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Tonto National Forest
Arizona

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Process Memorandum to File

Public Health and Safety Resource Analysis: Assumptions, Methodology Used, Relevant Regulations, Laws, and Guidance, and Key Documents

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Revision History

Date	Personnel	Revisions Made
08/06/18	Emily Newell	Process memo created
10/26/18	Chris Garrett	Edits made on tailings safety
11/16/18	Emily Newell	Edits made on fuels and fire and hazardous materials
01/14/19	Emily Newell	Ready for PM Review
7/12/19	Donna Morey	Update process memo to Draft EIS section
8/4/19	Chris Garrett	Final update for consistency prior to Draft EIS release

Purpose of Process Memorandum

In order to provide a concise and accessible summary of resource impacts, certain detailed information has not been included directly in the environmental impact statement (EIS). The purpose of this process memorandum is to describe additional supporting resource information in detail. The Public Health and Safety section of Chapter 3 of the EIS includes brief summaries of the information contained in this process memorandum. This process memorandum covers the following topics:

- Resource Analysis Area
- Analysis Methodology
- Regulations, Laws, and Guidance
- Key Documents and References Cited

Public health and safety involves three distinct areas of analysis: tailings safety, fuels and fire management, and hazardous materials. Each section is analyzed separately within this process memorandum to distinguish between the assumptions, methodology used, and relevant regulations, laws, and guidance in each resource.

Detailed Information Supporting EIS Analysis – Tailings and Pipeline Safety

Resource Analysis Area

Temporal Analysis

Risks to public health and safety due to the tailings storage facility primarily occur during operations and post-closure, once a tailings embankment has been constructed and tailings material begins to be deposited in the facility. Risks to public health and safety due to the tailings or concentrate pipelines occur solely during operations; there is no risk from the pipelines once the mine has ceased operations.

Spatial Analysis Area

The analysis area for tailings and pipeline safety primarily consists of all downstream areas that could be affected in the event of a partial or complete failure of the tailings embankment, or from a rupture of a tailings pipeline or concentrate pipeline.

Analysis Methodology

In concept, a tailings embankment failure can be viewed as being similar to other high-consequence, low-probability events, such as wildfires, hazardous material spills, mine emergencies, or 1,000-year floods. We typically do not analyze these types of events in detail in an EIS because they are not part of the proposed action, and they are not reasonably likely to occur because of the proposed action. Given their nature, it is not possible to predict exactly where and how these events might occur; therefore, it is difficult to disclose what effects they might have with any accuracy. By definition a failure is the outcome of unexpected conditions; mining companies do not design tailings embankments to fail. For example, in the case of a high-profile incident, the Fundão tailings dam failure in Brazil in 2015, the failure was in part the result of a string of three specific poor operational decisions that deviated from the original design (Fundão Tailings Dam Review Panel 2016). Analyzing a dam failure and the environmental consequences of such a failure is a difficult proposition.

Difficulties aside, the U.S. Forest Service has a more fundamental responsibility than the disclosure requirements under the National Environmental Policy Act (NEPA), which is to ensure that any tailings dam designed and built on Federal land meets or exceeds expectations for safety. Fundamentally, the Forest Service believes that no tailings failure is acceptable. Any tailings failure, at any proposed location, would lead to unacceptable consequences. This belief was echoed by the Mt. Polley Independent Expert Engineering Investigation and Review Panel in their report on the 2014 tailings dam failure:

> In risk-based dam safety practice for conventional water dams, some particular level of tolerable risk is often specified that, in turn, implies some tolerable failure rate. The Panel does not accept the concept of a tolerable failure rate for tailings dams. To do so, no matter how small, would institutionalize failure. (Province of British Columbia 2015)

The Forest Service undertook the following approach for analysis of the potential failure of the tailings embankment:

1. Assess the regulatory and industry framework under which tailings embankments are constructed;
2. Demonstrate that the Resolution Copper Mining, LLC (Resolution Copper) design criteria meet and exceed applicable standards, whether legally binding or not;
3. Describe the potential failure modes for tailings embankments and specifically how those failure modes are being addressed in the design (a failure modes analysis);
4. Describe general consequences of failure (a breach analysis); and

5. Describe future steps that would be taken prior to approval of a final plan of operations to further ensure safety.

For the EIS analysis, a hypothetical failure was assessed as a low-probability, high-consequence event in order to provide a qualitative assessment of such a failure, and to consider the relative consequences for each of the alternative sites.

Available Options for 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 dam height or total facility volume). These methods include the empirical, rheological, and energy balance methods described below. More refined methods that use advanced computer modeling or simulations require detailed site-specific information. Several possible advanced modeling methods are described below.

Of the techniques described below, for the preliminary breach analysis used in the draft EIS (DEIS), the Forest Service has chosen the Rico empirical method.

Empirical Method

Empirical methods use the known characteristics of historic tailings facility failures in order to estimate the characteristics of a failure at a hypothetical tailings facility. 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 data set included the two largest and most recent failures (at the time): Mount Polley in 2014, and Fundão 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. The second relationship predicts the maximum travel distance downstream based on the release volume and the embankment height. 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.

As noted in the DEIS, there are substantial limitations to the empirical approach:

- The largest facility in the data set is 74 million cubic meters,[1] 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 data set.
- 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

[1] 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.

used centerline (matching Alternatives 5 and 6) (Bowker 2019). The empirical data set is therefore not representative of the specific design proposed by Resolution Copper. The Resolution Copper facility has 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).

- The data set 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 is designed to modern standards (described in more detail in the DEIS in section 3.10.1.3, "Relevant Laws, Regulations, Policies, and Plans").
- 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 a preliminary breach analysis 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.

Rheological and Energy Balance Methods

Various researchers have developed methods for estimating tailings runout distances and depths based on fundamental physics equations. These methods are similar in that they envision an idealized block of tailings on a perfectly flat surface being allowed to come to rest. Jeyapalan (1982) presented a method for estimating runout based on the rheological (flow) properties of liquified tailings. This simplification can predict a depth of tailings at a given time and distance from the embankment, based on the physical properties of the tailings and the height of the embankment. However, it is assumed to occur over a wide breach and on a perfect planar surface with no real-world topography.

Seddon (2010) and Hungr (1995) both present methods that compare the potential energy of the tailings with the friction or physical resistance to the flow, in order to estimate the final resting shape. Energy balance can predict runout distance based on the physical properties of the tailings and the height of the embankment, but still must assume a release volume. These methods also assume a wide breach on a perfect planar surface with no real-world topography.

Seddon (2010) compared rheological and energy balance methods and found they had general agreement when calculating runout distance.

The Forest Service chose to use neither rheological nor energy balance methods. Unlike the empirical method, which relies on a database of real-world historical outcomes, these methods are highly idealized and take no account of real-world conditions. These methods also offer no method for estimating release volume, unlike the empirical method.

Advanced Modeling

Advanced modeling of a tailings breach and the downstream runout of tailings is complex and requires a high level of specific information on the embankment itself and the tailings properties. This information is required because the tools appropriate for the modeling differ based on the exact nature of the failure and the tailings. The Federal Emergency Management Agency (FEMA) has also issued guidance for conducting inundation modeling under the National Dam Safety Program (Federal Emergency Management Agency 2013).

One of the critical pieces of information is the percent solids, by volume. Roughly speaking, when the percent solids is below 20 percent, the runout is modeled as a Newtonian fluid, like water. Above 40 percent solids, the runout behaves as a non-Newtonian fluid, which becomes complex to model as the fluid properties and behavior change as stresses change. Between 20 and 40 percent solids, the flow might behave either as a Newtonian or non-Newtonian fluid.

Table 1 summarizes types of dam breaches and the models that are appropriate for use. Three of those models that are commercially available are briefly described below.

Table 1. Advanced Modeling Packages Potentially to be used for Refined Breach Analysis

Volumetric Sediment Concentration	Tailings Breach Cases	Flow Type		Applicable Models		
0%	1A,1B	Newtonian Flow		HEC-RAS	FLD-WAV, FLO-2D	
10%						
20%						
30%			Non-Newtonian Flow			DAN3D,MADFlow-3D*
40%						
45%	2A					
50%						
55%						
60%	2B					
70%						
80%						

* DAN3D and MADFlow-3D are not currently commercially available

Summary of tailings breach cases (Small et al. 2017):

1A – Release of recycle pond and liquified tailings; modeling includes the water in the facility, the liquified tailings, and tailings eroded by the release. Modeling involves both the initial flood wave and the deposition of solids downstream.

1B – Release of recycle pond, but tailings do not liquify; modeling includes the water in the facility and tailings eroded by the release. Modeling involves both the initial flood wave and the deposition of solids downstream.

2A – Release of liquified tailings without recycle pond. Modeling involves just the deposition of solids.

2B – Release of non-liquified tailings without recycle pond. Modeling involves just the deposition of solids.

FLDWAV

FLDWAV is a generalized flood or mud/debris flow routing program for one-dimensional flow, developed by the National Weather Service in 1998 (but no longer supported by the agency.

The FLDWAV model is based on the Saint-Venant equations and includes additional functions for dam failure, expansions/contractions, channel sinuosity, and non-Newtonian flow (Fread and Lewis 1998).

HEC-RAS

The HEC-RAS program was first released for one-dimensional steady and unsteady flow by the U.S. Army Corps of Engineers (USACE) in the 1990s (U.S. Army Corps of Engineers 2016). The dam breach module integrated in HEC-RAS can simulate overtopping and piping failures with user-defined dam breach parameters such as breach width, breach bottom elevation, breach formation time, etc. HEC-RAS is also capable of simulating sediment transport with a movable boundary flow.

FLO-2D

FLO-2D was developed in the 1990s, and can simulate overtopping and piping dam failures using a dam breach code that is based on the NWS BREACH model or using breach parameters input by the user. The subsequent flow propagation is simulated with a two-dimensional dynamic flood routing model. FLO-2D also has the option to simulate sediment transport and non-Newtonian flows like the Bingham flow (FLO-2D Software Inc. 2009, 2011). For high sediment concentrations, FLO-2D can simulate flows of viscous mudflows that could be approximated as tailings flow and deposition processes.

Forest Service Chosen Methodology

Aspects that were weighed by the Forest Service when choosing an appropriate breach analysis method for the DEIS are summarized in Table 2. To summarize, for the DEIS the Forest Service has chosen to use a preliminary breach analysis using the Rico empirical method. There are substantial limitations to this method, but it allows a rough estimate of the magnitude and extent of downstream effects based on available information, and is sufficient to inform the NEPA assessment of alternatives.

For the Final EIS, the Forest Service will lead a full Failure Modes and Effects Analysis (FMEA) process using advanced design and site-specific information for the Preferred Alternative. The results of the full FMEA will inform the selection of a reasonable failure scenario, and a breach analysis will be conducted for that scenario using an advanced computer model or simulation.

Table 2. Comparison of Breach Analysis Methodologies

	Method of Estimating Runout	**(Roughly in order of difficulty→)**					
	No Estimate of Runout	**Empirical Method** (Rico et al. 2008) (Larrauri and Lall 2018) (Chambers and Bowker 2017) [https://columbiawater.shinyapps.io/ShinyappRicoRedo/]	**Rheological Method** (Jeyapalan 1982) [http://www.wise-uranium.org/ctfs.html]	**Energy Balance Methods** (Seddon 2010) (Hungr 1995)	**Full Runout Analysis (FLOW2D or similar) on Arbitrary Release**	**Full Runout Analysis (FLOW2D or similar) on Rico-sized Release**	**Full Runout Analysis (FLOW2D or similar) on FMEA-derived Release**
Output variables provided by method	None	• Volume of release (formula essentially is one-third of total volume) • Distance downstream • Because this is an empirical analysis, can also calculate percentiles and ranges	• Depth of tailings at varying distances downstream • Travel time for various distances downstream	• Distance downstream	• Spatial maps of tailings depth • Travel time for various distances downstream?	• Spatial maps of tailings depth • Travel time for various distances downstream?	• Spatial maps of tailings depth • Travel time for various distances downstream?
Variables needed in order to use method	None	• Total facility volume • Dam height	• Dam height • Need to estimate tailings rheological properties	• Need an assumed release volume • Dam height • Need to estimate tailings rheological properties	• Need an assumed release. Prior work selected 10 Mm3 consistent between alternatives. • Need to assume the exact release location along dam • Need detailed topography • Need decision on effect of Whitlow Ranch Dam	• Use release assumed using Rico approach (one-third of total facility volume) • Need to assume the exact release location along dam • Need detailed topography • Need decision on effect of Whitlow Ranch Dam	• Use release volume developed by FMEA process • Use exact release location along dam developed by FMEA process • Need detailed topography • Need decision on effect of Whitlow Ranch Dam
Concerns with method	• Does not provide any disclosure of magnitude of a release, except descriptions of past failures (Mount Polley and Fundão)	• Data set is predominantly upstream dams (24 of 35) • Resolution Copper facility is more than an order of magnitude greater than the largest dam in the data set; we are extrapolating well beyond the data • Does not reflect tailings properties • Does not reflect real-world topography	• Assumes a perfectly flat idealized surface • Does not reflect tailings properties • Does not take into account changes with flow characteristics from added water (Gila River)	• Assumes a perfectly flat idealized surface • Does not reflect tailings properties • Still requires estimate of a release volume using some other method • Does not take into account changes with flow characteristics from added water (Gila River)	• Still requires estimate of a release volume using some other method	• Returns a realistic output, but is entirely dependent on the Rico method and those limitations/concerns	• No specific concerns identified

Assessment of Need to Collect Additional Information

In several circumstances in the analysis of Tailings and Pipeline Safety (section 3.10.1 of the DEIS), uncertainties exist, particularly with the foundation characteristics or geologic conditions at specific alternative locations.

As noted in the DEIS, this information is critical to the final design of a tailings facility and would be incorporated into the FMEA that is intended to be conducted between the Draft EIS and Final EIS, for the Preferred Alternative. During the FMEA, 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.

However, these uncertainties do not undermine the DEIS analysis. Council on Environmental Quality (CEQ) regulations address the need for additional data collection under 40 CFR 1502.22. The ability to collect additional information needs to be addressed when "…the incomplete information relevant to reasonably foreseeable significant adverse impacts is *essential to a reasoned choice among alternatives*…" (emphasis added).

While specific information would guide actual designs, enough existing information about the general foundation characteristics is known to allow an assessment of the strengths and weaknesses of each tailings alternative. The differences in foundation characteristics, site location, and known geologic conditions are clearly identified for each alternative. More detailed subsurface geologic information would supplement the current geologic knowledge used, but is not likely to contradict the basic differences between alternatives being considered in the DEIS.

Regulations, Laws, and Guidance – Tailings and Pipeline Safety

Several Federal and State agencies regulate tailings dams in the United States. Federal agencies with authority over aspects of tailings facilities include the Bureau of Land Management (BLM) and U.S. Forest Service (depending on jurisdiction), and the U.S. Environmental Protection Agency (EPA) and the USACE (potential permitting under Clean Water Act Section 404). In Arizona, tailings dam safety is primarily regulated by the office of the Arizona State Mining Inspector, and Arizona Department of Environmental Quality (ADEQ).

Table 3 lists relevant laws and regulations for tailings dams. Given the large scale of mining projects, it is not uncommon for mine facilities to be located in both Federal and State jurisdictions. In addition to the governing Federal or State regulations, there are also international, agency, and industry guidelines that may be applicable for tailings dams. In some cases, international guidelines may be more stringent than the governing regulations, and additional measures may be needed to meet all guidelines. Table 3 lists guidance and other considerations applicable to tailings dams; also see table 3.10.1-1 in the DEIS.

Table 3. Guidance on Tailings Embankments and Storage Facilities from Various Sources (may or may not be applicable to Resolution Copper Project)

Type of Guidance	Entity	Specific Reference
Federal	Federal Emergency Management Agency National Dam Safety Program	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 National Dam Safety Program Act (Establishing the National Dam Safety Program), Public Law 104-303, Section 215
Federal	Forest Service	Mineral regulations identifying that "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))
Federal	Bureau of Land Management	Mining regulations requiring the "prevention of unnecessary or undue degradation" (43 CFR 3809), in addition to the applicable considerations for surface use and occupancy (43 CFR 3715)
Federal	U.S. Army Corps of Engineers	Coastal Engineering Manual. EM 1110-2-1100. April 2002 General Design and Construction Considerations for Earth and Rock-Fill Dams. EM 1110-2-2300. July 2004 National Dam Safety Inspection Program (Public Law 92-367)
Federal	U.S. Environmental Protection Agency	Technical Report - Design and Evaluation of Tailings Dam. EPA 530-R-94-038. August 1994
State	Arizona APP Program	Arizona Mining Guidance Manual BADCT. Aquifer Protection Program. Publication No. TB-04-01. 2004
State	Arizona State Mine Inspector	Arizona Revised Statutes Title 27, Ch. 1, Art. 2, establishing and outlining the powers of the state mine inspector
State	Arizona Department of Water Resources	Arizona Administrative Code Title 12, Chapter 15; while tailings dams are exempt from regulation (R12-15-1203.7), this chapter contains requirements for dam safety applicable in Arizona
Industry Best Practices/ International	Rio Tinto	D5 - Management of tailings and water storage. Document No: HSEC-B-23. August 2015

Type of Guidance	Entity	Specific Reference
Industry Best Practices/ International	International Council on Mining and Metals	Position statement on preventing catastrophic failure of tailings storage facilities
Industry Best Practices/ International	Canadian Dam Association	Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams. 2014
Industry Best Practices/ International	Mining Association of Canada	A Guide to the Management of Tailings Facilities. 2019
Industry Best Practices/ International	International Commission on Large Dams	Compiles information on large dams worldwide, including causes of failure (https://www.icold-cigb.org/GB/dams/dams_safety.asp)
Industry Best Practices/ International	Australian National Committee on Large Dams	Guidelines on Tailings Dams: Planning, Design, Construction, Operation and Closure. May 2012
Industry Best Practices/ International	British Columbia Ministry of Energy and Mines	Health, Safety and Reclamation Code for Mines in British Columbia. June 2017

Federal Guidance

As noted in the DEIS, while neither BLM nor Forest Service guidance contains prescriptive requirements for how tailings embankments must be constructed, 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 in the DEIS (Federal Emergency Management Agency 2004, 2005, 2013).

State Agencies

Outside of Forest Service or BLM requirements, the most direct regulation for tailings embankments is through the ADEQ Aquifer Protection Permit (APP) process. This permit is required if the proposed facility has the possibility to discharge directly to an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that a pollutant could reach an underlying aquifer. This requires that facilities be constructed, operated, and maintained within Arizona Numeric Aquifer Water Quality Standards (AWQS) as monitored at applicable points of compliance.

Under the APP process, the tailings storage facility must be designed to meet the standards of prescriptive Best Available Demonstrated Control Technology (BADCT) and must be protective of water quality during operations and at closure. BADCT is utilized to prevent or reduce the discharge of pollutants to the aquifer and to confirm that aquifer quality standards will not be exceeded at the point of compliance (or that existing water quality will not worsen if standards are already exceeded at the point of compliance at the time of permit issuance). The BADCT guidance provides recommended geotechnical criteria for static and dynamic (earthquake) stability of tailings embankments, including minimum design earthquake magnitude and factors of safety for various loading conditions as well as maximum deformation magnitudes under seismic loading.

The APP requires facility inspections by the permittee which are to be instituted at the time of impoundment construction and thereafter on a quarterly basis and after major storm or surface water events. At a minimum, facility inspection will include: 1) a visual survey of the impoundment to evaluate its overall integrity, and 2) physical inspection of the impoundment to ensure design capacity and other engineering criteria are not exceeded. Additionally, all pipelines that transport fluids from or to the tailings impoundment are to be included in the facility inspection to evaluate the integrity of the structures over time. The APP also requires that the project proponent has the financial and technical capabilities to comply with the permit.

The applicant must also propose and draft a contingency plan to be approved by ADEQ. The plan shall be implemented in the event of an accidental discharge from the facility. The plan will identify the discharge discovery and notification procedure, and the general clean up and reporting procedures. In the event of an uncontrolled discharge from the impoundment, solutions contained within the impoundments are to be sampled to determine what has been discharged.

The responsibility for supervision of the safety of dams in Arizona is assigned to the Director of the Arizona Department of Water Resources (ADWR), Office of Dam Safety and Flood Mitigation. The ADWR statutes and rules define a dam as an artificial barrier over 25 feet in height or capable of storing more than 50 acre-feet of water. Tailings dams are not considered to be under ADWR jurisdiction; however, ancillary structures such as seepage control dams may be considered jurisdictional.

Industry Best Practices

There are several best practice guidelines covering the design and management of tailings storage facilities. The Mining Association of Canada (MAC), International Commission on Large Dams (ICOLD), Australian National Committee on Large Dams (ANCOLD), Canadian Dam Association (CDA), USACE, and South African National Standard (SANS) are all considered to provide best practice guidance. The Canadian guidelines (MAC and CDA) when taken together represent the most comprehensive of the national frameworks (Golder Associates 2016). The CDA and MAC guidelines contain key technical components, including those critical to the physical and chemical stability of tailings facilities, as well as key management components throughout the tailings facility's life cycle, such as change management, critical controls for risk management, and performance evaluation.

These standards are not applicable in a regulatory sense, but it has been recognized by the Independent Technical Review Board (ITRB) established by Resolution Copper that "the intent should be to meet international best practices that reflect the nature of hydraulic deposition, height and desert environment" (Resolution Copper 2017).

Best practices should include lessons learned from recent tailings failures, including the 2014 tailings incident at the Mount Polley Mine in British Columbia (BC) and the 2015 Fundão tailings dam failure at Samarco in Brazil. Both serious failures were determined to be due to design flaws. The BC Government-appointed Independent Expert Panel that examined the Mount Polley incident recommended that any mining operation proposing to operate a tailings facility in BC should either be required to adhere to the MAC guidelines or be obliged to commit to an equivalent program with auditing requirements. The Samarco incident was noted by the ITRB as potentially relevant to the Resolution Copper tailings facility design criteria development and stated, "[A]ll potentially liquefiable materials should be assumed to liquefy regardless of the triggering mechanism. This reflects a key learning from the failure of the upstream-constructed Fundão tailings dam at Samarco in Brazil. The seismic hazard at Samarco was low, as it is for Resolution, yet the impoundment suffered a static liquefaction failure. The design must provide either a dilatant or drained structural shell to provide resiliency against operational upsets that can happen during TSF construction" (Resolution Copper 2017).

In 2016, the International Council on Mining and Metals (ICMM) published a position statement on preventing catastrophic failure of tailings storage facilities and requires its member companies to commit to implementing practices consistent with a Tailings Governance Framework (International Council on Mining and Metals 2016). The ICMM considers the following minimum requirements for tailings management best practices:

- A current life-of-facility plan comprising a mine and site-specific sub-plan for each phase in the life cycle of the facility.
- An operating plan and procedures for each phase that clearly communicate the operating constraints imposed by the dam section, construction method, the consequences of breaching these operating constraints, prescribe critical procedures, and define roles, responsibilities and level of competency required, and clearly identify decision-making authorities.
- A resourcing plan for each phase that defines the human, financial, and system-related requirements as well as the training that is required.
- The tailings facility infrastructure and management requirements must be informed by the potential for the facility to do harm. As such, the baselines that characterize the residue source and the potential impacts on the environment and the extent of physical impacts in the "zone of influence" associated with a potential dam break must be well understood at the outset. The consequence classification of the tailings facility must follow from this understanding.
- All phases of the life cycle and in particular the design and operational phases should be informed by and take into account the possible failure consequences identified in a formal risk analysis which is recorded in a risk register and periodically updated. The identification of failure modes, assignment of likelihoods of occurrence, and development of mitigation strategies should be carried out by suitably qualified individuals.
- The stringency of the design and analysis methods used should be based on the consequence classification of the facility and should include the use of state of practice analysis methods and references. The design must be informed by the risk assessment, and the essential requirements for operation upon which success of the design depends should be comprehensively captured in the construction and operational specifications. The designer should also explicitly define the resourcing implications that are key to the achievement of the design objectives.
- Design, construction, and operation, as a minimum, should take place under the supervision of a suitably qualified team led by an "Engineer of Record." The Engineer of Record may be changed during the life of the facility, but the mine owner must ensure that this process of transition takes place within a structured change management process that ensures that the new Engineer of Record internalizes the background and basis for the design.
- Independent review by suitably qualified and experienced professionals should take place at appropriate milestones and intervals during each of the design, construction, and operation phases.
- In the operational and decommissioning phases the operations, the maintenance and surveillance manual should be viewed as the definitive reference that sets out the operational requirements, constraints, and limits of the design and construction method. As such, the manual must be comprehensive and must cover aspects that provide background and context, such as the basis for the design, minimum competence and training requirements, and especially why monitoring and reporting must be diligently carried out. It should also define the responses to observations that need adaptive changes in operating management.

The design engineer must formally communicate the content and intent of the manual to the operators and should be engaged to update this communication on a regular basis. The emergency preparedness and response plan also forms an important part of the operational readiness and must be updated regularly and informed by the current consequences that could be associated with a dam break.

ICMM has found that although its member companies' systems/guidelines may vary in terms of content and comprehensiveness, most have corporate guidance documents that meet and sometimes go beyond what would be considered to be good practice in tailings management.

As noted in the DEIS, because of high-profile embankment failures and loss of life, the methods and standards to which the mining industry designs tailings storage facilities are evolving world-wide.

Post-Closure Regulation

Public health and safety issues can extend beyond the operational life of the tailings storage facility. A number of Federal and State regulations are relevant to reclamation of the mine lands and public health and safety. Closure/post-closure must be considered in the tailings facility design submitted to ADEQ. The Arizona Mined Land Reclamation Act (AMLRA) was designed to provide a mechanism to require the reclamation of mined land in Arizona. Reclamation plans are required to include topographic information of the site including regrading of disturbed areas, surface water routing and impoundments, and information on structures left at the site. Arizona Revised Statutes (ARS) §27-971(B)(9) requires reclamation measures that will be taken to restrict public access to pits, adits, shafts, and other surface features that may be a hazard to public safety and that address erosion control and stability.

The Forest Service does not have specific technical requirements related to reclamation plans. However, there are a number of standards used in required reclamation bond estimates to ensure that the reclamation objectives and requirements provided in the plan of operations have been achieved.

Typically, the following issues are addressed in the reclamation and bonding packages:

- Interim Operations and Maintenance. The plan must include any operations and maintenance needed to ensure the integrity of the project facilities and systems whose failure could potentially endanger human health and the environment in the unlikely event that there is no operator, and the Forest Service is responsible for the site.
- Hazmat. Isolation, removal, treatment, or control of hazardous or toxic materials.
- Demolition. Removal/disposal of non-contaminated facilities, equipment, and materials.
- Facility Design. All engineered facilities that will be left, or constructed for reclamation/closure will have design standards such as covers, caps, water diversions, dams, etc.
- Water Quality. Water quality standards that should be met by project discharges and any applicable water treatment activities.

- Landform. Acceptable post-mining land slopes, drainages, and contours.
- Stability. Standards for physical and chemical stability.
- Revegetation. Acceptable vegetative communities and ground cover requirements. The activities for this section include subsoil preparation, topsoil or other growth media, seedbed preparation and amendments, sediment control measures, seeding, or planting. Bonding should include provision for retreatment or noxious weed control.
- Mitigation. Mitigation required to compensate for damage which cannot be avoided. This can include stream channels, wildlife habitat, recreation, etc.
- Monitoring/Maintenance. Reclamation protection and monitoring requirements.
- Safety. All public safety requirements including fencing, signs, berms, etc.

Key Documents and References Cited for Tailings and Pipeline Safety

The following list is meant to highlight key process or analysis documents available in the project record. It should not be considered a full list of all available documentation considered within this process memorandum or the EIS analysis.

AMEC Foster Wheeler Americas Limited. 2019. Tailings Corridor Pipeline Management Plan, Resolution Copper, Superior, Arizona. May.

Arizona Department of Environmental Quality. 2004. Arizona Mining Guidance Manual BADCT. Aquifer Protection Program. Publication No. TB-04-01. Phoenix, Arizona: Arizona Department of Environmental Quality.

Australian National Committee on Large Dams Inc. 2012. Guidelines on Tailings Dams: Planning, Design, Construction, Operation and Closure. Hobart, Australia: Australian National Committee on Large Dams Inc. May.

Bowker, L.N. 2019. World Mine Failures as of March 2019 - Database. Available at: https://worldminetailingsfailures.org/. Accessed May 6, 2019.

Canadian Dam Association. 2014. Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams. Toronto, Canada.

Federal Emergency Management Agency. 2004. Federal Guidelines for Dam Safety. (FEMA-93). Available at: https://www.fema.gov/media-library-data/20130726-1502-20490-5785/fema-93.pdf. Accessed May 24, 2019.

———. 2005. Federal Guidelines for Dam Safety: Earthquake Analyses and Design of Dams (FEMA-65). Available at: https://www.fema.gov/media-library-data/20130726-1500-20490-5113/fema-65.pdf. Accessed May 24, 2019.

———. 2013. Selecting and Accomodating Inflow Design Floods for Dams. FEMA P-94. Available at: https://www.fema.gov/media-library-data/1386108128706-

02191a433d6a703f8dbdd68cde574a0a/Selecting+and+Accommodating+Inflow+Design+Floods+for+Dams.PDF. Accessed May 24, 2019.

FLO-2D Software Inc. 2009. FLO-2D Reference Manual. Nutrioso, AZ: FLO-2D.

———. 2011. FLO-2D: Two-Dimensional flood routing model that simulates river, alluvial fan,urban and coastal flooding. Retrieved January 7, 2011, from http://www.flo-2d.com/products/flo-2d/.

Fread, D.L., and J. M. Lewis. 1998. NWS FLDWAV Model: Theoretical Description and User Documentation. Hydrologic Research Laboratory, Office of Hydrology, National Weather Service.

Fundão Tailings Dam Review Panel. 2016. Report on the Immediate Causes of the Failure of the Fundão Dam. Available at: http://fundaoinvestigation.com/wp-content/uploads/general/PR/en/FinalReport.pdf. Accessed December 23, 2018.

Golder Associates Inc. 2018a. Draft EIS Design: Peg Leg Site Alternative 5. CCC.03-26000-EB-REP-00003. Lakewood, Colorado: Golder Associates Inc. June 20.

———. 2018b. Peg Leg Pipeline Corridor DEIS Report. Tucson, Arizona: Golders Associates Inc. July 2.

Golder Associates. 2016. Review of Tailings Management Guidelines and Recommendations for Improvement. Submitted to International Council on Mining and Metals. Golder Associates. December.

Golder Associates Ltd. 2015. Mount Polley Mining Corporation, Post-Event Impact Assessment Report - Key Findings Report. Vancouver, Canada: Golder Associates Ltd. June 5.

Hungr, O. 1995. A model for the runout analysis of rapid flow slides, debris flows, and avalanches. Canadian Geotechnical Journal 32:610–623.

International Council on Mining and Metals. 2016. Position statement on preventing catastrophic failure of tailings storage facilities. Available at: https://www.icmm.com/website/publications/pdfs/commitments/2016_icmm-ps_tailings-governance.pdf. Accessed December 22, 2018.

Jeyapalan, J.K. 1982. Dam-break studies for mine tailings impoundments. Uranium Mill Tailings Management. Proceedings of the Fifth Symposium, December 9–10, 1982.

Klohn Crippen Berger Ltd. 2018a. Resolution Copper Project: DEIS Design for Alternative 3A Near West Modified Proposed Action (Modified Centerline Embankment - "wet"). Doc. # CCC.03-26000-EX-REP-00002 - Rev.0. Vancouver, Canada: Klohn Crippen Berger Ltd. June 8.

———. 2018b. Resolution Copper Project: DEIS Design for Alternative 3B Near West Modified Proposed Action (High-density Thickened NPAG Scavenger and Segregated PAG Pyrite Cell). Doc. # CCC.03-26000-EX-REP-00005 - Rev.0. Vancouver, Canada: Klohn Crippen Berger Ltd. June 8.

———. 2018c. Resolution Copper Project: DEIS Design for Alternative 4 - Silver King Filtered. Doc. # CCC.03-26000-EX-REP-00006 - Rev.0. Vancouver, Canada: Klohn Crippen Berger Ltd. June 4.

———. 2018d. Resolution Copper Project: DEIS Design for Alternative 6 - Skunk Camp. Doc. # CCC.03-81600-EX-REP-00006 - Rev.1. Vancouver, Canada: Klohn Crippen Berger Ltd. August 8.

———. 2019a. Resolution Copper Project DEIS Alternatives Failure Modes. Doc. # CCC.03-81600-EX-REP-00011 - Rev.0. Vancouver, Canada: Klohn Crippen Berger Ltd. January.

———. 2019b. Resolution Copper Project: Summary of DEIS Tailings Alternatives Seepage Control Levels. Doc. # CCC.03-81600-EX-LTR-00001 - Rev.0. Vancouver, Canada: Klohn Crippen Berger Ltd. February 22.

Larrauri, P.C., and U. Lall. 2018. Tailings dam failures: Updated statistical model for discharge volume and runout. Environments 5(28).

M3 Engineering and Technology Corporation. 2019. Resolution Copper Project: Concentrate Pipeline Corridor Management Plan, Superior, Arizona. Revision 4. Project No. M3-PN140023.603. Chandler, Arizona: M3 Engineering and Technology Corporation. May 2.

Mining and Mineral Resources Division. 2015. Mount Polley Mine Tailings Storage Facility Breach: August 4, 2014. Investigation Report of the Chief Inspector of Mines. Victoria, Canada: Mining and Mineral Resources Division, Ministry of Energy and Mines, British Columbia. November 30.

Mining Association of Canada. 2017. A Guide to the Management of Tailings Facilities. Third edition. Ottawa, Canada. October.

———. 2019. A Guide to the Management of Tailings Facilities. Version 3.1. Ottawa, Canada: The Mining Association of Canada. February.

Ministry of Energy and Mines. 2017. Health, Safety and Reclamation Code for Mines in British Columbia. Rev. Victoria, Canada: Ministry of Energy and Mines, British Columbia. June.

Pilz, J. 2019. Alternative 5 - Impacts to Public Safety. Project No. 1788500.002 TM01 Rev0. Technical memorandum. Salt Lake City, Utah: Golder Associates Inc. January 11.

Province of British Columbia. 2015. Independent Expert Engineering Investigation and Review Panel Report on Mount Polley Tailings Storage Facility Breach, January 30.

Resolution Copper. 2016. General Plan of Operations Resolution Copper Mining. Superior, Arizona. May 9.

———. 2017. Independent Technical Review Board Report No. 1, Rev. 1. Rev. Letter report to Rio Tinto. Superior, Arizona: Resolution Copper. March 8.

Rico, M., G. Benito, and A. Díez-Herrero. 2007. Floods from tailings dam failures. Journal of Hazardous Materials 154(2008):79-87.

Rio Tinto. 2015. D5 - Management of tailings and water storage. Document No: HSEC-B-23 Rio Tinto. August.

Seddon, K.D. 2010. Approaches to estimation of run-out distances for liquified tailings. Mine Waste 2010.

Small, A., M. James, and M. Al-Mamun. 2017. Advancing the State of Practice for Tailings Assessment Using Empirical Correlations. Proceedings of the Canadian Dam Association 2017 Annual Conference, Kelowna, BC, October 16–18, 2017.

U.S. Army Corps of Engineers. 2002. Coastal Engineering Manual. EM 1110-2-1100. Washington D.C.: U.S. Army Corps of Engineers. April.

———. 2004. General Design and Construction Considerations for Earth and Rock-Fill Dams. EM 1110-2-2300. Washington D.C.: U.S. Army Corps of Engineers. July 30.

———. 2016. HEC-RAS River Analysis System User's Manual Version 5.0, February.

Witt, J.K., M. Schönhardt, J. Saarela, R. Frilander, J. Csicsak, M. Csővari, A. Várhegyi, D.P. Georgescu, C.A. Radulescu, M. Zlagnean, J. Bõhm, Á. Debreczeni, I. Gombkötõ, A. Xenidis, E. Koffa, A. Kourtis, and J. Engels. 2004. Tailings Management Facilities - Risks and Reliability. Edited by J.K. Witt and M. Schönhardt. Contract Number: EVG1-CT-2002-00066. Report of the European RTD project TAILSAFE. Weimar, Germany: Bauhaus-University of Weimar; TAILSAFE. September.

Detailed Information Supporting EIS Analysis – Fuels and Fire Management

Resource Analysis Area

As noted in the EIS, 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 due to subsidence or increase the risk of inadvertent, human-caused fire ignitions that could spread to and impact adjacent National Forest System (NFS) lands and lands within the Pinal County "Community Wildfire Protection Plan" (CWPP)-designated wildland urban interface (WUI). This area is depicted in figure 3.10.2-2 in

section 3.10.2 of the DEIS. The temporal extent of analysis for fuels and fire management includes the construction phase, operations phase, and closure and reclamation phase of the proposed project.

Analysis Methodology

No additional details were identified regarding methodology not included in the DEIS.

Regulations, Laws, and Guidance – Fuels and Fire Management

The legal authorities guiding this analysis of the effects of change to fuels and fire management as a result of the Resolution Copper Project and land exchange, and the alternatives identified in the DEIS, are shown in Table 4.

Table 4. Fuels and Fire Management Laws, Regulations, Policies, and Plans

Laws, Ordinances, Regulations, and Standards	Description	Applicability
Organic Administration Act of 1897 (16 United States Code 551)	Authorizes the Secretary of Agriculture to make provisions for the protection of national forests against destruction by fire.	National and Forest-specific fire plans outline provisions for the protection of national forests against destruction by fire.
The Multiple Use Sustained Yield Act (Public Law 86-517)	States that it is the policy of Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes, and authorizes and directs the Secretary of Agriculture to develop and administer the renewable surface resources of the national forests for the multiple use and sustained yield of products and services.	A variety of land uses occur throughout the analysis area, including livestock grazing, camping, and hiking.
National Forest Management Act of 1976 (Public Law 94-588)	The primary statute governing the administration of national forests and was an amendment to the Forest and Rangeland Renewable Resource Planning Act of 1974, which called for the management of renewable resources on NFS lands.	The Forest Service has a responsibility to best preserve renewable resources while allowing Resolution Copper access to locatable minerals.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
2009 Guidance for Implementation of the Federal Wildland Fire Policy of 1995	The principal document guiding fire management on Federal lands. The 1995 Federal Wildland Fire Policy was reviewed and updated in 2001 (Review and Update of the 1995 Federal Wildland Fire Management Policy, 2001). In 2003 the Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy was approved. The 2003 Implementation Strategy was replaced in 2009 with the adoption of the Guidance for Implementation of Federal Wildland Fire Management Policy, which states that: "*Fire, as a critical natural process, will be integrated into land and resource management plans and activities on a landscape scale, and across agency boundaries. Response to wildland fire is based on ecological, social, and legal consequences of fire. The circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected dictate the appropriate management response to fire*." (DOI/DOA 2009, page 6).	Wildland Fire and Aviation Management on the Tonto National Forest is guided by national fire policy starting with the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy) which has three goals: Restore and Maintain Resilient Landscapes; Create Fire Adapted Communities; and Safe, Effective Wildfire Response (Wildland Fire Leadership Council 2014).
National Fire Plan (2001), including the Healthy Forest Restoration Act and the Healthy Forest Initiative	Addresses five key concepts: firefighting rehabilitation hazardous fuel reduction community assistance, and accountability. The U.S. Forest Service and the Department of the Interior work jointly to implement the key points outlined in the plan. Additional policies and guidance under the National Fire Plan include the Healthy Forest Restoration Act of 2003 and the Healthy Forest Initiative. The intent of these policies is to reduce the risks severe wildfire poses to people, communities, and the environment.	The National Forest Plan is a managing entity for Forest Service lands within the analysis area. Specifically, the project area falls under Management Areas MA 2F on the Globe Ranger District and MA 3I on the Mesa Ranger District.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
BLM Resource Management Plans	The 2012 Lower Sonoran Field Office Resource Management Plan provides direction for wildland fire management within the District boundary. The following overarching goals and specific objectives are presented on pages 2-45 to 2-54 (Bureau of Land Management 2012) and include specific management actions to achieve objectives: **WF-1**: Ensure firefighter and public safety is the highest priority in every fire or fuels management activity. WF-1.1: Set priorities among protecting residences, community infrastructure, and other man-made property improvements. **WF-2:** Wildland fuels are managed to protect Wildland Urban Interface (WUI) areas and meet resource management objectives. WF-2.1: Fuels within WUI areas are proactively managed to improve the protection of life and property. **WF-3:** Limit the extent of wildfires and the impact of fire suppression efforts on wildlife, plant communities, and natural and cultural features. WF-3.1: Reduce the frequency of human-caused wildland fires and minimize the total number of acres burned within the Planning Area. WF-3.2: For all fire management activities (wildfire suppression, prescribed fire, and mechanical, chemical, and biological vegetation treatments), a focus will be to maintain or improve habitat for federally threatened, endangered, proposed, and candidate (federally protected) species. WF- 3.3: For all fire management activities, efforts will be made to reduce the impacts on natural and cultural resources.	The Peg Leg alternative incorporates BLM-managed land and thus would be influenced by the 2012 Lower Sonoran Field Office Resource Management Plan in regard to wildland fire management.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
Tonto National Forest Land and Resource Management Plan	Provides comprehensive management direction for resources on NFS lands. This includes plan direction for management, protection, and uses of the Forest. Monitoring conditions on the Forest ensures projects are done in accordance with plan direction and identify conditions that might require a change in the Forest Plan.	The Tonto Forest Plan is a source of direction for fire management within the analysis area regarding resource management objectives based on area management and vegetation type. The Forest Plan also identifies constraints on certain activities or decisions in special areas (i.e., wilderness) and provides other resource management guidance.
The Clean Air Act (Public Law 88-206)	Provides for the protection and enhancement of national air resources by regulating air emissions from stationary and mobile sources. This law authorized the EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and welfare and to regulate emissions of hazardous air pollutants. NAAQS were established for specific pollutants emitted in significant quantities throughout the country that may be a danger to public health and welfare. If an area does not meet or "attain" the standards, it becomes a non-attainment area and must demonstrate to the public and the EPA how it will meet standards in the future via a State Implementation Plan. Section 112 of the Clean Air Act addresses emissions of hazardous air pollutants, including smoke from wildfires and prescribed fires. Section 160 of the Clean Air Act requires measures "to preserve, protect, and enhance the air quality . . ." in national parks, national wilderness areas, national monuments, and other areas of special national or regional natural, recreational, scenic, or historic value, some are classified as Class I attainment areas. Implementation of the Clean Air Act is largely the responsibility of the states, which may develop programs that are more restrictive than the Clean Air Act requires but never less.	Wildfires that occur within the analysis area would be under management by the Clean Air Act

Laws, Ordinances, Regulations, and Standards	Description	Applicability
Arizona Revised Statutes (ARS) – Title 37. Public Lands; Chapter 2.1. Forests (Sec 37-623)	Provides the State Forester with the authority to prevent and suppress any wildfires on State and private lands located outside incorporated municipalities and, if subject to cooperative agreements, on other lands located in this state. If there is no cooperative agreement, the State Forester may furnish wildfire suppression services on any lands in this state if the State Forester determines that suppression services are in the best interests of this state and are immediately necessary to protect state lands.	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 Design Inc. 2018).
ARS 37-623.02. Emergencies; prohibiting fireworks; liabilities and expenses; fire suppression revolving fund	Allows the State Forester to incur liabilities for suppressing wildland fires and responding to other unplanned risk activities from unrestricted monies in the State general fund, with or without legislature in session.	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 Design Inc. 2009).
ARS – Title 13. Criminal Code, Chapter 17. Arson (Sec 13-1706)	Designated unlawfulness for any person, without lawful authority, to intentionally, knowingly, recklessly, or with criminal negligence set or cause to be set on fire any wildland other than the person's own or to permit a fire that was set or caused to be set by the person to pass from the person's own grounds to the grounds of another person.	Any instances of arson within the analysis area would be illegal.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
FSM 5100 – Fire Management	Describes the authority for fire management activities on NFS lands. Forest Service direction on fire management on lands managed by the U.S. Forest Service are: Forest Service fire management activities shall always put human life as the single overriding priority. Forest Service fire management activities should result in safe, cost-effective fire management programs that protect, maintain, and enhance NFS lands, adjacent lands, and lands protected by the Forest Service under cooperative agreement. FSM 5100 also provides pertinent references on the minimum standards and procedures for wildland fire management. Fire management policy is outlined in the 2014 Tonto National Forest Fire Management Plan.	The project area falls under Management Areas MA 2F on the Globe Ranger District and MA 3I on the Mesa Ranger District.
Tonto National Forest Fire Management Plan	All unplanned wildfire ignitions occurring within the Tonto National Forest require a response. The response, which can range from aggressively suppressing a wildfire to managing an incident for beneficial objectives, is guided by strategies and objectives outlined in the Land and Resource Management Plan, reflecting land and resource values and management of goals and objectives. The Tonto National Forest Fire Management Plan outlines fire management activities and procedures to accomplish those objectives.	Areas of the analysis area are under current management by the Tonto National Forest, and thus the Tonto National Forest Fire Management Plan. Specifically, the project area falls under Management Areas MA 2F on the Globe Ranger District and MA 3I on the Mesa Ranger District.
Fire Management Units	The Tonto National Forest Fire Management Plan provides information organized by Fire Management Units (FMUs) which provides a finer-scale summarization of information than is possible at the forest level. FMUs divide the landscape into smaller geographic areas, they describe safety considerations, physical, biological, social characteristics that frame associated planning guidance based on these characteristics. The project area is located within the Mesa and Globe Ranger Districts of the Tonto National Forest. Each Ranger District is divided into several Fire Management Units as illustrated in Figures 1 and 2.	FMUs within the analysis area are mapped in Figures 1 and 2 below. The FMU identifiers are circled. A description of each FMU (vegetation type, acres, slope) and an outline of the management emphasis for each unit (e.g., recreation, wildlife habitat, wilderness) is provided in the Tonto National Forest Fire Management Plan.

Figure 1: Mesa Ranger District Fire Management Units. FMU identifiers are circled. Source: Tonto National Forest Fire Management Plan (2014).

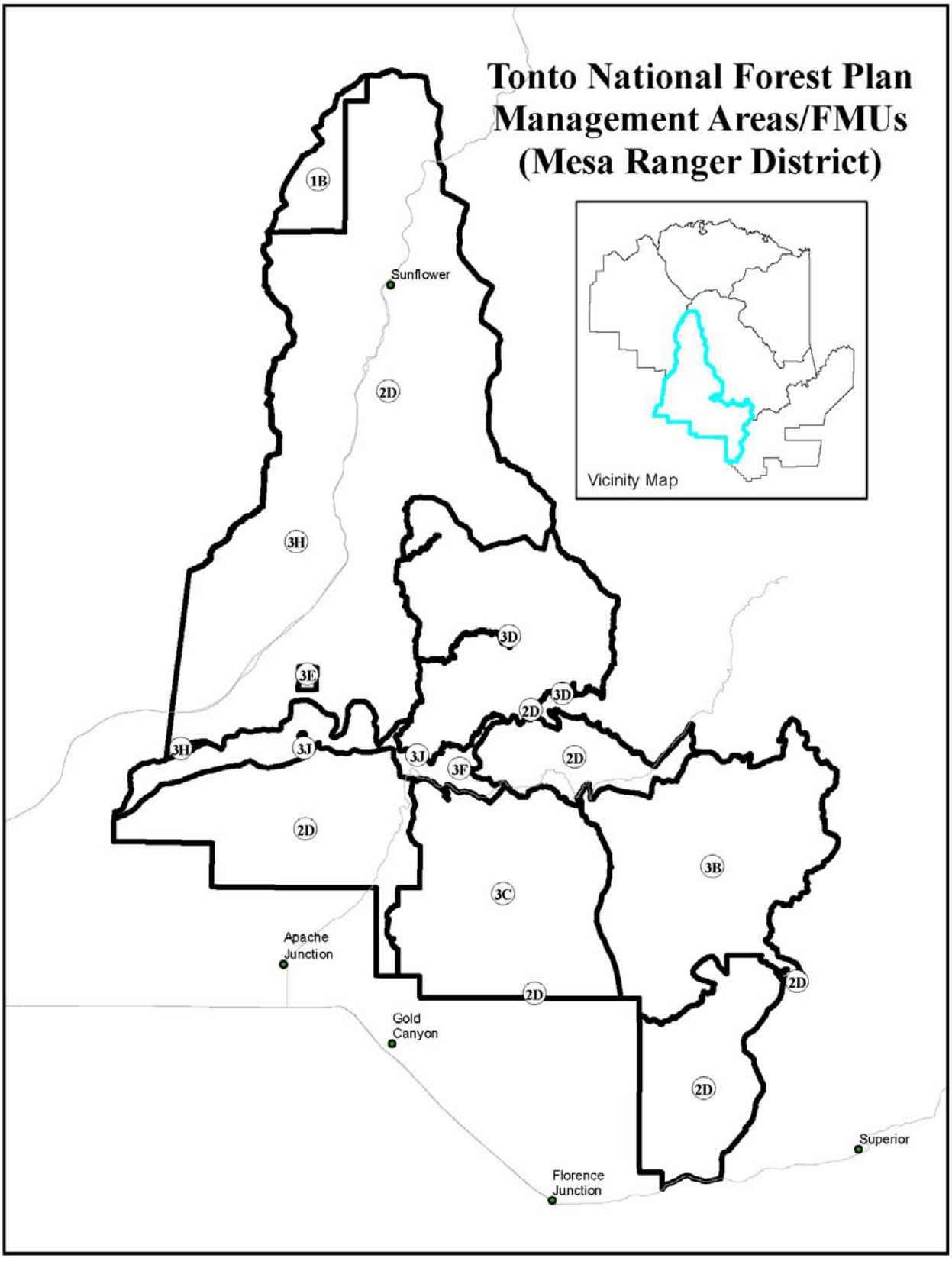
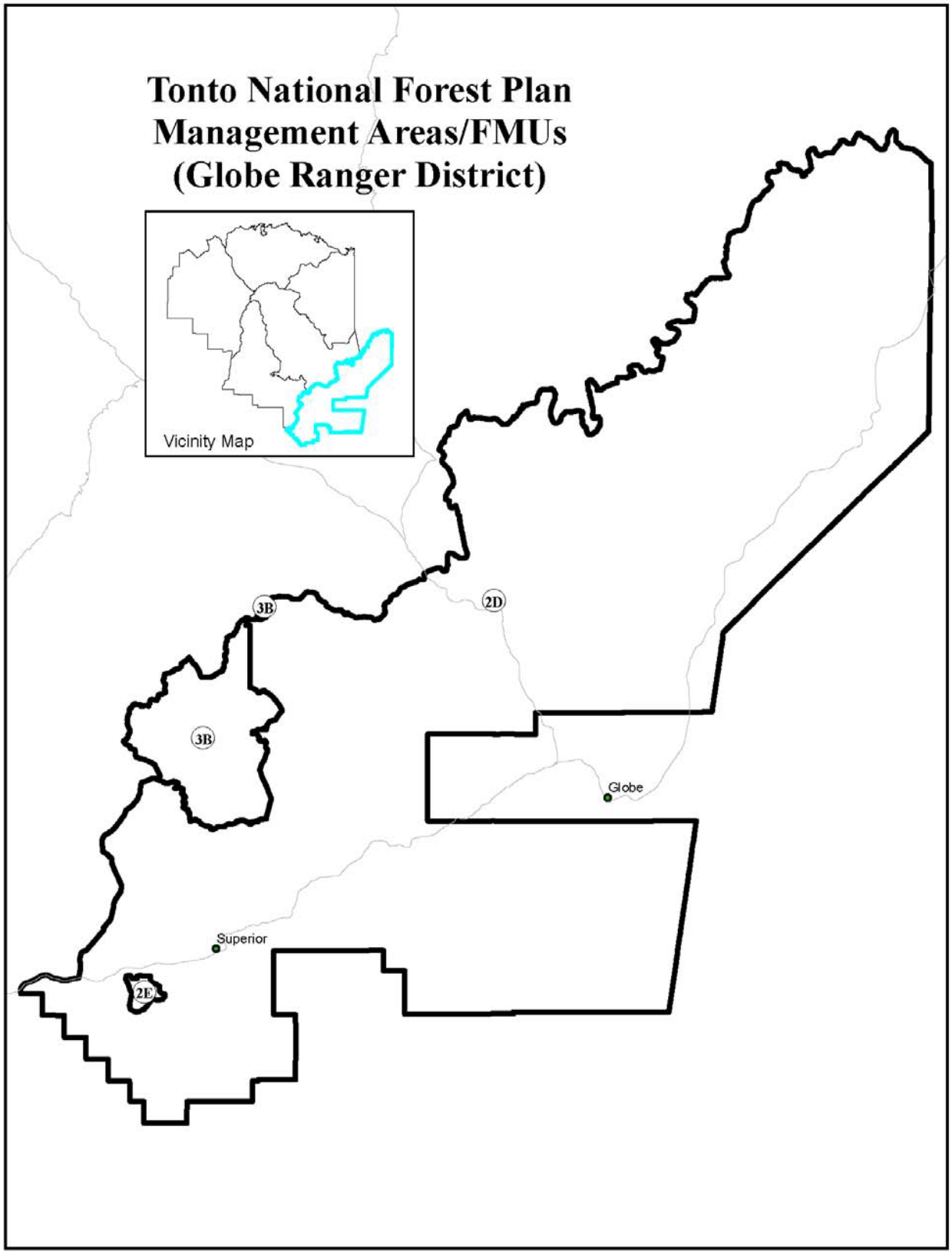


Figure 2: Globe Ranger District Fire Management Units. FMU identifiers are circled. Source: Tonto National Forest Fire Management Plan (2014).



Key Documents and References Cited for Fuels and Fire Management

The following list is meant to highlight key process or analysis documents available in the project record. It should not be considered a full list of all available documentation considered within this process memorandum or the EIS analysis.

Arizona Department of Forestry and Fire Management. 2018. Arizona Communities at Risk. Available at: https://dffm.az.gov/arizona-risk-communities. Accessed May 24, 2019.

Bureau of Land Management. 1991. *Safford District Resource Management Plan and Environmental Impact Statement*. Safford, Arizona: Bureau of Land Management. August.

———. 2012. *Lower Sonoran Record of Decision and Approved Resource Management Plan*. BLM/AZ/PL-12/007. Phoenix, Arizona: Bureau of Land Management. September.

Department of the Interior and U.S. Department of Agriculture. 2009. Guidance for Implementation of Federal Wildland Fire Management Policy, 2009. Available at: https://www.nifc.gov/policies/policies_documents/GIFWFMP.pdf. Accessed March 29, 2018.

Department of the Interior et al. 2001. Review and Update of the 1995 Federal Wildland Fire Management Policy. January.

Logan Simpson Design, Inc. 2018. *Pinal County Community Wildfire Protection Plan*. Tempe, Arizona: Logan Simpson. June.

Resolution Copper Mining, LLC. 2016. *General Plan of Operations Resolution Copper Mining*. Superior, Arizona. May 9.

Swetnam, T.W., and C.H. Baisan. 1996. Historical fire regime patterns in the southwestern United States since AD 1700. *Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium, Los Alamos, New Mexico, March 29-31, 1994*, edited by C.D. Allen, pp. 11–32. General Technical Report RM-GTR-286. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

U.S. Forest Service. 1985. *Tonto National Forest Land and Resource Management Plan.* U.S. Forest Service, Southwestern Region. October.

Detailed Information Supporting EIS Analysis – Hazardous Materials

Resource Analysis Area

Hazardous materials in the context of the Resolution Copper 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, properly disposed of.

The analysis area for hazardous materials encompasses the operational areas of the proposed project (i.e., mine process facilities, fuel storage tanks, processing fluid pipelines, tailings facility, and waste rock facility), where hazardous materials could be released into the environment (i.e., soils, vegetation, wildlife, aquifers, surface water drainages). The analysis area also includes areas with the potential to receive hazardous materials through migration in either groundwater or surface water.

The analysis for hazardous materials also encompasses the temporal and spatial extent necessary to describe any environmental impacts that may result from transportation of hazardous materials to the mine. Temporally, the potential impacts associated with transporting petroleum fuels, explosives, and other hazardous materials to the mine would occur during the pre-mining and active mining phases. However, because of the potential for long-term contamination, the temporal bounds of analysis have been extended to include the final reclamation and closure phase and post-closure phase.

The analysis area for transportation of hazardous materials encompasses the highway transportation system and adjacent environmental receptors, which may be impacted by transportation of hazardous materials to the project area. The proposed mine site and alternatives analysis area is defined to include Magma Mine Road, U.S. 60, Silver King Mine Road, Hewitt Canyon Road, East Skyline Road rail via MARRCO corridor, various service roads, and pipelines. 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, 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.

Analysis Methodology

No additional details were identified regarding methodology not included in the DEIS.

Regulations, Laws, and Guidance – Hazardous Materials

Table 5 summarizes the permits or regulatory actions and the laws and statutes related to the production, transportation, storage, and disposal of toxic or hazardous materials in Arizona that may apply to the proposed project.

Table 5. Hazardous Materials Laws, Regulations, Policies, and Plans

Laws, Ordinances, Regulations, and Standards	Description	Applicability
ARS 49-921 and AAC R18-8-260	Hazardous Waste Permit	Resolution Copper is required to obtain a hazardous waste permit as it would manage a facility that treats, stores, or disposes or hazardous waste (otherwise known as a Hazardous Waste TSDF).
ARS 49-922	EPA Identification Number	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.
ARS 49-961 through 49-973	Pollution Prevention Plan	Facility operations would directly or indirectly produce waste or use toxic substances. Therefore, Resolution Copper is required to create a Pollution Prevention Plan, a written, stand-alone management document that provides information on the facility operations.
ARS 49-929 and ARS 49-930	Hazardous Waste Management Facility – Annual Registration. This subtitle establishes reporting requirements for the generation, storage, handling, transport, and disposal of hazardous waste. Certain waste materials generated at mining sites, however, are excluded from subtitle C under the Bevill Amendment of 1980. Although the Bevill Amendment exempts much of the waste generated at mining facilities, hazardous waste generation activities that are "not unique" to the mining industry are subject to the Resource Conservation and Recovery Act, Subtitle C, such as hazardous waste generated from equipment servicing and repair and laboratory wastes that meet the criteria for hazardous waste under 40 CFR 262.	All hazardous waste treatment, storage and disposal facilities, hazardous waste transporters and hazardous waste generators are required to register annually and establish a hazardous waste program equivalent to and consistent with the Federal hazardous waste program promulgated under subtitle C of the Resource Conservation and Recovery Act. On-site accumulation in excess of the requirements under 40 CFR 262.34 would require a storage permit. In some cases, on-site treatment or disposal would require a hazardous waste permit.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
42 U.S.C. 11001 et seq., 40 CFR 300 to 313, and 40 CFR 372	Emergency and Community Right to Know. Requires notification of persons to whom distributors deliver mixtures or trade name products containing toxic chemicals that they contain such chemicals. In addition, distributors must inform the general public and the communities surrounding covered facilities about releases of toxic chemicals to assist research, to aid in the development of regulations, guidelines, and standards, and for other purposes. The National Oil and Hazardous Substances Pollution Contingency Plan outlines organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.	All hazardous materials and petroleum products will be transported to and from the project area by commercial trucks and rail access. 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. 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.
ARS 49-963, ARS 49-964, ARS 49-971, ARS 49-973	Toxic Data Report	Resolution Copper will be required to file a toxic data report on July 1 for the preceding calendar year if: During the preceding calendar year, the owner or operator was required to file an annual toxic chemical release form for the facility pursuant to section 313 of the superfund amendments and reauthorization act of 1986 (Public Law 99-499), and/or During the preceding calendar year, the facility generated an average of 1 kilogram per month of acutely hazardous waste as defined in 40 CFR 261 or an average of 1,000 kilograms per month of hazardous waste in a calendar year, exclusive of an episodic, accidental, or remediation-related release or occurrence.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
ARS 49-761 et seq. for solid waste, ARS 49-857.01, ARS 49-241 et seq. governs the Aquifer Protection Permit, and 40 CFR 257	Solid Waste Plan Approval	Resolution Copper, as an owner and operator of a solid waste facility, would be required to obtain department approval of a solid waste facility plan as follows: For a new solid waste facility and before commencing construction of the solid waste facility, the owner or operator shall obtain approval of a solid waste facility plan that satisfies rules adopted by the director. For an existing solid waste facility, the owner or operator shall file with the department a solid waste facility plan within 180 days after the effective date of rules adopted pursuant to section 49-761 that contain design and operation standards for that type of solid waste facility. An existing solid waste facility may continue to operate while the department reviews the plan. For an existing public solid waste facility that is currently subject to rules that contain design and operation standards, the owner or operator shall file with the department a solid waste facility plan by October 1, 1996, if the facility has not received plan approval before that date.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
FSM 2100, "Environmental Management," Chapter 2160, "Hazardous Materials Management"	Objectives include to protect the safety and health of the public and Forest Service employees from hazardous materials; to minimize future agency and personal liabilities related to hazardous materials; and to protect and/or restore, from the impact of hazardous materials, the natural resources and the environment on: National Forest System lands; Lands outside the National Forest System that are affected by actions authorized on National Forest System lands; and Lands leased by the Forest Service Policies to address these objectives include the following: Provide the appropriate level of training to employees on the potential safety and health risks from hazardous materials in accordance with the employee's duties. Incorporate pollution prevention in all aspects of hazardous materials management. Emphasize source reduction as the primary means of maintaining compliance with applicable Federal, State, and local environmental regulations. Ensure proper handling, storage, transportation, and disposal of hazardous materials in all activities. Prior to disposal of any material, consider reuse and recycling of that material. Consider need, employee risk of exposure, effectiveness, environmental impacts, economic efficiency, and availability of less hazardous alternatives when deciding whether and which hazardous materials to use. Ensure appropriate and timely response to release or threats of release of hazardous materials.	Proposed mining activities have the potential to release hazardous materials into the environment and affect the natural condition of soils, vegetation, wildlife, surface water and groundwater resources, and air quality. The issues considered under this section are (1) the use, storage, and disposal of hazardous materials within the mine; (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.

Laws, Ordinances, Regulations, and Standards	Description	Applicability
FSM 1400, "Controls", Chapter 1480, "Environmental Compliance Program"	The objective of the Forest Service Environmental Compliance Program is to ensure compliance with applicable Federal, State, departmental, and agency environmental requirements that affect NFS lands, facilities, operations, and the uses thereof. This includes integrating environmental accountability into agency day-to-day decision-making and long-term planning processes across all Forest Service activities and functions.	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.
BLM MS 1703, "Hazard Management and Resource Restoration (HMRR) Program"	The major objectives of the BLM's hazardous materials management program are, like the Forest Service, to protect public health and the environment by minimizing risks from hazards on public lands, to ensure public land health is maintained, and to prevent pollution by integrating effective environmental management into all BLM activities, authorized actions, and business processes (BLM 2009).	Applicable for activities that may occur at the Peg Leg tailings storage location.

ARS Title 49, Chapter 5 (Hazardous Waste Disposal), Article 2 identifies the State's requirements (see ARS 49-922) to establish a hazardous waste program, which is equivalent to and consistent with the Federal hazardous waste program promulgated under the Resource Conservation and Recovery Act (RCRA) (see 40 CFR Parts 260 through 268, 270 through 272, 279 and 124 261). Subtitle C of the Federal act allows EPA to delegate RCRA requirements to the State. Subtitle C of RCRA also sets the criteria for hazardous waste generators, transporters, and treatment, storage and disposal facilities, including permitting requirements, enforcement and corrective action or cleanup requirements. A 1980 Amendment to RCRA Subtitle C, the Bevill Amendment, also known as the "Mining Waste Exclusion," created a temporary exclusion for much of the solid waste generated at mining facilities (waste generated during the extraction, beneficiation, and processing of ores and minerals). However, 20 "special wastes," considered "not unique" to the mining industry, are still subject to the RCRA Subtitle C. These 20 special wastes can be found on the EPA's website.[2] They are as follows:

1. Slag from primary copper processing
2. Slag from primary lead processing
3. Red and brown muds from bauxite refining

[2] https://www.epa.gov/hw/special-wastes

4. Phosphogypsum from phosphoric acid production
5. Slag from elemental phosphorous production
6. Gasifier ash from coal gasification
7. Process wastewater from coal gasification
8. Calcium sulfate wastewater treatment plant sludge from primary copper processing
9. Slag tailings from primary copper processing
10. Flurogypsum from hydrofluoric acid production
11. Process wastewater from hydrofluoric acid production
12. Air pollution control dust/sludge from iron blast furnaces
13. Iron blast furnace slag
14. Treated residue from roasting/leaching of chrome ore
15. Process wastewater from primary magnesium processing by the anhydrous process
16. Process wastewater from phosphoric acid production
17. Basic oxygen furnace and open hearth furnace air pollution control dust/sludge from carbon steel production
18. Basic oxygen furnace and open hearth furnace slag from carbon steel production
19. Chloride process waste solids from titanium tetrachloride production
20. Slag from primary zinc processing

Hazardous waste generated from equipment servicing and repair and laboratory wastes that meet the criteria for hazardous waste under 40 CFR 262 are still subject to RCRA Subtitle C. Additionally, on-site accumulation in excess of the requirements under 40 CFR 262.34 would require a storage permit. In some cases, on-site treatment or disposal would require a hazardous waste permit.

Key Documents and References Cited for Hazardous Materials

The following list is meant to highlight key process or analysis documents available in the project record. It should not be considered a full list of all available documentation considered within this process memorandum or the EIS analysis.

Bureau of Land Management. 2009. BLM Policy Manual 1703 – Hazard Management and Resource Restoration Program.

———. 2012. *Lower Sonoran Record of Decision and Approved Resource Management Plan*. BLM/AZ/PL-12/007. Phoenix, Arizona: Bureau of Land Management. September.

Resolution Copper Mining, LLC. 2016. *General Plan of Operations Resolution Copper Mining*. Superior, Arizona. May 9.

U.S. Forest Service. 1985. *Tonto National Forest Land and Resource Management Plan.* U.S. Forest Service, Southwestern Region. October.