014).

† Arizona Administrative Code R18-7-205. Values shown represent the most stringent soil standard for both residential and non-residential property uses. Chromium standard shown is for chromium III.

conditions potentially change with tailings (as with Mount Polley), as well as operational mistakes in which the embankment construction does not adhere to the design or is managed or operated improperly (as with Fundão). The difference in embankment types is whether they are inherently resilient enough to withstand these series of unforeseen events or mistakes.

Even if embankments are designed to the same safety standards, an upstream embankment has less room for error when things do not go according to plan. A modified-centerline embankment is more resilient and has more ability to remain functional, despite any accumulated errors, and a centerline and downstream embankment have even higher resiliency.[67]

Alternative 2 would use a modified-centerline embankment, which is a design choice driven by the site geography, once the concept of an upstream embankment was abandoned (there is insufficient room at the Near West location for a full centerline embankment without expanding the footprint to another drainage). Modified-centerline embankments are inherently more resilient than upstream-type embankments, but less resilient to any accumulated missteps or unforeseen events than true centerline-type embankments.

The Alternative 2 main embankment is required to extend to three sides of the facility, is generally freestanding and not anchored to consolidated rock, and as such is the longest of the embankments proposed (10 miles). These design features are not inherently unsafe, but are potentially less resilient than a shorter, well-anchored embankment (such as Alternative 6).

Foundation Materials

The difference between foundation materials between alternatives is whether they are built primarily on consolidated rock or unconsolidated alluvium. Either type of foundation—rock or alluvium—can be appropriate for a tailings facility, provided there is adequate site characterization to identify all geological units present, understand their properties, and incorporate necessary treatment and preparation into the embankment design.

Alternative 2 is primarily built on consolidated rock, overlain by relatively thin surface soils and alluvial material along washes. Site preparation would likely involve removal of most loose material, including any weathered bedrock, and treating any problematic or weak spots in the exposed foundation. This allows better seepage control than an alluvial foundation. However, the proximity to Queen Creek downstream also limits the flexibility in adding seepage controls that can be employed in the event of unexpected seepage loss.

Storage of PAG Tailings

The method of storage of PAG tailings is another difference between alternatives that could affect outcomes associated with a failure of the facility. Alternative 2 employs a separate downstream-type starter embankment to initially contain the PAG tailings. Midway through the operational life, the PAG tailings are raised above the height of the starter embankment and therefore potentially would be released in the event of a facility failure.

A downstream embankment is one that is fully self-supporting and has no deposited tailings incorporated into the structure, though it could be composed of cyclone tailings. A downstream embankment is considered the most resilient embankment type and has more ability to remain functional, despite any accumulated errors.

67. A recent study indicates that roughly 70 percent of historic tailings failures involved upstream-type embankments, with the remainder roughly split between centerline and downstream-type embankments (Strachan and Van 2018). Note that there is inherent bias in these statistics, as the bulk of tailings structures have historically been upstream-type construction.

POTENTIAL RISK TO LIFE AND PROPERTY

The Near West location (Alternative 2) is upstream of substantial populations due to the proximity to the Phoenix metropolitan area. An estimated 600,000 people live in the communities downstream that would be affected by a hypothetical tailings storage facility failure. This location also would offer relatively little reaction time for evacuation in the event of a sudden failure, due to the close downstream presence of Queen Valley.

POTENTIAL EXPOSURE TO CONTAMINANTS

All materials released during a hypothetical tailings failure pose risk of contamination. The water present in the tailings storage facility contains concentrations of metals (cadmium, copper, nickel, selenium, silver, zinc) above Arizona surface water quality standards (see table 3.10.1-7). If released, this water would potentially impact beneficial uses of surface waters, including wildlife use, aquatic habitat, livestock use, agricultural use, and potable use. Given the highly permeable soils associated with alluvial washes like Queen Creek, released water would likely infiltrate and affect groundwater resources as well, impacting other water uses.

Similarly, the tailings material itself contains concentrations of metals (arsenic, copper) above Arizona soil remediation standards. This material would be deposited in large amounts along Queen Creek. Unless removed, the deposited tailings material would represent a long-term continuing source of contamination to groundwater and stormwater flows. The deposited tailings material could also represent a long-term hazard to public health if it became airborne during high-wind events. Wind direction is highly variable throughout the year and can include particularly intense wind events during the summer monsoon; the close proximity to the Phoenix metropolitan area would potentially expose a large population to airborne tailings.

The tailings samples have been analyzed for their long-term potential for oxidation of pyrite materials, the generation of acid, and the release of metals. While the bulk of the pyrite minerals has been segregated into the PAG tailings, both the NPAG and PAG tailings still show the potential for acid generation (see section 3.7.2). The continued oxidation of pyrite minerals in deposited tailings would represent a long-term source of impact on water quality, underlying and downstream soils, aquatic ecosystems, and the potential uses of downstream water and agricultural land.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

A hypothetical tailings failure for Alternative 2 represents a substantial risk to water supplies. Eight community water systems, serving a total population of almost 700,000, were identified in the downstream flowpath. Some of these water systems have robust water portfolios and draw on different water sources, including surface water that would be unimpacted by a tailings release. All of these systems, however, use groundwater in some capacity and have pumping wells located near the downstream flowpath. The primary risk to these water systems is the potential for groundwater resources to be contaminated, or loss of water-related infrastructure.

In addition, substantial agricultural water use occurs downstream, including almost 20,000 acres in the Queen Creek Irrigation District and San Tan Irrigation District. Water supplies to agricultural users could also be disrupted through loss of wells, delivery infrastructure, or groundwater contamination.

In addition to the disruption of community water systems and agricultural supplies, a hypothetical tailings release could also destroy key water supply infrastructure. Damage to the SRP system (Consolidated Canal, Eastern Canal) or to the CAP aqueduct could disrupt water supplies throughout central and southern Arizona, well beyond the immediate flowpath of a hypothetical tailings failure. For instance, in addition to agricultural users in Pinal County, more than a dozen CAP contract holders are located downstream, with systems serving over 850,000 people. As an example, the City of Tucson relies on CAP water (mixed with groundwater) as the primary supply for over 700,000 residents.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The deposition of large amounts of tailings in downstream waters would have widespread effects on the ecosystem, including riparian vegetation, wildlife habitat, and aquatic habitat. The immediate effect nearest the release would be direct physical removal or burying of vegetation from the debris. This effect would reduce with distance downstream. While woody riparian vegetation (mesquite, cottonwood, willow, saltcedar) could survive the immediate arrival of the tailings, most near-stream herbaceous and wetland vegetation would be destroyed even by a few inches of tailings.

Aquatic habitat would either physically disappear—filled with tailings—or would be rendered uninhabitable for some distance downstream by high levels of suspended sediment. After the initial impact, the geomorphology of the system would also be fundamentally altered by erosion of native material and deposition of tailings material. Expected concentrations of metals in the released water are above at least some acute wildlife standards (copper, zinc), so immediate effects on fish populations not directly lost to tailings would also be expected. Until cleanup, the tailings materials could also act as a continuing source of elevated metal concentrations.

The high-quality riparian habitat at Whitlow Ranch Dam would almost certainly be lost. Downstream of Whitlow Ranch Dam, primarily xeroriparian habitat would be lost along Queen Creek.

LARGE-SCALE SOCIETAL IMPACTS

A number of direct effects would result from a hypothetical tailings release: potential loss of life, disruptions from evacuation and relocation, destruction of property, loss of habitat, destruction or damage of infrastructure, loss or disruption of public and agricultural water supplies, disruption of regional transportation, and the long-term potential for soil, surface water, and groundwater contamination.

The large-scale societal impact of a hypothetical tailings failure is the combination of all these impacts and the fundamental disruption of a substantial portion of Arizona’s economy, the lives of a substantial portion of the population, and long-term changes to the environment.

The cost of remediation of such a release would be substantial. One research study developed a dataset of seven historical tailings failures between 1994 and 2008 for which estimates of natural resource losses could be quantified (albeit with difficulty) and found that the average natural resource loss per failure was over $500 million (in 2014 dollars) (Bowker and Chambers 2015). The size of the releases in the dataset ranged from 0.1 to 5.4 million cubic meters, much smaller than the release estimated using the empirical method.

Direct cleanup costs also can be substantial. As an example, the Mount Polley failure (23.6 million cubic meters) is estimated to have cleanup costs of roughly $67 million (Hoekstra 2014); it appears most of this cost is likely to be borne by Canadian taxpayers, not the mining company (Lavoie 2017). As another example, the mining companies involved in the Fundão failure agreed to pay over $5 billion in damages to the Brazilian government, which includes funds for remediation and restoration (Boadle and Eisenhammer 2016).

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

The presence of a tailings storage facility on the landscape has implications for long-term potential for downstream impacts as well, even if an embankment failure never occurs. Water entrained with the tailings gradually drains from the facility over many decades. This draining is beneficial for tailings safety as it enhances stability and would continue to reduce the risk of failure. However, this seepage also causes the long-term potential for water quality impacts downstream. The long-term ramifications of seepage from tailings storage facilities is addressed in detail in Section 3.7.2, Groundwater and Surface Water Quality.

There are additional long-term impacts associated with the landform itself, including the potential for air quality impacts or windborne dust, or erosion from the tailings and subsequent sedimentation of downstream waters. The potential for windblown dust from the tailings storage facilities is addressed in detail in Section 3.6, Air Quality, but the analysis is focused largely on operations. One assumption is that over the long term, the application and revegetation of a closure cover on the tailings facility would prevent large amounts of erosion by wind or water. The potential success of revegetation and long-term stability of the ecosystem is addressed in Section 3.3, Soils and Vegetation.

As noted, the risk of catastrophic failure decreases as water gradually drains from the facility. The duration of active seepage management after closure for Alternative 2 has been estimated as lasting up to 100 years after closure (Klohn Crippen Berger Ltd. 2018a). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. The risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

In the event of a potential rupture, spill, or failure of either the concentrate pipeline or the tailings pipeline, the effects would be similar to those of a tailings storage facility failure with respect to direct damage to vegetation and potential for contamination. However, because of the ability to monitor and shut down the pipeline immediately upon identifying a problem, the impact would be much more localized, involve much smaller volumes, and would be of a shorter duration.

All spills associated with the concentrate pipeline and the Alternative 2 tailings pipeline would occur in ephemeral drainages and would be unlikely to move far downstream if emergency cleanup were undertaken immediately. There would likely be localized impacts on xeroriparian vegetation. Potential for impact on groundwater quality would be relatively low, given limited release volumes and limited groundwater present in these ephemeral drainages.

The total length of pipeline corridors under Alternative 2 is about 27 miles (about 22 miles for the concentrate pipeline and about 5 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

Alternative 2 potentially involves long time periods of post-closure maintenance and monitoring related to ensuring the continued stability of the tailings storage facility. This raises the concern for the possibility of Resolution Copper going bankrupt or otherwise abandoning the property after operations have ceased. If this were to happen, the responsibility for these long-term activities would fall to the Forest Service. The Forest Service would need to have financial assurance in place to ensure adequate funds to undertake these activities for long periods of time—for decades or even longer.

The authority and mechanisms for ensuring long-term funding are discussed in section 1.5.5. The types of activities that would likely need to be funded could include the following:

- Monitoring of the embankment movement or stability
- Long-term control of water in the facility, such as control of stormwater entering the facility, long-term drawdown of the recycled water pond, or long-term operation of pumpback facilities
- Long-term maintenance of drains to ensure embankment stability
- Monitoring of the post-closure landform for excessive erosion or instability, and performance of any armoring
- Maintenance and monitoring of post-closure stormwater control features
- Continued implementation and periodic updating of emergency notification plans and response requirements

Additional financial assurance requirements for long-term maintenance and monitoring are part of the Arizona APP program and include the following:

> [T]he applicant or permittee shall demonstrate financial responsibility to cover the estimated costs to close the facility and, if necessary, to conduct postclosure monitoring and maintenance by providing to the director for approval a financial assurance mechanism or combination of mechanisms as prescribed in rules adopted by the director or in 40 Code of Federal Regulations section 264.143 (f)(1) and (10) as of January 1, 2014. (Arizona Revised Statutes 49-243; also see Arizona Administrative Code R18-9-A203 for specific regulations and methods allowed for financial assurance)

The Arizona State Mine Inspector also has authority to require a mine reclamation plan and financial assurance for mine closure (Arizona Administrative Code Title 11, Chapter 2). The regulations for these focus primarily on surface disturbance and revegetation.

Alternative 3 – Near West – Ultrathickened

TAILINGS STORAGE FACILITY DESIGN

While the modified-centerline embankment construction is similar between Alternatives 2 and 3, the use of ultrathickened deposition in Alternative 3 results in less water entrained in the tailings storage facility, making the facility inherently more resilient.

After the initial raises, Alternative 3 uses a splitter berm of cyclone sand to separate PAG from NPAG tailings. While this has benefits to water quality, the splitter berm would not prevent release of PAG tailings. There would be little difference in release of PAG tailings between Alternatives 2 and 3.

POTENTIAL RISK TO LIFE AND PROPERTY

The potential risks are identical to those from Alternative 2.

POTENTIAL EXPOSURE TO CONTAMINANTS

The potential risks are identical to those from Alternative 2.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

The potential risks are identical to those from Alternative 2.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential risks are identical to those from Alternative 2.

LARGE-SCALE SOCIETAL IMPACTS

The potential risks are identical to those from Alternative 2.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

The risk of catastrophic failure decreases as water gradually drains from the facility. Because of the use of ultrathickened tailings, the duration of active seepage management after closure for Alternative 3 has been estimated as about 9 years after closure, compared with 100 years for Alternative 2 (Klohn Crippen Berger Ltd. 2018b). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

The potential risks are identical to those from Alternative 2.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The financial assurances are identical to those from Alternative 2.

Alternative 4 – Silver King

TAILINGS STORAGE FACILITY DESIGN

The use of filtered tailings at the Silver King location represents the least risk to public health and safety related to a catastrophic failure. Filtered tailings are fundamentally more stable than slurry facilities, and unlike the other alternatives, a failure of the filtered tailings would likely be more localized.

POTENTIAL RISK TO LIFE AND PROPERTY

The potential risk to life and property is less than the other alternatives, based on the smaller area impacted. No communities are immediately downstream of Alternative 4, within the area in which a slump or landslide failure would occur.

POTENTIAL EXPOSURE TO CONTAMINANTS

No water would be potentially released during a catastrophic failure of Alternative 4, and exposure to contaminants would be primarily related to the long-term exposure of solid material in washes, including erosion and movement downstream, and leaching of contaminants. The filtered materials are estimated to have more potential for water quality impacts, due to the chemical weathering from the ingress of oxygen into the pore space. The PAG tailings, in particular, if deposited in washes, would represent a long-term risk to water quality if not removed.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

The potential disruption of water supplies and infrastructure is less than the other alternatives, based on the smaller area impacted.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential destruction of habitat and vegetation is less than the other alternatives, based on the smaller area impacted. In addition, primarily xeroriparian habitat along ephemeral washes would be impacted, rather than perennial waters and hydroriparian and aquatic habitat.

LARGE-SCALE SOCIETAL IMPACTS

The large-scale societal impact of a failure at Alternative 4 is less than the other alternatives, based on the smaller area impacted.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

The risk of catastrophic failure decreases as water gradually drains from the facility. As there is relatively little seepage associated with Alternative 4, the amount of time for active seepage management after closure is only 5 years, compared with 100 years for Alternative 2 (Klohn Crippen Berger Ltd. 2018c). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

Alternative 4 still requires concentrate and tailings pipelines; however, the overall distance is substantially less, and would represent less risk overall. The total length of pipeline corridors under Alternative 4 is less than 2 miles (there is no concentrate pipeline, and about 1.5 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The regulatory framework to require financial assurance to ensure closure and post-closure activities are conducted is the same as for Alternative 2.

Alternative 5 – Peg Leg

TAILINGS STORAGE FACILITY DESIGN

Tailings Embankment and Facility Design

Alternative 5 uses a centerline-type NPAG embankment, representing a more resilient design than Alternatives 2 and 3. Like Alternatives 2 and 3, the main embankment is a side hill embankment that extends on three sides of the facility and is generally freestanding and founded on alluvium versus bedrock, which is inherently less resilient than Alternative 6. The length of the embankment (7 miles) is slightly shorter than Alternatives 2 and 3. The PAG embankments use downstream construction to maintain a water cover over the PAG tailings. The PAG embankments are divided into cells to minimize seepage, reduce evaporation, and allow concurrent reclamation during operations.

Foundation Materials

The main NPAG embankment for Alternative 5 would be primarily underlain by thick unconsolidated alluvium, with some bedrock occurring below the PAG cells. Detailed site characterization through drilling and excavation would be used to understand the specific properties of the alluvial material beneath the main embankment and develop a design to address any stability concerns. Seepage may be more difficult to control with Alternative 5, as losses to an alluvial foundation are substantial and the downstream alluvial aquifer is relatively wide.

Storage of PAG Tailings

Unlike Alternatives 2 and 3, Alternative 5 uses an entirely separate PAG tailings facility with a downstream embankment to contain the PAG tailings throughout the life of the facility. In addition, the PAG tailings facility is divided into cells to reduce evaporation and seepage and allow concurrent reclamation. In the event of a failure of the NPAG main embankment, the double embankment of Alternative 5 means that PAG tailings would not be released unless both the NPAG and PAG embankments failed simultaneously. Alternatively, if one of the PAG cells failed, the runout could be contained within the NPAG facility.

POTENTIAL RISK TO LIFE AND PROPERTY

The Peg Leg location is upstream of populations in Pinal County and the Gila River Indian Community. An estimated 32,000 people live in the communities downstream that could be affected by a hypothetical tailings storage facility failure. This location would offer some improvement in reaction time over Alternatives 2 and 3 for evacuation in the event of a sudden failure, with no major population centers downstream for roughly 20 miles. The Peg Leg location offers the greatest risk to the town of Florence and the Gila River Indian Community.

POTENTIAL EXPOSURE TO CONTAMINANTS

As with Alternatives 2 and 3, all materials released during a hypothetical tailings failure pose risk of contamination, with metal concentrations in water and tailings material above Arizona standards. The risks to beneficial uses of surface waters, groundwater, and public health are similar, though receptors would differ.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

A hypothetical tailings failure for Alternative 5 represents a substantial risk to water supplies. Four community water systems, serving a total population of almost 30,000, were identified in the downstream flowpath. Unlike the community water systems downstream of Alternatives 2 and 3, which have robust water portfolios, most of these systems are highly reliant on groundwater and most have wells directly adjacent to the Gila River. The primary risk to these water systems is the potential for groundwater resources to be contaminated, or loss of water-related infrastructure. The town of Florence has one of the closest water systems, serving roughly 15,000 people and relying on groundwater wells immediately adjacent to the Gila River.

The disruption of agricultural water supplies would have a substantial effect on Pinal County and the Gila River Indian Community. The Pinal County economy relies heavily on agriculture and is one of the most important agricultural areas in the United States. Pinal County is in the top 2 percent of counties in the United States for total agricultural sales (Bickel et al. 2018) and has more than 230,000 acres under irrigation (National Agricultural Statistics Service 2014). The New Magma Irrigation and Drainage District and the San Carlos Irrigation and Drainage District both lie largely within Pinal County and account for about a third of agricultural acreage. A potential tailings release could affect water supplies for the roughly 77,000 acres within these districts, through destruction of infrastructure, contamination of surface supplies from the Gila River, or contamination of groundwater sources below the Gila River.

The total contribution of on-farm agriculture to Pinal County sales was an estimated $1.1 billion in 2016, supporting over 7,500 full- and part-time employees (Bickel et al. 2018). Bickel et al. (2018) also estimated the effect of a hypothetical loss of 300,000 acre-feet of irrigation water and found there would be an economic impact of up to $35 million, with up to 480 job losses. This hypothetical reduction represents about a one-third reduction in total water use of 800,000 acre-feet (Water Resources Research Center 2018).

The Gila River Indian Community is also reliant on agriculture, with about 27,000 acres irrigated (National Agricultural Statistics Service 2014), and a total market value of agricultural products sold of $38.4 million (Duval et al. 2018). Increased agriculture is the centerpiece of Gila River Indian Community economic growth, through the continued construction of the Pima-Maricopa Irrigation Project, which is meant to use water provided under the Arizona Water Settlements Act of 2004. The Community intends to increase agricultural production to over 140,000 acres of irrigable land. Water sources potentially disrupted by a hypothetical tailings release include supplies from the Gila River, groundwater, and water stored in underground recharge projects.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential destruction of habitat and vegetation for Alternative 5 is similar to Alternative 2, except the impacts would be borne by the Gila River, which has existing aquatic habitat as well as critical habitat and proposed critical habitat. The wetlands downstream on the Gila River Indian Community could also be impacted.

The modeled water quality results in table 3.10.1-7 suggest that Alternative 5 might have substantially higher dissolved metals, particularly copper, and would represent a greater risk of acute toxicity to aquatic wildlife in downstream waters not directly inundated by tailings.

LARGE-SCALE SOCIETAL IMPACTS

The societal impacts for Alternative 5 are similar to those discussed for Alternative 2. In addition, a hypothetical release from Alternative 5 could impact the town of Florence as well as the Gila River Indian Community. The Gila River Indian Community has a greater than 40 percent poverty rate, with a median household income about one-third of the national median (U.S. Census Bureau 2018). The population of the areas downstream of Alternative 5 (3,655) represent roughly 30 percent of the total Community population (U.S. Census Bureau 2018).

The impact of a hypothetical tailings release would be much more pronounced on the Gila River Indian Community, and the ability to recover would be much less than other communities.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

Alternative 5 has similar long-term implications for air quality, revegetation success, and groundwater quality, as those described for Alternative 2, with differences noted in the specific EIS sections referenced.

As noted, the risk of catastrophic failure decreases as water gradually drains from the facility. The duration of active seepage management after closure for Alternative 5 has been estimated to be up to 100 to 150 years after closure, similar to Alternative 2 (Golder Associates Inc. 2018b). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

For the ephemeral drainages crossed by either the west or east pipeline option for Alternative 5, the impacts from a pipeline failure would be identical to Alternative 2. However, both the west and east pipeline options also cross the Gila River, which represents a high-value riparian area that could be impacted in the event of a failure. In this case, the impacts would be similar to those described for a tailings storage facility runout reaching the Gila River, but more localized. The Alternative 5 east option also carries more risk for downstream habitat in Arnett Creek and Queen Creek by paralleling that water body for several miles and has a risk for destruction of downstream habitat associated with the Walnut Canyon ACEC.

The total length of pipeline corridors under Alternative 5 is about 47 miles (about 22 miles for the concentrate pipeline, and about 25 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, for the tailings facility, financial assurance requirements would be required by the BLM, not the Forest Service.

Like the Forest Service, the BLM also has regulatory authority to require financial assurance for closure activities, contained in their surface management regulations (43 CFR Subpart 3809). BLM considers that the financial assurance must cover the estimated cost as if BLM were hiring a third-party contractor to perform reclamation of an operation after the mine has been abandoned. The financial assurance must include construction and maintenance costs for any treatment facilities necessary to meet Federal and State environmental standards.

Alternative 6 – Skunk Camp

TAILINGS STORAGE FACILITY DESIGN

Tailings Embankment and Facility Design

Like Alternative 5, Alternative 6 uses a true centerline-type embankment, representing a more resilient design than Alternatives 2 and 3. The embankment design for Alternative 6 is substantially different from the other alternatives. This embankment uses a cross-valley construction, which would have a single face instead of three faces and would be tied into consolidated rock on either end. This construction results in a shorter face, only requiring 3 linear miles of embankment. As with the embankment type, all embankments would be designed to the same safety standards, but the simpler construction of the Alternative

6 embankment could be considered more resilient to any accumulated missteps or unforeseen events.

Foundation Materials

Alternative 6 is similar to Alternatives 2 and 3 and would be primarily underlain by unconsolidated alluvium within drainages and a thick sequence of Gila Conglomerate bedrock. Below the PAG facility, which is farthest away from the NPAG embankment, alluvium is less, and the primary subsurface material is Gila Conglomerate. Compared with Alternative 5, seepage is easier to control, with much of the facility underlain by bedrock rather than alluvium. In addition, the downstream alluvial aquifer is narrow and any downstream seepage controls would likely be more effective than at Alternative 5.

Storage of PAG Tailings

Like Alternative 5, Alternative 6 uses an entirely separate PAG tailings cell with a downstream-type embankment that would contain the PAG tailings throughout the life of the facility. In addition, the PAG tailings are divided and stored in entirely separate cells. Because of this double embankment within one impoundment, with Alternative 6, PAG tailings would be less likely to be released, and individual cells would limit the amount of PAG tailings released.

POTENTIAL RISK TO LIFE AND PROPERTY

Like Alternative 5, the Skunk Camp location is upstream of populations in Pinal County. Approximately 3,000 people live in the communities downstream that would be affected by a hypothetical tailings storage facility failure. This location also would offer some improvement in reaction time over Alternatives 2 and 3 for evacuation in the event of a sudden failure, with the major towns (Hayden, Kearny, Winkelman) located over 20 miles downstream, but the nearest population center (Dripping Springs) is still within 10 miles of the facility.

Alternative 6 offers less risk to the town of Florence and Gila River Indian Community than Alternative 5, as these communities are over 50 miles distant from the tailings location.

POTENTIAL EXPOSURE TO CONTAMINANTS

As with Alternatives 2, 3, 4, and 5, all materials released during a hypothetical tailings failure pose risk of contamination, with metal concentrations in water and tailings material above Arizona standards. The risks to beneficial uses of surface waters, groundwater, and public health are similar, though receptors would differ.

POTENTIAL DISRUPTION OF WATER SUPPLIES AND INFRASTRUCTURE

A hypothetical tailings failure for Alternative 6 represents a risk to water supplies. Four community water systems are located along the Gila River above Donnelly Wash, serving approximately 3,000 people. These systems are entirely reliant on groundwater and most have wells directly adjacent to the Gila River. The primary risk to these water systems is the potential for groundwater resources to be contaminated, or loss of infrastructure.

The potential disruption of agricultural water supplies would be less than those described for Alternative 5.

POTENTIAL DESTRUCTION OF HABITAT AND VEGETATION

The potential destruction of habitat and vegetation for Alternative 6 is similar to Alternative 5, but somewhat less due to the greater distance between Alternative 6 and the Gila River, compared with Alternative 5 and the Gila River. Alternative 6 carries a risk of potential destruction of habitat and vegetation associated with the area identified by BLM as suitable for the National Rivers System, between Dripping Springs and Winkelman, including the loss of recreation opportunities along this corridor.

LARGE-SCALE SOCIETAL IMPACTS

The societal impacts for Alternative 6 are similar to those discussed for Alternative 5, but the impacts would be felt mainly in the communities of Kearny, Hayden, and Winkelman, located along the Gila River. These are small communities directly adjacent to the river, heavily dependent on the local water supply. The economic impact from property loss, business disruption, and destruction of local infrastructure would affect every aspect of these communities.

LONG-TERM IMPLICATIONS OF PRESENCE OF TAILINGS STORAGE FACILITY

Alternative 6 has similar long-term implications for air quality, revegetation success, and groundwater quality, as those described for Alternative 2, with differences noted in the specific EIS sections referenced.

As noted, the risk of catastrophic failure decreases as water gradually drains from the facility. The duration of active seepage management after closure for Alternative 6 has been estimated to be up to 20 years after closure (Klohn Crippen Berger Ltd. 2018d). This represents the time period during which sufficient seepage is still being generated to require treatment or disposal, rather than relying on passive evaporation. Risk does not decrease to zero after this time period. Other failure modes still exist. This time period is being presented here solely as a proxy for how long substantial water remains in the facility for each alternative.

POTENTIAL IMPACTS FROM PIPELINES

For the ephemeral drainages crossed by either the north or south pipeline option for Alternative 6, the impacts from a pipeline failure would be identical to Alternative 2. However, both the north and south pipeline routes have to cross Devil’s Canyon and also parallel Mineral Creek, increasing the risk of adverse consequences to those perennial waters in the event of a failure. While the north route option would cross Devil’s Canyon farther upstream and away from perennial flow, a failure at either crossing location would have the potential to affect the water, aquatic, and riparian habitat downstream.

Similar to the Alternative 5 east route, the south option for Alternative 6 carries more risk for downstream habitat in Arnett Creek and Queen Creek by paralleling that water body for several miles.

The total length of pipeline corridors under Alternative 6 is about 47 miles (about 22 miles for the concentrate pipeline, and about 25 miles for the tailings pipelines). At closure, the risk of pipeline failure falls to zero.

FINANCIAL ASSURANCE FOR LONG-TERM MONITORING AND MAINTENANCE

The regulatory framework under the State of Arizona to require financial assurance for long-term closure activities is the same as described for Alternative 2. However, Alternative 6 differs from the other alternatives because the tailings facility would not be located on lands managed by the Forest Service (Alternatives 2, 3, and 4) or BLM (Alternative 5). For Alternative 6, the Federal financial assurance mechanisms would not be applicable.

Overall Conclusions of Potential Risk to Public Health and Safety

The Forest Service requirement for the tailings storage facility design, construction, and operation to adhere to National Dam Safety Program standards, as well as APP BADCT standards, minimizes the risk for a catastrophic failure of the tailings storage facility. Adherence by Resolution Copper to the applicant-committed environmental protection measures, including industry best practices, further reduces the risk both by proactively providing a robust design and containment measures, and by identifying operational steps that can be taken in reaction to a developing problem.

There are some qualitative differences in alternatives that are inherent in the design and location of each alternative that affect the resilience of the facility, as shown in table 3.10.1-9. There are also differences in the downstream environment.

Cumulative Effects

The Tonto National Forest identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative impacts on geology, minerals, and subsidence. However, it should be noted that no other mining or other human activities in the cumulative impact assessment area were identified as likely to result in geological subsidence. The analysis here therefore focuses on effects on area geology and mineral resources. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto an estimated 1,011 acres of new disturbance (245 acres on Tonto National Forest land and 766 acres on private land owned by Pinto Valley Mining Corporation) and extend the life of the mine to 2039. The company estimates average annual copper production rates of between 125 and 160 million pounds to continue through the extended operational life of this mine. This facility has a tailings impoundment, which is being expanded, and has had tailings failures in the past. However, the area potentially impacted downstream is in a different watershed than any of the Resolution Copper Project alternatives and would not contribute cumulatively to the overall risk to public safety.
- *Ripsey Wash Tailings Project.* ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The environmental effects of the project were analyzed in an EIS conducted by the USACE and approved in a ROD issued in December 2018. As approved, the proposed tailings storage facility project would occupy an estimated 2,574 acres and be situated in the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to approximately 750 million tons of material (tailings and embankment material). ASARCO estimates a construction period of 3 years and approximately 50 years of expansion of the footprint of the tailings storage facility as slurry tailings are added to the facility, followed by a 7- to 10-year period for reclamation and final closure. The Ripsey Wash facility is very near on the landscape to Alternative 5 – Peg Leg, and the same downstream communities would be impacted in the event of a failure. This represents a cumulative impact on the overall risk to public safety, in combination with the Resolution Copper Project, in the event Alternative 5 or 6 is selected.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no specific details are currently available as to potential environmental effects resulting from this future mining operation. While this area would be used for mining, it is believed that existing ASARCO tailings facilities (including Ripsey Wash) would be the likely recipient of tailings. In this case, this project would not contribute cumulatively to the overall risk to public safety.
- *ASARCO Mine, including the Hayden Concentrator and Smelter.* The Ray Operations consists of a 250,000 ton/day open-pit mine with a 30,000 ton/day concentrator, a 103 million

Table 3.10.1-9. Differences between alternatives pertinent to tailings and pipeline safety

	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Embankment type	Modified centerline	Modified centerline	Filtered tailings; structural zone, but no embankment. Most resilient alternative.	True centerline. Improved resilience, compared with Alternatives 2 and 3.	True centerline Improved resilience, compared with Alternatives 2 and 3.
Embankment size and design	Freestanding; 10-mile length	Freestanding; 10-mile length	No embankment	Freestanding; 7-mile length	Cross-valley construction; 3-mile length. Improved resilience, compared with Alternatives 2, 3, and 5.
Potential for PAG release	PAG deposition inside NPAG facility, no separate embankment (at buildout)	PAG deposition inside NPAG facility, no separate embankment (at buildout)	Separate PAG facility. Downstream risk for PAG release less, due to localized failure.	Separate PAG facility; multiple cells; separate downstream embankment. Less risk for release of PAG tailings during catastrophic failure than Alternatives 2 and 3.	Separate PAG facility; multiple cells; separate downstream embankment. Less risk for release of PAG tailings during catastrophic failure than Alternatives 2 and 3.
Downstream population (within 50 miles)	600,000	600,000	700	32,000	3,200
Nearest population	Within 10 miles	Within 10 miles	Within 10 miles	Over 20 miles	Within 10 miles
Pipeline risk	Ephemeral drainages; relatively low risk	Ephemeral drainages; relatively low risk	Ephemeral drainages; relatively low risk	West option: Higher risk at crossings of Queen Creek, Gila River, and parallel of Reymert Wash East option: Higher risk from crossings of Queen Creek, Gila River, and parallel of Arnett Creek	North option: Higher risk at crossings of Devil's Canyon and parallel of Mineral Creek South option: Higher risk at crossings of Queen Creek, Devil's Canyon, and parallel of Mineral Creek
Miles of pipeline	Concentrate = 22 Tailings = 5	Concentrate = 22 Tailings = 5	Concentrate = 0 Tailings = 1.5	Concentrate = 22 Tailings = 25	Concentrate = 22 Tailings = 25
Anticipated risk period for pipelines	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure	41 years. LOM only. Risk ends upon closure
Anticipated risk period for tailings storage facilities*	150 years (LOM, plus estimated seepage for ~100 years post-closure)	50 years (LOM, plus estimated seepage for ~9 years post-closure)	45–50 years (LOM, plus estimated seepage for ~5 years post-closure)	150–200 years (LOM, plus estimated seepage or 100–150 years post-closure)	70 years (LOM, plus estimated seepage for 20 years post-closure)

LOM = Life of mine

* The estimate shown here is the life of mine, plus the length of time active seepage management is anticipated to take after closure (see section 3.7.2). This is being presented as a proxy for risk, only to highlight differences in the period of drain-down between alternatives. A number of failure modes continue to be possible after active seepage management has been discontinued.

pounds/year solvent extraction-electrowinning operation, and associated maintenance, warehouse, and administrative facilities. Cathode copper produced in the solvent extraction and electrowinning operation is shipped to outside customers and to the ASARCO Amarillo Copper Refinery. A local railroad, Copper Basin Railway, transports ore from the mine to the Hayden concentrator, concentrate from the Ray concentrator to the smelter, and sulfuric acid from the smelter to the leaching facilities.

- The ASARCO Hayden Plant Superfund site is located 100 miles southeast of Phoenix and consists of the towns of Hayden and Winkelman and nearby industrial areas, including the ASARCO smelter, concentrator, former Kennecott smelter and all associated tailings facilities in the area surrounding the confluence of the Gila and San Pedro Rivers. These tailings facilities are smaller than the planned Ripsey Wash or Resolution Copper Project tailings facilities but are near the Gila River and upstream of the same communities and ecosystems. These tailings facilities, though already on the landscape and not expanding, still represent a cumulative risk to overall public safety, in combination with the Resolution Copper Project, in the event Alternatives 5 or 6 are selected.

Two other large-scale mining operations in cumulative assessment area, Freeport-McMoRan's Miami Inspiration Mine and KGHM's Carlota Mine, are nearing the end of their effective mine life and are limiting current and future mineral extraction activities to leaching of existing rock stockpiles. The facilities would be in a different watershed, they would not be expanding their tailings facilities, and they do not contribute cumulatively to the risk to public safety. It is reasonable to assume that during the projected life of the Resolution Copper Mine (50–55 years), other tailings facilities would be developed in association with the widespread mining activity in the Copper Triangle and within the cumulative effects analysis area.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the DEIS, and in particular appendix J, will inform the final suite of mitigations.

This section contains an assessment of the effectiveness of design features from the GPO and mitigation and monitoring measures found in appendix J that are applicable to tailings safety.

MITIGATION MEASURES APPLICABLE TO TAILINGS AND PIPELINE SAFETY

Satellite Monitoring of Tailings Storage Facility (FS-01): High-resolution satellite imagery would be collected and processed at regular intervals. Processed output provided to the Forest Service or BLM would include beach width, tailings surface slope contours, and constructed site topography. This output could be provided for land manager verification of adherence to design criteria, as well as long-term monitoring of facility performance over time. This measure would be applicable to Alternatives 2, 3, 4, and 5 through 36 CFR 228.8 (Forest Service authority to regulate mining to minimize adverse environmental impacts on NFS surface resources) and 43 CFR 3809.2 (BLM authority to regulate mining to prevent unnecessary or undue degradation). This measure primarily focuses on tailings safety, which in turn is protective of human life, property, and numerous downstream resources.

Improve Resiliency of Tailings Storage Facility (GP-26). Some recommended mitigation measures regarding the tailings storage facility, to include where appropriate, are the use of a liner, constructing a secondary backup containment facility, developing a mitigation plan for tailings storage facility embankment breach, implementing a cease operation plan in the event of a tailings embankment failure, requiring an environmental damage assessment in the event of a tailings embankment release, and identifying alternative energy sources for the tailings storage facility in the event of an electrical outage. These measures would be applicable to all alternatives, noted in the ROD/Final Mining Plan of Operations, and required by the Forest Service. No additional ground disturbance would be required.

Conduct Refined FMEA before FEIS (FS-227): The failure modes analysis conducted by Resolution Copper is based on the DEIS alternative design documents. With more refined designs and site-specific information, a more robust and refined FMEA can be conducted. The Forest Service is requiring that this refined FMEA be conducted between the DEIS and FEIS. This exercise will inform the requirements to be specified in the ROD and ultimately incorporated into a final plan of operations.

The refined FMEA would be a collaborative group process that would be led by the Forest Service. It is likely to include Forest Service personnel, cooperating agency representatives, Resolution Copper and their tailings experts and contractors, and the NEPA team and their tailings experts. This group would identify possible failure modes, their likelihood of occurring, the level of confidence in the predictions, the severity of the consequences if that failure mode were to occur, and possible controls to reduce the risk of failure. The collaborative group would likely also be asked to identify a reasonable failure scenario to use in a refined breach analysis.

During an FMEA, the tailings storage facility is considered as a complete system with a number of components, including geology, foundation, engineered structures, seepage controls, drains, containment, diversions, and spillways. Sufficient information on the design and specifications of each component is needed in order to understand how the components would function as a system, and how they might respond to the anticipated stresses on the system. The information needed to support a collaborative, refined FMEA would include the results of site investigations (geology and foundation), lab testing, engineering analyses, borrow material analyses and specifications, and engineered drawings and specifications. The less information available during the FMEA process, the more assumptions have to be made, leading to a less meaningful assessment that may not be representative of the true risks for the ultimate designed facility.

Adherence to National Dam Safety Program Standard (FS-228): For a tailings storage facility built on Federal land, the Forest Service is requiring that Resolution Copper adhere, at a minimum, to the requirements of the National Dam Safety Program discussed in “Relevant Laws, Regulations, Policies, and Plans” in section 3.10.1.3.

Development of an Emergency Action Plan for the Tailings Storage Facility (FS-229): For a tailings storage facility built on Federal land, the Forest Service is requiring that Resolution Copper undertake Emergency Action Planning, as required under the National Dam Safety Program (Federal Emergency Management Agency 2004). The FMEA would provide key information to this process. Emergency Action Planning would include evaluation of emergency potential, inundation mapping and classification of downstream inundated areas, response times, notification plans, evacuation plans, and plans for actions upon discovery of a potentially unsafe condition.

The breach analysis prepared for the DEIS is not sufficient to meet National Dam Safety Standards for emergency planning. The Forest Service will require a refined breach analysis be conducted between the DEIS and FEIS, using appropriate models, based on the outcome of the FMEA and a selected failure scenario.

MITIGATION EFFECTIVENESS AND IMPACTS

Adherence to National Dam Safety Program standards, incorporating additional features to enhance resiliency, and conducting an FMEA between the DEIS and FEIS all would help reduce or minimize the inherent risk from a tailings storage facility by ensuring that the design is appropriate and robust, and addresses possible failure modes.

Conducting satellite monitoring would provide a means of independently detecting deviations from operational plans and enhance the ability of Federal agencies to provide meaningful oversight; this would reduce the inherent risk from a tailings storage facility.

Development of an emergency action plan would not reduce the risk of failure but would reduce the potential consequences in the event of a failure.

UNAVOIDABLE ADVERSE IMPACTS

The mine and associated activities are expected to increase risks to public health and safety from the presence of a large tailings storage facility on the landscape, and the transport of concentrate and tailings by pipeline. These risks are unavoidable. However, risk of failure is minimized by required adherence to National Dam Safety Program and APP program standards, applicant-committed environmental protection measures, and the mitigation measures described here.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Impacts from risk associated with tailings embankment safety would exist for a long time on the landscape and may result in some land uses downstream of the facility being curtailed. Over time, the reduction of risk would diminish, and productivity of downstream areas would recover.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible changes with respect to tailings safety are not expected. The risk from pipeline failures ends upon closure of the mine and would be considered irretrievable but not irreversible. The risk from a tailings facility would persist for decades but would diminish as the structure drains. Impacts on public safety from tailings or tailings and concentrate pipelines would constitute an irretrievable commitment of resources.

3.10.2 Fuels and Fire Management

3.10.2.1 Introduction

This section assesses fuels and fire management both in the project area and within the larger analysis area (figure 3.10.2-1). Fuel means any vegetation, including grass, shrubs, and trees, that could sustain a wildfire. "Fuels and fire management" refers to the ability of land managers and emergency responders to maintain fuel levels and conduct other activities to prevent wildfires or control their extent or severity. Mine operations would include activities that would change fuel loads in the area or increase the possibility of accidental ignition of a wildfire, which would result in increased risk of fire and would change the severity and extent of fires that could occur. This section discusses the vegetation communities present, fire history and fire management, wildfire-urban interfaces (WUIs), and changes in wildfire risk resulting from the proposed project.

3.10.2.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for considering direct and indirect effects on fuels and fire management includes all proposed mine components, the four alternative tailings storage facility locations, and mine-related linear facilities such as pipelines, power lines, and roads. This area includes all lands where mine-related activities would increase fuel accumulations as a result of subsidence or increase the risk of inadvertent, human-caused fire ignitions that could spread to and impact adjacent NFS, BLM, State Trust, and private lands, as well as lands within the Pinal County "*Community Wildfire Protection Plan*" (CWPP)-designated WUI. This analysis area is depicted in figure 3.10.2-2. The temporal extent of analysis for fuels and fire management includes the construction, operations, and closure and reclamation phases of the proposed project.

Methodology

Analysts assess impacts associated with both fuel loading and fire risk qualitatively based on the types and locations of mining activities. Specific mine activities that analysts considered include blasting, increased vehicle traffic, storage and transportation of flammable materials, fuel loading from clearing of vegetation, impacts on vegetation from water use, introduction of noxious weeds, construction activities, and reduction in recreational use. Fuels and fire data (e.g., fire behavior-based fuel classifications, vegetation community-based fire regime information, local fire history, and jurisdictional wildfire response strategies) were compiled to identify where and when changes in wildfire risk are most likely to occur as a result of implementing the proposed project.

The available resources to analyze fuels and fire management impacts were adequate; no uncertain or unknown information has been identified.

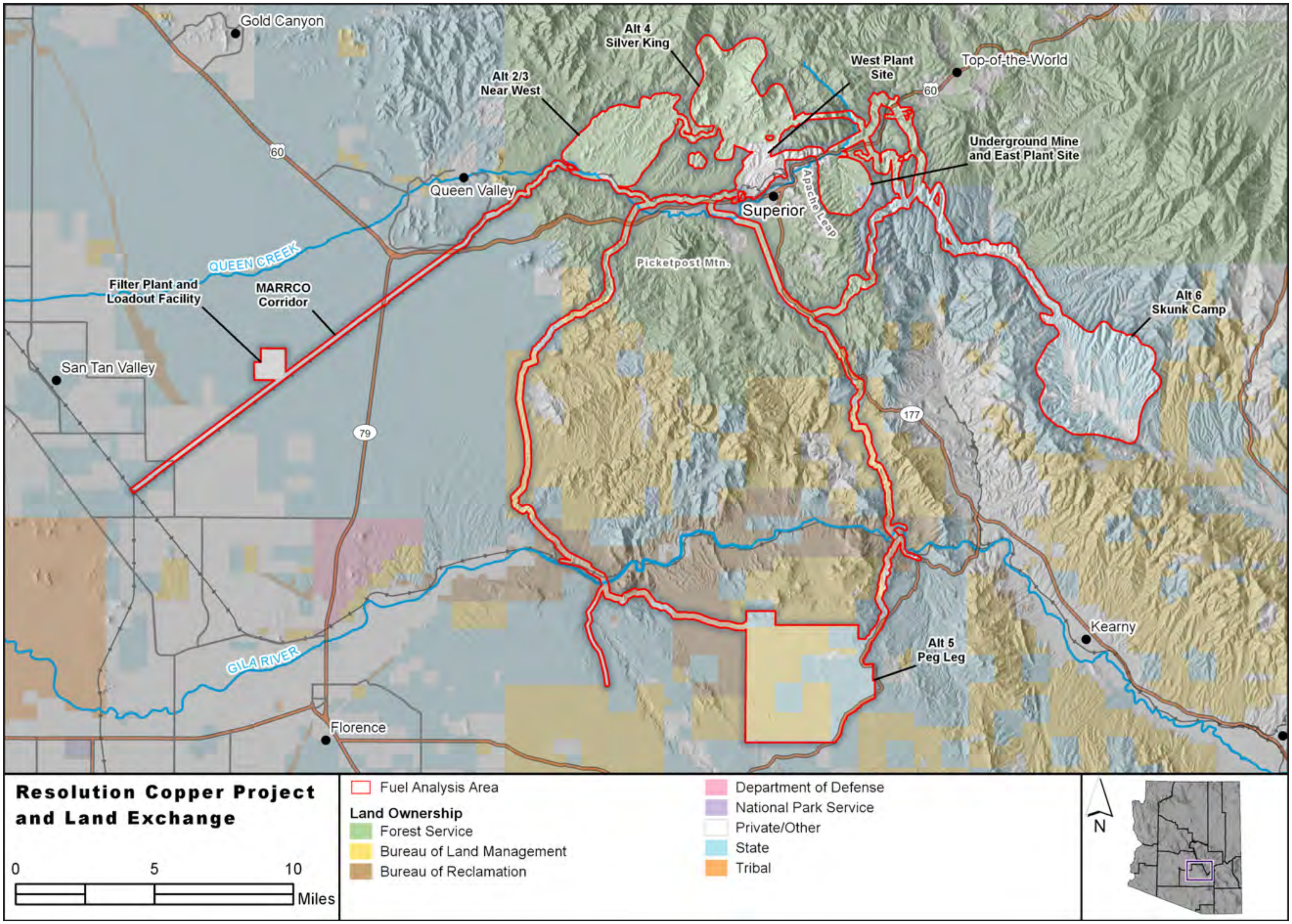

Figure 3.10.2-1. Fuels and fire management analysis area

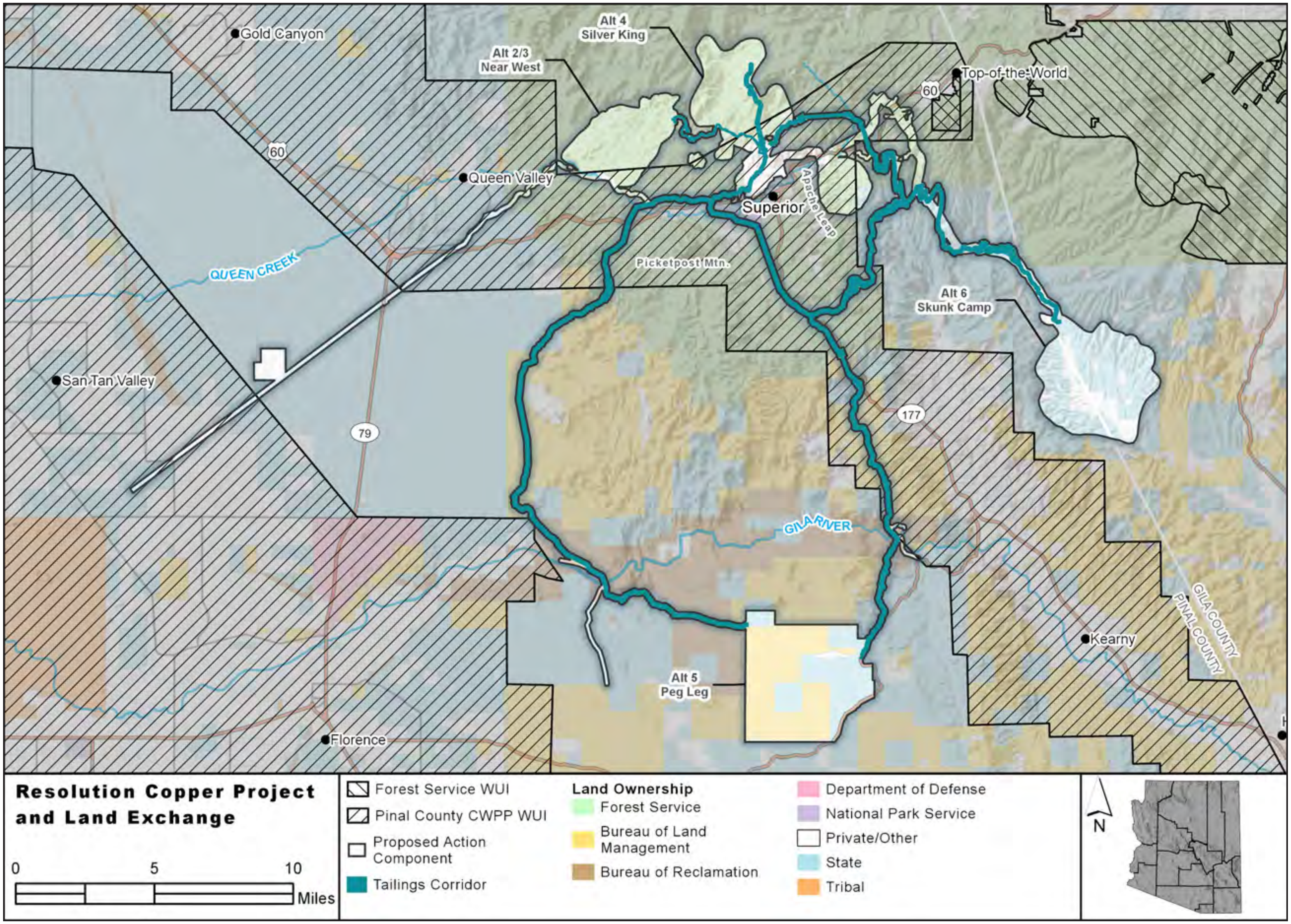

Figure 3.10.2-2. Wildland-urban interface delineation for the project area, comprising Forest Service–delineated and Pinal County CWPP–delineated WUI

3.10.2.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

The legal authorities guiding this analysis of the effects of change on fuels and fire management as a result of the project, along with the alternatives identified in the EIS, are shown in the accompanying text box. A complete listing and brief description of the laws, regulations, reference documents, and agency guidance used in this fuels and fire management effects analysis may be reviewed in Newell and Garrett (2018b).

Primary Legal Authorities Relevant to the Fuels and Fire Management Effects Analysis

- Federal Wildland Fire Policy of 1995
- National Fire Plan (2001), including the Healthy Forest Restoration Act and the Healthy Forest Initiative
- Tonto National Forest Land and Resource Management Plan

Existing Conditions and Ongoing Trends

FUEL CLASSIFICATION

Fuel is the term given to vegetation that is available for combustion. Fuels generally belong to three categories: grass, shrubs, and timber.

Modeling fire behavior requires an additional breakdown of fuel characteristics: fuel-bed depth, surface area-to-volume ratio, and the amount of fuel loading in a given area. Surface fuels include litter, duff, and coarse woody debris greater than 3 inches in diameter. Surface fuel loading (quantities) influences fire behavior. High surface fuel loading can result in high-severity fire effects because the fire can smolder in place for long periods and transfer more heat into soils and tree stems. Lessening surface fuels reduces fire intensity and severity. Scott and Burgan's (2005) report on 40 fire behavior fuel models classifies the most dominant fuels in the project area as grass and shrub fuels, which are surface fuels consisting of grasses, forbs, shrubs, and Interior Chaparral.

VEGETATION COMMUNITIES

Three primary vegetation communities make up the majority of the overall project area: the Upland Subdivision and the Lower Colorado River Valley region of the Sonoran Desertscrub, and Interior Chaparral (see figure 3.3.2-2). In addition, Interior Riparian Deciduous Forest and Madrean Evergreen Woodland occur in limited extent, such as within the projected subsidence area at Oak Flat. Mining activities have disturbed some portions of the project area, and areas of bare ground and various nonnative invasive plant species are common (Resolution Copper 2016d).

The Sonoran Desertscrub (Arizona Upland subdivision) is composed primarily of cactus, including saguaro (*Carnegiea gigantea*), chollas (*Cylindropuntia* spp.), and prickly pears (*Opuntia* spp.), as well as some common small trees and shrubs, including paloverde (*Parkinsonia* spp.), ironwood (*Olneya* sp.), velvet mesquite (Prosopis velutina), acacias (*Senegalia* spp.), and creosotebush (*Larrea tridentata*). This desertscrub community is undergoing an infrequent, high-severity fire regime (FR V) that would undergo stand-replacing fire with an average fire return interval of 103 to 1,428 years (Missoula Fire Sciences Laboratory 2012). Infrequent fires are due to the slower and often inadequate accumulation of fuel in desert systems (Worthington and Corral 1987). When it does occur, wildfire typically kills Sonoran Desert cactus species (McLaughlin and Bowers 1982).

The Sonoran Desertscrub (Lower Colorado River Valley subdivision) is composed of creosotebush, white bursage (*Ambrosia dumosa*), and saltbush (*Atriplex* sp.). Creosotebush-white bursage communities have been described as "essentially nonflammable" because the shrubs are too sparse to carry fire (Humphrey 1974).

Creosotebush is poorly adapted to fire because of its limited sprouting ability (Brown and Minnich 1986), particularly under severe burning conditions (Marshall 1995). White bursage similarly is killed by fire and has been found to have limited sprouting and seedling establishment even after 5 years post-fire (Brown and Minnich 1986).

Interior chaparral comprising shrub live oak (*Quercus turbinella*; also known as Sonoran scrub oak) experiences fire-return intervals of approximately 74 to 100 years (Tirmenstein 1999). Fires typically burn with high severity and cause stand replacement (FR IV). Shrub live oak is well adapted to survive fire, and even after complete stand replacement, the oak typically sprouts vigorously from the root crown and rhizomes (Davis 1977). Burned areas may be completely revegetated with shrub live oak within 4 to 8 years of a high-severity fire (Tiedemann and Schmutz 1966). Post-fire establishment by seed also occurs (Tirmenstein 1999). Following fire, the production of annual grasses may increase until the overstory is reestablished (Tiedemann and Schmutz 1966).

FIRE OCCURRENCE HISTORY

Since 1980, authorities have recorded over 3,900 wildfire ignitions within Pinal County (Logan Simpson 2018). Only 20 of those fires were within the footprint of the proposed project alternatives. Of those fires, only 20 percent ignited naturally; the remainder were a result of various human causes. Figure 3.10.2-3 shows the fire occurrence (ignition points and perimeters of previous fires) within the project boundary from 1980 to 2017. Most of these fires have been less than 1 acre in size. However, between 1979 and 2017, three large wildfires have occurred close to the project area: the Silverona Fire, which broke out in 1979 and consumed 1,730 acres; the Peachville Fire, which occurred in July 2005 and was 9,750 acres; and the Queen Fire, which occurred in 2012 and was 679 acres (Interagency Fuels Treatment Decision Support System 2018). These fire perimeters overlapped, as seen in figure 3.10.2-3.

The Peachville Fire was ignited by lightning on July 18, 2005, and threatened existing mining resources within the project area. The fire burned for 9 days through chaparral fuels and required 199 personnel, seven engines, one dozer, and three water tenders for suppression. Crews were supported by one helicopter for aerial suppression (Tonto National Forest 2005).

Due to the presence of non-native annual grasses, large wildfires that are uncharacteristic of the desert vegetation zone are becoming increasingly common. In addition, growing recreational use and transportation along highways has increased human-caused ignitions in the region. According to the Pinal County CWPP, the areas with the greatest potential for fire ignition, either from natural or human (though unplanned) causes, are found within the Tonto National Forest along the northeastern portion of the CWPP WUI (see figure 3.10.2-3), including Superior and Top-of-the-World. In figure 3.10.2-3, it is evident that most previous fires have occurred along transportation corridors and on NFS lands; fire occurrence on BLM lands is less frequent.

WILDFIRE RESPONSE

Wildland and structural fire response in and adjacent to the project area is provided by local fire departments and districts. The BLM and Tonto National Forest also provide support for initial wildland fire attack for areas within and adjacent to WUI areas. Initial attack response from additional local fire departments and districts can occur under the authority of mutual-aid agreements between individual departments or under the intergovernmental agreements that individual fire departments and districts have with the Arizona State Forester and adjacent fire departments and districts (Logan Simpson 2018).

Tonto National Forest

The project area falls in MA 2F on the Globe Ranger District and MA 3I on the Mesa Ranger District. Under the forest plan, fire management direction in both management areas is as follows:

> Wildland Fires will be managed consistent with resource objectives. Wildland Fires will be managed with an appropriate suppression response. Fire management

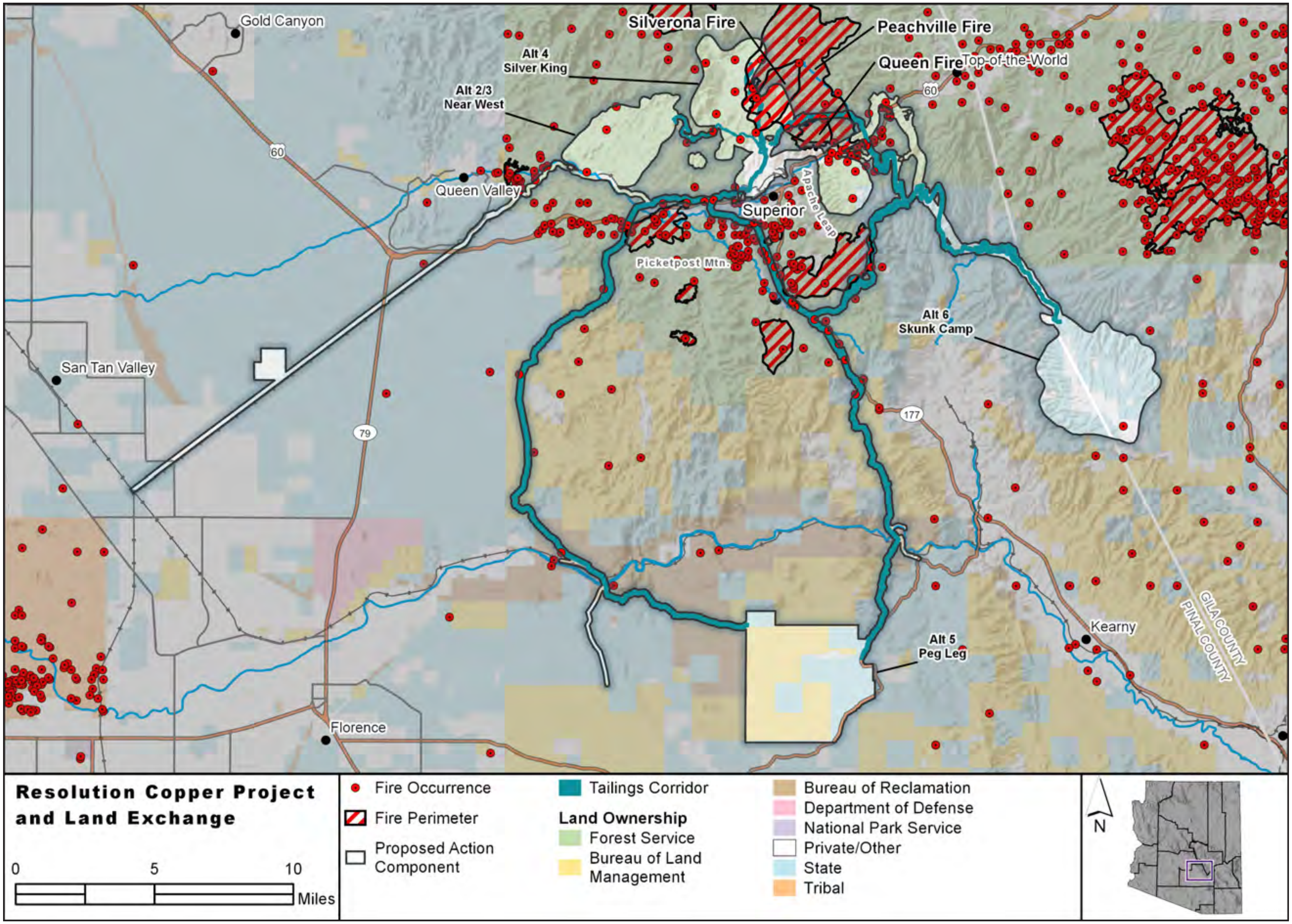

Figure 3.10.2-3. Fire occurrence history for the project area and surrounding lands

> objectives for this area include: providing a mosaic of age classes within the total type which will provide for a mix of successional stages, and to allow fire to resume its natural ecological role within ecosystems.
>
> Wildland Fires or portions of fires will be suppressed when they adversely affect forest resources, endanger public safety or have a potential to damage significant capital investments.

During the height of the fire season when there are multiple fires in northern and central Arizona response zones, there is a draw-down on resources leading to shortages. Responses to fires on the Tonto National Forest are timely but may not involve more than a single resource able to provide equipment and personnel.

BLM Lower Sonoran Field Office

According to the BLM Lower Sonoran Field Office and Safford District Resource Management Plans (Bureau of Land Management 1991, 2012), management response is to fully suppress all unplanned ignitions within the district. The resource management plans direct management actions to implement fuels treatments, suppression activities, and prevention activities that target reducing the size and number of human-caused wildland fires.

State Lands

State Trust lands occur on the periphery of the communities and are included in several of the alternatives. State Trust lands are administered by the ASLD and are managed for a variety of uses. The ASLD has a forestry division with fire and fuels crew who work on fire prevention activities, including hazardous fuels treatments around at-risk communities in the WUI. The Arizona Department of Forestry and Fire Management is responsible for prevention and suppression of wildland fire on State Trust land and private property located outside incorporated communities. The agency has ready access to over 3,000 local firefighting vehicles and more than 2,700 trained state and local wildland firefighters plus substantial national resources from Federal agencies.

Private Lands

Pinal County fire departments and districts maintain wildland fire response teams supported by various engines and other wildland equipment. Wildland fire response teams are composed of personnel with various levels of wildland firefighting training, including red-carded firefighters. Specially trained wildland fire response teams not only provide suppression response to brush fires but also community awareness programs and structural-fire risk assessments (Logan Simpson 2018).

The Town of Superior is served by the Superior Fire Department. The fire department has improved wildland fire suppression response and continues public education and outreach programs concerning wildland fire threat and home-ignition-zone recommendations.

The community of Top-of-the-World is outside a fire district, is not under Forest Service jurisdiction for fire protection, and is outside of fire department jurisdiction. The Arizona Department of Forestry and Fire Management provides fire suppression. The community is prioritized in the Pinal County CWPP for fuel treatments because of its moderate risk and potential slow response times.

Resolution Copper

Resolution Copper Mining, LLC (called RCML in the quoted material here), holds an Emergency Services Agreement with the Town of Superior (called the Town, in the quoted material) for the provision of emergency services to the RCML property. In the Emergency Services Agreement, the Town agrees to

> [provide] certain emergency services . . . to the RCML Property. In the event RCML acquires additional property in the vicinity of the Town through a land exchange with U.S. Government or from BHP Copper Inc., such additional real

> property shall be considered part of the RCML Property for purposes of this Agreement and the Town shall provide or cause to be provided Emergency Services to all of the RCML Property, including such additional real property. (Town of Superior 2008)

Emergency services include police services, fire suppression services, and ambulance services. Specific to fire services, the agreement states:

> Fire suppression services, which shall include emergency fire suppression services for fire outbreaks on the surface and in above-ground improvements on the RCML Property. Nothing herein shall require the Town to provide fire suppression services for any underground fire on the RCML Property. (Town of Superior 2008)

The “Apache Leap Special Management Area Management Plan” (U.S. Forest Service 2017c) outlines the vision for the Apache Leap SMA. The “Vision Statement” (provided in appendix C of the “Apache Leap Special Management Area Management Plan”) describes a vision for ongoing access by the Forest Service into the Apache Leap SMA for fire suppression actions (U.S. Forest Service 2017c).

AT-RISK COMMUNITIES AND WILDLAND-URBAN INTERFACE

The Arizona Department of Forestry and Fire Management compiles a list of communities at risk from wildfire each year. Six communities fall within Pinal County and three communities fall within the project area (Arizona Department of Forestry and Fire Management 2018). Typically, these at-risk communities are located within a defined WUI. The Tonto National Forest adopted the following definition for WUI in its Amendment #25:

> Wildland Urban Interface (WUI)—The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.

The project area falls within the Tonto National Forest–defined WUI (see figure 3.10.2-2) but portions also fall within the broader WUI delineated for the Pinal County CWPP (Logan Simpson 2018). Figure 3.10.2-2 presents a map of both the Forest Service–derived and CWPP-derived WUI boundaries, relative to the project boundary.

The Pinal County CWPP analyzes risk and makes recommendations to reduce the potential for unwanted wildland fire within at-risk communities. Three of the communities within the Pinal County CWPP WUI—Superior, Queen Valley, and Top-of-the-World—fall within the project area. The CWPP makes recommendations for risk ratings for all communities within the county. Those 2018 recommendations rate all three communities as having moderate risk of wildfire. These ratings were used as the basis for the analysis in the following text. The Queen Valley community is adjacent to the project area and is discussed in the context of potential wildfire spread. The following is taken from the Pinal County CWPP (Logan Simpson 2018) and describes the conditions of these moderate-risk WUI communities.

Superior Sub-WUI

The Superior fire department provides structural and wildland fire response to over 1,459 housing units. The Superior sub-WUI is composed primarily of high wildland fire-risk vegetation associations in conjunction with a steadily rising elevation and slope from south to north throughout the sub-WUI. Substantial threats to structure and infrastructure are found within and adjacent to the community. Several large wildfires have occurred within or adjacent to the community. Vegetative associations within this sub-WUI range from desert scrub types on the desert floor to mixed desert shrub associations in the mountain foothills. These areas of the sub-WUI can create extreme risk during years of extraordinary rainfall, due to elevated growth of fine fuels. Analysis of fire-start data for the past 36 years (1980–2016) indicates that the highest incidences of ignition occur within or adjacent to Tonto National Forest lands along the northern portion of the sub-WUI. The majority (76 percent) of the Superior sub-WUI has a moderate wildfire risk, with an elevated risk from a density of developed areas in proximity to high-risk wildland fuels and elevated areas of risk in the Queen Creek riparian corridor; the overall wildland fire risk rating of the sub-WUI is moderate.

Top-of-the-World Sub-WUI

The Top-of-the-World sub-WUI includes the unincorporated community of Top-of-the-World and the Oak Flat area. Top-of-the-World is a rural community located along U.S. 60 near the Pinal County line. U.S. 60 is the only transportation route for this community. According to the 2000 census data, the population of the community of Top-of-the-World is 236 (Logan Simpson 2018). There are 196 housing units, of which 47 are classified as owner-occupied units and 61 are classified as detached single-family units, while 135 are classified as mobile homes. Top-of-the-World is not within a fire district and therefore has an Insurance Services Office (ISO) rating of 10 (the worst rating class for fire protection: 10 indicates virtually no protection). Fire suppression is provided by the Arizona Department of Forestry and Fire Management. The highest risk for wildland fires within the Top-of-the-World sub-WUI is a result of the combination of volatile vegetative associations occurring in conjunction with southerly exposures of increasing steep slopes. These areas of the sub-WUI can create extreme risk during normal precipitation years as well as during years of extraordinary rainfall. Analysis of fire-start data for the past 36 years (1980–2016) indicates that the highest incidences of ignition occur within or adjacent to the Tonto National Forest lands along the northern and eastern portions of the sub-WUI. The majority (97 percent) of the Top-of-the-World sub-WUI has a moderate to high wildfire risk, with an elevated risk from ignition history in areas of high-risk wildland fuels; the overall wildland fire risk rating of the sub-WUI is moderate.

Queen Valley Sub-WUI

The Queen Valley sub-WUI has areas at high risk from brush fires around homes with a high density of brush growth on adjacent hillsides. The population of Queen Valley has been declining over the last decade, with 712 residents in 2016. The Queen Valley Fire District has an ISO rating of 8. The Queen Valley sub-WUI is primarily composed of areas at moderate to high risk from wildland fire during extreme rainfall years. The Queen Valley sub-WUI consist of a steadily rising elevation and areas of increasing slope from the lower elevations of Queen Valley to the foothills of the Superstition Mountains within the northern portion of the sub-WUI. Vegetation associations within this sub-WUI range from desert scrub types on the desert floor to mixed desert shrub and woodlands in the foothills of the Superstition Mountains. The majority (92 percent) of the Queen Valley sub-WUI is classified at moderate risk for wildland fire (Logan Simpson 2018); the sub-WUI has an elevated risk from the density of developed areas in proximity to high-risk wildland fuels, but the area has a low to moderate ignition history and overall low wildfire effects.

COMMUNITY VALUES AT RISK

In addition to communities at risk, there are several values at risk that were identified in the Pinal County CWPP and by the Forest Service that are within or adjacent to the project area and analysis area. These include campgrounds, recreational trails and recreational areas, power lines, communication facilities, cultural and historic resources, sensitive wildlife habitat, watersheds, water supplies, and air quality.

3.10.2.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Proposed mining activities have the potential to change fuels and fire management conditions. The factors considered to address the fuels and fire management issues stated previously are (1) the type and location of activities that would change fuel loads, and (2) the type and location of activities that would increase risk for fire. Impacts associated with both fuel loading and fire risk are qualitatively assessed, based on the type and location of mining and mining-related activities.

Alternative 1 – No Action

Under the no action alternative, the project area would remain in its present condition. There would be no change to fuels and fire management conditions. Fires resulting from lightning would continue to occur at the same frequency. Human-caused fires from recreation, ranching, and transportation could increase over time as population continues to increase in the area and a corresponding increase in use of public land occurs. Continued invasion by annual grasses combined with climate change would likely result in a continuation of trends of increasing wildfire size and intensity, and increased potential for high-intensity fires when ignitions do occur. Continued growth of the WUI would expose more life and property to wildfire. Fire prevention and fire response would remain the same, with no change to access for emergency response.

Impacts Common to All Action Alternatives

The action alternatives are similar with respect to the types of mining activities proposed. The location of certain mining activities, particularly the locations of tailings, do vary by alternative. Most differences between alternatives are considered insignificant when assessing impacts on fuels and fire management, and as such effects common to all alternatives are presented. Mining operations or implementation of projects occurring on NFS, BLM, State, Pinal County, or Gila County land would need to comply with any fire restrictions that are in effect. Where differences between alternatives would have different impacts on fuels and fire management, these impacts are discussed separately by alternative.

General changes in fuel loading or risk of accidental ignition caused by mine activities include the following:

- Blasting. Regular blasting would take place under controlled conditions underground, although some aboveground blasting might be used during the construction phase for other facilities or pipelines. This could increase risk of ignition, but typically blasting is done with emergency response crews standing by.
- Increased vehicle traffic. Increased vehicle traffic increases risk of accidental ignition, through careless disposal of smoking materials, vehicles pulling over on combustible dry vegetation, or impact sparks from loose mechanical parts.
- Storage and transportation of flammable materials would not necessarily increase risk of accidental ignition but could worsen any fire that happened to occur. Adhering to hazardous and flammable material storage requirements would reduce this risk.
- Fuel loading from clearing of vegetation. Any stockpiled vegetation left to dry out would increase fuel loads, increasing the overall fire risk.
- Impacts on vegetation from water use. A number of riparian systems are predicted to be impacted by groundwater drawdown, but mitigation is largely expected to maintain vegetation communities in a relatively healthy condition and not increase fuel loading (see section 3.7.1 for analysis of these riparian areas).
- Introduction of noxious weeds. All surface-disturbing project activities increase the potential for spread of noxious and invasive weeds, which can increase fuel loads and overall fire risk. These effects would be reduced, but not eliminated

by implementation of noxious weed management plans (see section 3.3 for analysis of noxious weeds).

- Construction activities. Use of power equipment and welding equipment specifically increases the risk of accidental ignition from sparks.
- Reduction in recreational use. Reductions in recreational use over large portions of the Tonto National Forest associated with the tailings storage facility would decrease the risk of accidental ignition caused by recreation, such as vehicles, shooting, or camping. However, this might be offset by the shift of recreation to other areas.

EFFECTS OF RECLAMATION

The tailings storage facility represents a large area of disturbance that would be reclaimed after closure. The success of reclamation and the ability to reestablish vegetation on the tailings storage facility surface would have a large effect on post-closure fire risk. Potential reclamation success is analyzed in detail in section 3.3. Overall, in areas where ground disturbance is relatively low, and soil resources (e.g., nutrients, organic matter, microbial communities) and vegetation propagules (e.g., seedbank or root systems to resprout) remain relatively intact, it would be expected that vegetation communities could rebound to similar pre-disturbance conditions in a matter of decades to centuries. In contrast, for the tailings storage facility, which would be covered in non-soil capping material (such as Gila Conglomerate), biodiversity and ecosystem function may never reach the original, pre-disturbance conditions even after centuries of recovery. The vegetation on the reclaimed tailings storage facility might be more sparse than the natural landscape, but also might increase fuel loading if survivorship of plants is low.

EFFECTS OF THE LAND EXCHANGE

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. This would not impact the Forest Service's ability to fight any potential fires, as the Tonto National Forest would still cover fires occurring on private lands; however, the Tonto National Forest would lose their authority to actively manage wildfire suppression and prescribed fires within the parcel in order to meet management objectives. However, this change in management would not necessarily result in increased fire risk on the Oak Flat Federal Parcel.

The eight offered lands parcels would move into Federal jurisdiction and grant the Forest Service and BLM the authority to manage fuel loads and fire risks within those parcels where there was previously no Federal management. This would enable more cohesive management techniques as the parcels include inholdings surrounded by federally managed land. The respective Federal authority would manage the parcels for multiple uses, of which fire is recognized as a resource management tool with the potential included in a management prescription where it can effectively accomplish resource management objectives. In all, the main effect on fuels and fire management from the transfer of the offered lands parcels to Federal jurisdiction would be the authority of Federal agencies to actively manage for fires and could potentially reduce fire risks in those areas.

EFFECTS OF FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 Forest Plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). As a result of this review, 30 standards and guidelines were identified as applicable to management of ecosystems and vegetation communities. None of these standards and guidelines was found to require amendment to the proposed project, on either a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts on fuels and fire management. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

In appendix M of the GPO, Resolution Copper has committed to various measures to reduce impacts on fuels and fire management:

- Any vegetation cleared from the site would be temporarily stored on-site at a location with minimal fire risk, well within a cleared area away from ignition sources. Handheld and large equipment (e.g., saws, tractors) used for vegetation clearing would be equipped with working spark arresters. Resolution Copper would take additional precautions if work is to be conducted during critical dry season, which may include larger amounts of extinguishing agents, shovels, and possibly a fire watch.
- Parking will be prohibited on vegetated areas and proper disposal of smoking materials will be required. All surface mine vehicles would be equipped with, at a minimum, fire extinguishers and first aid kits.
- Resolution Copper will establish an emergency service or maintain contracts and agreements with outside emergency response contractors for emergency response support services to surface facilities on a 24/7 on-call basis. Fire emergency and response procedures specific to underground operations would be prepared and implemented.

Alternative 2 – Near West Proposed Action

Potential impacts on fuels and fire management would be the same as described earlier in this section in “Impacts Common to All Action Alternatives.” The tailings facility for Alternative 2 would be located on NFS lands, in an area that has historically received very few wildfire ignitions. Although the tailings facility footprint includes a portion of the Queen Valley WUI, the majority of the footprint is 2 miles or more from the community. Fuel types in the area of the tailings facility are characterized by grass/shrub fuels and Sonoran Desert vegetation that does not typically transmit wildfire. Following very wet years, however, these fuel types would be at elevated risk of large fire spread due to the presence of annual grass fuels. This risk may be mitigated, but not eliminated, using noxious weed management techniques. Fire response to the area would be rapid, due to the emergency services provided by both the Tonto National Forest and the Town of Superior. Fires have a better chance of being contained during initial attack, before they can gain in size.

Alternative 3 – Near West – ULTRATHICKENED

Potential impacts on fuels and fire management would be the same in magnitude and nature as those described for Alternative 2 since they have the same footprint, and differences in the tailings site embankment structure would not increase or decrease potential impacts between the two alternatives.

Alternative 4 – Silver King

Potential impacts on fuels and fire management from proposed project activities would be similar to those described earlier in this section in “Impacts Common to All Action Alternatives,” but the location of the tailings facility, the location of the filter plant and loadout facility, and other emergency storage ponds would increase the West Plant Site footprint and require different access road alignment along Silver King Mine Road, compared with the GPO and Alternatives 2, 3, 5, and 6. Because the facilities would be contained within the West Plant Site, the potential exposure of surrounding areas to West Plant Site–related ignitions resulting from transportation of materials or construction activities would be slightly reduced.

Alternative 4 includes areas classified with shrub fuels (SH7) that burn with high intensity in the event of an ignition. Intense fire behavior was observed within the footprint of Alternative 4 during the Peachville Fire, which burned a portion of the proposed tailings area in 2005. Several after-wildfire ignitions have also occurred within the footprint over the past several decades. The southern portion of the Alternative 4 footprint is located within the WUI for the town of Superior, showing that the location would expose life and property to wildfire impacts, should an ignition occur. Because of the close proximity to Superior, fire response to the area would be rapid due to the emergency services provided by both the Tonto National Forest and the Town of Superior. Fires have a better chance of being contained during initial attack, before they can gain in size.

Alternative 5 – Peg Leg

Potential impacts on fuels and fire management from proposed project activities would be similar to those described earlier in this section in "Impacts Common to All Action Alternatives." The area of disturbance would be larger under Alternative 5 in order to accommodate two separate facilities, one for NPAG tailings and one for PAG tailings, as well as ancillary tailings facilities such as borrow and storage areas, roads, and realignment of two existing transmission line corridors (10,782 acres). This would increase construction impacts on fuels and fire management and increase the length of the perimeter that abuts wildland fuels, elevating the potential for wildfire spread. However, the tailings facility is located at a greater distance from residential areas, and outside of any delineated WUI areas, which reduces the potential for fire originating from tailings activities to spread to homes and structures. Alternative 5 tailings facilities are also located in an area that has experienced lower fire occurrence historically than locations for other alternatives.

Alternative 5 would use ASLD, BLM, and private lands for the tailings facilities. Fire management would therefore differ when compared with other alternatives, including potentially slower response times due to the location. BLM fire management policy is to fully suppress all unplanned ignitions that occur in the district. Fire suppression on ASLD and private lands is provided by the Arizona Department of Forestry and Fire Management. Fires have a better chance of being contained during initial attack, before they can gain in size.

Alternative 6 – Skunk Camp

Potential impacts on fuels and fire management from proposed project activities would be similar to those described earlier in this section in "Impacts Common to All Action Alternatives." Similar to Alternative 5, Alternative 6 would be located at a greater distance from residential areas than Alternatives 2, 3, and 4, but slightly closer to WUI areas along the SR 177 corridor than Alternative 5. The footprint for the tailings facility under Alternative 6 would be substantially larger than under Alternatives 2, 3, and 4, but smaller than the footprint for Alternative 5. The tailings facility would be located in an area of steep terrain and heavy shrub fuels (fuel model SH7) that would burn with intense fire behavior in the event that an ignition occurs; however, historically fire occurrence in the area has been infrequent and potential ignitions originating from the tailings facility would be limited, due to the nature of the activities there and fencing that prevents unauthorized access.

This alternative is the only alternative that would require a new transmission line to be constructed outside of an existing corridor. This would increase the risk of fire, by exposing surrounding wildland fuels to construction-related ignition sources.

This alternative would use ASLD and private lands. Fire suppression on ASLD and private lands is provided by the Arizona Department of Forestry and Fire Management. Fires have a better chance of being contained during initial attack, before they can gain in size.

Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine, and as having potential to contribute to incremental changes in fuels and fire management conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *APS Herbicide Use within Authorized Power Line Rights-of-Way on NFS lands.* APS has proposed to include Forest Service–approved herbicides as a method of vegetation management, in addition to existing vegetation treatment methods, on existing APS transmission rights-of-way within five National Forests: Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto National Forests. If approved, the use of herbicides as well as currently authorized treatments would become part of the APS Integrated Vegetation Management approach. An EA with a FONSI was published in December 2018. The EA determined that environmental resource impacts would be minimal, and the use of herbicides would prevent and/or reduce fuel build-up that would otherwise result from rapid, dense regrowth and sprouting of undesired vegetation.
- *Ray Land Exchange and Proposed Plan Amendment*. ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed action, fire management on the selected lands would no longer be managed under their current respective resource management plans but would instead fall under the control of the new landowner. Wildfire management for the offered lands would fall under the administration of the BLM.
- *Tonto National Forest Travel Management Plan*. The Tonto National Forest is currently in the process of developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. This document and its implementing decisions are expected within the next 2 years. Specifically, the Supplemental EIS currently proposes a total of 3,708 miles of motorized routes open to the public, a reduction from the 4,959 miles of motorized open routes prior to the Travel Management Rule. Limiting availability of motorized routes open to the public would result in reduced access to recreational activities currently practiced on the Forest, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products. Such a reduction in miles of available motorized routes has the potential to lower overall risks of inadvertent human-induced wildfire.

The RFFAs concerning APS's new Integrated Vegetation Management strategy using herbicides would act to reduce the overall fuel loads and fire potential in and around the proposed Resolution Copper Mine. This would incrementally reduce fuel loads, reduce wildfire risk, and mitigate potential extreme fire behavior when considered together with development of the Resolution Copper Project. The Ray Land Exchange would remove over 10,000 acres from Federal ownership and reduce the ability for BLM to manage resources to reduce wildfire risk, potentially increasing fuel loading. Combined with the potential for accidental ignition from mining activities that might occur on the parcels, this increases wildfire risk when considered together with development of the Resolution Copper Project.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

There were no mitigation measures applicable to fuels and fire that were considered required; therefore, no mitigation ideas were considered in the analysis.

UNAVOIDABLE ADVERSE IMPACTS

While increased risks of fire ignition from mine activities cannot be entirely prevented, risks are expected to be substantially mitigated through adherence to a fire plan that requires mine employees to be trained for initial fire suppression and to have fire tools and water readily available.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Impacts from increased mine-related traffic, increased fire hazard, and hazardous materials use in mine operations would be short-term impacts that would end with mine reclamation.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

With respect to fuels and fire management, there are not expected to be any irretrievable or irreversible impacts on resources. Vegetation and fuels in the project area would be constantly changing as reclamation procedures are implemented. Eventually, reclamation is expected to return site vegetation to a state that is reminiscent of existing vegetation communities in the area.

3.10.3 Hazardous Materials

3.10.3.1 Introduction

Hazardous materials in the context of this project include fuels, chemicals, and explosives that are used for mine equipment and operations. These materials must be transported to the mine properties, stored, and if not consumed by the process, disposed of properly.

3.10.3.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The geographic extent of the analysis area for hazardous materials, as shown in figure 3.10.3-1, encompasses any environmental impacts that may result from the transport, storage, use, or disposal of hazardous materials at the proposed project. Thus, it includes all primary mine components (East Plant Site, West Plant Site, tailings storage proposed and alternative locations, MARRCO corridor and filter plant and loadout facility, and linear facilities such as pipelines), as well as primary transport routes to and from each location. Utility corridors were not considered in the analysis area, as the use and risk of release of hazardous materials in these areas is considered negligible. In terms of supply routes, while there is no guarantee that shipments to mine facilities, including those of hazardous materials, would come solely from the Phoenix metropolitan area eastward along U.S. 60, this is considered the most likely scenario.

The analysis area for hazardous materials encompasses the operational areas of the proposed project (i.e., mine process facilities, fuel storage tanks, storage ponds), where hazardous materials would be used and stored. The potential exists at these locations for accidental leaks, spills, or releases to the environment (e.g., soils, vegetation, wildlife, aquifers, surface water drainages).

The temporal bounds of analysis for hazardous materials for the project includes the construction, operations, and closure and reclamation phases.

Note that the potential for and impacts of a release of concentrate, tailings, and process water during a pipeline failure or catastrophic failure of a tailings facility are analyzed in Section 3.10.1, Tailings and Pipeline Safety; the anticipated impacts from the expected migration of seepage from the tailings facility are analyzed in Section 3.7.2, Groundwater and Surface Water Quality; and the anticipated impacts from air emissions are analyzed in Section 3.6, Air Quality.

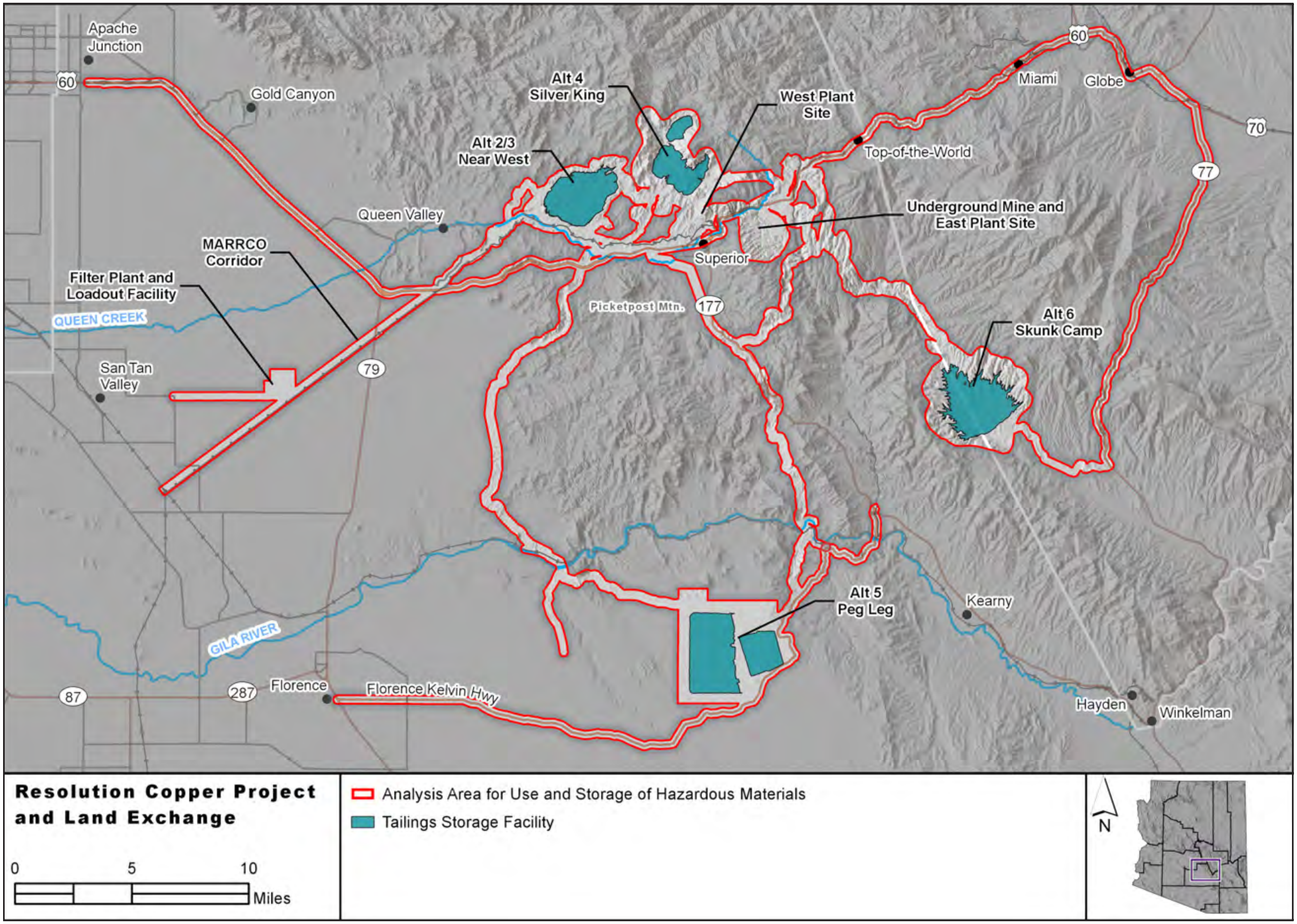

Figure 3.10.3-1. Hazardous materials analysis area

3.10.3.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

The use, storage, transport, and disposal of hazardous materials are governed by a variety of Federal and State laws, as well as Forest Service guidance. For more detail on the applicable guidance, see Newell and Garrett (2018c).

Primary Legal Authorities Relevant to the Hazardous Materials

- Resource Conservation and Recovery Act, including mining waste exclusion provisions (Subtitle C)
- Arizona Revised Statutes Title 49, Chapter 5 (Hazardous Waste Disposal)
- Emergency Community Planning and Right to Know Act
- Arizona Pollutant Discharge Elimination System (AZPDES) and Stormwater Pollution Prevention Plans
- Forest Service Manual 2100, “Environmental Management,” Chapter 2160, “Hazardous Materials Management”
- BLM Manual 1703, “Hazard Management and Resource Restoration (HMRR) Program”

Existing Conditions and Ongoing Trends

HISTORICAL AND CURRENT HAZARDOUS MATERIALS USE

Hazardous materials have historically been used for mining operations at the East Plant Site and West Plant Site and are currently being used for exploratory operations. The tailings facilities and filter plant and loadout facility are, in general, undeveloped natural desert that do not have a historical or current use of hazardous materials. Therefore, the following discussion provides the existing conditions for hazardous materials at the East Plant Site and West Plant Site.

EAST PLANT SITE

The East Plant Site is at the former site of the Magma Mine, which employed the use of hazardous materials like those that Resolution Copper currently uses for mineral exploration activities. Because the East Plant Site is currently in use, all Federal and State laws regarding the storage, use, transportation, and disposal of hazardous materials must be followed. Hazardous materials used at the East Plant Site for the exploratory operations include diesel fuel, oil/lubricants, antifreeze, and solvents. These materials are used for the operation and maintenance of mining equipment aboveground and belowground and are delivered to the East Plant Site by delivery trucks using Magma Mine Road from U.S. 60. Gasoline is not stored at the East Plant Site, but vehicles traveling to and parked at the East Plant Site use gasoline. At the East Plant Site, hazardous materials are stored in appropriate sealed containers (tanks, drums, and totes). Resolution Copper stores diesel fuel in an existing aboveground storage tank. The mine collects spent hazardous materials and either disposes of or recycles them with qualified vendors. To prevent potential surface spills from spreading and leaving the East Plant Site, a contact water basin contains surface water runoff.

WEST PLANT SITE

Parts of the West Plant Site were historically used as a concentrator and smelter site for the Magma Mine. The concentrator became operational in 1914, and the smelter site was operational between 1924 and 1972. These historic-era facilities are located adjacent to the town of Superior.

Particulate emissions from the smelter stack and fugitive emissions from other mineral processing operations (e.g., crushing and concentrating) led to soil contamination with elevated levels of arsenic, copper, and lead. In 2011, Resolution Copper conducted a site characterization study under the authority of the ADEQ Voluntary Remediation Program to understand the nature and extent of the historical soil contamination. The results of the site characterization study are presented in “Site Characterization Report for the West Site Plant, Superior, Arizona” (Golder Associates Inc. 2011).

After Resolution Copper conducted the site characterization study and the nature and extent of the soil contamination was better understood, they developed site-specific soil remediation levels for the contaminated soils that were approved by the ADEQ Voluntary Remediation Program. Resolution Copper then developed a Remedial Action Work Plan for returning the affected area to pre-contamination levels. The Remedial Action Work Plan involves excavating the contaminated soils, using the contaminated soils as fill for reclamation efforts at Tailings Pond 6, and capping the reclaimed tailings pond with cover material in accordance with APP requirements. The Remedial Action Work Plan was approved by the ADEQ in 2016, and remediation efforts for the historic smelter site are currently underway. Removal of the smelter building and stack was completed in December 2018.

The West Plant Site currently processes development rock from the East Plant Site’s exploratory operations. Because the West Plant Site is a currently operating mine facility, all Federal and State laws regarding the storage, use, transportation, and disposal of hazardous materials must be followed. Hazardous materials currently used at the West Plant Site are the same as described for the East Plant Site, except for the lab chemicals and reagents used at the West Plant Site’s laboratory to test the development rock. These chemicals are stored in appropriate individual containers in the Chemical Storage Facility in Building 203. The West Plant Site employs stormwater management controls and containment measures to prevent the spread of chemicals following an accidental release.

3.10.3.4 Environmental Consequences of Implementation of the Proposed Mine Plan and Alternatives

Alternative 1 – No Action

Under the no action alternative, the project area would remain in its present condition. The potential of additional impacts from hazardous materials would not occur, and there would be no risk of a potential accident or spill involving hazardous materials from the proposed project activities. Transportation of hazardous materials along U.S. 60 would continue to occur for non-mine-related businesses and industries that currently use the highway for hazardous materials deliveries.

Impacts Common to All Action Alternatives

Based on the preliminary GPO, potentially hazardous materials, including petroleum products, processing fluids, and reagents and explosives, would be transported to and stored within the boundaries of the mine in large quantities for use in various operational components of the mine (Resolution Copper 2016d). Hazardous and non-hazardous materials and supplies are included in section 3.9 of the GPO, “Materials, Supplies and Equipment.” Transportation of hazardous materials as well as proposed mining activities have the potential to release these materials into the environment and affect the natural condition of soils, vegetation, wildlife, surface water and groundwater resources, and air quality within the analysis area. The issues considered in this section are (1) the use, storage, and disposal of hazardous materials within the project area; (2) the transportation of hazardous materials to the project area; and (3) the potential for those materials to enter the environment in an uncontrolled manner, such as by accidental spill.

An accidental release or significant threat of a release of hazardous chemicals into the environment could result in direct and indirect harmful effects on or threat to public health and welfare or the environment. The environmental effects of a hazardous chemical release would depend on the substance, quantity, timing, and location of the release. A release event could range from a minor diesel fuel spill within the boundaries of the mine, where cleanup would be readily available, to a major or catastrophic spill of contaminants into a stream or populated area during transportation. Some hazardous chemicals could have immediate destructive effects on soils and vegetation, and there also could be immediate degradation of aquatic resources and water quality if spills were to enter surface water. Spills of hazardous materials could potentially seep into the ground and contaminate the groundwater system over the long term.

EFFECTS OF THE LAND EXCHANGE

The land exchange would have an effect on the potential presence and use of hazardous materials on these lands.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. The role of the Tonto National Forest under its primary authorities in the Organic Administration Act, Locatable Regulations (36 CFR 228 Subpart A), and Multiple-Use Mining Act is to ensure that mining activities minimize adverse environmental effects on NFS surface resources; this includes use of hazardous materials. The removal of the Oak Flat Federal Parcel from Forest Service jurisdiction negates the ability of the Tonto National Forest to regulate effects on these resources. No hazardous materials are presently being used at the Oak Flat Federal Parcel; once the land exchange occurs, Resolution Copper could use hazardous materials on this land without approval. However, all other environmental laws regarding the use, storage, transport, and disposal of hazardous materials would still apply and need to be followed.

The offered land parcels would enter either Forest Service or BLM jurisdiction. This would provide a new level of control over the use of hazardous materials on these properties.

EFFECTS OF FOREST PLAN AMENDMENT

The Tonto National Forest Land and Resource Management Plan (1985b) provides guidance for management of lands and activities within the Tonto National Forest. It accomplishes this by establishing a mission, goals, objectives, and standards and guidelines. Missions, goals, and objectives are applicable on a forest-wide basis. Standards and guidelines are either applicable on a forest-wide basis or by specific management area.

A review of all components of the 1985 forest plan was conducted to identify the need for amendment due to the effects of the project, including both the land exchange and the proposed mine plan (Shin 2019). No standards and guidelines were identified as applicable to hazardous materials. For additional details on specific rationale, see Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

A number of environmental protection measures are incorporated into the design of the project that would act to reduce potential impacts from hazardous materials and to reduce impacts on public safety from hazardous materials. These are non-discretionary measures outlined in a variety of protection plans (listed here and included in the GPO) and their effects are accounted for in the analysis of environmental consequences.

Applicable emergency response protection plans include the following:

- Spill Prevention Control and Countermeasures Plan (Appendix O of the GPO)
- Emergency Response and Contingency Plan (Appendix L of the GPO)
- Stormwater Pollution Prevention Plan (Appendix W of the GPO)
- Fire Prevention and Response Plan (Appendix M of the GPO)
- Environmental Materials Management Plan (Appendix V of the GPO)
- Explosives Management Plan (Appendix P of the GPO)

- Hydrocarbon Management Plan (Appendix U of the GPO)
- Tailings Pipeline Management Plan (AMEC Foster Wheeler Americas Limited 2019)
- Concentrate Pipeline Management Plan (M3 Engineering and Technology Corporation 2019b)

TRANSPORTATION OF HAZARDOUS MATERIALS

The impacts from the proposed action and the other action alternatives are identical with respect to the type and quantity of hazardous materials used, stored, disposed of, and transported. There may be slight variations in the location of use amongst the alternatives, such as the exact location of hazardous materials storage within the plant site, but these changes are considered insignificant for assessing impacts.

All hazardous materials and petroleum products would be transported to and from the project area by commercial trucks and rail access, in accordance with 49 CFR and 28 ARS. Transporters must be properly licensed and inspected, in accordance with ADOT guidelines. Hazardous materials must be properly labeled, and shipping papers must include information describing the substance, health hazards, fire and explosion risk, immediate precautions, firefighting information, procedures for handling leaks or spills, first aid measures, and emergency response contact information. Because of the quantity and number of daily deliveries, petroleum fuels are of the greatest concern.

Waste that may be classified as hazardous, such as grease, unused chemicals, paint and related materials, and various reagents, would be shipped to an off-site disposal facility licensed to manage and dispose of hazardous waste. Prior to disposal, Resolution Copper would be required to characterize the waste and properly mark and manifest each shipment.

TRANSPORTATION OF HAZARDOUS MATERIALS WITHIN THE MINE

Transportation of hazardous materials within the boundaries of the mine would occur on the primary access roads, in-plant roads between facilities, and haul roads. Hazardous materials would enter and exit the plant along the primary access roads. Once inside, all hazardous materials would be delivered to their appropriate storage location.

Reagents would be received from vendors and stored in individual storage tanks, drums on pallets, dry-storage silos, or a nitrogen tank. Refer to section 3.9 of the GPO, “Materials, Supplies, and Equipment,” for more detail on material being delivered and stored on-site. Deliveries of reagents, diesel fuel and gasoline, and nitrogen would be direct to storage locations. The plant layout would be designed so that these delivery trucks would remain in the right-hand traffic lanes.

FREQUENCY OF SHIPMENTS OF HAZARDOUS MATERIALS

Hazardous materials would be transported to the project area during the pre-mining and active mining phases of the mine. Section 3.4.2.1 of the GPO, “Construction Phase,” provides more detail regarding the estimated shipment of hazardous material in large quantities to and from the East Plant Site or West Plant Site, along with the expected quantities and number of trips. The most sensitive times of the day are considered to be around shift change and early weekday mornings and afternoons during school bus hours on U.S. 60.

ANALYTICAL LABORATORY

The analytical laboratory would be a pre-engineered building located at the West Plant Site. The laboratory would consist of a sample preparation area, a wet laboratory, a metallurgical laboratory, an environmental laboratory, offices, lunchroom, and restrooms. It would contain sample crushers, pulverizers, sample splitters, and a dust collection system to capture and contain any dust generated from this operation. The analytical laboratory would also contain a reagent storage area, balance rooms, and various types of analytical equipment. Disposal of chemical and laboratory waste would follow appropriate regulatory requirements, depending on the waste generated.

STORAGE OF HAZARDOUS MATERIALS WITHIN THE MINE

Storage of hazardous materials would begin during the pre-mining phase and continue through the active mining phase. All hazardous materials storage facilities would be removed during the final reclamation and closure phase of the mine. The storage facilities would be maintained throughout this period. Refer to appendix V of the GPO, “Environmental Materials Management Plan,” for more information.

HAZARDOUS WASTE MANAGEMENT AND DISPOSAL

A waste management plan was prepared for the preliminary GPO. The disposal of hazardous waste and petroleum products, along with the type of storage container, location, use, and quantity of these materials, is described in appendix V of the GPO, “Environmental Materials Management Plan.”

Many of the petroleum products and potential hazardous materials would be consumed during use by the various components of the mining operation and mineral processing circuits. However, potential hazardous waste that may be generated at the mine includes waste paint materials and thinners, chemical wastes such as acetone from the on-site laboratory, and residue wastes from containers or cans. As a generator of hazardous waste, Resolution Copper would be required to file for a hazardous waste identification number from the EPA and register as a hazardous waste generator with the ADEQ. Based on the proposed activities, the Resolution Copper Mine would likely qualify as a conditionally exempt small-quantity generator of hazardous wastes. Conditionally exempt small-quantity generators generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste.

FATE AND TRANSPORT OF POTENTIAL RELEASES

The potential impacts of accidental releases of hazardous materials or wastes depend on the nature of the material, the amount released, where in the environment the material or waste is released (soil, groundwater, or surface water), and the potential for migration of the material or waste.

POTENTIAL RELEASES TO SOILS OR SURFACE WATERS WITHIN THE MINE

Releases of hazardous materials within the boundaries of the mine could include accidental spills during use, rupture of storage tanks, release during emergency fire or explosion, or improper disposal. In almost all cases, hazardous materials would be released to soils. Release of hazardous materials into soils does not present a major environmental risk. Both wildlife and vegetation would be largely absent within the mine boundaries. Soils absorb and immobilize small amounts of hazardous materials, and within the controlled boundaries of the mine, it would be relatively easy to excavate and dispose of them.

The more significant risk is for hazardous materials, once within the soil matrix, to migrate to surface water or groundwater, either in dissolved phase or through erosion and movement of contaminated soil. With respect to stormwater, the mine stormwater management has been designed with two basic premises in mind: divert all possible stormwater away from the plant site (i.e., East Plant Site or West Plant Site) to avoid the potential for contamination, and treat all stormwater within the plant site as potentially contaminated, to be retained, recycled, and not discharged. For more information, refer to GPO Appendix W, “Stormwater Pollution Prevention Plan;” and GPO Section 4.5.4, “Stormwater Management.” There are no likely exposure pathways where a spill to soils or surface waters within the mine boundary would leave the site and impact downstream wildlife, vegetation, waters, or people.

POTENTIAL RELEASES TO GROUNDWATER WITHIN THE MINE

Any release of hazardous materials to soils presents the potential for release to groundwater, either directly if large enough quantities of hazardous materials are released, or indirectly through infiltration of precipitation or runoff through contaminated soils. In addition, the various storage ponds would provide a concentration point for potentially contaminated runoff, and infiltration could occur directly to groundwater from these locations.

The process water temporary storage ponds are double-lined with leak detection and collection in accordance with the ADEQ BADCT requirements. Infiltration is unlikely to occur under normal operating conditions, and leak detection is incorporated into the process water portion of the pond (see Section 3.3, "Milling and Processing," of the GPO).

If an unplanned spill were to occur, once released to groundwater the primary concern is migration of contaminants. Based on groundwater flow modeling (see section 3.7.2), releases underground are unlikely to migrate, as the dewatering has created a large hydraulic sink that prevents outward movement for hundreds of years. Spills at the surface within the East Plant Site would potentially migrate to the Apache Leap Tuff aquifer, which during operations generally would be draining toward the subsidence area and would be unlikely to migrate beyond the property boundaries. The tailings facilities all incorporate a suite of engineered seepage controls to capture seepage, and migration of an unplanned spill would be controlled as a matter of operations.

The primary concern would be spills within the West Plant Site that entered groundwater. These spills would likely migrate toward Queen Creek and eventually downstream. The primary exposure point would likely be Whitlow Ranch Dam, where groundwater is forced to the surface and supports perennial flow. If a spill migrated this far, it could impact wildlife, vegetation, and surface waters; the exact nature of impact is not possible to know without knowing the release volume and type of material released.

POTENTIAL RELEASES DURING TRANSPORTATION

Potential releases of hazardous materials during transportation could occur, but the fate and transport of those hazardous materials depend entirely on where the release occurs and the quantity of the release. In general, releases during transportation of hazardous materials on U.S. 60 could, if sufficient quantities were released, migrate to Queen Creek or Silver King Wash, either directly or as a result of contact between surface runoff and contaminated soil.

SIGNIFICANCE OF POTENTIAL RELEASES

The following uses present little risk of release, or risk of minor releases only:

- Laboratory reagents. Laboratory reagents are used in controlled conditions and in negligible or minor quantities.
- Cleaning fluids. Cleaning fluids generally are used in controlled conditions and in negligible or minor quantities.
- Sulfide mineral processing. These reagents are stored and used in minor quantities or are dry ingredients, presenting little risk for accidental release or migration.
- Hazardous waste. Hazardous waste does not present a high risk of accidental release when stored, transported, and disposed of properly.

Overall, the significant unmitigated risks of released hazardous materials based on amount, storage, and use are as follows:

- Catastrophic release of contaminant or petroleum product (i.e., gasoline, diesel, kerosene, new or used engine and gear oil, transmission fluid) during transportation.
- Catastrophic release of contaminants or major releases of petroleum product at storage tank locations within the mine or from the fuel piping system.

EFFECTS FROM CATASTROPHIC RELEASE DURING TRANSPORTATION

The effects of a catastrophic release of hazardous materials and/or petroleum products during transportation would depend on the specific location and amount of release. In general, there would be direct impacts on plants and wildlife in the immediate vicinity, direct impacts on soil in the immediate vicinity, and possible migration into surface water either directly or via stormwater runoff from contaminated areas. If migration occurs, there would be indirect effects downstream on vegetation, aquatic species, and wildlife. Along U.S. 60, most downstream impacts would occur along Queen Creek and its tributaries. Direct impacts on vegetation could include mortality or long-term loss of vigor; indirect effects could include long-term exposure of wildlife or humans.

There is also the potential for migration into groundwater, depending on the exact location of the release. Typically, a one-time accidental release, even if catastrophic, does not pose as large a risk for groundwater contamination as it does for contamination of surface water or soils, as product is often held up in soil or recovered during the emergency response before migration can occur.

EFFECTS FROM CATASTROPHIC OR MAJOR RELEASES WITHIN THE MINE

Minor amounts of petroleum products accidentally released within the boundaries of the mine can often be completely mitigated. Major releases unable to be completely mitigated can come in two forms: catastrophic release and long-term undetected release.

Catastrophic release would include damage to a storage tank or fuel piping system and the immediate loss of most or all of the stored product. This type of release would differ from a similar catastrophic release experienced during transportation; within the mine there are fewer receptors, less potential for migration, and more opportunities to fully control any spill. In general, there would be immediate direct impacts on soil and vegetation, but there would be little potential for migration beyond the boundaries of the mine either in surface water or groundwater. Most of the areas within the mine site are developed with little vegetation or natural soil, making either direct impacts (mortality, loss of vigor) or indirect impacts (long-term exposure of wildlife or humans to pollutants) unlikely.

In the event of a long-term undetected release, quantities are small enough that there would be no immediate effects on plants or animals and little potential for migration via stormwater. There is a greater potential for direct effects on soil and groundwater in the immediate vicinity, as the minor releases migrate downward undetected. As noted earlier in this section, the only facility with a likely migration downstream is at the West Plant Site, in close proximity to Queen Creek.

Cumulative Effects

The Tonto National Forest identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine, and as having potential to contribute to incremental changes in hazardous materials conditions near the Resolution Copper Mine. As noted in section 3.1, past and present actions are assessed as part of the affected environment; this section analyzes the effects of any RFFAs, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

- *Pinto Valley Mine Expansion.* The Pinto Valley Mine is an existing open-pit copper and molybdenum mine located approximately 8 miles west of Miami, Arizona, in Gila County. Pinto Valley Mining Corporation is proposing to expand mining activities onto the Tonto National Forest and extend the life of the mine to 2039. EIS impact analysis is pending. Potential impacts on public health and safety are expected to include the potential for exposure from accidental spills of hazardous materials being transported to or from the mine.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. The tailings storage facility is to be situated in the Ripsey Wash watershed just south of the

Gila River approximately 5 miles west-northwest of Kearny, Arizona. The new tailings storage facility would be designed to replace the existing Elder Gulch tailings storage facility and would be operated with the current on-site workforce. The tailings pipeline across Gila River would be double-cased, and a tailings collection pond would be in place in the event of a problem or maintenance issue. Spill control contingency plans as required by the ADEQ would be in place to handle accidents and spills. Hazardous materials spill and/or exposure risks would be low given safety awareness and precaution measures. Cumulative effects from this project are primarily associated with Alternative 5 – Peg Leg, as the same transportation routes would be used, and the pipelines and tailings facilities for the two projects are in close proximity.

- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is also seeking to complete a land exchange with the BLM by which the mining company would gain title to approximately 10,976 acres of public lands and federally owned mineral estate located near ASARCO's Ray Mine in exchange for transferring to the BLM approximately 7,304 acres of private lands, primarily in northwestern Arizona. It is known that at some point ASARCO wishes to develop a copper mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed action, BLM would transfer their regulatory, managerial, and administrative responsibility for hazardous materials from the selected lands to the offered lands. Hazardous materials would still be regulated under standards administered by MSHA.

Other future projects not yet planned, such as commercial development, large-scale mining, and pipeline projects, are expected to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). These types of unplanned projects, as well as the specific RFFAs listed here, would contribute incrementally to changes in hazardous materials conditions. Hazardous materials from these projects are expected to include explosives, lubricants, fuels, solvents, antifreeze, transmitted petroleum products, etc. Each project would transport, use, and store hazardous materials to varying degrees based on the type of commercial enterprise. As each new project comes online it would constitute an incremental increase in hazardous materials when considered with the proposed Resolution Copper Project. However, hazardous materials used on mining projects would be regulated under MSHA, and hazardous materials involved in other projects would be regulated under the appropriate State or Federal regulations, depending upon project type and land ownership.

Mitigation Effectiveness

The Forest Service is in the process of developing a robust mitigation plan to avoid, minimize, rectify, reduce, or compensate for resource impacts that have been identified during the process of preparing this EIS. Appendix J contains descriptions of mitigation concepts being considered and known to be effective, as of publication of the DEIS. Appendix J also contains descriptions of monitoring that would be needed to identify potential impacts and mitigation effectiveness. As noted in chapter 2 (section 2.3), the full suite of mitigation would be contained in the FEIS, required by the ROD, and ultimately included in the final GPO approved by the Forest Service. Public comment on the EIS, and in particular appendix J, will inform the final suite of mitigations.

At this time, no mitigation measures have been identified that would be pertinent to hazardous materials. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, would be a requirement for the project, and have already been incorporated into the analysis of impacts.

UNAVOIDABLE ADVERSE IMPACTS

While the risk of hazardous materials spills would increase during construction and active mining phases, following applicable Federal and State laws and regulations for storage, transport, and handling of such materials is expected to mitigate for this risk. Resolution Copper has prepared a wide variety of emergency response and material handling plans; implementation of these plans minimizes the risk for unexpected releases of hazardous materials and provides for rapid emergency cleanup.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Impacts from increased mine-related traffic, increased fire hazard, and hazardous materials use in mine operations would be short-term impacts that would end with mine reclamation.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible impacts with respect to public health and safety are not expected. All potential hazards discussed are limited solely to the construction and operations phases and are not expected to remain after closure of the mine. Therefore, they would constitute an irretrievable commitment of resources.

With respect to hazardous materials, there are not expected to be any irretrievable or irreversible impacts on resources. Although there is the potential for contamination of surface water, groundwater, or soils in the event of a spill or accidental release, this is not expected to occur, and environmental remediation is possible (and required by law) if it does occur.