United States Department of Agriculture

DRAFT Environmental Impact Statement

Resolution Copper Project and Land Exchange

Volume 2

Forest Service Tonto National Forest MB-R3-12-07 August 2019

Front Cover photo captions:
Top: Oak Flat Federal Parcel;
Bottom Left: Oak Flat Federal Parcel;
Bottom Right: Headframe of Shaft 10 at East Plant Site

Back Cover photo captions:
Top left: Shaft 9 and 10 at East Plant Site;
Top center: MARRCO corridor;
Top right: Picket Post mountain;
Bottom left: Oak Flat Federal Parcel ;
Bottom right: Overlooking West Plant Site, Town of Superior and Picket Post mountain

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Environmental Impact Statement

Pinal County, Arizona
August 2019

LEAD AGENCY:	**USDA Forest Service**
COOPERATING AGENCIES:	**Arizona Department of Environmental Quality, Arizona Department of Water Resources, Arizona Game and Fish Department, Arizona State Land Department, Arizona State Mine Inspector, Bureau of Land Management, Pinal County Air Quality Control District, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency**
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Abstract: The purpose of and need for the environmental impact statement includes evaluating the impacts associated with approval of a mine plan, and considering the effects of the exchange of lands between Resolution Copper Mining, LLC, and the United States as directed by Section 3003 of the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA).

The analysis includes six alternatives: the proposed action, which calls for a new underground mine underneath Oak Flat east of Superior, Arizona, and a tailings storage facility on National Forest System (NFS) lands west of Superior; a no action alternative under which neither the land exchange nor the mine plan would be authorized; an alternative that would allow a modified tailings disposal method at the same Near West tailings storage location as proposed; an alternative that would allow filtered tailings to be stored at another location on NFS lands north of Superior; and two alternatives that would not allow tailings to be stored on NFS lands, but on other agency or private lands. The scoping process identified water quantity, water quality, public health and safety, cultural resources, tribal concerns, and recreation as significant issues.

It is important that reviewers provide their comments at such times and in such a way that they are useful to the Agency's preparation of the EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. The submission of timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative or judicial reviews.

Send Comments To:	**Resolution Copper EIS** **P.O. Box 34468** **Phoenix, AZ 85067-4468**
Date Comments Must Be Received:	**November 7, 2019**

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

CHAPTER 4

Consulted Parties

TABLE OF CONTENTS

FIGURES

FIGURES

TABLES

TABLES

TABLES

TABLES

3.7.2 Groundwater and Surface Water Quality

3.7.2.1 Introduction

The proposed mine could potentially impact groundwater and surface water quality in several ways. The exposure of the mined rock to water and oxygen, inside the mine as well as in stockpiles prior to processing, can create depressed pH levels and high concentrations of dissolved metals, sulfate, and dissolved solids. After processing, the tailings would be transported for disposal into the tailings storage facility. Seepage from the tailings has the potential to enter underlying aquifers and impact groundwater quality. In addition, contact of surface runoff with mined ore, tailings, or processing areas has the potential to impact surface water quality.

This section contains analysis of existing groundwater and surface water quality; results of a suite of geochemical tests on mine rock; predicted water quality in the block-cave zone and potential exposure pathways, including the potential for a lake to form in the subsidence crater; impacts on groundwater and surface water from tailings seepage; impacts on surface water from runoff exposed to tailings; impacts on assimilative capacity of perennial waters; impacts on impaired waters; whether chemicals added during processing would persist in the tailings storage facility; the potential for asbestiform minerals to be present; and the potential for naturally occurring radioactive materials to be present. Some additional details not discussed in detail here are captured in the project record (Newell and Garrett 2018d).

3.7.2.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area is shown in figure 3.7.2-1 and encompasses all areas where groundwater or surface water quality changes could potentially occur due to the proposed project and alternatives. This includes the block-cave zone, each alternatives tailings footprint, aquifers downgradient from each tailings facility, and downstream surface waters. The downstream limit of the analysis area is the location of the first perennial water, specifically Queen Creek at Whitlow Ranch Dam and the Gila River either at Donnelly Wash or Dripping Spring Wash. The goal of this section is to identify potential risks to water quality, including surface water. These perennial surface water locations are the point at which seepage would enter the surface water system and represent the location at which surface water quality is most at risk and any impacts on surface water or aquatic habitat would be greatest.

Geochemistry Modeling Process

All tailings storage facilities—including filtered tailings—lose water to the environment in the form of seepage that drains by gravity over time. This seepage into groundwater is the primary source of potential water contamination from the project and has the potential to affect the quality of underlying aquifers as well as downstream surface waters fed by those aquifers. The water quality of tailings seepage reflects a mixture of different water sources used in the mining process (see figure 2.2.2-16) as well as geochemical changes that occur over time within the tailings storage facility and changes that occur as seepage moves downgradient through the aquifer.

Modeling the water quality changes caused by seepage from the tailings storage facility[39] requires a series of interconnected analyses, as shown on figure 3.7.2-2. These analyses include the following:

- The amount of water that must be removed from the block-cave zone during operations to allow mining. This is estimated using the **groundwater flow model** discussed in detail in section 3.7.1.
- The geochemical changes of the groundwater within the underground block-cave zone caused by the interaction of

39. For details of the geochemistry modeling workgroup formed to direct and review the water quality modeling, see Newell and Garrett (2018d).

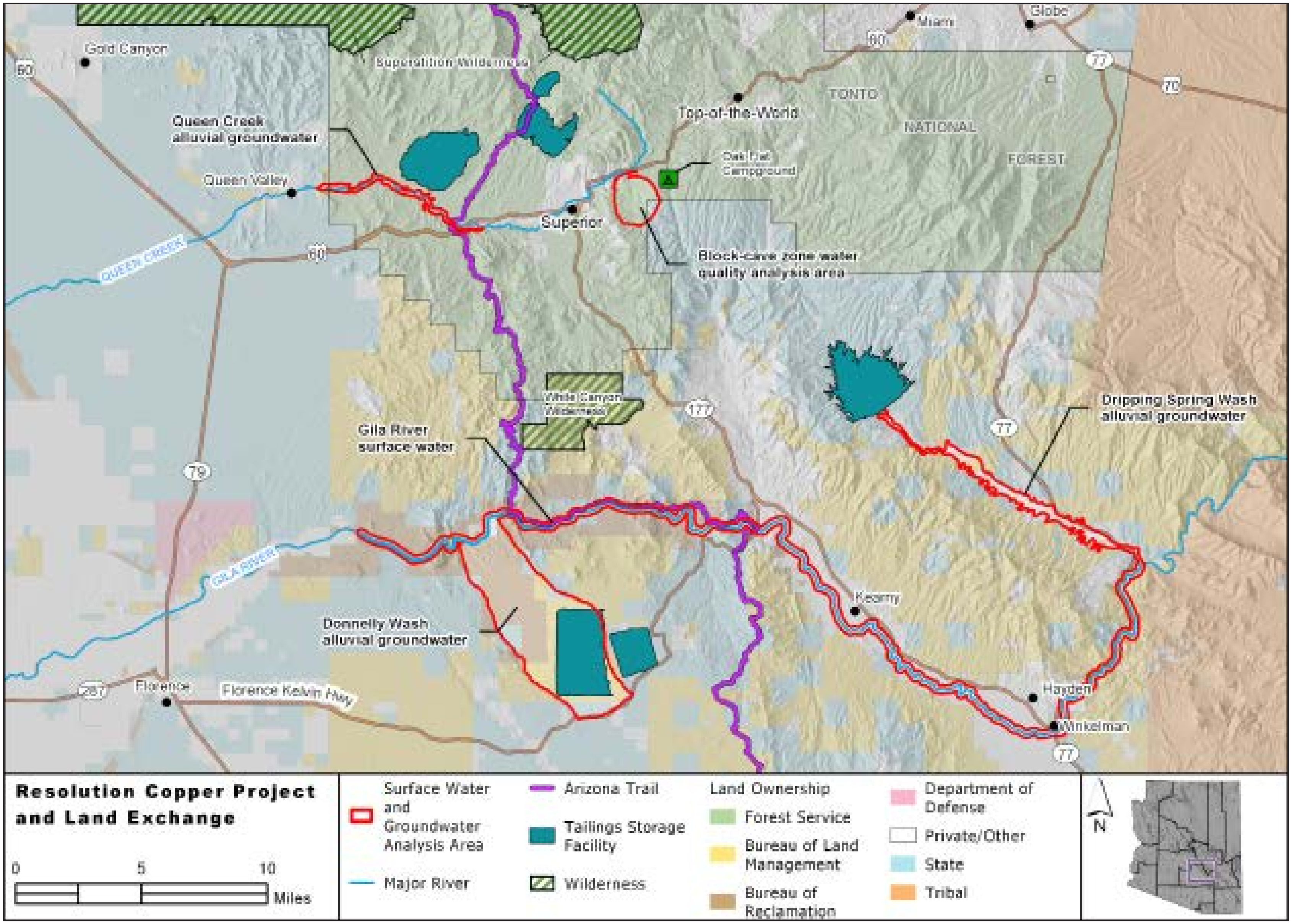


Figure 3.7.2-1. Analysis area for groundwater and surface water quality

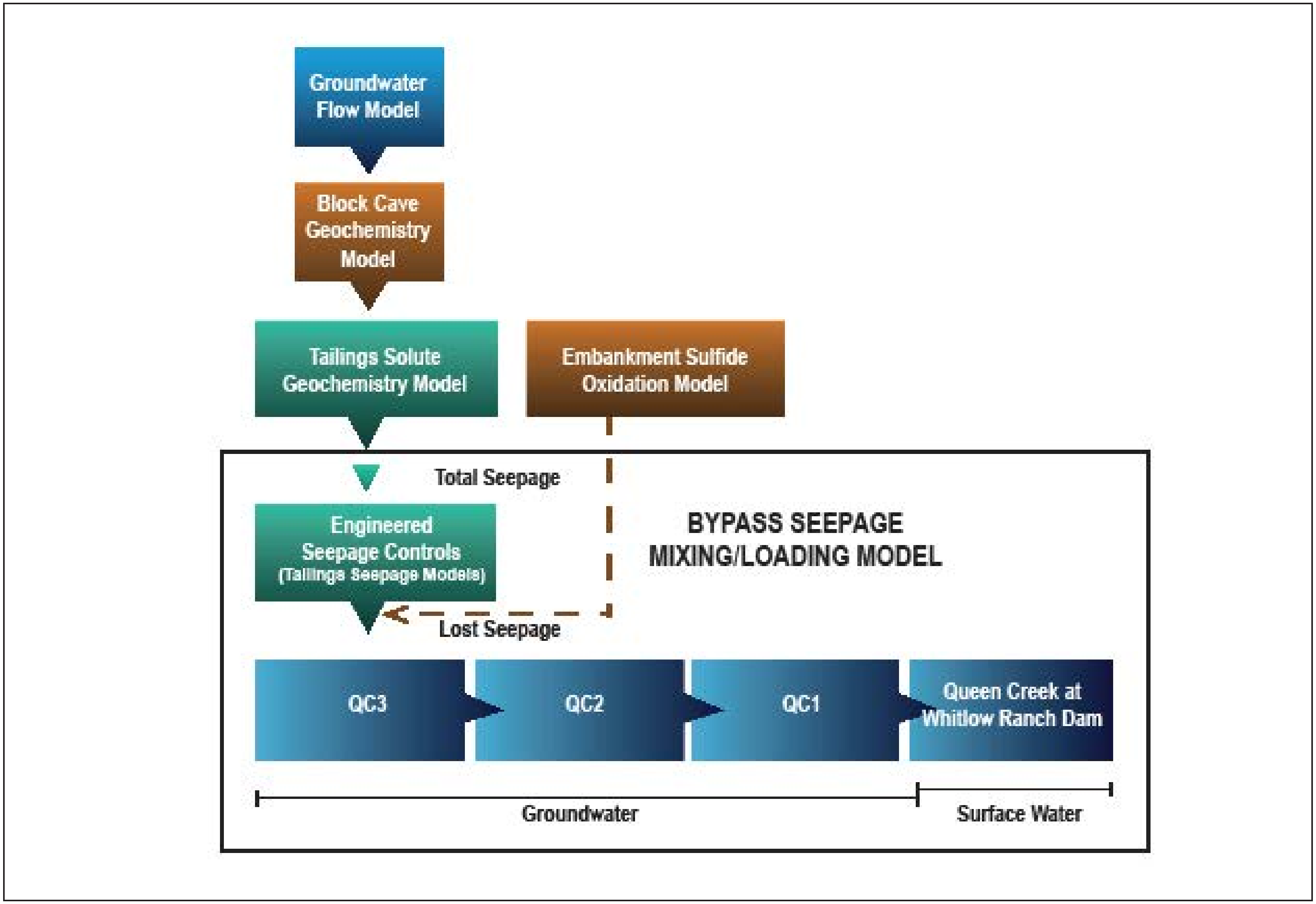


Figure 3.7.2-2. General components and process flow for water quality modeling analysis shown for Alternative 2

exposed rock surfaces to water and oxygen. These changes are estimated using a **block-cave geochemistry mode**l.

- The tailings slurry that leaves the processing facility is a mix of tailings and process water. As the tailings are deposited in the tailings storage facility, some process water is collected in the recycled water pond and sent back to the West Plant Site, but some process water stays trapped in the pore space of the tailings (this is known as "entrainment"). Eventually some of this water can seep or drain out of the tailings facility. The water quality at various locations in the tailings facility is estimated using a **tailings solute geochemistry model**.[40]
- Some of the tailings that are deposited in the tailings storage facility would remain saturated indefinitely with little possibility of oxidation occurring. However, within the embankment and beach areas, sulfide-containing minerals in the tailings would be exposed to oxygen over time, which would cause geochemical changes. These changes are estimated using the **embankment sulfide oxidation model**.
- A wide variety of engineered seepage controls are in place to intercept and collect entrained water that seeps out of the tailings facility, but despite these controls some seepage still enters the environment. The effectiveness of engineered seepage controls is estimated using a variety of **tailings seepage models**.
- The seepage not captured and entering the environment causes water quality changes in the downgradient aquifers and eventually in surface waters fed by those aquifers. The changes in groundwater and surface water quality are estimated using a series of **bypass seepage mixing/loading models**. Figure 3.7.2-2 shows the groundwater modeling cells (QC3, QC2, and QC1) and surface water modeling cells (Queen Creek at Whitlow Ranch Dam) downstream of Alternatives 2 and 3 – Near West tailings storage facility. The groundwater and surface water modeling cells would vary based on alternative tailings storage facility location.

Assumptions, Uncertain and Unknown Information for Geochemistry Models

BLOCK-CAVE GEOCHEMISTRY MODEL

Modeling Details

Water collects in the sump of the block-cave zone during operations and is derived from several sources:

- Groundwater inflow from the Apache Leap Tuff,
- Groundwater inflow from the deep groundwater system,
- Blowdown water from ventilation and cooling systems, and
- Excess mine service water.[41]

The block-cave sump water is pumped out during operations and incorporated into the processing water stream and therefore is one of the sources ultimately contributing to the water in the tailings facility. A block-cave geochemistry model was constructed to blend these flows and their associated chemical composition over the time of operation of the mine (Eary 2018f). Groundwater flow modeling was used to assign the flow rate for how much groundwater flows into the block-cave zone (WSP USA 2019). The rate of supply of blowdown water from ventilation systems is based on the overall water balance for the mine (WestLand Resources Inc. 2018b).

Apache Leap Tuff and deep groundwater chemistries are based upon analysis of site groundwater samples. The chemical composition of

40. The term "solute" refers to substances that are dissolved in water, such as metals like arsenic or selenium, or inorganic molecules like sulfate or nitrate.

41. Mine service water is used for a variety of tasks underground, including dust suppression and cooling. Much of this water evaporates or leaves with the ore; any excess water left over would likely find its way to the sump.

blowdown water is based upon analysis of CAP water and groundwater sourced from the Arizona Water Company (Arizona Water Company 2017). Resolution Copper projects this blended water to be composed of 25 percent CAP water and 75 percent Arizona Water Company water. Owing to evaporation associated with cooling, this water mixture is concentrated to an assumed value for total dissolved solids of 2,500 milligrams per liter (mg/L).

The model time frame is 41 years and ends with the cessation of mining. Inflows to the block-cave sump vary over time, but their chemical composition does not. The mixed waters reporting to the sump from their individual sources are equilibrated with any chemical precipitates that are oversaturated and likely to precipitate from solution. This precipitation of solids removes chemical mass from the mixed water. Results for model year 41, at the end of mining, are reported in table 3.7.2-1. Chemical weathering of wall rock and uneconomic mineralized fractured rock in the collapsed block-cave zone are assumed to not supply any chemical load to the sump water; this assumption is reflected in the column titled "Eary Block-Cave Geochemistry Model Predicted Concentrations" and is discussed in more detail after the table.

Assumptions, Uncertain and Unknown Information

The block-cave geochemistry model, like all models, necessarily includes assumptions in its effort to forecast future conditions. Assumptions are made to constrain model components that cannot be conclusively known and therefore represent uncertainty in the model results. The key assumptions in the block-cave geochemistry model, the level of uncertainty, and their potential implications are summarized here:

- The model assumes the chemistry of various water sources (Apache Leap Tuff, deep groundwater system, CAP water, Desert Wellfield) remains constant over time. In reality, the chemical load[42] from these sources could increase or decrease over time.
    - Applies to: all action alternatives.
    - Possible outcome if real-world conditions differ from the assumption: Modeled tailings seepage concentrations could be higher or lower.
    - Likely magnitude of effect for all action alternatives: Low. Water sources are primarily from large aquifers that change slowly in response to climatic trends and are not the primary source of chemical loading to the block-cave zone.
- The model assumes fractured rock in the collapsed block-cave zone does not contact oxygen and chemical weathering does not supply any chemical load to the sump water. If chemical weathering occurs, percolation of groundwater through these rocks could transport weathering products to the sump.
    - Applies to: all action alternatives.
    - Possible outcome if real-world conditions differ from the assumption: Sump water and modeled tailings seepage concentrations could be higher.
    - Likely magnitude of effect for all action alternatives: High. Possible outcomes are bracketed by the two sump chemistries shown in table 3.7.2-1 (Eary 2018f; Hatch 2016). The sump water only makes up between 20 and 24 percent of the inflow to the West Plant Site (see Ritter (2018)), but the loads for all constituents of concern could substantially increase if this assumption does not match real-world conditions. See section "Overall Effect of Uncertainties on the Model Outcomes" later in this section for more discussion.

42. The word "loading" is used throughout this section. In this context, "chemical loading" or "pollutant loading" refers to the total amount, by weight, of a chemical, metal, or other pollutant that enters the environment over some time period (usually a day or year). For example, the total selenium load entering the environment from Alternative 2 seepage has been estimated as 0.0242 kilograms per day.

Table 3.7.2-1. Modeled block-cave sump water chemistry

Constituent	Eary Block-Cave Geochemistry Model* Predicted Concentrations (mg/L)	Hatch Block-Cave Geochemistry Model† Predicted Concentrations (mg/L)	Arizona Aquifer Water Quality Standard (mg/L)
Ca	237	434	–
Mg	63	147	–
Na	130	181	–
K	28	85	–
Cl	46	85	–
HCO_3	114	19.9	–
SO_4	934	2,247	–
SiO_2	22.4	17	–
F	2.3	Not reported	4
N	0.8	Not reported	–
Al	0.0857	9.3	–
Sb	0.0047	**0.035**	0.006
As	0.0227	0.013	0.05
Ba	0.0199	0.02	2
Be	0.0003	**0.036**	0.004
B	0.342	0.48	–
Cd	0.0008	**0.19**	0.005
Cr	0.0027	**0.241**	0.1
Co	0.0063	2.72	–
Cu	0.0158	141	–
Fe	0.0025	0.1	–
Pb	0.005	**0.088**	0.05
Mn	0	14.2	–
Hg	Not reported	0.018	0.002
Mo	0.0135	0.000012	–
Ni	0.0076	**2.5**	0.01
Se	0.0051	**0.5**	0.05
Ag	0.0039	0.165	–
Tl	**0.0043**	**0.009**	0.002
Zn	0.221	8.2	–
pH s.u.	8.58	5.05	–

continued

TABLE OF CONTENTS BACK

Table 3.7.2-1. Modeled block-cave sump water chemistry *(cont'd)*

Constituent	Eary Block-Cave Geochemistry Model* Predicted Concentrations (mg/L)	Hatch Block-Cave Geochemistry Model† Predicted Concentrations (mg/L)	Arizona Aquifer Water Quality Standard (mg/L)
TDS	1528	Not reported	–

Notes: Modeled concentrations that are above Arizona aquifer water quality standards are show in bold and shaded. Model data are not specific to total or dissolved fractions.

Dash indicates no Arizona numeric aquifer water quality standard exists for this constituent.

* Eary (2018f)

† Hatch (2016)

- The model assumes that weathering products from ore remain with the ore and report to the tailings storage facility. These weathering products could rinse off ore and report to the sump.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Sump chemical load could be higher, but whether traveling with ore or reporting to sump, the weathering products enter the process stream either way, and there would be no change to the overall tailings seepage models.
  - Likely magnitude of effect for all action alternatives: None.

TAILINGS SOLUTE GEOCHEMISTRY MODEL

Modeling Details

The water balance for the mine is complex, with multiple sources and recycling loops, and how these sources mix forms the fundamental basis for predicting the water quality in the tailings facility. The water balance differs for each tailings alternative (Golder Associates Inc. 2018a; Klohn Crippen Berger Ltd. 2018a, 2018b, 2018c, 2018d; WestLand Resources Inc. 2018b). Chemical loading inputs are applied to each water source, and the resulting water quality is calculated with a mixing model (PHREEQC) for the entire operational life of the mine, with a different analysis conducted for each alternative (Eary 2018a, 2018b, 2018c, 2018d, 2018e, 2018g). Water quality is modeled for six different locations:

- the mixture of water entering the West Plant Site;
- the PAG recycled water pond (not applicable to Alternative 4 – Silver King);
- the NPAG recycled water pond (not applicable to Alternative 4 – Silver King);
- the water within the pore space of the tailings embankment;
- the seepage collection ponds; and
- the seepage lost to underlying aquifers not captured by the seepage collection ponds.

The tailings solute geochemistry model determines the chemistry of all water and chemicals reporting to the tailings storage facility, and the degree of evaporative concentration. It produces estimates of dissolved constituent concentrations in the tailings storage facility, a portion of which is lost seepage that is used in modeling impacts on downgradient water resources. The tailings solute geochemistry model results are strongly affected by the water balance for the tailings storage facility, which provides flows for the various components reporting to the tailings storage facility and accommodates for evaporative loss. This loss is used in the tailings solute geochemistry model to concentrate dissolved chemical constituents.

Assumptions, Uncertain and Unknown Information

The tailings solute geochemistry model is largely a mathematical process of tracking and combining chemical masses, given various input flow rates and chemical concentrations. While the inputs have uncertainty (such as the block-cave sump chemistry), the model itself highly certain. The release of chemical mass from the ore during processing is also part of the tailings solute geochemistry model; this is based on rates observed during site-specific metallurgical testing and is considered reasonable with relatively low uncertainty.

EMBANKMENT SULFIDE OXIDATION MODEL

Modeling Details

During operations, the tailings that are most likely to experience oxidation of sulfide minerals—the PAG tailings—would be kept in a subaqueous state with an overlying water cap (a minimum of 10 feet deep) to prevent oxygen from reaching and interacting with the tailings. During closure, the water cap would gradually be replaced with a cover of NPAG tailings and a reclamation cover to achieve the same result. The fine-grained tailings on the interior of the facility are expected to exhibit a low vertical permeability and a high moisture content, and oxygen is not expected to penetrate the tailings at rates sufficient to affect seepage chemistry for hundreds of years (Wickham 2018). This would eliminate (or greatly reduce) the risk of acid rock drainage from the PAG tailings, which would otherwise have the potential to impact downstream waters and aquifers.

However, the embankments of the NPAG tailings facility would be constructed of well-drained cyclone sands. Oxygen would be able to enter these areas and react with sulfide minerals over time. The same is true of the entirety of the filtered tailings facility (Alternative 4 – Silver King). The embankment sulfide oxidation model determines the chemical quality of seepage derived from the oxidation occurring in the tailings embankment for the 41 years of operation and an additional 204-year post-closure period[43] (Wickham 2018).

Assumptions, Uncertain and Unknown Information

Chemical loading is calculated using theoretical concepts regarding oxygen movement into the tailings that make up the embankment, and an experimentally derived rate equation for the oxidation of sulfide minerals. The rate equation's validity is supported by field and laboratory testing, and the movement of oxygen is supported by literature-based studies; both assumptions are considered reasonable for the estimate of embankment seepage water quality with relatively low uncertainty.

TAILINGS SEEPAGE MODELS

Modeling Details

Management of water in the tailings storage facility must accomplish a variety of outcomes. For structural integrity, it is desirable to allow water to leave the NPAG tailings storage facility and the tailings embankment in the form of seepage (see section 3.10.1 for a further discussion of tailings stability). However, it is undesirable to allow that seepage to enter downstream aquifers or surface waters in amounts that can cause water quality problems. For PAG tailings, which tend to generate the worst seepage water quality, not only is it undesirable to allow seepage from PAG tailings to enter the environment but it is also necessary to prevent seepage in order to maintain saturation of the PAG tailings to prevent oxidation.

43. The duration of the geochemical modeling matches a global decision made by the Tonto National Forest with input from the Groundwater Modeling Workgroup that quantitative modeling results are not reliable longer than 200 years in the future. This is described more in section 3.7.1.

Each alternative would use a specific set of engineered seepage controls that are built into the design in order to accomplish these goals. These include such controls as liners, blanket and finger drains, seepage collection ponds, and pumpback wells. The specific controls incorporated into each alternative design are described in section 3.7.2.4.

For a given tailings storage facility, estimates have been made of the "total seepage" and the "lost seepage." Total seepage is all water that drains from the tailings storage facility by gravity. Lost seepage is seepage that is not recovered with the engineered seepage controls. Lost seepage is assumed to discharge to the environment. The role of consolidation of the tailings over time was incorporated into the seepage estimates, described further in Garrett and Newell (2018d).

All alternative designs use a strategy of layering on engineered seepage controls to reduce the amount of lost seepage to acceptable levels. Some of these controls, such as foundation preparation, liners, drains, and seepage collection ponds, are implemented during construction of the facility. Other controls, such as auxiliary pumpback wells, grout curtains, or additional seepage collection ponds, would be added as needed during operations depending on the amounts of seepage observed and the observed effectiveness of the existing controls.

The amount of seepage entering the environment is modeled in a variety of ways, depending on alternative (Klohn Crippen Berger Ltd. 2019d).[44] Common to all of these models is that the engineered seepage controls described in section 3.7.2.4 are assumed to be in place, and the combined effectiveness of the layered engineered seepage controls is a key assumption in the ultimate predicted impacts on water.

The level of engineered seepage controls for each alternative was assigned based on practicability and initial modeling estimates of the "allowable seepage" (Gregory and Bayley 2018a). Allowable seepage is the estimated quantity, as a percentage of total seepage, that can be released without resulting in groundwater concentrations that are above Arizona aquifer water quality standards, or surface water concentrations that are above Arizona surface water quality standards. The allowable seepage target is a significant driver for the design of each facility; engineered seepage controls were increased in the design as needed to limit lost seepage to the allowable amount.

Comparison of Engineered Seepage Controls to a Fully Lined Facility

During alternatives development, the concept of a fully lined tailings storage facility was pursued. Eventually this concept was eliminated from detailed analysis, although liners are still used in some areas and some of the techniques used to control seepage that have been incorporated into the design accomplish similar results as a liner. A full description of this evolution is contained in Garrett and Newell (2018d), as are calculations of expected seepage from a fully lined facility. These calculations are used for comparison in section 3.7.2.4.

Assumptions, Uncertain and Unknown Information

Engineered seepage controls incorporated into the tailings storage facility design serve to ensure geotechnical stability/safety and recover a percentage of the total seepage released, in order to meet the limits of allowable seepage. The bypass seepage mixing/loading model is reliant on the amount of lost seepage, and therefore reliant on both the feasibility and effectiveness of the engineered seepage controls. Details of the engineered seepage controls (broken out by Levels 0 through 4) and an assessment of their ability to control seepage are discussed in section 3.7.2.4. The key assumptions in the tailings seepage models, and the level of uncertainty are summarized here:

- The tailings seepage models calculate seepage during the mine life under full-buildout conditions, with gradual increases in acreage and tapering of seepage over time.
  - Applies to: all action alternatives.

44. The choice of models used to estimate seepage for each alternative was based on the specific location, design, level of information, and seepage controls. Further details of the models are contained in Newell and Garrett (2018d).

- Possible outcome if real-world conditions differ from the assumption: Modeled tailings seepage during operations is overestimated.
- Likely magnitude of effect for all action alternatives: Low to none. This approach overestimates chemical loading, rather than underestimates it, and therefore is conservative. In addition, this applies only during the operational life and would not affect the post-closure seepage estimates.

- Incomplete removal of alluvial channels within the interior of the tailings storage facility would allow for faster transport of seepage.
  - Applies to: Alternatives 2, 3, and 4.
  - Possible outcome if real-world conditions differ from the assumption: Seepage reaches finger drains and blanket drains faster.
  - Likely magnitude of effect for Alternatives 2, 3, and 4: Low to none. This would only enhance the operation of the finger and blanket drainage system, which captures seepage and pumps it back to the recycled water pond.
- The seepage estimates do not account for possible preferential flow along minor faults in the bedrock underlying the tailings storage facility footprint.
  - Applies to: Alternatives 2, 3, and 4.
  - Possible outcome if real-world conditions differ from the assumption: Seepage bypasses drains and seepage collection ponds, increasing amount of lost seepage and chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternatives 2 and 3: Low to none. While seepage would bypass the drains and seepage collection ponds, for seepage to enter the environment assumes that all foundation treatments (Level 1, Level 4) were ineffective as well as the downstream grout curtain (Level 2, Level 4) and auxiliary pumpback wells (Level 4). The variety of layered controls have a high likelihood of capturing this seepage.
  - Likely magnitude of effect for Alternative 4: Moderate. This alternative has fewer layered seepage controls, and places sole reliance on the drains and seepage collection ponds.
- The modeling used to estimate seepage efficiency assumes ideal placement of all pumpback wells, embankments, and grout curtains. Pumpback wells might not be located in ideal locations and therefore allow more flow to escape than modeled.
  - Applies to: Alternatives 2 and 3.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternatives 2 and 3: Low. The primary ring of seepage collection dams (Level 1) is located along alluvial drainages which are highly likely to be the preferential flow paths. The secondary ring of seepage collection dams (Level 3), auxiliary pumpback wells (Level 4), and grout curtains (Level 2, Level 4) are controls that would be installed during operations as needed. Placement of these would be driven by direct observation, and it is reasonable to assume they would be targeted to areas of concern.
- The modeled efficiencies for Alternative 2 (99 percent) and Alternative 3 (99.5 percent) could be difficult to achieve in practice. For instance, the length of the Level 4 grout curtain for both alternatives (approximately 7.5 miles) is believed to be larger by a factor of 10 than any other grout curtain in the United States. Similarly, for comparison, the full suite of

engineered seepage controls would result in 97 percent less seepage than a fully lined facility.

  - Applies to: Alternatives 2 and 3.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternatives 2 and 3: Moderate to high. The overall reliance on a variety of engineered seepage controls in a layered defense reduces the likelihood that the failure of any one control would change the outcome. For the Near West location, however, the proximity to Queen Creek provides little room for flexibility to add or modify controls during operations.

- Unlike Alternatives 2 and 3, there is limited information on the hydrology and geology of the proposed Silver King tailings location (Alternative 4). Seepage capture was not modeled, but instead based on professional judgment of the design engineers and an understanding of the potential flow pathways for seepage. Results could vary widely based on field conditions encountered.
  - Applies to: Alternative 4.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternative 4: Moderate. Filtered tailings involve less initial seepage to control, but concentrations of metals are generally higher. Complex and poorly understood geology complicates control efforts. However, at this location there is also potentially room to layer on additional seepage controls downstream.

- Alternative 5 has limited site-specific information on the foundation conditions. However, the general characteristics of the aquifer are reasonably well understood from site-specific geophysics (resistivity, seismic, and gravity surveys), surface geology mapping, review of records and logs from 20 to 30 wells in the near vicinity, and site-specific water levels from nine wells in the near vicinity (Fleming, Kikuchi, et al. 2018; hydroGEOPHYSICS Inc. 2017).
  - Applies to: Alternative 5.
  - Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
  - Likely magnitude of effect for Alternative 5: Low to none. Unlike Alternatives 2, 3, and 4, the large volume of groundwater flow in the substantial alluvial aquifer downstream creates dilution and can accept larger amounts of seepage without resulting in concentrations above water quality standards. In addition, the lost seepage as modeled is based on a reduced pumping amount from the pumpback well system. Additional pumping could take place as needed. In addition, the nearest perennial water is several miles downstream, so there is substantial room to add or modify seepage controls.
  - Alternative 6 has limited site-specific information on the foundation conditions. The general characteristics of the aquifer are understood based on surface geology mapping, review of records and logs from 35 wells in the area (10 within the footprint), including six with driller's logs, and site-specific water levels from 11 wells in the near vicinity (Fleming, Shelley, et al. 2018). In addition, the geological units (Gila Conglomerate) at this location are similar to Alternatives 2 and 3, allowing some reasonable extrapolation of their characteristics. However, this site is not as well understood as

Alternatives 2 and 3, nor does it have as large a downstream aquifer as Alternative 5.

- Applies to: Alternative 6.
- Possible outcome if real-world conditions differ from the assumption: More seepage escapes, increasing chemical load to downstream aquifer.
- Likely magnitude of effect for Alternative 6: Moderate to low. Although not as large as Alternative 5, the volume of groundwater flow in the alluvial aquifer downstream creates dilution and can accept larger amounts of seepage without resulting in concentrations above water quality standards. The flow characteristics of the downstream alluvial aquifer are relatively straightforward, and the spatial extent is well-defined from surface geological mapping. The thickness of the aquifer is uncertain, however, which could affect the overall amount of water available for dilution in the modeling. Seasonal fluctuations in water levels could affect the aquifer capacity. Countering these uncertainties, the relatively narrow aquifer width likely makes existing planned controls (like the grout curtain) simpler to implement, and with the nearest perennial water over a dozen miles downstream, there is substantial room to add or modify seepage controls.

BYPASS SEEPAGE MIXING/LOADING MODELS

Modeling Details

The water quality of the tailings seepage (estimated using the tailings solute geochemistry models), the changes in water quality from the embankment (estimated using the embankment sulfide oxidation model), and the predicted amounts of lost seepage from the facility (estimated using the tailings seepage models), are input into a series of bypass seepage mixing/loading models. These models predict the changes in aquifer water quality as lost seepage flows downgradient from each tailings storage facility. The bypass seepage mixing/loading model uses the Goldsim software package to calculate the mass balance and account for dilution from groundwater present in a series of connected mixing cells. The model cells and framework are slightly different for each alternative; all models are run for the 41 years of operation and an additional 204 years post-closure.

- **Near West (Alternatives 2 and 3)**. The mixing/loading model for Alternatives 2 and 3 estimates groundwater quality in five different mixing cells, starting with Roblas Canyon and Potts Canyon, then flowing into Queen Creek. Queen Creek is represented by three mixing cells, which lead downstream to where the model ends at Whitlow Ranch Dam, where groundwater emerges as surface water (Gregory and Bayley 2018e). Background groundwater quality is derived from a well located adjacent to Queen Creek, using the median of nine samples collected between May 2017 and February 2018. Background surface water quality is derived from the median of 15 samples collected at Whitlow Ranch Dam between March 2015 and December 2017.
- **Silver King (Alternative 4)**. Even though this alternative is composed of filtered tailings, some seepage is still expected to occur with Alternative 4, though a very small amount, compared with Alternatives 2, 3, 5 and 6. The downstream mixing model estimates groundwater quality in nine cells, which start with Potts Canyon, Silver King Wash, and Happy Camp Wash East and West, then flowing into Queen Creek. Queen Creek is represented by five mixing cells, which lead downstream to where the model ends at Whitlow Ranch Dam, where groundwater emerges as surface water (Gregory and Bayley 2018b). Background groundwater and surface water quality are derived from the same sources as Alternatives 2 and 3.
- **Peg Leg (Alternative 5)**. The Peg Leg location is fundamentally different from Alternatives 2, 3, and 4 in that much of the facility overlies a large alluvial aquifer, resulting in relatively large seepage rates, compared with other alternatives.

The downstream mixing model estimates groundwater quality in five cells along Donnelly Wash, leading to the Gila River where groundwater emerges as surface water (Gregory and Bayley 2018c). Background groundwater quality is derived from a single sample in September 2017 from a well located adjacent to Donnelly Wash. Background surface water quality is derived from a single sample in November 2018 from the Gila River at the confluence with Donnelly Wash.

- **Skunk Camp (Alternative 6)**. The Skunk Camp model is similar to the Peg Leg model, with the alluvial aquifer associated with Dripping Spring Wash located downstream. The downstream mixing model estimates groundwater quality in five cells along Dripping Spring Wash, leading to the Gila River, where groundwater emerges as surface water (Gregory and Bayley 2018d). Background groundwater quality is derived from a single sample in November 2018 from a well located adjacent to Dripping Spring Wash. Background surface water quality is derived from a single sample in November 2018 from the Gila River at the confluence with Dripping Spring Wash.

A relatively straightforward mixing cell model is used to evaluate the impact on water, as shown in figure 3.7.2-2. Lost seepage from a given tailings storage facility alternative mixes with the flow of underlying groundwater in the first model cell. The flow of water and dissolved chemicals from this cell passes to the next cell downgradient and is combined with any other flows reporting to that cell. Flows are passed from one groundwater cell to the next until it discharges to a receiving surface water, which is the last cell in the model. At each step, the concentrations of chemical constituents are calculated. The model dimensions of the groundwater cells dictate the amount of dilution that is achieved on mixing with lost seepage; the larger the cells, the greater the diluting effect.

The specific geographic points selected to represent the aquifer and surface water modeled impacts are shown in figure 3.7.2-3.

Assumptions, Uncertain and Unknown Information

The uncertainties described for the block-cave geochemistry model, the tailings solute geochemistry model, and the embankment sulfide oxidation model also add to the uncertainty of the bypass seepage mixing/loading model. Specific uncertainties that affect the bypass seepage mixing/loading model include the following:

- The size of the groundwater cells in the model affects the amount of dilution and the outcome.
    - Applies to: all action alternatives.
    - Possible outcome if real-world conditions differ from the assumption: More or less dilution occurs, changing chemical load to downstream aquifers and perennial waters.
    - Likely magnitude of effect for Alternatives 2 and 3: Low. Substantial site-specific investigation has taken place at the Near West location; this location has the most hydrologic and geological information of any of the alternatives.
    - Likely magnitude of effect for Alternative 4: Low. While the hydrology and geology near the Silver King location is uncertain, the groundwater mixing component happens downstream in Queen Creek, which is relatively well-defined.
    - Likely magnitude of effect for Alternative 5: Low to none. Substantial site-specific investigations have occurred at the Peg Leg location that define the size of the aquifer, which even with uncertainties is substantial.
    - Likely magnitude of effect for Alternative 6: Moderate. The spatial extent of the downstream aquifer is well defined, and characteristics of the aquifer are reasonably understood. However, the thickness of the aquifer is

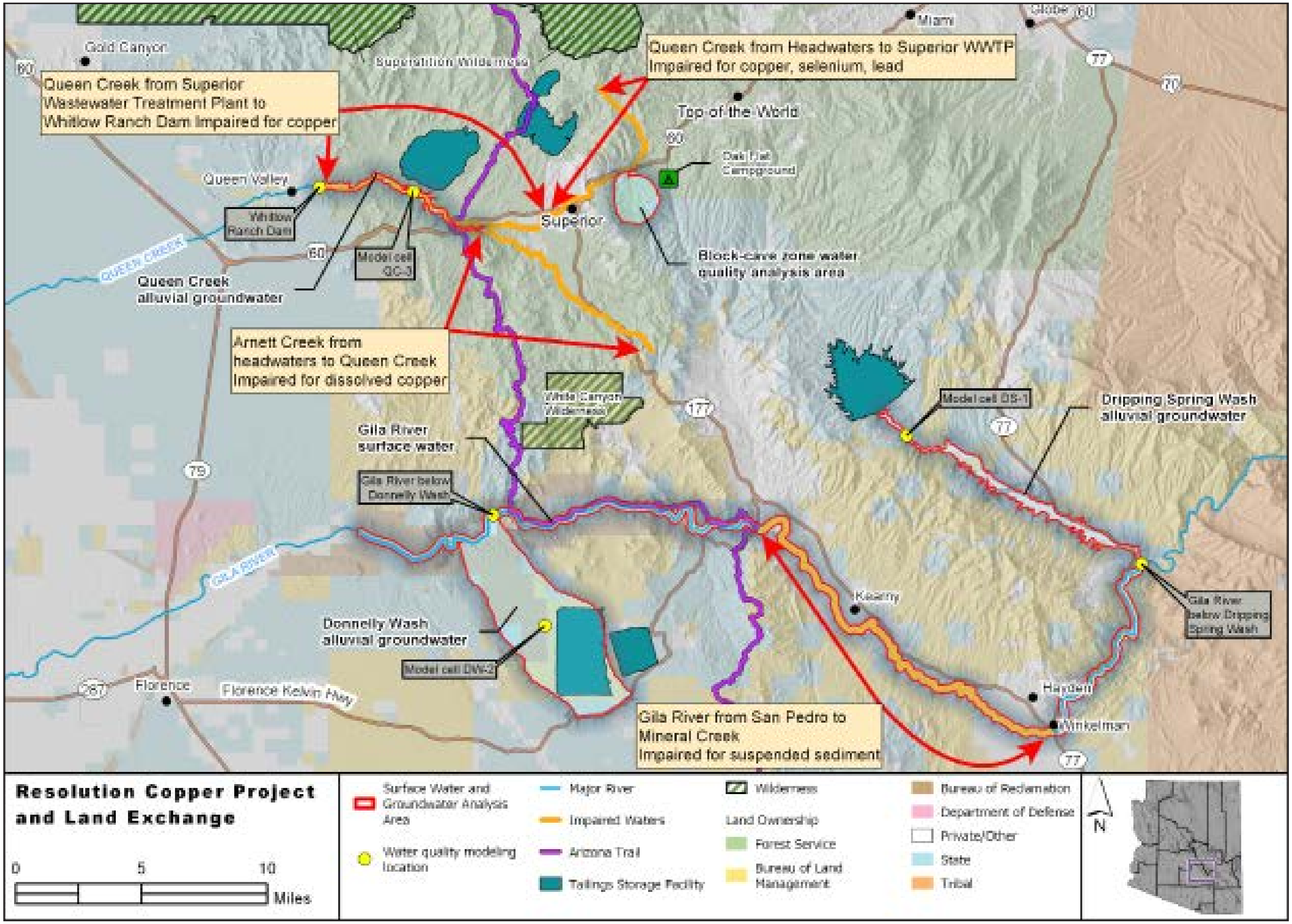


Figure 3.7.2-3. Water quality modeling locations and impaired waters

uncertain, which would directly affect the amount of water available for dilution in the model.

- There is a limited knowledge of baseline aquifer water chemistry.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Baseline chemistry may be higher or lower, leading to different combined concentrations in downstream aquifers.
  - Likely magnitude of effect for Alternatives 2, 3, and 4: Low. Water quality modeling used the median results from nine different samples collected from the nearest downstream well.
  - Likely magnitude of effect for Alternative 5: Moderate. The water quality modeling was based on a single groundwater sample. While water quality modeling did not result in concentrations near aquifer water quality standards for most constituents, selenium approaches the standard late in the modeling run. Even moderate changes in selenium based on additional groundwater sampling could change the outcome of the models.
  - Likely magnitude of effect for Alternative 6: Moderate to low. The water quality modeling was based on a single groundwater sample. However, water quality modeling did not result in concentrations near aquifer water quality standards, allowing some room for variation as future samples are collected.
- There is a limited knowledge of baseline surface water chemistry.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Baseline chemistry may be higher or lower, leading to different assimilative capacity and different predicted concentrations in downstream perennial waters.
  - Likely magnitude of effect for Alternatives 2, 3, and 4: Low. Water quality modeling used the median results from 15 different samples collected from Queen Creek at Whitlow Ranch Dam.
  - Likely magnitude of effect for Alternatives 5 and 6: Low. The water quality modeling was based on a single surface water sample for each alternative, driven by the necessity to have recent surface water quality results at two specific locations (Donnelly Wash and Dripping Spring Wash). A longer period of record exists for the Gila River at other locations and these samples have been assessed against the values used; the model outcomes would not substantially change if surface water quality varied similar to the historic record (see Newell and Garrett (2018d)).
- Modeling idealizes mixing and assumes that seepage fully mixes across the full width of the alluvium of Queen Creek, Donnelly Wash, or Dripping Spring Wash. Should only partial mixing occur, this would also increase concentrations in parts of the alluvial aquifer. Modeling also does not take into account seasonal flow patterns of water levels.
  - Applies to: all action alternatives.
  - Possible outcome if real-world conditions differ from the assumption: Preferential mixing or flow paths would effectively reduce the amount of dilution of seepage, resulting in higher downstream concentrations. Changing water levels could result in more or less dilution.
  - Likely magnitude of effect for all action alternatives: Moderate. Flow through alluvial aquifers is relatively straightforward to model as an idealized system, but real-world conditions (like the periodic recharge effects

of stormflow) could greatly affect the outcomes. These types of uncertainties are inherent; no amount of hydrologic investigation is likely to resolve these uncertainties.

OVERALL EFFECT OF UNCERTAINTIES ON THE MODEL OUTCOMES

As with all modeling, the modeling used to estimate water quality impacts for each alternative contains assumptions and uncertainty that limit the accuracy and reliability of the associated results.

The model construction includes some intentional bias to skew results that produce a greater negative impact and therefore provide the greatest environmental protection. Examples include the following:

- The assumption that life-of-mine discharge from the tailings storage facility remains at the highest levels associated with the drain down process, rather than decreasing over time. This maximizes the modeled chemical discharge from the tailings storage facility.
- The model does not consider any geochemical processes in the groundwater and surface water flow that might lower concentrations. Examples include potential chemical precipitation of oversaturated solids, or adsorption of chemical constituents onto aquifer solids, which can both lower concentrations in the water.
- For comparisons against surface water standards, median flow values were used which is appropriate when replicating baseflow. Concentrations during runoff events would be expected to be lower due to dilution from stormflows. However, it should be noted that lower flow conditions can occur during the year that would not be reflected by median flow conditions, and for some constituents like copper, studies suggest that stormflows might increase in copper concentrations (Louis Berger Group Inc. 2013).
- Variations in hardness can change surface water quality standards for some metals, with increasing hardness resulting in a higher water quality standard; for the comparisons in section 3.7.2.4, the best available information on existing hardness was used (as calculated from calcium and magnesium concentrations).

A number of uncertainties have been disclosed in this section that affect the ultimate outcome of the water quality modeling. These are summarized in table 3.7.2-2.

Many of the uncertainties identified could result in either higher or lower concentrations in modeled outcomes, or overall would be expected to have a low (or no) impact on the outcomes.

A number of uncertainties reflect limited information on the geology and hydrology at alternative tailings locations or limited baseline water quality samples. This does not mean that the models are unrealistic or unreasonable. They rely on the best available hydrologic and geological information and make reasonable assumptions about aquifer conditions. Future hydrologic and geological investigations at these locations would reduce some uncertainty and refine some model parameters; the overall flow regime of the downstream aquifers and surface waters is understood well enough that the model framework would likely remain the same.

One of the most uncertain aspects of the modeling is the assumption about oxidation in the block-cave zone. Two different models of the geochemistry of the block-cave zone have been conducted, one assuming that oxidation occurs (Hatch 2016) and one assuming that it does not (Eary 2018f). The block-cave geochemistry model used as a basis for the water quality modeling (Eary 2018f) represents the current conception of the mechanics of block-caving and ventilation of the mine and how that would affect the presence of oxygen in the cave zone; this is considered a reasonable interpretation. However, the earlier interpretation—while not as advanced—is also a reasonable interpretation, and this source of uncertainty could result in higher concentrations that would cascade through the water quality modeling.

Table 3.7.2-2. Compilation of magnitude of uncertainties disclosed for water quality modeling

Modeling Component/ Uncertainty	Potential Effect on Modeled Tailings Seepage	Alternative 2 Likely Magnitude of Effect on Outcomes	Alternative 3 Likely Magnitude of Effect on Outcomes	Alternative 4 Likely Magnitude of Effect on Outcomes	Alternative 5 Likely Magnitude of Effect on Outcomes	Alt 6 Likely Magnitude of Effect on Outcomes
Block-cave model						
Source water chemistry could vary	Higher or lower	Low	Low	Low	Low	Low
Cave-zone in-situ weathering could occur	Higher	High	High	High	High	High
Weathering products stay with ore	None	None	None	None	None	None
Tailings seepage models						
Full-buildout seepage during operations	Lower	Low to none	Low to none	Low to none	Low to none	Low to none
Alluvial channels could remain in footprint	None	Low to none	Low to none	Low to none	–	–
Minor faults could cause preferential flow	Higher	Low to none	Low to none	Moderate	–	–
Ideal placement of controls assumed	Higher	Low	Low	–	–	–
Seepage efficiency difficult to meet	Higher	Moderate to high	Moderate to high	–	–	–
Limited site-specific hydrologic/geological information	Higher	–	–	Moderate	Low to None	Moderate to Low
Bypass seepage mixing/ loading models						
Mixing cells could be different sizes	Higher or lower	Low	Low	Low	Low to None	Moderate
Limited baseline aquifer water quality	Higher or lower	Low	Low	Low	Moderate	Moderate to Low
Limited baseline surface water quality	Higher or lower	Low	Low	Low	Low	Low
Idealized mixing	Higher	Moderate	Moderate	Moderate	Moderate	Moderate

Note: A dash indicates that this was not identified as a specific concern for this alternative

It is possible further field tests could be designed to explore this phenomenon, though these would be experimental in nature and are not industry-standard practices. The real-world effect of chemical weathering in the block-cave zone is likely bracketed by the two different models.

Conclusion as to reasonableness of models

The CEQ regulations provide guidance for dealing with incomplete or uncertain information:

> When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking. . . . If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement. (40 CFR 1502.22)

While future work or additional information could reduce some of these uncertainties, the water quality modeling results disclosed in the EIS (section 3.7.2.4) are sufficiently different between alternatives that such refinements are not "essential to a reasoned choice among alternatives." The broad conclusions in section 3.7.2.4 are not likely to change, specifically:

- It is difficult to meet water quality objectives at Alternatives 2, 3, and 4 without extensive engineered seepage controls.
- Alternatives 5 and 6 not only meet water quality objectives as modeled but have substantial additional capacity to do so, and flexibility

Forest Service disclosure and ADEQ permitting requirements

The State of Arizona has the authority to determine whether or not the proposed project would violate State water quality regulations. The person or entity seeking authorization for a regulated discharge (in this case Resolution Copper) has the responsibility to demonstrate to the State of Arizona that the regulated discharge would not violate water quality standards. This demonstration takes place through the application for and issuance of permits. Resolution Copper would be required to obtain a permit under the Arizona Pollutant Discharge Elimination System (AZPDES) program for any discharges to surface waters, including stormwater runoff, as well as an Aquifer Protection Permit (APP) for any discharges to groundwater, or discharges to the ground that could seep into groundwater.

The Forest Service is responsible for ensuring that mine operators on NFS lands obtain the proper permits and certifications to demonstrate they comply with applicable water quality standards. This constitutes compliance with the Clean Water Act (CWA). The ROD would require that Resolution Copper obtain the applicable State permits prior to approval of the final mining plan of operations, which authorizes mine activities. If the permits are issued, then ADEQ has determined that the project would be compliant with State law and identified the steps that would occur if monitoring indicates noncompliance.

While the permitting process provides an assurance to the public that the project would not cause impacts on water quality, it does not relieve the Forest Service of several other responsibilities:

- The Forest Service has a responsibility to analyze and disclose to the public any potential impacts on surface water and groundwater as part of the NEPA process, separate from the State permitting process.
- The role of the Tonto National Forest under its primary authorities is to ensure that mining activities minimize adverse environmental effects on NFS lands and comply with all applicable laws and regulations. As such, the Forest Supervisor

ultimately cannot select an alternative that is unable to meet applicable laws and regulations.[45] However, it may be after the EIS is published when permits are issued by ADEQ that demonstrate that the project complies with state laws. In the meantime, it would be undesirable for the Forest Service to pursue and analyze alternatives that may not be able to comply. Therefore, a second goal of the analysis in this EIS is to inform the Forest Supervisor of alternatives that may prove difficult to permit.

The analysis approaches used by the Forest Service in this EIS likely differ from those that ADEQ would use in assessing and issuing permits. ADEQ would use the assumptions, techniques, tools, and data deemed appropriate for those permits. The Forest Service has selected to use a series of simpler mixing-cell models to provide a reasonable assessment of potential water quality impacts that is consistent with the level of hydrologic and geological information currently available for the alternative tailings sites. This approach is sufficient to provide the necessary comparison between alternatives and assess the relative risk of violation of water quality standards. It is understood different analysis may be conducted later when ADEQ is reviewing permit applications for the preferred alternative.

There are two specific additional aspects of the analysis in this section of the EIS that have a bearing on the ADEQ permitting process: assimilative capacity, and impaired waters.

ASSIMILATIVE CAPACITY

Assimilative capacity is the ability for a perennial water to receive additional pollutants without being degraded; assimilative capacity is calculated as the difference in concentration between the baseline water quality for a pollutant and the most stringent applicable water quality criterion for that pollutant.

Under Arizona surface water regulations, the addition of a pollutant may be considered "significant degradation" of a perennial water if, during critical flow conditions, the regulated discharge consumes 20 percent or more of the available assimilative capacity for each pollutant of concern (Arizona Administrative Code R18-11-107.01(B)). The addition of contaminants to surface waters through seepage could result in a reduction in the assimilative capacity of perennial waters. The EIS therefore contains an analysis of reductions in assimilative capacity.

The regulatory determination of significant degradation of perennial waters is under the purview of the State of Arizona. This determination is usually made when a permit is requested for a discharge directly to surface waters. However, Resolution Copper is not proposing any direct discharges to surface waters. Alternatively, ADEQ could consider the indirect effects of seepage from the tailings storage facility to surface waters under the APP program, or under a CWA Section 401 water quality certification (which is only done if a CWA Section 404 permit is required).

The 20 percent threshold that defines significant degradation is not absolute; if ADEQ decides to assess antidegradation standards as part of a permitting action, there are also provisions in Arizona regulations for degradation to be allowed, provided certain criteria are met (Arizona Administrative Code R18-11-107.C).

In other words, neither the regulatory need to assess assimilative capacity, nor the consequences of exceeding the 20 percent threshold can be assessed outside of a specific permitting decision by ADEQ. Regardless, the Forest Service responsibility for the DEIS is to disclose possible water quality concerns. This includes the reduction in

45. Note that Alternative 6 would involve a tailings facility located off of Federal lands, and permitting the tailings facility would not be part of the Federal decision. In this case, the State permitting process that would ensue would require that applicable laws and regulations be met.

assimilative capacity of a perennial water. For this purpose, a threshold of 20 percent loss in assimilative capacity is used.[46]

IMPAIRED WATERS

Under the CWA, the State of Arizona must identify waters that are impaired for water quality.[47] As with assimilative capacity, the regulatory determination of how impaired waters could be affected by a discharge is solely under the purview of the State of Arizona.

For the purposes of disclosure, the Forest Service approach in the EIS is to identify what surface waters have been determined to be impaired, where contaminants from the project could enter these surface waters and exacerbate an already impaired water, and the estimated loading for constituents associated with the impairment.

Constituents of Concern

While the background references and reports contain information for the full suite of metals, inorganic constituents, and field measurements, the analysis we present in this section focuses on selected "constituents of concern." For example, appendix M of this EIS only includes graphs for the following constituents (these are constituents that are typically known to be issues for tailings facilities, or that the bypass seepage mixing/loading models have indicated may be a problem). These include the following:

- Total dissolved solids
- Sulfate
- Nitrate
- Selenium, cadmium, antimony, and copper

46. The calculation of assimilative capacity depends in part on the specific numeric surface water standard being used. Several surface water quality standards for metals change based on the hardness of the water. A hardness of 307 mg/L $CaCO_3$ was used for Queen Creek, which is based on the lowest hardness observed (sample date August 25, 2017); a hardness of 290 mg/L $CaCO_3$ was used for the Gila River below Donnelly Wash (sample date November 13, 2018); and a hardness of 242 mg/L $CaCO_3$ was used for the Gila River below Dripping Spring Wash (sample date November 9, 2018). The addition of the modeled seepage does increase hardness but only slightly (less than 2%). The values of hardness used are based on the best available information at this time; ADEQ could choose to apply different hardness values during permitting.

    The calculation of assimilative capacity also depends on specific "critical flow conditions." One technique (often called 7Q10) is to choose the lowest flow over 7 consecutive days that has a probability of occurring once every 10 years. By contrast, the seepage modeling in the EIS uses the median flow for surface waters, which is a common method of estimating baseflow conditions, because it tends to exclude large flood events. While assessing typical baseflow conditions (using the median flow) were determined to be the most appropriate method for the EIS disclosure, ADEQ could choose to apply different flow conditions during permitting.

47. "Impaired" refers to a regulatory designation under the CWA, and generally means that existing water quality is degraded to the point that an applicable water quality standard is not being attained.

Primary Legal Authorities Relevant to the Groundwater and Surface Water Quality Analysis

- Clean Water Act and Federal primary and secondary water quality standards
- State of Arizona Aquifer Water Quality Standards and the Aquifer Protection Permit program
- State of Arizona Surface Water Quality Standards and the Arizona Pollutant Discharge Elimination System program (delegated primacy for Clean Water Act Section 402)

3.7.2.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

For the most part, impacts on groundwater and surface water quality fall under State of Arizona regulations, which are derived in part from the CWA. Additional details of the regulatory framework for groundwater and surface water quality are captured in the project record (Newell and Garrett 2018d).

Existing Conditions and Ongoing Trends

This section discusses three aspects of the affected environment:

- Existing groundwater quality for various aquifers, including what types and quantity of data have been collected to date; the general geochemistry of the groundwater for major constituents; the occurrence and concentrations of constituents of concern, compared with water quality standards; the age of the groundwater; and existing trends in groundwater quality.
- Existing surface water quality for various streams, including what types and quantity of data have been collected to date; the general geochemistry of surface waters for major constituents; and the occurrence and concentrations of constituents of concern, compared with water quality standards.
- Characterization of mine rock ore, and tailings, including the types and quantity of data for different geological units and alteration types that have been collected to date, and the static and kinetic laboratory testing undertaken to describe the likely changes in water quality when exposed to oxygen in the presence of sulfide minerals.

EXISTING GROUNDWATER QUALITY

Types of Groundwater Present

As more fully described in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems, three types of groundwater exist in the area: shallow groundwater occurring in shallow alluvial materials, perched zones, or shallow fractures; the Apache Leap Tuff aquifer; and the deep groundwater system (units generally below the Whitetail Conglomerate, and extending into the Superior Basin) as seen in figure 3.7.1-4. These groundwater systems are identified as separate based on the different ages of the water within them and because they do not appear to be hydraulically connected based on aquifer testing.

The tailings facilities for Alternatives 2, 3, and 4 in the Superior Basin include shallow alluvial materials along washes and underlying fractured hard rock units like the Gila Conglomerate, which are assumed to be in hydraulic connection with the deep groundwater system. The tailings facilities for Alternatives 5 and 6 are geographically separate from the Superior Basin and overlie alluvial aquifers associated with Donnelly Wash and Dripping Spring Wash, respectively, with some hard rock units along the margins of the facilities.

Period of Record for Groundwater Quality Data

Groundwater quality data have been collected since monitor well drilling and development was initiated in 2003, and collection continues into the present. Groundwater samples from each monitoring well are analyzed for common dissolved constituents when the wells are completed, and then periodically thereafter. Overall, 31 wells in the project area have been sampled since 2003, and a total of 150 samples has been collected to characterize groundwater in the project area through 2015. These samples are largely focused on the East Plant Site and surrounding areas.

Near the West Plant Site, 48 wells have been developed and sampled, yielding 102 samples of groundwater (including duplicate samples). This sampling has largely been the result of ongoing voluntary cleanup activities at the West Plant Site, and the results are generally geared toward assessing contamination rather than hydrogeological conditions and general water quality.

Additional piezometers and monitoring wells were constructed in the Near West area in 2016 and 2017, where the tailings storage facility for Alternatives 2 and 3 would be located. Groundwater quality results from these wells have not yet been submitted.

Several other sampling locations provide the basis for background water quality in the bypass seepage mixing/loading models. These include a well near Queen Creek (nine samples between 2017 and 2018), a well near Donnelly Wash (one sample in 2018), and a well near Dripping Spring Wash (one sample in 2018).

Types of Groundwater Quality Data Collected

All samples were analyzed for a wide range of chemical constituents, including water quality measurements made on water samples in the field at the point of collection (e.g., pH, temperature) and analyses conducted by Arizona-certified analytical laboratories. Some of the constituents analyzed are directly related to water quality, including those that have regulatory standards in the state of Arizona. Other constituents such as isotopes were sampled to help understand groundwater dynamics and the potential for interaction with local surface water resources (Garrett 2018d). The number, date range, and types of samples collected are shown in table 3.7.2-3. A summary of existing groundwater quality for each aquifer is shown in appendix N, table N-1.

Table 3.7.2-3. Number of groundwater samples available for analysis

Type of Analysis	Shallow Groundwater Samples	Apache Leap Tuff Samples	Deep Groundwater Samples
General chemistry	25 (June 1986–Nov 2015)	104 (March 2004–Dec 2015)	19 (Nov 2008–Feb 2015)
Metals	25 (June 1986–Nov 2015)	105 (March 2004–Dec 2015)	19 (Nov 2008–Feb 2015)
Isotopes	24 (June 1986–May 2012)	90 (March 2004–Dec 2015)	19 (Nov 2008–Feb 2015)
Radionuclides	12 (June 2007–Dec 2008)	63 (June 2007–Dec 2015)	19 (Nov 2008–Feb 2015)

Chemical Quality of Groundwater

There are differences in water quality among the three principal groundwater sources (shallow, Apache Leap Tuff, deep groundwater system) in the project area (Montgomery and Associates Inc. 2012, 2016).[48] The shallow groundwater system can be described as a calcium/magnesium bicarbonate type with varying amounts of sulfate. The total dissolved solids content is generally low (median of 290 mg/L). Constituents in water samples from the shallow groundwater system rarely have concentrations above Arizona numeric Aquifer Water Quality Standards (AWQS) and EPA primary maximum contaminant levels, with nitrate and lead being the only constituents with concentrations above these standards. Samples also rarely have concentrations above EPA secondary maximum contaminant levels,

48. For a complete summary of the number of samples with concentrations over Arizona or EPA standards to support the qualitative terms used in this section (i.e., “rarely,” “occasionally,” “often”), see Newell and Garrett (2018d).

but this does occur for iron, manganese, sulfate, aluminum, and total dissolved solids; secondary standards are generally established for aesthetics and taste, rather than safety.

The Apache Leap Tuff aquifer has been sampled much more than either the shallow or deep groundwater systems, since it is the aquifer from which most springs and stream derive their flow. Overall the Apache Leap Tuff is a calcium-magnesium-bicarbonate water type, with low total dissolved solids (median of 217 mg/L). Constituents in water samples from the Apache Leap Tuff rarely appear in concentrations above Arizona numeric AWQS or EPA primary standards, although this has occurred for antimony, thallium, and beryllium. Concentrations above EPA secondary standards occur occasionally for aluminum, iron, and manganese, and rarely for total dissolved solids.

The overall water quality of the deep groundwater system is more variable than the shallow and Apache Leap Tuff systems, with greater total dissolved solids (median of 410 mg/L) that often can be above the EPA secondary standard. Only one sample (in 2011) exhibited concentrations above AWQS values. Concentrations often are above EPA secondary standards for aluminum, iron, manganese, sulfate, and fluoride. Samples with elevated sulfate, total dissolved solids, iron, and manganese appear to be within the proposed mineralized ore zone (Montgomery and Associates Inc. 2012).

Groundwater is also extracted from Shaft 9 as part of the ongoing dewatering. Groundwater associated with discharge from Shaft 9 has very high sulfate concentrations and, by extension, elevated total dissolved solids. Numerous constituents can be found in concentrations above Arizona numeric AWQS and EPA primary and secondary standards. This sampling location should not, however, be considered representative of the deep groundwater system, as it is affected by historical mine activity. The impacts at this location appear to be influenced by sulfide mineral oxidation, although the solution is routinely near neutral pH.

Age of Groundwater

Chemical characteristics of groundwater (isotopes) that may be used to assess age do not have explicit regulatory standards. Carbon-14 (^{14}C) and tritium have both been measured in shallow system, Apache Leap Tuff aquifer, and deep groundwater system sources to constrain age and provide understanding of water movement. These isotopic measurements indicate that shallow groundwater is typically estimated to be less than 700 years old, whereas Apache Leap Tuff and deep groundwater are 3,000–5,000 and 6,000–15,000 years old, respectively.

Trends in Groundwater Quality

Based on groundwater samples collected roughly between 2003 and 2015, over time the groundwater quality, in terms of major chemical constituents (e.g., calcium, magnesium, bicarbonate, sulfate) has remained generally stable in the shallow groundwater system and Apache Leap Tuff aquifer. The shallow system has displayed the greatest amount of variation, largely confined to variations in sulfate concentration. Although data for deep groundwater show significant variation with location, available data indicate there is little seasonal variability.

EXISTING SURFACE WATER QUALITY

Surface water occurs broadly across the entire project area. The settings in which surface water occurs span a wide range, from small to large drainage areas and channels and with highly variable flow rates. The kinds of surface water present (including springs and perennial streams) are described in further detail in both the “Groundwater Quantity and Groundwater-Dependent Ecosystems” and “Surface Water Quantity” resource sections in this chapter.

Period of Record for Surface Water Quality Data

The surface water baseline monitoring program for the project area was initiated in 2003 and has continued through present, with a 2-year hiatus in 2006 and 2007. Although surface water data have been collected since 2003, the number of samples collected varies from location to location. Water quality data are available for a total of 47 locations. Through 2015, 505 samples of surface water have been collected and chemically analyzed for 37 water quality parameters.

Most surface water monitoring has been conducted in the Devil's Canyon watershed (main canyon and two tributaries). Queen Creek, along the northern margin of Oak Flat prior to entering the Superior area, has also been extensively characterized (Montgomery and Associates Inc. 2013, 2017d).

Several other sampling locations provide the basis for background water quality in the bypass seepage mixing/loading models. These include Queen Creek at Whitlow Ranch Dam (15 samples between 2017 and 2018), the Gila River below Donnelly Wash (one sample in 2018), and the Gila River below Dripping Spring Wash (one sample in 2018).

Types of Surface Water Quality Data Collected

As with groundwater, all samples were analyzed for a wide range of chemical constituents, including water quality measurements made on water samples in the field at the point of collection (e.g., pH, temperature) and analyses conducted by State-certified analytical laboratories. Some of the constituents analyzed are directly related to water quality, including those that have regulatory standards in the state of Arizona. Other constituents such as isotopes were sampled to help understand groundwater dynamics and the potential for interaction with local surface water resources (Garrett 2018d).

Chemical Quality of Surface Waters

In general, surface water in the area is a calcium-sodium-bicarbonate type, with a neutral to alkaline pH. Based on sampling conducted by Resolution Copper, the basic chemistry of surface water does not vary widely across the project site and does not show any identifiable long-term trends, either increasing or decreasing. For the three principal drainages associated with the project—Devil's Canyon, Queen Creek, and Mineral Creek—water quality is generally considered to be of acceptable quality, although all three have exhibited concentrations above Arizona surface water quality standards at different times for several different constituents (Montgomery and Associates Inc. 2013, 2017d). A summary of the number of surface water samples with concentrations above Arizona numeric surface water standards is included in appendix N, table N-4; the constituents most often noted are arsenic, thallium, copper, lead, and selenium.

Appendix N, table N-2 presents a summary of water quality for defined reaches of the principal drainages, for filtered water samples (dissolved concentrations). Appendix N, table N-3 presents the same types of data for unfiltered samples (total concentrations). A summary of Arizona numeric surface water standards and which bodies they are applicable to is included in appendix N, table N-5. The State of Arizona has conducted more extensive sampling throughout the watershed since 2002–2003, with a focus on identifying sources of pollutants affecting impaired reaches of Queen Creek, Arnett Creek, and several tributary washes. ADEQ found that copper and lead vary across the watershed, with the highest concentrations of copper observed in runoff from Oak Flat and subwatersheds generally north of the West Plant Site. ADEQ also observed variations in runoff hardness (which is important for calculating surface water quality standards) and lead across the watershed (Louis Berger Group Inc. 2013).

Impaired Waters

The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. To fulfill this objective, the State of Arizona is required to assess the existing quality of surface waters and identify any water bodies that do not meet State surface water quality standards. Each pollutant (i.e., copper, lead, suspended sediment) is looked at individually.

When a water body is identified that does not meet water quality standards, the next step taken by ADEQ is to develop a total maximum daily load (TMDL) for that pollutant. The TMDL is the amount to of a pollutant that a stream or lake can receive and still meet water quality standards. The studies to support developing a TMDL look at the point sources (i.e., discharge from municipalities or industries) and nonpoint sources (i.e., stormwater runoff from agriculture or the natural landscape).

Within the Queen Creek, Mineral Creek, and Gila River watersheds, several streams appear on the 303(d) Impaired Waters List (Arizona Department of Environmental Quality 2018a). The most recent list (2018) includes the following streams within the analysis area:

- Queen Creek, from headwaters to Superior Wastewater Treatment Plant discharge. Impaired for dissolved copper (since 2002), total lead (since 2010), and total selenium (since 2012). Two unnamed tributaries to this reach are also impaired for dissolved copper (since 2010).
- Queen Creek, from Superior Wastewater Treatment Plant discharge to Potts Canyon. Impaired for dissolved copper (since 2004).
- Queen Creek, from Potts Canyon to Whitlow Canyon. Impaired for dissolved copper (since 2010).
- Arnett Creek, from headwaters to Queen Creek. Impaired for dissolved copper (since 2010).
- Gila River, from San Pedro River to Mineral Creek. Impaired for suspended sediment (since 2006).

Of these, the only two reaches with the potential to receive additional pollutants caused by the Resolution Copper Project are Queen Creek below the Superior Wastewater Treatment Plant, due to runoff or seepage from Alternatives 2, 3, and 4, and the Gila River from the San Pedro River to Mineral Creek, due to runoff or seepage from Alternative 6.

In investigating the potential sources of copper in the watershed, ADEQ identified that the dominant source of copper to Queen Creek was runoff from the soils and rocks in the watershed, not point source discharges, and was a combination of natural background copper content and historic fallout from copper smelting (Louis Berger Group Inc. 2013). Part of the copper contribution looked at specifically by ADEQ was from Oak Flat. About 20 percent of the runoff reaching Superior would be captured by the subsidence crater and potentially could reduce copper loads to Queen Creek. For the purposes of the EIS, no such reductions are being assumed, in order to ensure that the impacts from copper loads from tailings seepage are not underestimated. Copper loads to Queen Creek due to the Resolution Copper Project are discussed in section 3.7.2.4.

MINE ROCK ANALYSIS

Rock within the proposed subsurface zone of mining is highly mineralized. However, not all the rock that is mineralized is ore grade and identified for proposed recovery. Much mineralized rock would remain in place during, and after mining. This rock contains sulfide minerals (e.g., pyrite, iron disulfide) and other metal-containing material. During mining, and after mining for some time, exposure of these minerals to oxygen could lead to their chemical weathering. This weathering may contribute acidity and metals to contact water and diminish its overall quality. The mine rock has been sampled and analyzed to assess the extent to which it might affect water that accumulates and is removed during mining, as well as the potential effects on groundwater that floods the mine void after mining is completed.

Amount of Geochemistry Tests Conducted

MWH Americas (2013) reports the rock units and alteration types that have been evaluated, and the number of samples for each. This information is summarized in table 3.7.2-4. Overall, 226 samples were submitted for analysis of Tier 1 procedures, with 13 duplicates for a total of 239 samples. A total of 54 samples were identified and submitted for Tier 2 evaluation using humidity cells; these cells were run for periods lasting from 16 to 74 weeks. Saturated column tests were then performed on samples from 14 of the 54 humidity cell tests, and were

Table 3.7.2-4. Rock units, alteration types, and number of samples submitted for Tier 1 geochemical evaluation

Code	**Rock Unit**	**Count**
Tal	Tertiary Apache Leap Tuff (Ignimbrite)	7
Tw	Tertiary Whitetail Conglomerate	11
Kvs	Cretaceous volcanics and sediments (undifferentiated)	101
Kqs	Cretaceous quartz-rich sediments	1
QEP	Quartz eye porphyry; rhyodacite porphyry	37
FP/LP	Felsic porphyry; latite porphyry	3
Dm	Devonian Martin limestone (skarn)	21
Andesite	Andesite	1
Diabase	Diabase	22
Qzite	Quartzite	17
Breccia/Hbx	Heterolithic breccia	3
Fault	Fault	2
	Total	**226**
Code	Alteration Type	**Count**
AA	Advanced argillic	19
ARG	Argillic	1
HFLRET	Retrograde hornfels	5
PHY	Phyllic	111
POT	Potassic	31
PRO	Propylitic	16
SA	Supergene argillic	7
SIL	Siliceous	1
SKN/SKRET	Skarn/Retrograde skarn	16
UNALT	Unaltered	18
ZEO	Zeolite	1
	Total	**226**

run for a 12-week period. Specific Tier 1 and Tier 2 tests are described in the next section

Types of Geochemistry Tests Conducted

Mine rock has been evaluated using a range of established, standard (best practices) methods for the mining industry (International Network for Acid Prevention 2018) as well as those that are regulatorily mandated procedures (Arizona Department of Environmental Quality 2004). These methods assess

- the potential for rock to generate acidic drainage,
- the rate at which such acid generation may occur, and
- what constituents of concern might be released and their associated concentrations.

Specific methods include

- whole rock chemical composition (concentration of wide range of elements),
- acid-base accounting (Sobek et al. 1978),
- net acid generation test (Stewart et al. 2006),
- synthetic precipitation leaching procedure (U.S. Environmental Protection Agency 1994),
- particle size analysis,
- humidity cell testing (American Society for Testing and Materials 1996), and
- saturated column testing (a project-specific test to leach the residual humidity cell testing procedure material.

The first five procedures (whole rock chemical composition, acid-base accounting, net acid generation test, synthetic precipitation leaching procedure, and particle size analysis) are Tier 1 procedures required in the Arizona Best Available Demonstrated Control Technology (BADCT) guidance (Arizona Department of Environmental Quality 2004). The last two are called for in the Tier 2 test-level requirements, which are generally conducted on fewer samples but take place over a longer period of time. Humidity cells are designed to mimic chemical weathering in the laboratory, and assess the rate of acid generation over time, and changes in water quality over time as a sample weathers. Saturated column tests are designed to mimic what would happen when the block-cave zone refloods after mining.

Beyond these chemical testing methods that directly assess potential impacts on the quality of contacting water, mine rock has been evaluated using mineralogical techniques such as

- petrography (microscopic evaluation of mineral grain sizes and contact boundaries),
- X-ray diffraction (identifies actual minerals present and their abundance), and
- scanning electron microscopy (evaluation of mineral formulas and textures).

Geochemical testing fundamentally is meant to determine if a given rock sample is potentially acid generating or not, and if so, to what extent. The geochemical tests indicate that there are numerous rock units associated with the project that have acid generation potential; geochemical tests on simulated tailings samples similarly have demonstrated the potential for acid generation.

Results of Geochemistry Tests – Mine Rock

Acid-base account testing of mine rock indicates that overall, most rock is classified as likely to generate acid rock drainage. ADEQ (2004) provides guidance for using acid-base account measurements to classify mine rock as either acid generating, non-potentially acid generating (NPAG), or potentially acid generating (PAG). To do this, the net neutralizing potential (NNP) is calculated, which is simply the acid neutralizing potential of the sample minus the acid generating potential of the sample. These prescriptive guidelines (Arizona Department of Environmental Quality 2004) for classifying mine materials use the following definitions:

- If NNP is less than −20, the rock can be considered acid generating.
- If NNP is greater than +20, the rock can generally be considered NPAG.
- Samples that fall between −20 and +20 are considered uncertain and may be tested further using kinetic testing methods.

Table 3.7.2-5 summarizes the percentage of each major rock type, according to hydrothermal alteration type, that is classified as either acid generating, NPAG, or PAG.

Humidity cell testing (a type of kinetic testing) has been conducted for assessing PAG and NPAG material. The kinetic testing is less for identifying the potential for acid generation, but more importantly for estimating specific weathering rates for developing chemical loading terms to be used in the seepage modeling. Humidity cell testing confirmed that samples identified as PAG in Tier 1 testing continued to produce acid leachates over time.

Results of Geochemistry Tests – Tailings

Tailings samples have been produced as part of metallurgical processing investigations and have been characterized for the potential to produce acid. Tailings would be produced in a such a way that part of the production stream would be highly enriched in acid-generating pyrite (the PAG tailings), and the balance would be depleted in pyrite as a result (the NPAG tailings). As summarized by Duke HydroChem LLC (2016), and reported in table 3.7.2-6, as would be expected all the PAG tailings are classified as acid-generating, whereas NPAG tailings are roughly equal parts non-acid generating and potentially acid generating, with a small percentage considered acid generating.

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

No Action Alternative

Under the no action alternative, seepage would not develop from a tailings facility and contribute to chemical loading in downgradient aquifers or surface waters, and stormwater would not potentially contact tailings, ore, or process areas. Water quality in the block-cave zone and surrounding aquifers would continue to match current conditions.

Impacts Common to All Action Alternatives

EFFECTS OF THE LAND EXCHANGE

The land exchange would have effects on groundwater and surface water quality.

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 water quality. 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.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. A number of perennial water features are located on these lands and entering Federal management would offer additional protection for the water quality of these resources.

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

Table 3.7.2-5. Acid-generating ion classification of mine rock samples based on geological unit and alteration type

Geological Unit*	Alteration Type	Acid Generating	Non-acid Generating	Potentially Acid Generating
Andesite	Potassic	0.0%	0.0%	100.0%
Breccia	Advanced Argillic	100.0%	0.0%	0.0%
Breccia	Phyllic	50.0%	50.0%	0.0%
Diabase	Phyllic	100.0%	0.0%	0.0%
Diabase	Potassic	73.7%	0.0%	26.3%
Martin limestone	Retrograde Hornfels	16.7%	83.3%	0.0%
Martin limestone	Skarn	40.0%	53.3%	6.7%
Cretaceous volcanics & sediments (undifferentiated)	Advanced Argillic	36.4%	45.5%	18.2%
Cretaceous volcanics & sediments (undifferentiated)	Phyllic	70.8%	12.3%	16.9%
Cretaceous volcanics & sediments (undifferentiated)	Propylitic	85.7%	0.0%	14.3%
Quartz eye porphyry	Advanced Argillic	100.0%	0.0%	0.0%
Quartz eye porphyry	Phyllic	75.0%	12.5%	12.5%
Quartz eye porphyry	Potassic	75.0%	25.0%	0.0%
Quartz eye porphyry	Siliceous	100.0%	0.0%	0.0%
Quartzite	Advanced Argillic	100.0%	0.0%	0.0%
Quartzite	Phyllic	100.0%	0.0%	0.0%
Quartzite	Zeolite	100.0%	0.0%	0.0%
Apache Leap Tuff	Unaltered	0.0%	83.3%	16.7%
Overall		**63.7%**	**22.4%**	**13.9%**

* The percentage of the ore body of each rock type are generally: diabase (30%); quartzite (11%); quartz eye porphyry (15%); breccia (19%); Cretaceous volcanics and sediments (26%); Apache Leap Tuff (0%) (see Garrett (2017b)).

Table 3.7.2-6. Acid-generation classification of tailings samples

Tailings Type	Acid Generating	Non-acid Generating	Potentially Acid Generating
NPAG tailings (84% of total amount)	15%	41%	44%
PAG tailings (16% of total amount)	100%	0%	0%

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). A number of standards and guidelines (16) were identified applicable to management of water resources. None of these standards and guidelines were found to require amendment to the proposed project, either on 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 groundwater and surface water quality. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

- Stormwater controls (described in detail in "Potential Surface Water Quality Impacts from Stormwater Runoff")
- Engineered seepage controls (described in detail under each alternative in "Potential Water Quality Impacts from Tailings Storage Facility")

POTENTIAL GROUNDWATER QUALITY IMPACTS WITHIN BLOCK-CAVE ZONE

Predicted Block-Cave Water Quality at Closure

The water quality in the block-cave sump at the end of active mining was modeled using the block-cave geochemistry model (Eary 2018f), as shown previously in table 3.7.2-1. At the end of mine life, no constituents in the block-cave sump are anticipated to have concentrations above Arizona numeric AWQS except for thallium. Several constituents are anticipated to have concentrations above EPA secondary standards, including aluminum, fluoride, sulfate, and total dissolved solids, and arsenic is anticipated to be above the EPA primary standard (which is lower than the Arizona numeric AWQS).

Post-Closure Trends in Block-Cave Water Quality

Even if ventilation assumptions used in Eary (2018f) bear out during operations, weathering products may accumulate on collapsed, mineralized rock in the block cave during mining due to the exposure to humid air and oxygen. If the oxygenated conditions of Hatch (2016) predominate, some of these products would dissolve in downward-migrating Apache Leap Tuff groundwater. Some can, however, be expected to be retained on unrinsed rock. These products would be dissolved in water that floods the block cave post-mining. Because these products are not associated with the block-cave water quality model, their release to reflooding waters would increase the concentration of chemical constituents and the water quality would worsen over time, potentially resulting in concentrations of metals (antimony, beryllium, cadmium, chromium, lead, nickel, selenium, thallium) above Arizona aquifer water quality standards, as shown in table 3.7.2-1.

Potential for Subsidence Lake Development

The Groundwater Modeling Workgroup recognized that three simultaneous events would take place that suggest there could be the potential for the creation of a surface lake on Oak Flat after closure of the mine:

- The subsidence crater would develop. The base case model run indicates the subsidence crater would be about 800 feet deep. Most of the sensitivity runs of the subsidence model are similar, although one sensitivity model run reached about 1,100 feet deep (Garza-Cruz and Pierce 2018).

Table 3.7.2-7. Comparison of rebounding groundwater levels and subsidence crater elevation

Well	Current Land Surface Elevation (from well schematics)	Estimated Elevation of Bottom of Subsidence Crater (based on a total crater depth of 800–1,100 feet)	Estimated Water Level Elevation at End of Mining	Estimated Water Level Elevation After 1,000 Years	Elevation of MSD One Portal	Elevation of Never Sweat Tunnel	Elevation of Umbrella Cave
DHRES-01	4,076	3,276–2,976	−2,799	2,666	2,930	3,200	2,992
DHRES-02	3,976	3,176–2,876	−2,798	2,666	2,930	3,200	2,992
DHRES-08	4,120	3,320–3,020	−2,798	2,666	2,930	3,200	2,992

Note: All elevations are given in feet above mean sea level (amsl).

- Groundwater levels would rebound and rise as the aquifer equilibrates after dewatering is curtailed after closure of the mine.
- Block-caving would have created a hydraulic connection from the surface to the deep groundwater system and eliminated any intervening layers like the Whitetail Conglomerate that formerly were able to prevent or slow vertical groundwater flow.

The Groundwater Modeling Workgroup explored the potential for a subsidence lake to form. Ultimately the Forest Service determined that the presence of a subsidence lake was speculative and not reasonably foreseeable, and as such it would therefore be inappropriate to analyze in the EIS. For a subsidence lake to form, groundwater levels would have to rebound to an elevation greater than the bottom of the subsidence crater. Table 3.7.2-7 summarizes the modeled groundwater levels for the three wells within the area of the subsidence crater. The best-calibrated model indicates that after 1,000 years, groundwater levels are still at least 200 feet below the bottom of the subsidence crater, and possibly as much as 650 feet below the bottom of the subsidence crater. Relative positions of the subsidence crater and recovering groundwater levels are shown in figure 3.7.2-4.

Potential for Other Exposure Pathways for Block-Cave Groundwater

The Groundwater Modeling Workgroup explored the potential for exposure to block-cave groundwater at the surface other than through a subsidence lake. The Magma Mine workings connect the block-cave area to the ground surface, and questions arose if the historic workings of the Magma Mine could be a pathway for block-cave groundwater to emerge at the surface. There is also at least one natural cave in the area (Umbrella Cave) that could represent an exposure pathway. Elevations for possible exposure points are shown in table 3.7.2-7.

Ultimately the group determined that block-cave groundwater would not rise to an elevation that would allow it to daylight through the Magma Mine workings, and thus there would be little potential for exposure to block-cave groundwater. The Groundwater Modeling Workgroup determined this based on the following rationale:

- During operations, pumping would dewater the Magma Mine workings. After dewatering ends, collected water in the Magma Mine workings would drain toward the block-cave zone, and not outward.
- The Magma Mine portal that comes to surface at the lowest elevation (MSD One Portal) daylights at an elevation of 2,930 feet amsl. At 1,000 years, this remains over 260 feet above recovered groundwater levels.

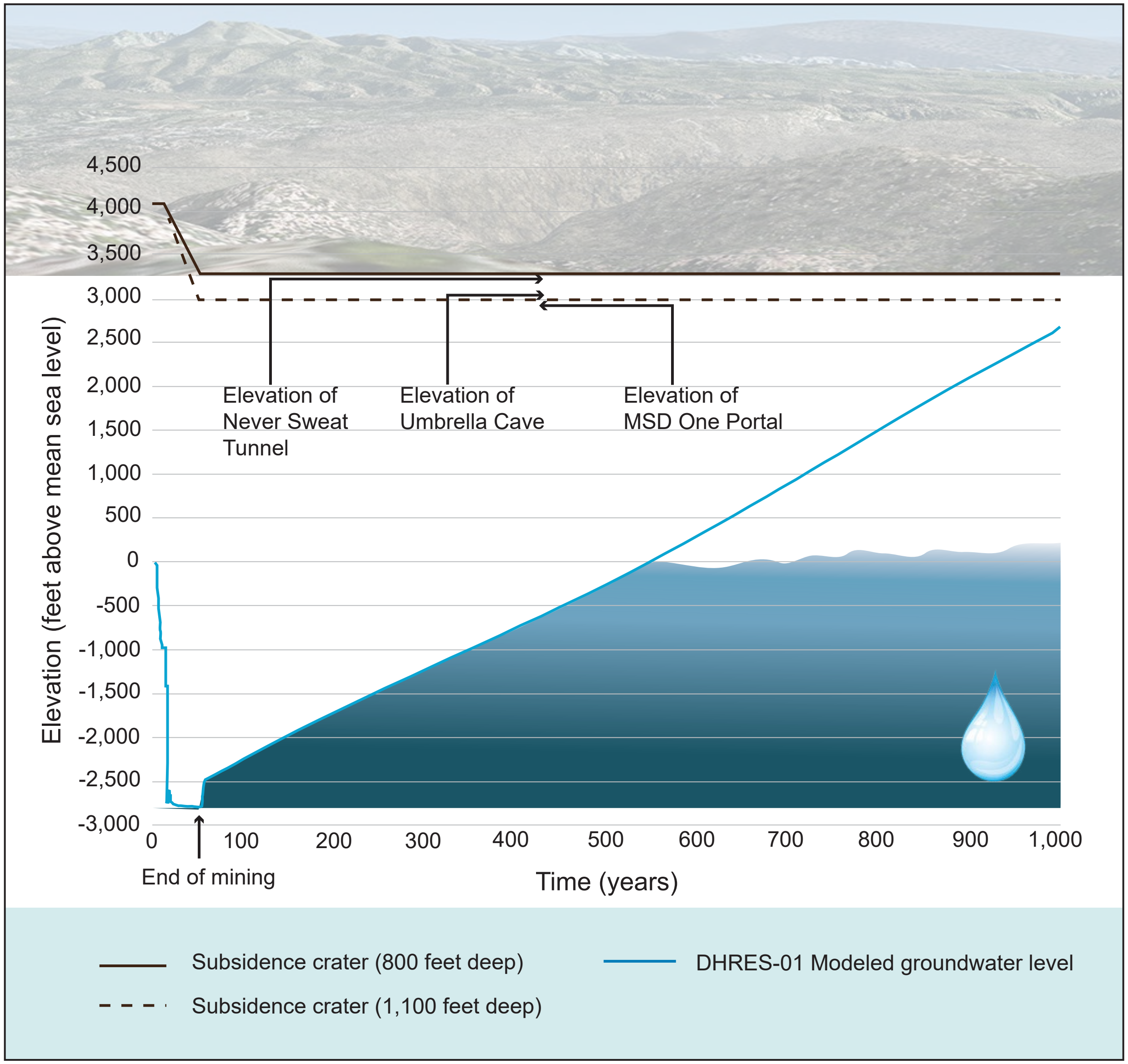


Figure 3.7.2-4. Potential for subsidence lake and other points of exposure of block-cave water

Table 3.7.2-8. Representative values of possible subsidence lake water sources (mg/L)

Constituent	Apache Leap Tuff Groundwater (see appendix N)	Deep Groundwater (see appendix N)	Block-Cave Sump Geochemistry at Closure (see table 3.7.2-1)	Precipitation*	Surface Water Quality Standard†
Total dissolved solids	248	638	1,528	10–20	–
Sulfate	18	252	934–2,247	2.2	–
Antimony	Non-detect	0.01	0.0047–0.035	Non-detect	0.030
Cadmium	Non-detect	Non-detect	0.0008–0.19	Non-detect	0.00068–0.0062
Selenium	Non-detect	Non-detect	0.0051–0.5	Non-detect	0.002
Copper	0.01	0.10	0.0148–141	Non-detect	0.0023–0.0293
Nitrate	0.52	0.43	Not modeled	0.27–1.05	–
Hardness (as $CaCO_3$)	126	335	851–1,690	4	–

* Carroll (1962); Root et al. (2004); metal loads in precipitation are assumed to be insignificant for comparison

† For comparison, the standard for Aquatic and Wildlife-Warmwater, chronic exposure is shown. Where hardness is required to calculate the standard, a range is shown. Antimony, cadmium, and copper standards are for dissolved concentrations, selenium is for total concentrations. Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

- A tunnel that drains away from the block-cave zone (Never Sweat Tunnel) intercepts the subsidence crater at approximately 3,200 feet amsl. At 1,000 years, this remains over 530 feet above recovered groundwater levels.
- Umbrella Cave has an elevation of 2,992 feet amsl and remains over 320 feet above recovered groundwater levels at 1,000 years.
- The cone of depression in the aquifer created by the mine dewatering would persist for hundreds of years, creating hydraulic conditions that prevent subsurface flow away from the block-cave area.

The relative positions of the subsidence crater, other potential exposure points, and the modeled rise of groundwater levels is shown in figure 3.7.2-4.

Possible Water Quality Outcomes from a Subsidence Lake

While the fundamental processes needed to create a subsidence lake are reasonably foreseeable—rebounding water levels, subsiding ground surface, fracturing of intervening geological layers—the relative elevations based on the modeling conducted does not support that these processes would come together in a way that would actually create a lake within the subsidence crater.

Similarly, if a lake developed, it is not possible to predict the details that would be necessary to conduct even a rudimentary analysis of effects. For instance, the depth of the lake cannot be known with any accuracy. That single parameter would affect both the amount of inflow of native groundwater and the amount of evaporation that would occur from the lake surface, and it is the interplay of these two parameters that largely determines how constituents would concentrate in the lake and whether the ultimate water quality would be hazardous to wildlife.

Formation of a lake is speculative, but some context can be provided for the possible water quality in the subsidence lake. Water quality for the basic inputs is generally known, even if the relative amounts, how they would mix, and what evaporation would take place are not known. Representative values are shown in table 3.7.2-8, with comparison to Arizona surface water standards for wildlife. The broad conclusion that can be drawn is that if a subsidence lake were to form, a potential exists for concentrations above Arizona surface water standards, particularly copper. However, the potential also exists for water quality to be acceptable. These represent the bounds of possible outcomes.

POTENTIAL SURFACE WATER QUALITY IMPACTS FROM STORMWATER RUNOFF

Stormwater Controls and Potential for Discharge of Stormwater

Construction and Operation Phases

Stormwater control measures for each alternative are described in Newell and Garrett (2018d). During construction, temporary sediment and erosion controls would be implemented as required under a stormwater permit issued by ADEQ. These controls would include physical control structures as well as best management practices. Physical control structures could include diversions, berms, sediment traps, detention basins, silt fences, or straw wattles. Best management practices could include limiting vegetation removal, good housekeeping, proper material storage, and limiting ground disturbance. Stormwater control measures are generally kept in place until disturbed areas are stabilized either through revegetation or by permanent constructed facilities.

Generally speaking, during operations any precipitation or runoff that comes into contact with tailings, ore, hazardous material storage areas, or processing areas is considered “contact water.” During operations contact water would be captured, contained in basins, pumped out after storm events, and recycled back into the process water stream. This type of containment would be required by both the stormwater and aquifer protection permits that would be issued for the project. Contact water would not be released to the environment at any time during operations.

There are areas of the West Plant Site and filter plant and loadout facility that are undisturbed or contain only ancillary facilities. Stormwater from these areas is considered “non-contact” stormwater. In many cases, upstream runoff would be diverted around the project facilities to prevent the stormwater from becoming contact water and would be allowed to continue flowing into downstream drainages. Non-contact stormwater would be allowed to leave the property.

The tailings storage facility generally follows the same strategy during operations. For all alternatives, runoff from upstream of the facility would be diverted around the facility to prevent any contact with tailings. For Alternatives 2, 3, 5, and 6, any precipitation falling within the facility would run into the recycled water pond, and any runoff from the external embankments would be routed to the downstream seepage collection ponds, then pumped back and recycled into the process water stream. For Alternative 4, with filtered tailings, the tailings surface is designed to minimize ponding, and all contact water would be routed to downstream seepage collection ponds. As with the other alternatives, the water from the Alternative 4 seepage collection ponds would be pumped back and recycled in the process water stream; however, with Alternative 4, the water quality running off of the PAG tailings facility may be such that it requires further treatment prior to reuse.

Closure and Post-closure Phases

With respect to stormwater, the goal upon closure is to stabilize disturbed areas, minimize long-term active management, and return as much flow as possible to the environment. This is readily accomplished at the East Plant Site, West Plant Site, and filter plant and loadout facility once facilities are demolished and removed, and the sites are revegetated. Closure details for these areas are included in sections 6.5, 6.6, 6.8, and appendix Y of the GPO (Resolution Copper 2016d).

The tailings storage facility represents a more complex closure problem, regardless of alternative. The specific goals of closing the tailings storage facility are as follows:

- Develop a stable landform
- Develop a stable vegetated cover that limits infiltration and protects surface water quality by preventing contact of stormwater with tailings
- Minimize ponded water on the closed tailings surface
- Limit access of oxygen to PAG tailings to prevent oxidation of pyrite materials (acid rock drainage)
- Protect the reclaimed surface against wind or water erosion
- Provide a growth medium for vegetation to establish and be sustained in perpetuity

Closure of the tailings facilities for Alternatives 2, 3, 5, and 6 is a long-term phased process that involves gradually reducing the size of the recycled water pond and then encapsulating the PAG tailings with NPAG tailings. Eventually the tailings embankments and top surface of the facility are given a soil cover with a thickness of at least 1 to 2 feet and revegetated. Stormwater conveyance channels and armoring would be used where appropriate to protect the reclaimed surface. Once surfaces are covered and stable, stormwater could be allowed to discharge downstream if water quality meets release criteria.

For some time after closure, the seepage collection ponds would be maintained downstream of the tailings storage facility to collect drainage from the facility. This time could vary from years to decades, depending on the alternative. There would be no discharge from the collection ponds to downstream waters, neither seepage nor stormwater that collects within the ponds. For some time the recycled water pond would still exist within the tailings facility, and during this time collected water in the seepage ponds could be pumped back to the recycled water pond for evaporation. Once the recycled water pond disappears, the seepage collection ponds are designed to be large enough to evaporate any collected seepage and stormwater. The seepage collection ponds are meant to stay in place until all water reporting to the ponds is of adequate quality to allow discharge downstream.

Closure of the filtered tailings facility (Alternative 4) is similar but simplified by the lack of any recycled water pond. Instead, all surfaces of the PAG and NPAG facilities would be given a soil cover and revegetated. Stormwater from upstream in the watershed would be diverted around the facilities in perpetuity, and once surfaces are covered and stable, stormwater from the facilities could be allowed to discharge downstream as well if water quality meets release criteria.

For some time after closure (estimated to be about 5 years), the seepage collection ponds for Alternative 4 would be maintained downstream of the tailings storage facility. The seepage collection ponds are meant to stay in place until all water reporting to the ponds is of adequate quality to allow discharge downstream. Unlike Alternatives 2, 3, 5, and 6, any excess water in the seepage collection ponds during closure cannot be pumped back to a recycled water pond; these ponds therefore could require active water treatment. In the long term, the ponds are designed to be large enough to evaporate any collected seepage and stormwater.

The potential for ponds to impact wildlife is assessed in section 3.8.4.2.

Summary of Stormwater Controls

At no point during construction, operation, closure, or post-closure would stormwater coming into contact with tailings, ore, or processing areas be allowed to discharge downstream. After closure, precipitation falling on the tailings facilities would interact with the soil cover, not tailings. The seepage collection ponds represent a long-term commitment for managing seepage and stormwater, but eventually would either become passive systems fully evaporating collected water, or would be removed after demonstrating that collected water is of adequate quality to discharge.

Stormwater mixes with collected seepage in collection ponds and some would be lost to the environment; this occurrence is incorporated into the bypass seepage mixing/loading model.

Predicted Quality of Stormwater Runoff

Stormwater contacting tailing would not be released downstream; however, the potential water quality of this runoff has been estimated.

The quality of stormwater runoff from tailings and the soil cover can be predicted in several ways. In the aquifer protection permitting process, ADEQ often relies on a test called the synthetic precipitate leaching procedure (SPLP). This test measures contaminants in a slightly acidic water solution that has interacted with a rock or tailings sample. One drawback of relying solely on the SPLP test is that it is usually conducted only using fresh core or lab-created tailings samples that have not weathered. By contrast, in reality, precipitation could interact with embankment tailings that could have been weathering for years or decades.

Two additional methods reflect the water quality from interaction with weathered materials. As part of the geochemical characterization activities, Resolution Copper conducted a series of "barrel" tests, in which barrels of material were left exposed to natural precipitation over the course of several years. The resulting leachate from the barrels was periodically collected and analyzed. Numerous humidity cell tests also were run for long periods of time. These tests involve periodic exposure of samples to water over many weeks, even years. An estimate of the potential runoff water quality from PAG and NPAG tailings was produced, drawing on the results of these various geochemical tests (Eary 2018g). Runoff from NPAG tailings was calculated by combining the results of 12 humidity cell tests conducted on tailings samples representing different lithologies. Potential runoff water quality from PAG tailings (applicable to Alternative 4 only) was estimated from barrel tests conducted on filtered PAG tailings (specifically Barrel #3), supplemented with results from barrel tests conducted on paste PAG tailings (specifically Barrel #1).

Resolution Copper also sampled natural runoff quality, specifically during a storm event in February 2018 in the vicinity of the Near West location (specific to Alternatives 2 and 3).

Water quality results for SPLP tests, Resolution Copper estimates of runoff quality, and natural runoff are shown in table 3.7.2-9 and compared with the surface water quality standards for the most restrictive use.[49]

All methods of estimating stormwater runoff quality suggest that both NPAG and PAG tailings may have concentrations of some constituents that are above Arizona surface water standards. As stated above, this stormwater would not be discharged to the environment at any time; the results shown in table 3.7.2-9 reinforce the need for requiring stormwater controls during operations. Post-closure runoff water quality, after the soil cover is in place and revegetated, should be similar to natural runoff water quality and concentrations above surface water quality standards would not be anticipated.

Alternative 2 – Near West Proposed Action

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

A tailings storage facility creates seepage. Total seepage is all water that drains from the tailings storage facility by gravity. Lost seepage is seepage that is not recovered with the engineered seepage controls. Lost seepage is assumed to discharge to the environment.

The design of engineered seepage controls for each alternative has been approached in stages. For Alternatives 2 and 3:

49. Surface water quality standards are difficult to succinctly summarize, as the standards vary by specific designated use of the water body and in some cases vary by hardness of the water. For reference, table N-5 in appendix N summarizes all surface water standards for water bodies in the area, as well as aquifer water quality standards.

Table 3.7.2-9. Predicted stormwater runoff water quality (mg/L)

	Estimated Runoff Water Quality from NPAG Tailings (Alternatives 2, 3, 5, 6)*	Estimated Runoff Water Quality from PAG Tailings (Alternative 4)*	Water Quality Measured in Natural Runoff†	SPLP Results for NPAG Tailings‡	SPLP Results for PAG Tailings‡	Surface Water Standard for Most Restrictive Use (Gila River or Queen Creek)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)
Regulated Constituents							
Antimony	0.00073	0.00062	0.00027	0.003	0.003	0.030	0.747
Arsenic	0.00016	**0.576**	0.0052			0.030	0.280
Barium	0.0128	0.208	0.0128	0.0122	0.0275	98	98
Beryllium	0.0022	**0.192**	0.0005	0.002	0.002	0.0053	1.867
Boron	0.0028	0.104	0.03			1	186.667
Cadmium	0.00097	**0.106**	0.000019	0.0002	0.0002	0.0043	0.2175
Chromium, Total	0.00036	**9.107**	0.00095	0.006	0.006	1	–
Copper	**9.81**	**3,294**	0.012	0.01	0.01	0.0191	0.0669
Fluoride	0	**424.6**	0.13			140	140
Iron	0.177	**5,353.8**	0.0225	0.06	0.06	1	–
Lead	0.00026	**0.0095**	0.0001	**0.0115**	0.003	0.0065	0.015
Manganese	0.693	**43**	0.017	0.0106	0.0313	10	130.667
Mercury				**0.0002**	**0.0002**	0.00001	0.005
Nickel	**0.112**	**26.39**	0.0013			0.1098	10.7379
Nitrate	0	0	3.1			3733.333	3733.333
Nitrite						233.333	233.333
Selenium	**0.0088**	**0.322**	0.00027	**0.003**	0.0043	0.002	0.033
Silver	0.000006	**1.78**	0.000018	0.005	0.005	0.0147	0.0221
Thallium	0.00008	**0.0177**	0.000015	0.001	0.001	0.0072	0.075
Uranium				0.001	0.001	2.8	2.8
Zinc	0.171	**17.29**	**0.0015**	**0.01**	0.01	0.2477	2.8758
pH	**5.48**	**2.13**	7.59	6.53	6.72	**6.5–9.0**	**6.5–9.0**

continued

Table 3.7.2-9. Predicted stormwater runoff water quality (mg/L) *(cont'd)*

	Estimated Runoff Water Quality from NPAG Tailings (Alternatives 2, 3, 5, 6)*	Estimated Runoff Water Quality from PAG Tailings (Alternative 4)*	Water Quality Measured in Natural Runoff†	SPLP Results for NPAG Tailings‡	SPLP Results for PAG Tailings‡	Surface Water Standard for Most Restrictive Use (Gila River or Queen Creek)	Surface Water Standard for Most Restrictive Use (Ephemeral Tributaries)
Constituents without Numeric Standards							
Sulfate	264	28,452	6.8	229	115	–	–
Total Dissolved Solids	–	–	–	294	186	–	–

Notes:

See appendix N, table N-5, for details regarding the water quality standards used in this table.

All values shown in milligrams per liter. Shaded cell and bolded text indicate concentrations above at least one water quality standard.

For all analyses, values below the laboratory detection limit are calculated as equal to the detection limit. There are other valid methods that could be used, such as using a zero value, or more commonly, using half the detection limit. Because surface water standards for some constituents—particularly mercury—can be extremely low, it is important to use the detection limit when looking at non-detect results. To use any lower value could yield results that meet the water quality standard, even when the detection limit was actually too high to draw this conclusion.

Some water quality standards for metals are specific to total recoverable metals or dissolved metals. Predicted results are compared with standards regardless of whether the standard specifies total or dissolved.

* From Enchemica, Common Inputs Memorandum, 7/18/18, table 3-4 (Eary 2018g).

† From Enchemica, Common Inputs Memorandum, 7/18/18, table 3-2; from stormwater samples collected at Near West location (Eary 2018g).

‡ NPAG results taken from "7/7A 7C Scavenger" sample from Verberg and Harvey (2008); PAG results taken from "7/7A 7C Cleaner" sample from Verberg and Harvey (2008)

- Level 0: Controls that are inherent in the design of the embankment itself and required for stability, but also function to control seepage.
- Level 1: A suite of engineered seepage controls always envisioned to be part of the design, that served as the starting point for the seepage modeling.
- Levels 2–4: These represent additional layers of engineered seepage control considered during the design process in order to reduce seepage to meet water quality objectives. Some of these controls would have to be built into the facility from the start, such as low-permeability liners for the PAG tailings. Others are expected to be necessary but can be implemented if real-world observations indicate existing seepage controls are not sufficient, such as downstream grout curtains and additional seepage collection ponds.

The following describes the various engineered seepage controls assessed in the Alternative 2 alternative design, and table 3.7.2-10 summarizes how these are expected to be applied. A conceptual diagram of the seepage controls is shown in figure 3.7.2-5. The initial suite of engineered seepage controls includes blanket and finger drains, foundation treatment, and downstream seepage collection dams and pumpback wells.

- Primary seepage control measures for stability (Level 0) include blanket and finger drains built into the facility. Sand and gravel blanket drains are required beneath the cyclone sand embankment; the blanket drain was modeled as a 3-foot-thick, highly conductive layer consisting of coarse gravel that drains the embankment and conveys seepage to the seepage collection ponds downstream of the facility. Finger drains would also collect water from beneath the tailings and convey it beneath the starter dam via a series of lined channels to the seepage collection ponds. Finger drains were modeled as channels 10 feet thick by 30 feet wide, and filled with highly conductive coarse gravel, following the topography of the existing alluvial tributaries.
    - Enhancements: For Level 1 controls, the blanket drain was expanded further beneath the facility to increase seepage control, ultimately extending 200 feet upstream.
- The foundation would be treated during construction to reduce seepage and encourage flow into the drain system. Foundation treatment can include a variety of techniques such as dental concrete,[50] cut-offs, grouting, or engineered low-permeability layers such as compacted fine tailings, engineered low-permeability liners, asphalt, slurry bentonite, and/or cemented paste tailings. Specific treatments would be designed based on real-world conditions encountered during site preparation. For the purposes of the alternative design, it is assumed that engineered low-permeability layers would be used with geological units with relatively higher conductivities (Tertiary perlite, Tertiary tuff, and Precambrian Apache Group units) that underlie approximately one-third of the tailings footprint.
    - Enhancements: For Level 1 controls, the full starter PAG cell was assumed to be underlain by an engineered low-permeability layer. For Level 4 controls, this was expanded to the entire PAG cell.
- Eleven primary seepage collection dams with associated seepage collection ponds would be constructed in natural valleys downstream of the cycloned sand embankment. All alluvial soil underneath the crest of the seepage collection dams would be excavated until competent foundation material is reached. Dams are then covered on the upstream side with an engineered low-permeability layer and built with grouted cut-off walls to help intercept subsurface flow. Pumpback wells would be installed upstream of the grout curtain and would return seepage to the recycled water pond.

50. ”Dental concrete” is conventional concrete that is used to shape surfaces and fill irregularities, much like filling a cavity in a tooth.

Table 3.7.2-10. Effectiveness of Alternative 2 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	2,132 acre-feet/year	Groenendyk and Bayley (2018b) and Klohn Crippen Berger Ltd. (2018a)
Level 0 (seepage controls for geotechnical stability)		
- Modified centerline cyclone sand embankment - Blanket drain under embankment; finger drains	Not explicitly modeled; incorporated into Level 1 modeling	
Level 0–1		
- Blanket drain extends into facility under NPAG beach; finger drains (blanket/finger drains account for roughly 88% of seepage collected) - Seepage collection ponds with pumpback wells and cut-off walls	194 acre-feet/year	Groenendyk and Bayley (2018a)
Level 1		
- Blanket drain extends 200-feet into facility - Foundation treatment and selected areas of engineered low-permeability layers, for all areas not Gila Conglomerate - Engineered low-permeability layer for starter PAG facility - Seepage collection ponds with pumpback wells, cut-off walls, and grout curtain to 100-foot depth	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 2		
- Grout curtain extended to target high-permeability zones and seepage pathways	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 3		
- Add second perimeter of seepage collection ponds downstream	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 4 (includes Levels 0 through 4)		
- Add pumpback wells, cut-off walls, and grout curtains to second perimeter of seepage collection ponds - Engineered low-permeability layer for entire PAG cell - Downgradient grout curtain extending to 100-foot depth - Additional pumpback wells in targeted areas to maximize capture	20.7 acre-feet/year†	Groenendyk and Bayley (2019)
- For comparison: fully lined facility (3,300 acres)*	792 acre-feet/year	Rowe (2012)

* See Newell and Garrett (2018d) for details of calculations; assumes 1 foot of head over liner.

† Initial estimate of post-closure seepage based on infiltration of precipitation was 17 acre-feet per year; post-closure seepage was later changed to match operational seepage of 20.7 acre-feet per year.

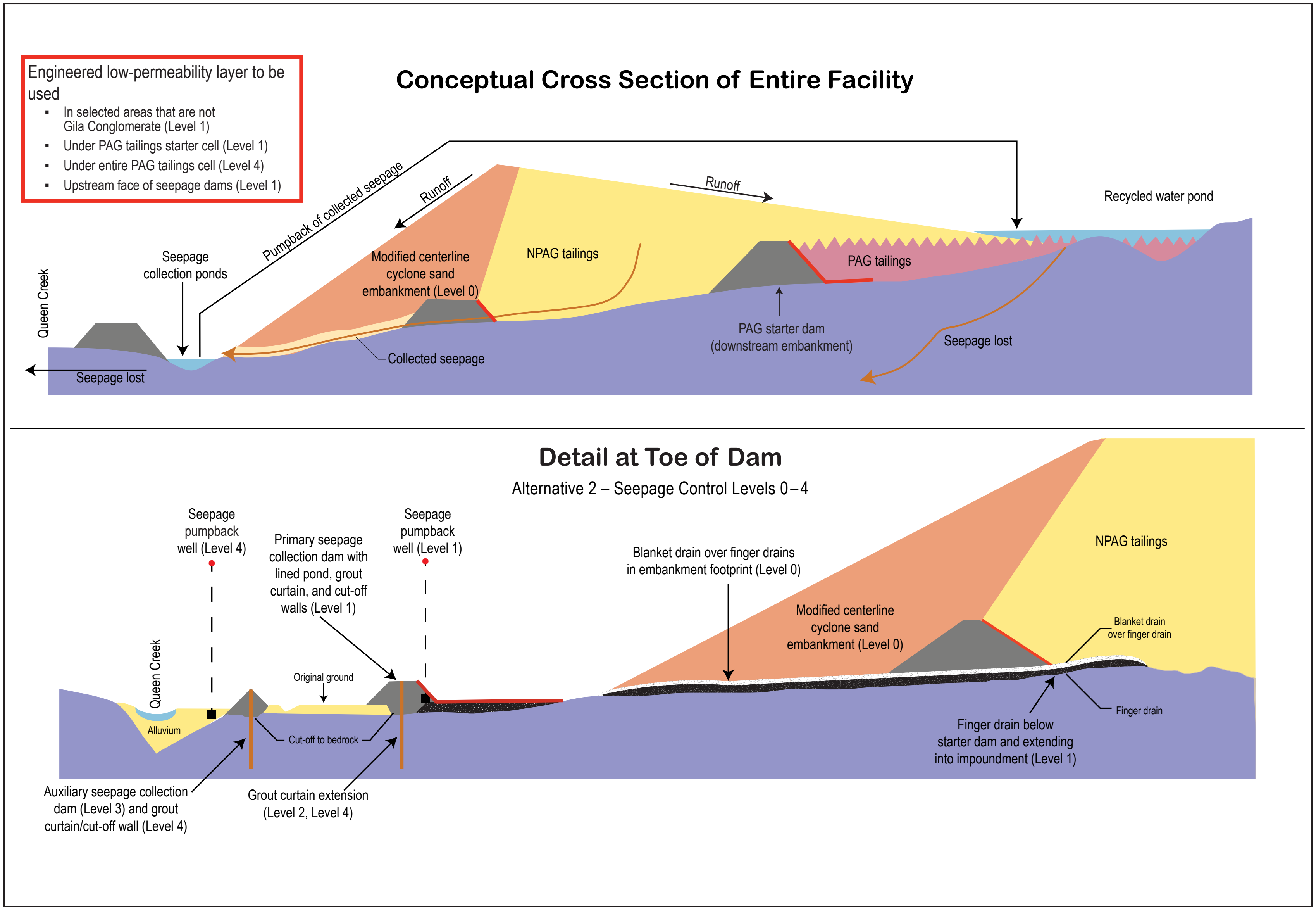


Figure 3.7.2-5. Alternative 2 seepage controls

- Enhancements: Under Level 1 controls, grout curtains were expanded to 100-foot depth. Under Level 2 controls, grout curtains were expanded to the bedrock ridges between seepage collection dams and any high-permeability zones.

In addition to the basic suite of engineered controls, three additional concepts were brought into the design for further seepage control:

- Five auxiliary seepage collection dams would be constructed downstream of the primary seepage collection dams (Level 3). These could be further enhanced with pumpback wells, cut-off walls, and grout curtains (Level 4).
- A 7.5-mile-long and 100-foot-deep grout curtain would be installed downgradient of the tailings facility (Level 4).
- Twenty-one auxiliary pumpback wells would be installed beyond the grout curtain with depths of approximately 200 feet, wherever deemed useful (Level 4).

Anticipated Effectiveness of Seepage Controls

Total seepage was estimated during the initial design phase using a one-dimensional, unsaturated flow model (Klohn Crippen Berger Ltd. 2018a). Total seepage estimates start with a water balance calculation of flow through the tailings during full buildout, based on assumptions about weather (precipitation and evaporation), consolidation, and area and depth of the tailings.

A three-dimensional groundwater flow model was then used to model the amount of this total seepage that would be captured by various engineered seepage controls, leaving some amount of lost seepage to enter the environment downgradient (Groenendyk and Bayley 2018b, 2019).

During operations, total seepage created by the tailings was estimated at 2,132 acre-feet per year (1,912 and 220 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 194 acre-feet per year with Level 1 seepage controls, and 21 acre-feet per year with all enhanced engineered seepage controls (Level 4).

Modeling indicates the Level 4 seepage controls would reach a seepage capture efficiency of 99 percent. Most of this seepage is captured by blanket and finger drains (88 percent).

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-11 presents model results for all modeled chemical constituents in the first groundwater cell along Queen Creek (cell QC-3)[51] and the ultimate, final surface water cell (Queen Creek at Whitlow Ranch Dam), for model years 41, 100, and 245.[52] This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-11 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-1 through M-7 in appendix M illustrate model results for seven chemical constituents of concern that either are regulated constituents that helped drive the required level of engineered seepage controls incorporated into the design (cadmium, selenium, antimony, copper) or offer other significant perspective on water quality (nitrate,

51. Results are included in the modeling for several washes that would receive lost seepage (Potts and Roblas Canyon), which are upgradient from cell QC-3. It is not likely that substantial groundwater exists in these alluvial channels; these modeled results are indicative of seepage itself, rather than groundwater concentrations expected in the aquifer.

52. Note that model year 41 represents the end of mining, the end of tailings production, and the start of facility closure.

Table 3.7.2-11. Seepage water quality modeling results for Alternative 2 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for the Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00021	0.00026	0.00034	0.00036	0.030	0.00052	0.00054	0.00059	0.00065
Arsenic	0.05	0.0013	0.0013	0.0013	0.0014	0.030	0.00235	0.0024	0.0024	0.0024
Barium	2	0.0261	0.0263	0.0263	0.0263	98	0.0350	0.035	0.035	0.035
Beryllium	0.004	0.00100	0.00100	0.00101	0.00101	0.0053	0.0010	0.0010	0.0010	0.0010
Boron	–	0.069	0.073	0.078	0.078	1	0.057	0.059	0.062	0.066
Cadmium	0.005	0.00004	0.0001	0.0002	0.0002	0.0051	0.00005‡	0.00007‡	0.00015‡	0.00020‡
Chromium, Total	0.1	0.0019	0.0022	0.0029	0.0027	1	0.0015	0.0016	0.0020	0.0023
Copper	–	0.00076	0.004	0.004	0.003	0.0234	0.00230‡	0.0041‡	0.0039‡	0.0045‡
Fluoride	4	0.529	0.56	0.57	0.56	140	0.4	0.42	0.43	0.43
Iron	–	0.045	0.0450	0.0450	0.0450	1	0.048	0.048	0.048	0.048
Lead	0.05	0.000065	0.00008	0.00009	0.00009	0.0083	0.00008‡	0.00008‡	0.00009‡	0.00010‡
Manganese	–	0.0049	0.011	0.028	0.025	10	0.150	0.153	0.162	0.169
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.003	0.005	0.005	0.1343	0.0027‡	0.0030‡	0.0041‡	0.0050‡
Nitrate	10	0.38†	0.43	0.46	0.45	3,733.333	1.900	1.93	1.94	1.97
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0009	0.002	0.005	0.004	0.002	0.0007	0.0012	**0.0027**	**0.0038**
Silver	–	0.000036	0.0003	0.0009	0.0007	0.0221	0.000036	0.00016	0.00049	0.00071
Thallium	0.002	0.00003	0.00006	0.00009	0.00008	0.0072	0.000030	0.00004	0.00006	0.00008
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.005	0.018	0.045	0.039	0.3031	0.0030‡	0.0088‡	0.0238‡	0.0353‡
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-11. Seepage water quality modeling results for Alternative 2 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for the Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	173	186	208	209	–	136	144	154	168
Total Dissolved Solids	**–**	**589**	**614**	**652**	**652**	**–**	**546**	**561**	**579**	**603**

Notes: N/A = not analyzed in seepage modeling

Shaded cell and bolded text indicate concentrations above water quality standard.

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Results shown represent median values from water quality measurements

† No available data for well DS17-17. NO_3-N value calculated as median of three samples collected from Bear Tank and Benson Springs between November 2014 and March 2015

‡ Standards are hardness dependent and were calculated using lowest (most stringent) hardness value recorded for Whitlow Ranch Dam (307 mg/L $CaCO_3$ on 8/25/2017); see appendix N, table N-5, for details on how these standards were selected

total dissolved solids, sulfate). These figures depict the model results for all groundwater and surface water cells.

Modeling results for Alternative 2 indicate the following:

- Modeling estimates that engineered seepage controls can recover 99 percent of total seepage. All levels of control (Levels 0 through 4) have been applied to Alternative 2 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- There are no concentrations above aquifer water quality standards for the first model cell corresponding to groundwater (cell QC-3) or subsequent downgradient cells.
- Concentrations of selenium are above the surface water regulatory standard for the most restrictive use in model year 64 and onward for Queen Creek at Whitlow Ranch Dam (see appendix M, figure M-3), despite incorporation of engineered seepage controls estimated to capture 99 percent of total seepage. No other constituents are modeled to have concentrations above surface water regulatory standards. The model result is above the standard by a very small amount, and the uncertainty in the model does not allow a strict comparison. It can only be concluded that concentrations are expected to be near the standard.
- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise slightly above the 250 mg/L secondary standard, to 340 mg/L (see appendix M, figure M-1).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- The risk of not being able to meet desired seepage capture efficiencies is high. While the determination of whether water quality standards would be met is under the jurisdiction of ADEQ, the disclosure undertaken by the Forest Service suggests that the high capture efficiency required of the engineered seepage controls could make meeting water quality standards under this alternative challenging. The number and types of engineered seepage controls represent significant economic and engineering challenges.

Practicability for Additional Seepage Controls

The site-specific suite of engineered seepage controls designed for Alternative 2 is substantially more effective at controlling seepage than a fully lined facility with no other controls. The estimated loss through a full liner due to defects is 792 acre-feet per year (see Rowe (2012) and Newell and Garrett (2018d) for details of this estimate). This estimate is specifically for geomembrane as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind (see Newell and Garrett (2018d) for a summary of concerns).

Under the suite of engineered seepage controls considered (Levels 0 through 4), all parts of the foundation except those on Gila Conglomerate would already use low-permeability layers which have similar permeabilities to the Arizona BADCT specifications. The comparison to a full liner illustrates the need for layered seepage controls, particularly downstream seepage collection dams and pumpback wells, to control seepage that would be generated from within the facility, regardless of the foundation treatment.

Alternative 2 has limited ability to add further layers of seepage controls during operations. The envisioned seepage controls (Levels 0 through 4) already would extend downstream to the edge of Queen Creek. Logistically, there is little physical room to add additional controls.

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. In addition, the estimated long-term post-closure seepage rate of 17 acre-feet per year (Gregory and Bayley 2018a) is close to the seepage rate only achieved with all Level 4 engineered seepage controls in place (20.7 acre-feet per year), including the active pumpback wells. This suggests that passive closure of the tailings storage facility may be difficult, and active management may be required.

In the alternative design, Klohn Crippen Berger Ltd. (2018a) estimated that active closure would be required up to 100 years after the end of operations. Up to 25 years after closure, the recycled water pond still is present and therefore all engineered seepage controls could remain operational, with seepage pumped back to the tailings storage facility. After 25 years, the recycled water pond is no longer present. At this time the seepage collection ponds would be expanded to maximize evaporation, and then active water management (either enhanced evaporation or treatment prior to release) would take place until the ponds could passively evaporate all incoming seepage. The sludge containing concentrated metals and salts from evaporation would eventually require cleanup and handling as solid or hazardous waste.

Financial Assurance for Closure and Post-closure Activities

Alternative 2 potentially involves long time periods of post-closure monitoring and mitigation related to stormwater or seepage water quality. This raises concern regarding 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 is discussed in section 1.5.5. The types of activities that would likely need to be funded could include the following:

- Active (such as water treatment plant) or passive (such as wetlands) water treatment systems, including design, operational maintenance, and replacement costs
- Treatment and disposal of any sludge generated by water treatment plants, or through passive evaporation
- Monitoring of water quality of seepage and downstream waters
- Maintenance and monitoring of post-closure stormwater control features
- Monitoring the water quality of stormwater runoff associated with the closure cover, to determine ability to release stormwater back to the downstream watershed

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

> [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, rather than water quality.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, in the project area Queen Creek is currently considered impaired for copper. The overall estimated current copper loading on this reach of Queen Creek is 0.101 kg/day. The draft TMDL for dissolved copper estimated for this reach of Queen Creek is 0.080 kg/day; this represents the total allowable amount of dissolved copper that would not result in surface water quality standards being exceeded. Note that these calculations include Resolution Copper's current permits for the West Plant Site and East Plant Site, but no discharges from a future tailings facility. ADEQ has identified the need for more than a 20 percent reduction in dissolved copper loading in order for this reach of Queen Creek to not be impaired (Arizona Department of Environmental Quality 2017).

Seepage from Alternative 2 would represent an additional dissolved copper load to Queen Creek of 0.0227 kg/day during operations and 0.0072 kg/day post-closure (see Newell and Garrett (2018d) for calculations of pollutant loading from each alternative). Alternative 2 would increase the dissolved copper load in Queen Creek by 7 to 22 percent and would interfere with efforts to reduce dissolved copper loads to Queen Creek.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 2, since concentrations for selenium were already predicted to be above the surface water quality standards, by definition no assimilative capacity remains for this pollutant (table 3.7.2-12).

Table 3.7.2-12. Predicted changes in assimilative capacity due to seepage entering surface waters

Alternative	Receiving Water	Remaining Assimilative Capacity After Seepage Enters Surface Water
Alternative 2	Queen Creek at Whitlow Ranch Dam	Selenium (0%); the selenium concentration is above the numeric surface water quality standard
Alternative 3	Queen Creek at Whitlow Ranch Dam	No changes in assimilative capacity greater than 20 percent are anticipated
Alternative 4	Queen Creek at Whitlow Ranch Dam	Selenium (0%); the selenium concentration is above the numeric surface water quality standard
Alternative 5	Gila River below Donnelly Wash	Copper (77%); Selenium (63%)
Alternative 6	Gila River below Dripping Spring Wash	Selenium (67%)

Note: For full calculations, see Newell and Garrett (2018d); this document also contains an assessment of potential changes in assimilative capacity due to reductions in stormwater runoff discussed in section 3.7.3.

Alternative 3 – Near West – Ultrathickened

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

The various engineered seepage controls assessed in the Alternative 3 design and how they are expected to be applied are shown in table 3.7.2-13. A conceptual diagram of the seepage controls is shown in figure 3.7.2-6. These are almost entirely identical to Alternative 2, except in Alternative 3 a low-permeability layer is used for the entire PAG cell starting with Level 1 controls.

Anticipated Effectiveness of Seepage Controls

As with Alternative 2, total seepage was estimated during the initial design phase using a one-dimensional, unsaturated flow model (Klohn

Table 3.7.2-13. Effectiveness of Alternative 3 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	728 acre-feet/year	Groenendyk and Bayley (2018b) and Klohn Crippen Berger Ltd. (2018b)
Level 0 (seepage controls for geotechnical stability)		
- Modified centerline cyclone sand embankment - Blanket drain under embankment; finger drains	Not explicitly modeled; incorporated into Level 1 modeling	
Level 0-1		
- Blanket drain extends into facility under NPAG beach; finger drains (blanket/finger drains account for roughly 88% of seepage collected) - Seepage collection ponds with pumpback wells and cut-off walls	116 acre-feet/year	Groenendyk and Bayley (2018a)
Level 1		
- Foundation treatment and selected areas of engineered low-permeability layers, for all areas not Gila Conglomerate - Engineered low-permeability layer for entire PAG facility - Seepage collection ponds with pumpback wells, cut-off walls, and grout curtain to 100-foot depth	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 2		
- Grout curtain extended to target high-permeability zones and seepage pathways	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 3		
- Add second perimeter of seepage collection ponds downstream	Not explicitly modeled; incorporated into Level 4 modeling	N/A
Level 4 (includes Levels 0 through 4)		
- Add pumpback wells, cut-off walls, and grout curtains to second perimeter of seepage collection ponds - Downgradient grout curtain extending to 100-foot depth - Additional pumpback wells in targeted areas to maximize capture	2.7 acre-feet/year	Groenendyk and Bayley (2019)

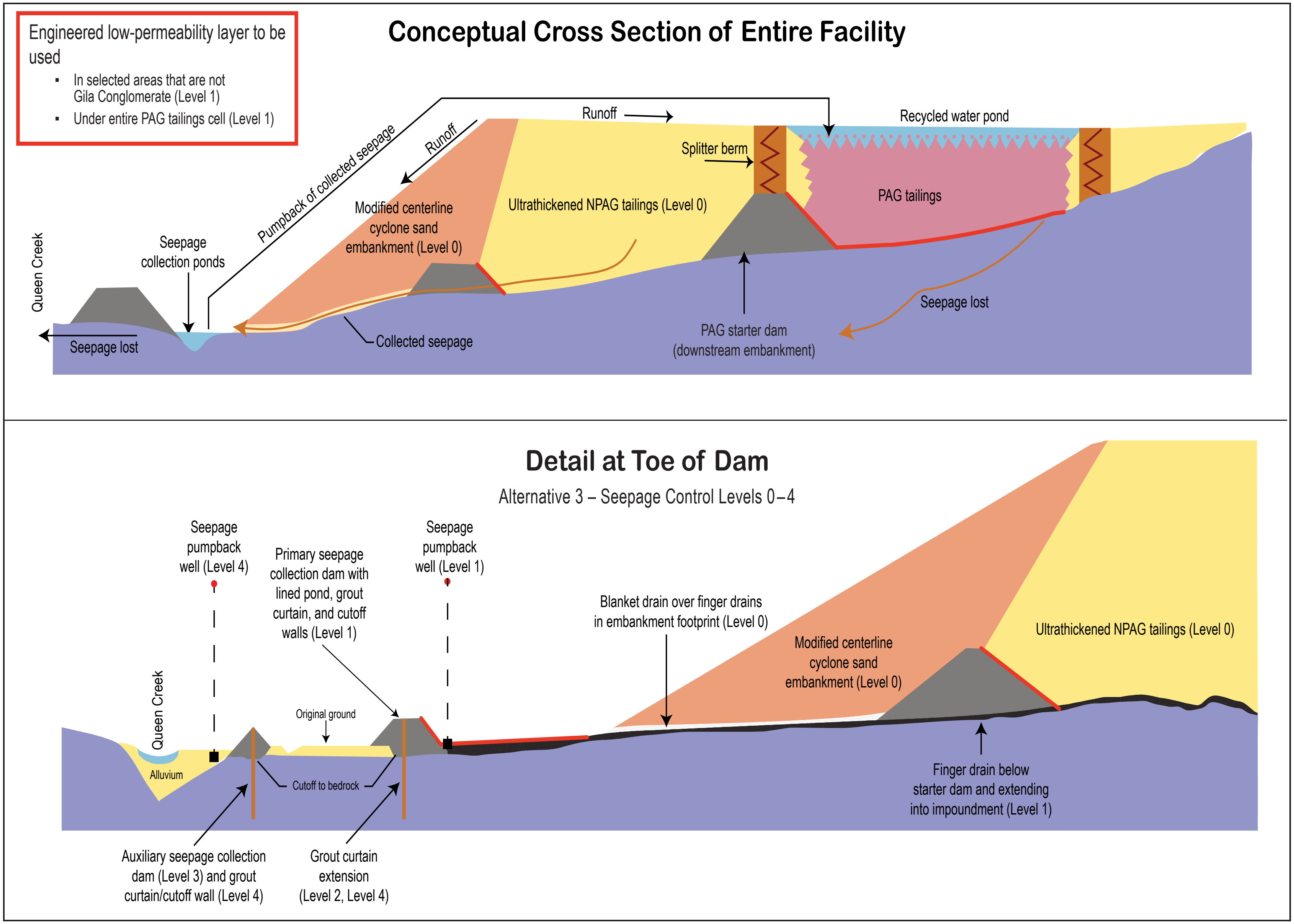


Figure 3.7.2-6. Alternative 3 seepage controls

Crippen Berger Ltd. 2018b), and a three-dimensional groundwater flow model was used to model the amount of total seepage that would be captured by various engineered seepage controls, leaving some amount of lost seepage to enter the environment downgradient (Groenendyk and Bayley 2018b, 2019).

During operations, total seepage created by the tailings was estimated at 728 acre-feet per year (508 and 220 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 116 acre-feet per year with Level 1 seepage controls, and 2.7 acre-feet per year with all enhanced engineered seepage controls (Level 4).

Modeling indicates the Level 4 seepage controls would reach a seepage capture efficiency of 99.5 percent. Most of this is captured by blanket and finger drains (88 percent).

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-14 presents model results for all modeled chemical constituents in the first groundwater cell along Queen Creek (cell QC-3)[53] and the ultimate, final surface water cell (Queen Creek at Whitlow Ranch Dam), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-14 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-8 through M-14 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 3 indicate the following:

- Modeling estimates that engineered seepage controls can recover 99.5 percent of total seepage. All levels of control (Levels 0 through 4) have been applied to Alternative 3 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- No chemical constituent are anticipated in concentrations above groundwater or surface water standards.
- Selenium and cadmium are increased slightly above baseline conditions in groundwater and surface water (see appendix M, figures M-10 and M-11).
- The risk of not being able to meet desired seepage capture efficiencies is high. While the determination of whether water quality standards would be met is under the jurisdiction of ADEQ, the disclosure undertaken by the Forest Service suggests that the high capture efficiency required of the engineered seepage controls could make meeting water quality standards under this alternative challenging. The number and types of engineered seepage controls represent significant economic and engineering challenges.

Practicability for Additional Seepage Controls

The assessment of practicability of using a full liner, or adding extra layers of seepage controls during operations, is the same as for Alternative 2.

53. Similar to Alternative 2, results are included in the modeling for several washes that would receive lost seepage (Potts and Roblas Canyons), which are upgradient from cell QC-3. It is not likely that substantial groundwater exists in these alluvial channels; these modeled results are indicative of seepage itself, rather than groundwater concentrations expected in the aquifer.

Table 3.7.2-14. Seepage water quality modeling results for Alternative 3 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00021	0.00021	0.00021	0.00022	0.030	0.00052	0.00052	0.00052	0.00053
Arsenic	0.05	0.0013	0.0013	0.0013	0.0013	0.030	0.00235	0.0024	0.0024	0.0024
Barium	2	0.0261	0.0261	0.0261	0.0261	98	0.035	0.035	0.035	0.035
Beryllium	0.004	0.00100	0.00100	0.00100	0.00100	0.0053	0.0010	0.0010	0.0010	0.0010
Boron	–	0.069	0.069	0.069	0.069	1	0.057	0.057	0.057	0.057
Cadmium	0.005	0.00004	0.0000	0.0000	0.0001	0.0051	0.00005‡	0.00005‡	0.00005‡	0.00006‡
Chromium, Total	0.1	0.0019	0.0019	0.0019	0.0020	1	0.0015	0.0015	0.0015	0.0015
Copper	–	0.00076	0.001	0.001	0.001	0.0234	0.00230‡	0.0023‡	0.0024‡	0.0024‡
Fluoride	4	0.529	0.53	0.53	0.53	140	0.4	0.41	0.41	0.41
Iron	–	0.045	0.0450	0.0450	0.0450	1	0.048	0.048	0.048	0.048
Lead	0.05	0.000065	0.00007	0.00007	0.00007	0.0083	0.00008‡	0.00008‡	0.00008‡	0.00008‡
Manganese	–	0.0049	0.005	0.005	0.007	10	0.150	0.150	0.150	0.151
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.003	0.003	0.003	0.1343	0.0027‡	0.0027‡	0.0027‡	0.0028‡
Nitrate	10	0.38†	0.38	0.38	0.39	3,733.333	1.90	1.90	1.90	1.90
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0009	0.001	0.001	0.001	0.002	0.0007	0.0007	0.0007	0.0009
Silver	–	0.000036	0.0000	0.0001	0.0001	0.0221	0.000036	0.00004	0.00005	0.00007
Thallium	0.002	0.00003	0.00003	0.00003	0.00004	0.0072	0.000030	0.00003	0.00003	0.00003
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.005	0.005	0.006	0.008	0.3031	0.0030‡	0.0030‡	0.0034‡	0.0045‡
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-14. Seepage water quality modeling results for Alternative 3 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	173	173	174	176	–	136	136	136	138
Total Dissolved Solids	**–**	**589**	**589**	**590**	**594**	–	**546**	**546**	**546**	**549**

Notes: N/A= not analyzed in seepage modeling

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Results shown represent median values from water quality measurements.

† No available data for well DS17-17. NO_3-N value calculated as median of three samples collected from Bear Tank and Benson Springs between November 2014 and March 2015.

‡ Standards are hardness dependent and were calculated using lowest (most stringent) hardness value recorded for Whitlow Ranch Dam (307 mg/L $CaCO_3$ on 8/25/2017); see appendix N, table N-5, for details on how these standards were selected

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. In the alternative design, KCB (2018b) estimated that active closure would only be required up to 9 years after the end of operations. At that time, the seepage collection ponds would be expanded to maximize evaporation; passive evaporation of all incoming seepage was anticipated. The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

The final seepage modeling assumes that long-term lost seepage rates would match those during operations (2.7 acre-feet per year), which is much lower than original estimates of long-term recharge through the tailings storage facility caused by infiltration of precipitation (25 acre-feet per year (Gregory and Bayley 2018a)). This suggests that active management may be needed indefinitely post-closure.

Financial Assurance for Closure and Post-closure Activities

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

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, in the project area Queen Creek is currently considered impaired for copper. The overall estimated current loading on this reach of Queen Creek is 0.101 kg/day. The draft TMDL for dissolved copper estimated for this reach of Queen Creek is 0.080 kg/day; this represents the total allowable amount of dissolved copper that would not result in surface water quality standards being exceeded. Note that these calculations include Resolution Copper's current permits for the West Plant Site and East Plant Site, but no discharges from a tailings facility. ADEQ has identified the need for more than a 20 percent reduction in dissolved copper loading in order for this reach of Queen Creek to not be impaired (Arizona Department of Environmental Quality 2017).

Seepage from Alternative 3 would represent an additional dissolved copper load to Queen Creek of 0.0018 kg/day during operations and 0.0010 kg/day post-closure (see Newell and Garrett (2018d) for calculations of pollutant loading from each alternative). Alternative 3 would increase the dissolved copper load in Queen Creek by 1 to 2 percent and would minimally interfere with efforts to reduce dissolved copper loads to Queen Creek.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 3, seepage is not anticipated to use up more than 20 percent of the assimilative capacity in Queen Creek.

Alternative 4 – Silver King

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

Alternative 4 includes the following seepage controls, similar in nature to those described for Alternative 2. A conceptual diagram of the seepage controls is shown in figure 3.7.2-7. Table 3.7.2-15 summarizes how these are expected to be applied:

- Blanket drains and/or finger drains beneath the embankment and the tailings facility (Level 0).
- Lined collection ditches and five seepage collection ponds downstream of PAG and NPAG facilities designed to cut off the alluvium (Level 1).
- Grouting of fractures in the bedrock foundation, and pumpback wells (Level 2).

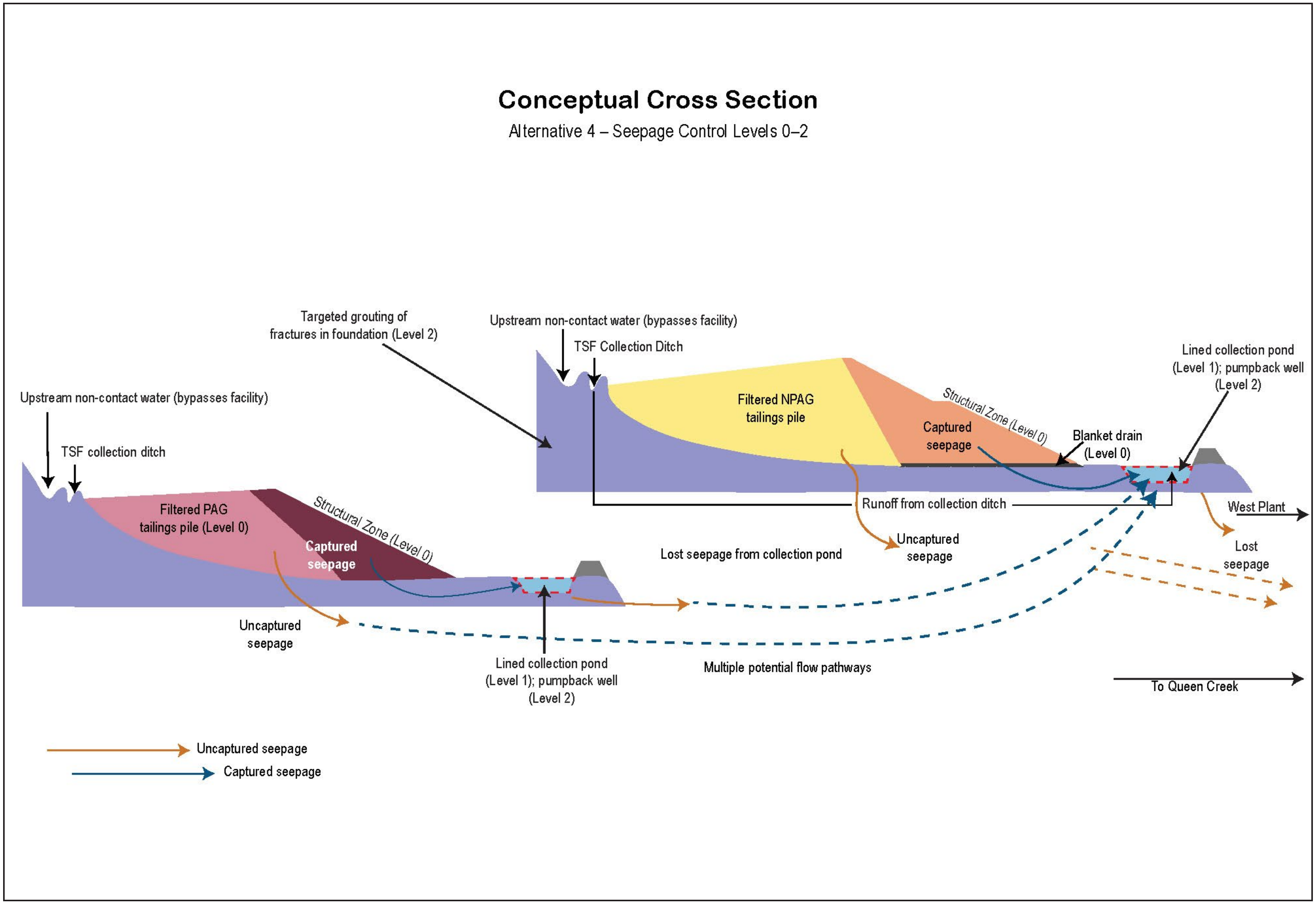


Figure 3.7.2-7. Alternative 4 seepage controls

Table 3.7.2-15. Effectiveness of Alternative 4 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	79 acre-feet/year	Klohn Crippen Berger Ltd. (2019b)
Level 0 (seepage controls for geotechnical stability)		
- Dewatered (filtered) tailings - Compacted structural zone - Blanket drain under structural zone; finger drains	Not explicitly modeled; incorporated into Level 1 modeling	N/A
Level 1		
- Lined collection ditches and ponds in alluvial channels - Based on professional judgement, estimated to have no greater than 80% efficiency at seepage control	17 acre-feet per year or more	Klohn Crippen Berger Ltd. (2019b)
Level 2		
- Targeted grouting of fractures in foundation - Pumpback wells for seepage return - Based on professional judgment, estimated to have no greater than 90% efficiency at seepage control	9 acre-feet per year or more	Klohn Crippen Berger Ltd. (2019b)

Anticipated Effectiveness of Seepage Controls

For Alternative 4 – Silver King, total seepage was estimated during the initial design phase using a one-dimensional, unsaturated flow model (Klohn Crippen Berger Ltd. 2018c). Unlike Alternatives 2 and 3, there is limited information on the hydrology and geology of the proposed Silver King tailings location and constructing a similar three-dimensional steady-state flow model is not feasible. The efficiency of seepage capture was estimated instead, based on professional judgment of the design engineers and an understanding of the potential flow pathways for seepage. Based on the professional judgement of the design engineers, it is estimated that these seepage controls would capture no more than 80 percent of seepage using Level 1 controls and no more than 90 percent of seepage using Level 2 controls (Klohn Crippen Berger Ltd. 2019b).

During operations, total seepage created by the tailings was estimated at 79 acre-feet per year (77.5 and 1.9 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 17 or more acre-feet per year with Level 1 seepage controls, and 9 or more acre-feet per year with all enhanced engineered seepage controls (Level 2).

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-16 presents model results for all modeled chemical constituents in the first groundwater cell along Queen Creek (cell QC-1)[54] and the ultimate surface water cell (Queen Creek at Whitlow Ranch Dam), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-16 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-15 through M-21 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 4 indicate the following:

- The model results rely on the 90 percent estimated efficiency of engineered seepage controls, which is not based on technical analysis (unlike Alternatives 2, 3, 5, and 6) but on professional judgment.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- There are no concentrations above aquifer water quality standards for the first model cell corresponding to groundwater (cell QC-1) or subsequent downgradient cells. Note that although Gregory and Bayley (2019) report that concentrations are above groundwater standards for Alternative 4, their conclusion is based upon the interpretation of first groundwater occurring in the alluvial channels very close to the tailings storage facility. As noted above, it is not likely that groundwater actually occurs until further downgradient, near Queen Creek.
- Concentrations of selenium are above the surface water regulatory standard for the most restrictive use in model years 59 and onward for Queen Creek at Whitlow Ranch Dam (see appendix M, figure M-17), despite incorporation of engineered seepage controls estimated to capture 90 percent of total seepage. No other constituents are modeled to have concentrations above surface water regulatory standards. The model result is above the standard by a very small amount, and the uncertainty in the model does not allow a strict comparison. It can only be concluded that concentrations are expected to be near the standard.

54. Results are included in the modeling for several washes that would receive lost seepage (Happy Camp Wash East and West, Silver King Wash, Potts Canyon), which are upgradient from cell QC-1. It is not likely that substantial groundwater exists in these alluvial channels; these modeled results are indicative of seepage itself, rather than groundwater concentrations expected in the aquifer.

Table 3.7.2-16. Seepage water quality modeling results for Alternative 4 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00021	0.00022	0.00052	0.00074	0.030	0.00052	0.00052	0.00068	0.00080
Arsenic	0.05	0.0013	0.0013	0.0016	0.0018	0.030	0.00235	0.0024	0.0025	0.0026
Barium	2	0.0261	0.0263	0.0263	0.0264	98	0.0350	0.035	0.035	0.035
Beryllium	0.004	0.00100	0.00102	0.00102	0.00104	0.0053	0.0010	0.0010	0.0010	0.0010
Boron	–	0.069	0.069	0.082	0.091	1	0.057	0.057	0.064	0.069
Cadmium	0.005	0.00004	0.0000	0.0003	0.0004	0.0051	0.00005‡	0.00005‡	0.00016‡	0.00023‡
Chromium, Total	0.1	0.0019	0.0019	0.0026	0.0030	1	0.0015	0.0015	0.0019	0.0021
Copper	–	0.00076	0.003	0.004	0.006	0.0234	0.00230‡	0.0035‡	0.0038‡	0.0049‡
Fluoride	4	0.529	0.53	0.56	0.58	140	0.4	0.41	0.42	0.43
Iron	–	0.045	0.0450	0.0450	0.0450	1	0.048	0.048	0.048	0.048
Lead	0.05	0.000065	0.00007	0.00012	0.00015	0.0083	0.00008‡	0.00008‡	0.00010‡	0.00012‡
Manganese	–	0.0049	0.010	0.060	0.088	10	0.150	0.153	0.178	0.194
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.004	0.007	0.009	0.1343	0.0027‡	0.0031‡	0.0047‡	0.0060‡
Nitrate	10	0.38†	0.40	0.40	0.42	3,733.333	1.90	1.91	1.91	1.92
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0009	0.001	0.006	0.008	0.002	0.0007	0.0007	**0.0031**	**0.0046**
Silver	–	0.000036	0.0000	0.0009	0.0014	0.0221	0.000036	0.00004	0.0005	0.00074
Thallium	0.002	0.00003	0.00003	0.00009	0.00012	0.0072	0.000030	0.00003	0.00006	0.00008
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.005	0.006	0.053	0.081	0.3031	0.0030‡	0.0036‡	0.0281‡	0.0428‡
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-16. Seepage water quality modeling results for Alternative 4 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Well DS17-17*)	QC-3 Model Cell Year 41	QC-3 Model Cell Year 100	QC-3 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Whitlow Ranch Dam*)	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 41	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 100	Queen Creek at Whitlow Ranch Dam Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	173	175	212	241	–	136	137	156	172
Total Dissolved Solids	**–**	**589**	**592**	**647**	**688**	**–**	**546**	**547**	**576**	**598**

Notes: N/A= not analyzed in seepage modeling

Shaded cell and bolded text indicate concentrations above water quality standard.

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Results shown represent median values from water quality measurements.

† No available data for well DS17-17. NO_3-N value calculated as median of three samples collected from Bear Tank and Benson Springs between November 2014 and March 2015.

‡ Standards are hardness dependent and were calculated using lowest (most stringent) hardness value recorded for Whitlow Ranch Dam (307 mg/L $CaCO_3$ on 8/25/2017); see appendix N, table N-5, for details on how these standards were selected.

- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise slightly above the 250 mg/L secondary standard, to 284 mg/L (see appendix M, figure M-15).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- Of all the alternatives, Alternative 4 is the only one where seepage control effectiveness was not able to be modeled; instead this alternative relies on professional engineering judgment for the effectiveness of the seepage controls. Additional controls could be needed; the practicability of this is described in the following section.

Practicability for Additional Seepage Controls

The amount of seepage without engineered controls is considerably less for Alternative 4, compared with the other alternatives, with only 79 acre-feet per year. The estimated loss through a full liner is about 550 acre-feet per year for a 2,300-acre facility. This estimate is specifically for a geomembrane as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind, and the terrain at Alternative 4 was specifically considered for feasibility (see Newell and Garrett (2018d) for a summary of concerns).

Unlike Alternatives 2 and 3, Alternative 4 has more ability to add further layers of seepage control during operations. For instance, there is room to install additional downstream seepage collection ponds with cut-off walls and pumpback wells, in Silver King Wash and Happy Camp Wash. The greater distance downstream to Queen Creek allows more flexibility during operations for this location, compared with Alternatives 2 and 3.

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. Post-closure seepage rates are estimated as 15.2 to 31.9 acre-feet per year (Wickham 2018).

In the alternative design, Klohn Crippen Berger Ltd. (2018c) estimated that active closure would be required for 5 years after the end of operations. During this time, reclamation of the exposed tailings would be in progress, and the need to retain stormwater in the collection ponds requires more capacity than the collection ponds can passively evaporate and may require active treatment. Once stormwater can again be released downstream, after the tailings surface has been reclaimed with a stable closure cover, the collection ponds would be able to passively evaporate collected water. The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

Financial Assurance for Closure and Post-closure Activities

The regulatory framework to require financial assurance to ensure closure and post-closure activities are conducted is the same as for Alternatives 2 and 3.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, in the project area Queen Creek is currently considered impaired for copper. The overall estimated current loading on this reach of Queen Creek is 0.101 kg/day. The draft TMDL for dissolved copper estimated for this reach of Queen Creek is 0.080 kg/day; this represents the total allowable amount of dissolved copper that would not result in surface water quality standards being exceeded. Note that these calculations include Resolution Copper's current permits for the West Plant Site and East Plant Site, but no discharges from a tailings facility.

ADEQ has identified the need for more than a 20 percent reduction in dissolved copper loading in order for this reach of Queen Creek to not be impaired (Arizona Department of Environmental Quality 2017).

Seepage from Alternative 4 would represent an additional dissolved copper load to Queen Creek of 0.0116 kg/day during operations and 0.0217 kg/day post-closure (see Newell and Garrett (2018d) for calculations of pollutant loading from each alternative). Alternative 4 would increase the dissolved copper load in Queen Creek by 11 to 21 percent and would interfere with efforts to reduce dissolved copper loads to Queen Creek.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in Table 3.7.2-12. For Alternative 4, since concentrations for selenium were already predicted to be above the surface water quality standards, by definition no assimilative capacity remains for this pollutant.

Alternative 5 – Peg Leg

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

Alternative 5 includes the following seepage controls, similar in nature to those described for Alternative 2. A conceptual diagram of the seepage controls is shown in figure 3.7.2-8. Table 3.7.2-17 summarizes how these are expected to be applied:

- Blanket drains beneath the embankment (Level 0)
- Lined collection ditches and six seepage collection ponds (Level 1)
- A geomembrane (HDPE) over 300 acres where the initial recycled water pond would be, in order to maintain operational control of tailings deposition (Level 1)
- An engineered low-permeability layer under the entire separate PAG cell (Level 1); under Level 2 controls this would be upgraded to a full synthetic liner and additional foundation preparation to remove material down to bedrock
- A pumpback well system (Level 1)
- Use of thin-lift deposition in Year 7 once adequate room becomes available (Level 2)

Anticipated Effectiveness of Seepage Controls

For Alternative 5, total seepage estimates are based on an "Order of Magnitude" water balance estimated using a two-dimensional finite element model (SLIDE V7.0) (Golder Associates Inc. 2018a).

The amount of lost seepage for Alternative 5 is calculated in a different manner than other alternatives. Much of the foundation consists of a deep alluvial aquifer associated with Donnelly Wash, which results in substantial seepage losses even with engineered seepage controls built into the facility. Therefore, a downstream pumpback system is a key component of the engineered seepage controls. The amount of flow the alluvial aquifer is able to handle was estimated and a downstream pumpback well system is expected to remove enough water to maintain the aquifer at equilibrium.

During operations, total seepage created by the tailings was estimated at 3,930 acre-feet per year (2,660 and 1,270 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 1,317 acre-feet per year with Level 1 seepage controls, and 261 acre-feet per year with all enhanced engineered seepage controls (Level 2).

Modeling indicates the Level 2 seepage controls would reach a seepage capture efficiency of 84 percent of the seepage. It is important to note that the pumpback well system is adjusted under Level 2 and pumpage is reduced to only what is needed to control water quality; substantial additional pumping could be undertaken if needed at this location.

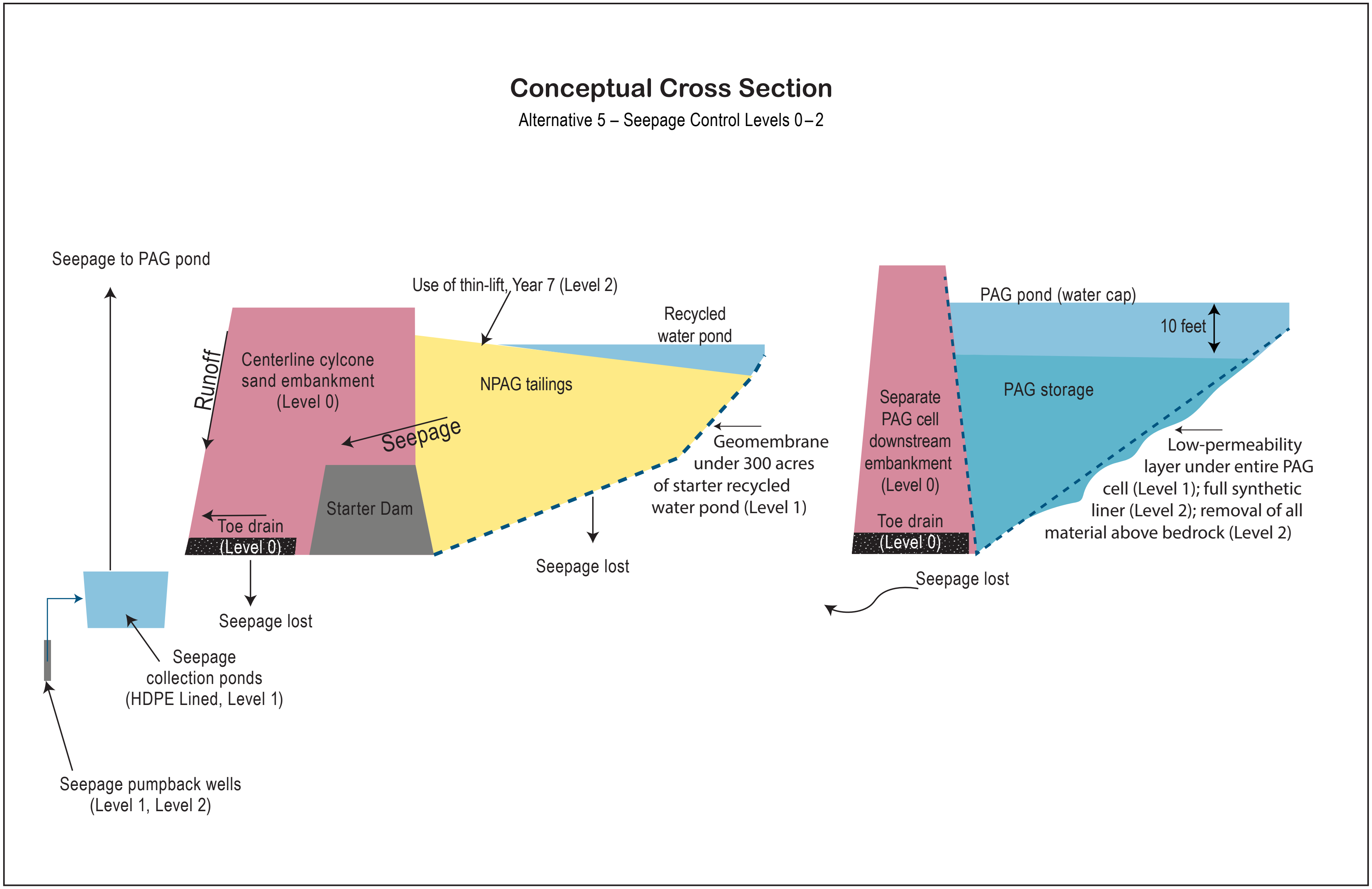


Figure 3.7.2-8. Alternative 5 seepage controls

Table 3.7.2-17. Effectiveness of Alternative 5 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	3,930 acre-feet/year	Klohn Crippen Berger Ltd. (2019d)
Level 0 (seepage controls for geotechnical stability)		
- Centerline cyclone sand embankment - Blanket drain under embankment - Separate PAG and NPAG cells	Not explicitly modeled; incorporated into Level 1 modeling	N/A
Level 1		
- Lined seepage collection ditches and ponds - Finger drains under facility along natural drainages - 300 acres of geomembrane (HDPE) underneath recycled water pond - Engineered low-permeability layer under entire PAG cell - Pumpback well system to control downgradient flow	1,317 acre-feet per year	Klohn Crippen Berger Ltd. (2019d)
Level 2		
- Full synthetic liner below entire PAG cell - Removal of all material above bedrock below PAG cell - Thin-lift deposition to start in year 7 (requires sufficient room) - Adjustment to pumpback well system, reducing pumping to just amount necessary to control water quality	261 acre-feet per year	Kidner and Pilz (2019) and Klohn Crippen Berger Ltd. (2019d)

Table 3.7.2-18. Seepage water quality modeling results for Alternative 5 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Tea Cup Well*)	DW-2 Model Cell Year 41	DW-2 Model Cell Year 100	DW-2 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Donnelly Wash**)	Gila River below Donnelly Wash Modeled Surface Water Year 41	Gila River below Donnelly Wash Modeled Surface Water Year 100	Gila River below Donnelly Wash Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00003	0.00003	0.00044	0.00214	0.030	0.00023	0.00023	0.00023	0.00025
Arsenic	0.05	0.0021	0.0021	0.0022	0.0032	0.030	0.00889	0.0089	0.0089	0.0089
Barium	2	0.0428	0.0428	0.0442	0.0483	98	0.0826	0.083	0.083	0.083
Beryllium	0.004	0.0010	0.00100	0.00104	0.00202	0.0053	0.0017	0.0017	0.0017	0.0017
Boron	–	0.082	0.082	0.112	0.205	1	0.190	0.190	0.190	0.191
Cadmium	0.005	0.00004	0.0000	0.0006	0.0026	0.0049	0.00006‡	0.00006‡	0.00006‡	0.00009‡
Chromium, Total	0.1	0.0019	0.0019	0.0050	0.0137	1	0.0020	0.0020	0.0020	0.0021
Copper	–	0.00330	0.003	0.034	1.035	0.0222	0.00408‡	0.0041‡	0.0041‡	0.0099‡
Fluoride	4	0.68	0.68	0.90	1.71	140	0.987	0.99	0.99	1.00
Iron	–	0.045	0.0450	0.0452	0.0470	1	0.056	0.056	0.056	0.056
Lead	0.05	0.002630	0.00263	0.00274	0.00321	0.0078	0.00015‡	0.00015‡	0.00015‡	0.00016‡
Manganese	–	0.0049	0.005	0.075	0.580	10	0.028	0.028	0.028	0.033
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0027	0.003	0.012	0.085	0.1280	0.0023‡	0.0023‡	0.0023‡	0.0030‡
Nitrate	10	**15.20†**	**15.26**	**15.53**	**16.34**	3,733.333	0.091	0.09	0.09	0.11
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0011	0.001	0.013	0.050	0.002	0.0004	0.0004	0.0004	0.0010
Silver	–	0.000036	0.0000	0.0026	0.0100	0.0201	0.000061	0.00006	0.00006	0.00018
Thallium	0.002	0.00003	0.00003	0.00024	0.00073	0.0072	0.000080	0.00008	0.00008	0.00009
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.016	0.016	0.132	0.560	0.2888	0.0050‡	0.0050‡	0.0050‡	0.0109‡
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-18. Seepage water quality modeling results for Alternative 5 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	**Baseline Groundwater Quality (Tea Cup Well*)**	**DW-2 Model Cell Year 41**	**DW-2 Model Cell Year 100**	**DW-2 Model Cell Year 245**	**Surface Water Standard for Most Restrictive Use**	**Baseline Surface Water Quality (Gila River below Donnelly Wash**)**	**Gila River below Donnelly Wash Modeled Surface Water Year 41**	**Gila River below Donnelly Wash Modeled Surface Water Year 100**	**Gila River below Donnelly Wash Modeled Surface Water Year 245**
Constituents without Numeric Standards										
Sulfate	–	59	59	138	594	–	159	159	159	164
Total Dissolved Solids	**–**	**523**	**523**	**648**	**1,338**	**–**	**776**	**776**	**776**	**783**

Notes: N/A= not analyzed in seepage modeling

Shaded cell and bolded text indicate concentrations above water quality standard.

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Assumed concentrations are based on single sample collected on 27 September 2017 and are therefore approximate.

** Assumed concentrations are based on single sample collected on 13 November 2018 and are therefore approximate.

† NO_3-N concentration shown is above its standard; additional water quality monitoring is required to determine if value is representative of aquifer water quality or due to localized contamination

‡ Standards are hardness dependent and were calculated using a hardness value of 290 mg/L $CaCO_3$ (from sample collected on 13 November 2018); see appendix N, table N-5 for details on how these standards were selected

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet, and can be found in Garrett (2019c). Table 3.7.2-18 presents model results for all modeled chemical constituents for cells in the first groundwater cell along Donnelly Wash (cell DW-2) and the ultimate surface water cell (Gila River below Donnelly Wash), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-18 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-22 through M-28 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 5 indicate the following:

- Modeling estimates that engineered seepage controls can recover 84 percent of total seepage. All levels of control (Levels 0 through 2) have been applied to Alternative 5 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- No chemical constituent are anticipated in concentrations above groundwater or surface water standards. Nitrate is present in concentrations above aquifer water quality standards, but this is due to background nitrate concentrations and not seepage from the facility. Note also that in year 245, selenium just reaches the aquifer water quality standard but is not above it.
- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise substantially above the 250 mg/L secondary standard to 594 mg/L (see appendix M, figure M-22).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- The practicability of adding seepage controls during operations is assessed in the following section.

Practicability for Additional Seepage Controls

The site-specific suite of engineered seepage controls designed for Alternative 5 is substantially more effective at controlling seepage than a fully lined facility with no other controls. The estimated loss through a full liner is about 1,400 acre-feet per year for a 5,900-acre facility (see Rowe (2012) and Newell and Garrett (2018d) for details of this estimate). This estimate is specifically for an engineered low-permeability liner as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind (see Newell and Garrett (2018d) for a summary of concerns).

Under the suite of engineered seepage controls considered (Levels 0 through 2), the entire PAG cell and about 300 acres of the NPAG facility would already use low-permeability layers which have similar permeabilities to the Arizona BADCT specifications. The comparison with a full liner illustrates the need for layered seepage controls, particularly downstream seepage collection dams and pumpback wells, to control seepage that would be generated from within the facility regardless of the foundation treatment.

Alternative 5 has substantial flexibility for adding other layers of seepage controls during operation as needed. The pumpback system for Level 2 seepage controls is not assumed to be operating at full capacity, and this would be an efficient way of increasing seepage capture as needed. The distance downstream to the Gila River offers opportunities for modified or expanded pumpback systems or physical barriers (grout curtains).

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continue to increase over time, post-closure. Post-closure seepage rates are estimated to be 261 acre-feet per year (Kidner and Pilz 2019).

In the alternative design, Kidner and Pilz (2019) estimated during closure the facility would gradually drain down. The seepage collection ponds would remain in place and passively evaporate seepage, and the seepage extraction wells downstream would remain in place to control seepage as long as necessary. This time frame is estimated from 100 to 150 years (Kidner and Pilz 2019). Once the collection ponds can be closed, the closure plans call for encapsulating the accumulated sludge in the geomembrane and backfilling with soil to grade.

Financial Assurance for Closure and Post-closure Activities

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 BLM, not the Forest Service.

Like the Forest Service, 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.

POTENTIAL IMPACTS ON IMPAIRED WATERS

Any discharges from Alternative 5 are downstream of any impaired waters.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-11. For Alternative 5, the discharge of seepage into the Gila River uses more than 20 percent of the assimilative capacity for copper and selenium.

Alternative 6 – Skunk Camp

POTENTIAL WATER QUALITY IMPACTS FROM TAILINGS STORAGE FACILITY

Seepage Controls Incorporated into Design

Alternative 6 includes the following seepage controls, similar in nature to those described for Alternative 2. A conceptual diagram of the seepage controls is shown in figure 3.7.2-9. Table 3.7.2-19 summarizes how these are expected to be applied:

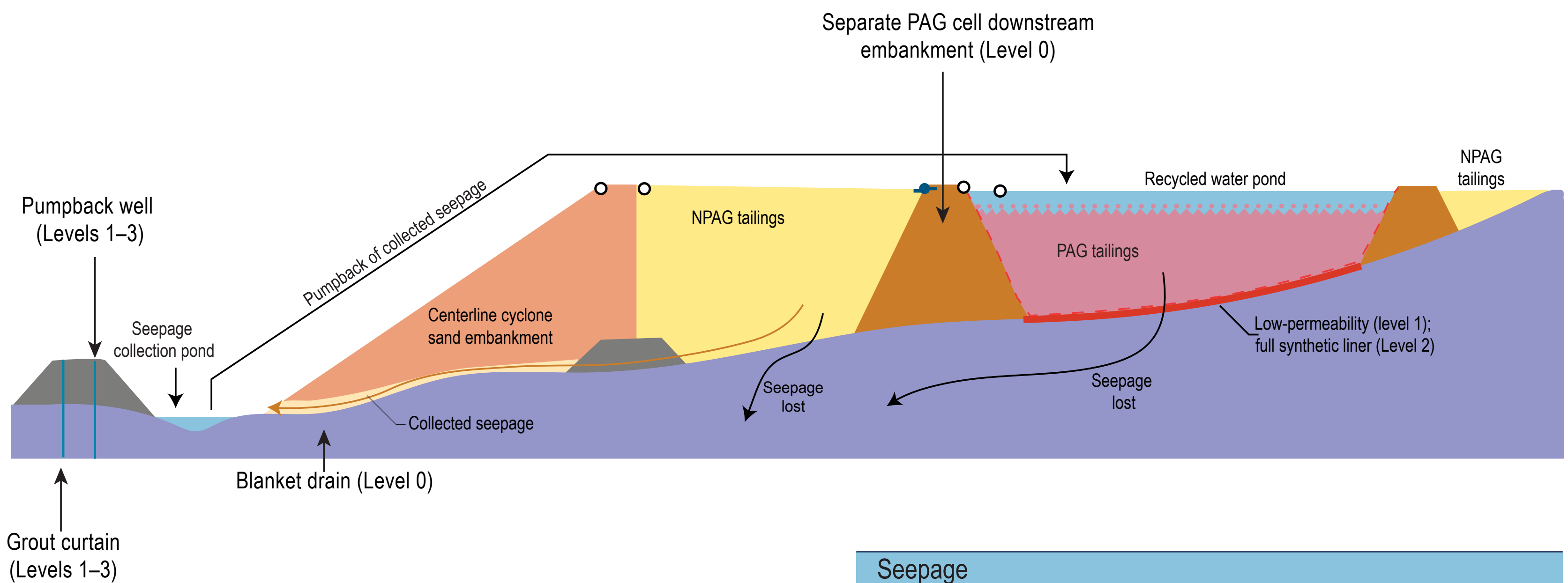
- Blanket drains beneath the embankment (Level 0), extending farther under the facility under Level 1 controls.
- A low-permeability layer under the entire separate PAG cell (Level 1).
- A single downstream seepage collection pond with grout curtains and a pumpback well system (Level 1). Under Level 2 the grout curtain and wells are deepened, and then under Level 3 they are deepened again.

Anticipated Effectiveness of Seepage Controls

For Alternative 6, total seepage estimates are based on two-dimensional steady-state finite element model (SEEP/W) (Klohn Crippen Berger Ltd. 2019c). The amount of lost seepage for Alternative 6 is estimated in two ways, both derived from the two-dimensional model. One estimate of lost seepage is the difference between the modeled seepage from the NPAG and PAG facilities, minus the amount of seepage modeled to be collected in the downstream seepage collection pond. A second

Conceptual Cross Section of Entire Facility

Alternative 6 – Seepage Control Levels 0–3



Seepage Control Level	Grout Curtain/Cut-off	PumpBack Well
1	Depth of 70 feet	Depth of 20 feet
2	Depth of 100 feet	Depth of 70 feet
3	Depth of 100 feet	Depth of 100 feet

Figure 3.7.2-9. Alternative 6 seepage controls

Table 3.7.2-19. Effectiveness of Alternative 6 engineered seepage controls

Seepage Control Levels and Components	Uncaptured Seepage from Facility	Source
Uncontrolled seepage from tailings facility	1,870 acre-feet/year	Klohn Crippen Berger Ltd. (2019c)
Level 0 (seepage controls for geotechnical stability)		
- Centerline cyclone sand embankment - Blanket drain under embankment - Separate PAG and NPAG cells	Not explicitly modeled; incorporated into Level 1 modeling	N/A
Level 1		
- Blanket drain extends 100–200 feet underneath impoundment - Engineered low-permeability layer under entire PAG cell - Seepage collection ponds, with cut-offs, grout curtains, and pumpback wells; grout curtains extend to 70 feet (estimated base of alluvium); pumpback wells extend to 20 feet	580 to 660 acre-feet per year	Klohn Crippen Berger Ltd. (2019c)
Level 2		
- Grout curtains extended to 100 feet (estimated base of Gila Conglomerate); pumpback wells extend to 70 feet	270 to 370 acre-feet per year	Klohn Crippen Berger Ltd. (2019c)
Level 3		
- Pumpback wells extend to 100 feet	70 to 180 acre-feet per year	Klohn Crippen Berger Ltd. (2019c)

estimate is derived directly from the modeled flux of water downstream of the seepage collection pond.

During operations, total seepage created by the tailings was estimated at 1,870 acre-feet per year (1,820 and 50 acre-feet per year of NPAG and PAG seepage, respectively) and lost seepage was modeled to be 580 to 660 acre-feet per year with Level 1 seepage controls, 270 to 370 acre-feet per year with Level 2 enhancements to the grout curtains and wells, and 200 to 260 acre-feet per year with all Level 3 enhancements.

Risk of Seepage Impacting Groundwater or Surface Water Quality

Modeled results for groundwater and surface water impacts are reported by Gregory and Bayley (2019). The detailed results of the bypass seepage mixing/loading model were supplied as an Excel spreadsheet and can be found in Garrett (2019c). Table 3.7.2-20 presents model results for all modeled chemical constituents in the first groundwater cell (cell DS-1) and the ultimate surface water cell (Gila River below Dripping Spring Wash), for model years 41, 100, and 245. This provides perspective on trends and expected conditions at the end of mining and in the long term. Table 3.7.2-20 also presents Arizona water quality standards and baseline chemistry for added perspective.

Figures M-29 through M-35 in appendix M illustrate model results for the seven constituents of concern.

Modeling results for Alternative 6 indicate the following:

- Modeling estimates that engineered seepage controls can recover 90 percent of total seepage. All levels of control (Levels 0 through 3) have been applied to Alternative 6 for the purposes of estimating the effects of tailings seepage on water quality.
- For all constituents, concentrations decrease with distance from the tailings storage facility, but increase over time.
- No chemical constituents are anticipated in concentrations above groundwater or surface water standards.
- Sulfate and total dissolved solids are significant constituents in tailings seepage and can alter the potential use of downstream water resources, but do not have numeric standards. Over time, sulfate concentrations in groundwater closest to the tailings storage facility are expected to rise slightly above the 250 mg/L secondary standard, to 385 mg/L (see appendix M, figure M-29).
- Most constituents increase in concentration in groundwater and surface water above existing baseline conditions.
- The practicability of adding seepage controls during operations is assessed in the following section. Resolution Copper is currently conducting further investigation at the site; this would inform the design of further controls. This investigation currently includes 17 test pits or drill holes, with an additional 15 possible locations within the tailings footprint.

Practicability for Additional Seepage Controls

The site-specific suite of engineered seepage controls designed for Alternative 6 is substantially more effective at controlling seepage than a fully lined facility with no other controls. The estimated loss through a full liner is about 960 acre-feet per year for a 4,000-acre facility (see Rowe (2012) and Newell and Garrett (2018d) for details of this estimate). This estimate is specifically for an engineered low-permeability liner as specified under Arizona BADCT; composite liners are able to reach better performance, but there are substantial logistical concerns about the ability to successfully install a full liner of any kind (see Newell and Garrett (2018d) for a summary of concerns).

Under the suite of engineered seepage controls considered (Levels 0 through 2), the entire PAG cell would already use low-permeability layers which have similar permeabilities to the Arizona BADCT specifications. The comparison to a full liner illustrates the need for layered seepage controls, particularly downstream seepage collection dams and pumpback wells, to control seepage that would be generated from within the facility, regardless of the foundation treatment.

Table 3.7.2-20. Seepage water quality modeling results for Alternative 6 (mg/L)

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Skunk Camp Well*)	DS-1 Model Cell Year 41	DS-1 Model Cell Year 100	DS-1 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Dripping Spring Wash*)	Gila River below Dripping Spring Wash Modeled Surface Water Year 41	Gila River below Dripping Spring Wash Modeled Surface Water Year 100	Gila River below Dripping Spring Wash Modeled Surface Water Year 245
Constituents with Numeric Standards										
Antimony	0.006	0.00023	0.00091	0.00128	0.00162	0.030	0.00023	0.00024	0.00025	0.00025
Arsenic	0.05	0.0003	0.0003	0.0005	0.0011	0.030	0.00861	0.0086	0.0086	0.0086
Barium	2	0.0038	0.0073	0.0081	0.0078	98	0.0749	0.075	0.075	0.075
Beryllium	0.004	0.0017	0.00171	0.00171	0.00171	0.0053	0.0017	0.0017	0.0017	0.0017
Boron	–	0.026	0.076	0.100	0.109	1	0.196	0.197	0.197	0.197
Cadmium	0.005	0.00006	0.0011	0.0015	0.0014	0.0043	0.00006†	0.00008†	0.00009†	0.00009†
Chromium, Total	0.1	0.0020	0.0077	0.0098	0.0087	1	0.0020	0.0021	0.0021	0.0021
Copper	–	0.00165	0.038	0.051	0.044	0.0191	0.00207†	0.0026†	0.00291	0.0028†
Fluoride	4	0.232	0.78	0.96	0.87	140	1.0	1.04	1.04	1.04
Iron	–	0.056	0.0563	0.0564	0.0564	1	0.071	0.071	0.071	0.071
Lead	0.05	0.000140	0.00031	0.00040	0.00045	0.0065	0.00014†	0.00014†	0.00014†	0.00015†
Manganese	–	0.0034	0.122	0.170	0.156	10	0.029	0.031	0.032	0.032
Mercury	0.002	N/A	N/A	N/A	N/A	0.00001	N/A	N/A	N/A	N/A
Nickel	0.1	0.0023	0.015	0.020	0.022	0.1098	0.0023†	0.0025†	0.0026†	0.0026†
Nitrate	10	1.34	1.82	1.95	1.91	3,733.333	0.305	0.31	0.32	0.31
Nitrite	1	N/A	N/A	N/A	N/A	233.333	N/A	N/A	N/A	N/A
Selenium	0.05	0.0004	0.022	0.030	0.028	0.002	0.0004	0.0007	0.0009	0.0009
Silver	–	0.000061	0.0050	0.0069	0.0059	0.0147	0.000061	0.00014	0.00018	0.00016
Thallium	0.002	0.00008	0.00042	0.00053	0.00047	0.0072	0.000080	0.00009	0.00009	0.00009
Uranium	–	N/A	N/A	N/A	N/A	2.8	N/A	N/A	N/A	N/A
Zinc	–	0.224	0.445	0.538	0.518	0.2477	0.0050†	0.0085†	0.0103†	0.0099†
pH	–	N/A	N/A	N/A	N/A	6.5–9.0	N/A	N/A	N/A	N/A

continued

Table 3.7.2-20. Seepage water quality modeling results for Alternative 6 (mg/L) *(cont'd)*

	Aquifer Water Quality Standard	Baseline Groundwater Quality (Skunk Camp Well*)	DS-1 Model Cell Year 41	DS-1 Model Cell Year 100	DS-1 Model Cell Year 245	Surface Water Standard for Most Restrictive Use	Baseline Surface Water Quality (Gila River below Dripping Spring Wash*)	Gila River below Dripping Spring Wash Modeled Surface Water Year 41	Gila River below Dripping Spring Wash Modeled Surface Water Year 100	Gila River below Dripping Spring Wash Modeled Surface Water Year 245
Constituents without Numeric Standards										
Sulfate	–	54	196	365	385	–	100	102	105	105
Total Dissolved Solids	–	327	575	830	846	–	702	706	710	711

Notes: N/A = not analyzed in seepage modeling

Model data are not specific to total or dissolved fractions; for the purposes of comparison to surface water standards it can be assumed to apply to both.

* Assumed concentrations are based on single sample collected on 9 November 2018 and are therefore approximate.

† Standards are hardness dependent and were calculated using a hardness value of 242 mg/L $CaCO_3$ (from sample collected on 9 November 2018); see appendix N, table N-5, for details on how these standards were selected

Like Alternative 5, Alternative 6 has substantial flexibility for adding other layers of seepage controls during operations as needed. The distance downstream to the Gila River offers opportunities for modified or expanded pumpback systems or physical barriers (grout curtains).

RAMIFICATIONS FOR LONG-TERM CLOSURE

Post-closure Water Quality, Seepage Rates, and Closure Timing

Modeling indicates that the concentrations of constituents of concern continues to increase over time, post-closure. Post-closure seepage rates are estimated to be 200 to 260 acre-feet per year (Klohn Crippen Berger Ltd. 2019c). In the alternative design, Klohn Crippen Berger Ltd. (2018d) estimated that active closure would be required up to 20 years after the end of operations. Up to 5 years after closure, the recycled water pond still is present and therefore all engineered seepage controls could remain operational, with seepage pumped back to the tailings storage facility. After 5 years, the recycled water pond is no longer present. At this time the seepage collection ponds would be expanded to maximize evaporation, and then active water management (either enhanced evaporation or treatment for release) would take place until the ponds could passively evaporate all incoming seepage (estimated at 20 years). The sludge of concentrated metals and salts from evaporation would likely eventually require cleanup and handling as solid or hazardous waste.

Financial Assurance for Closure and Post-closure Activities

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.

POTENTIAL IMPACTS ON IMPAIRED WATERS

As noted, the Gila River between the San Pedro River and Mineral Creek is currently considered impaired for suspended sediment concentrations. Given the stormwater controls put in place during operation and the long-term reclamation after closure, it is unlikely that Alternative 6 would contribute to suspended sediment in the Gila River.

PREDICTED REDUCTIONS IN ASSIMILATIVE CAPACITY

The calculated reductions in assimilative capacity are shown in table 3.7.2-12. For Alternative 6, the discharge of seepage into the Gila River uses more than 20 percent of the assimilative capacity for selenium.

Other Water Quality Concerns

PERSISTENCE OF PROCESSING CHEMICALS IN TAILINGS

In order to extract concentrated copper and molybdenum using flotation, Resolution Copper would add a series of substances or reagents during processing. If these substances were to persist in the processing water, they have the potential to be released to the environment along with seepage from the tailings storage facilities. Six reagents expected to be used in the processing facility were analyzed (Hudson 2018):

- AERO 8989. This substance renders the copper minerals hydrophobic, causing them to attach to air bubbles blown into the flotation tank. The copper-molybdenum concentrate froth then floats to the top of the tank and is skimmed off. The majority of the AERO 8989 exits the process with the copper-molybdenum concentrate. This concentrate gets thickened and separated into copper concentrate and molybdenum concentrate and sent off-site for additional processing. Water recovered from the concentrate thickeners is recycled back to the processing plant. While some small amounts may persist in the tailings stream, there is no pathway for a substantial release of AERO 8989 to the environment.

- Diesel. Diesel acts similarly to AERO 8989 but for molybdenum minerals. Water recovered from the concentrate thickeners is recycled back to the processing plant. As with AERO 8989, while some small amounts may persist in the tailings stream, there is no pathway for a substantial release of diesel to the environment.
- Sodium isopropyl xanthate (SIPX) acts similarly to AERO 8989 and diesel but attaches to pyrite and sulfide minerals and renders them hydrophobic. SIPX is used later in the process, after copper and molybdenum concentrates have been removed, in order to separate the PAG and NPAG tailings streams. The majority of this reagent would enter the tailings storage facility with the PAG tailings stream. Any water recovered in the recycled water pond would potentially contain SIPX and would be recycled back to the processing plant. Some SIPX remains entrained with the PAG tailings and therefore has the potential to contribute to seepage water quality. The breakdown of SIPX yields xanthate and carbon disulfide as two major byproducts. Xanthate decomposes as well as adsorbs; depending on the temperature the half-life can range from less than 1 hour to almost 4 months (Eary 2018h). At the concentrations being considered and the likely temperatures, xanthate is unlikely to survive long enough to be detectable in any lost seepage. Most of the carbon disulfide generated is expected to be volatilized as tailings pass through the spigots and are deposited in the facility; in the atmosphere carbon disulfide decomposes to carbonyl sulfide, carbon monoxide, and sulfur dioxide. The carbon disulfide that remains decomposes with a half-life ranging from roughly 6 months to 1 year. Given that the transit times for seepage to reach aquifers is estimated in the range of decades (Groenendyk and Bayley 2018a), carbon disulfide is unlikely to survive long enough to be detectable in any lost seepage.
- Methyl isobutyl carbinol (MIBC). MIBC is used to lower the surface tension of the water, thus strengthening the air bubbles in the flotation tank. MIBC is used during concentration of copper and molybdenum and during separation of the PAG and NPAG tailings streams. Most MIBC would volatize, and the MIBC that remains degrades relatively quickly, at about 14 percent per day (Hudson 2018). MIBC is unlikely to survive long enough to be detectable in any lost seepage.
- Sodium hydrogen sulfide. This substance is used to separate copper from molybdenum concentrate by causing copper minerals to sink, while molybdenum concentrate remains in flotation. Water recovered from the concentrate thickeners is recycled back to the processing plant. There is no pathway for a substantial release of sodium hydrogen sulfide to the environment.
- Magnafloc 155. This substance is a flocculant, used to cause particles to combine into large groups and therefore settle more readily. This substance would be present in the PAG and NPAG tailings streams and in the copper and molybdenum concentrates. Specific information on the degradation of Magnafloc 155 is lacking. Some evidence exists that exposure to sunlight and physical processing are both likely to cause degradation. The potential for Magnafloc 155 to persist in tailings seepage is unclear, but as the purpose of using Magnafloc is to bind with solid particles it would not be expected to have substantial mobility.

TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM)

The potential for the occurrence of natural radioactive materials in the ore deposit, the potential to concentrate those materials during processing, and the potential for these materials to affect tailings seepage were raised as potential concerns for the project. This topic was investigated by Resolution Copper (Duke 2019b), and further analyzed by the Forest Service for the EIS. Full details of the analysis are contained in Newell and Garrett (2018d) and are summarized here.

Radioactive materials such as uranium, thorium, and radium occur naturally in the earth's crust and soil. In some cases, these materials can be concentrated by mining processes, leading to a concern that technologically enhanced naturally occurring radioactive materials (TENORM) could result in water quality concerns in seepage from the tailings storage facility.

The potential for this problem to occur was assessed based on analysis conducted on 5,987 samples of Resolution copper ore from 137 exploration boreholes, master ore composites, laboratory-simulated tailings samples, and background groundwater quality samples. When compared with common background levels, review of existing information at the site does not suggest the strong presence of naturally occurring radioactive materials above typical concentrations, although a small percentage (2 to 6 percent) of samples have exhibited concentrations above thresholds of concern.

Several past examples of TENORM have been documented in the vicinity of the project, including at the Magma Mine, Pinto Valley, and the Ray Mine. However, all of these were associated with acidic leaching and electrowinning. The Resolution Copper Project does not include any heap leaching, solvent extraction-electrowinning, or recycling of raffinate. The processes that historically have been documented with problems would not occur as part of this project.

With respect to the processing (flotation) that would be used during the Resolution Copper Project, site-specific locked cycle testing has simulated the effect of processing to potentially concentrate radioactive materials, and no concentrations are above any thresholds of concern for uranium, radium, and gross alpha activity.

PRESENCE OF ASBESTIFORM MINERALS

Similar to radioactive materials, the potential for asbestiform minerals to occur in the Resolution ore deposit and eventually end up in the tailings facility was raised as a possible concern. Resolution Copper investigated the overall occurrence of these minerals (Duke 2019a).

Asbestos is present in trace to minor amounts in the Resolution ore and development rock as fibrous forms of the amphibole minerals tremolite and actinolite, primarily tremolite. The general threshold for asbestos-containing material is more than 1 percent asbestos as determined by polarized light microscopy (40 CFR 61.141).

Abundances of tremolite and actinolite in the ore body were assessed from 992 samples from 110 exploration boreholes. Tremolite is consistently present (90 percent of samples), with the highest concentrations generally associated with skarn rock units. Abundance ranged from less than 0.01 to 24.24 percent by weight, with a mean of 0.27 percent by weight.

Resolution Copper has conducted two additional targeted studies. In 2006, 34 samples of development rock were submitted for bulk asbestos analysis. Of these, 85 percent of the samples did not contain detectable asbestiform minerals. All samples with detectable asbestiform minerals were associated with skarn rock units. In 2007, 53 samples specific to skarn rock units were submitted for bulk asbestos analysis. Of these, 66 percent of the samples did not contain detectable asbestiform minerals; the remaining abundances ranged from 0.5 to 4.0 percent by weight.

These analyses indicate that asbestiform minerals are present in the ore deposit, but on average the percentage is below the threshold for concern. However, the block caving is not conducted on the ore deposit as a whole, but panel by panel. When viewed on a panel-by-panel basis, overall asbestiform minerals are not anticipated to exceed 0.1 percent by weight.

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 groundwater or surface water quality. 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.

- *Ripsey Wash Tailings Project.* Mining company 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. Results of geochemistry characterization and testing on the proposed tailings and borrow materials reveal a low potential to impact groundwater or surface water with the design and operational safeguards proposed for the facility. Kinetic testing revealed a low potential for any acid generation from tailings materials and confirmed that alluvium materials to be used for construction activities are not acid-generating. The meteoric water mobility testing on both tailings and alluvium material also revealed that possible dissolution and mobilization of minerals from these materials are low. The facility is located close to the Gila River, downstream of Dripping Spring Wash (where Alternative 6 discharges would occur) and upstream of Donnelly Wash (where Alternative 5 discharges would occur). Any pollutant load to the Gila River from the facility, even if within permit limits, would cumulatively affect water quality in the Gila River in combination with Resolution Copper Project impacts for Alternative 5 or 6.
- *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. Specific pollutant discharges are not yet known, but given the location of this future mining activity, any impacts on water quality could potentially be cumulative with Resolution Copper Project–related impacts on the Gila River for Alternatives 5 and 6.
- *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 primary concern with regard to water quality centers around the potential for geochemical seepage or runoff from tailings or other mine facilities into groundwater and surface waters within the Pinto Creek watershed. This is in a different watershed from any Resolution Copper Project–related impacts and would not cumulatively affect this resource.

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.

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

UNAVOIDABLE ADVERSE EFFECTS

The applicant-committed environmental protection measures for stormwater control would effectively eliminate any runoff in contact with ore or tailings. There are no anticipated unavoidable adverse effects associated with the quality of stormwater runoff.

Seepage from the tailings storage facilities has a number of unavoidable adverse effects. In all cases, the tailings seepage adds a pollutant load to the downstream environment, including downstream aquifers and downstream surface waters where groundwater eventually daylights. The overall impact of this seepage varies by alternative. Alternatives 2, 3, and 4 all either have anticipated impacts on water quality or have a high risk to water quality because of the extreme seepage control measures that must be implemented, and the relative inflexibility of adding more measures as needed, given the proximity to Queen Creek.

Alternatives 5 and 6 are located at the head of larger alluvial aquifers with some distance downstream before the first perennial water (the Gila River). Adverse effects are not anticipated from these alternatives, and in addition these locations offer more flexibility in responding to potential problems with additional seepage controls.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The use of the alternative sites for tailings storage represents a short-term use, with disposal happening over the operational life of the mine. However, the seepage from the tailings facilities would continue for much longer, with potential management anticipated being required over 100 years in some cases. While seepage persists, the long-term productivity of the downstream aquifers and surface waters could be impaired for some alternatives.

Irreversible and Irretrievable Commitment of Resources

The potential impacts on water quality from tailings seepage would cause an irretrievable commitment of water resources downstream of the tailings storage facility, lasting as long as seepage continued. Eventually the seepage amount and pollutant load would decline, and water quality conditions would return to a natural state. This may take over 100 years to achieve in some instances.

While long lived, the impacts on water quality would not be irreversible, and would eventually end as the seepage and pollutant load declined.

3.7.3 Surface Water Quantity

3.7.3.1 Introduction

Perennial streams and springs are relatively rare in the area but do exist (see discussion in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems). For the most part, surface waters in the area consist of dry washes or ephemeral channels that flow only in response to moderate- to high-intensity rainfall events. Water that flows in these washes and streams due to runoff from rainfall events reflects conditions in the upstream watershed—the geographic area that contributes to flow in the stream—and these flows could change if the upstream watershed changes.

The project would cause two major changes to these watersheds. Once the subsidence area develops at the surface, precipitation falling within this area would no longer report to the downstream stream network, potentially reducing runoff reaching both Devil's Canyon and Queen Creek.

In addition to the loss of runoff from the subsidence area, precipitation falling on or within the tailings storage facility would also be unavailable to downstream washes. All the tailings alternatives are designed to allow any runoff from upstream in the watershed to flow around the facility and continue flowing downstream. However, for the slurry tailings facilities (Alternatives 2, 3, 5, and 6), the top of the tailings facility is managed as a pond to allow process water to be recycled. Any rain falling within the bounds of a slurry facility, including the seepage recovery ponds at the downstream toe of the tailings embankment, is retained and recycled.

Alternative 4 – Silver King is the sole filtered tailings alternative and is different from the slurry alternatives. Filtered tailings must be managed to shed, not retain, water. However, because rain that sheds off the filtered tailings has contacted tailings, it must be collected downstream and not released to the environment during operations. The overall result for the filtered tailings alternative is the same as for the slurry alternatives—less surface water reporting downstream.

This section analyzes the reduction in streamflow caused by each of the alternatives, in terms of both total volume and peak flows during flood events. This section also analyzes the impacts that would be expected on sediment yields and stream geomorphology, impacts on water quality from sediment changes, impacts on jurisdictional waters of the U.S. (related to the CWA Section 404 program), impacts on floodplains, and impacts on wetlands (related to Executive Order 11990). Some aspects of the analysis are briefly summarized in this section. Additional details not included are captured in the project record (Newell and Garrett 2018d).

3.7.3.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

Analysis Area

The analysis area for surface water quantity includes the Queen Creek, Devil's Canyon, Dripping Spring Wash, and Donnelley Wash drainages: all of these watercourses are tributaries of the Gila River. The primary focus of the analysis is on waters downstream of areas that would be directly impacted by the mine, including by the subsidence area. Since the entire watershed affects flow in these areas, the analysis area also includes the larger watershed of these channels, as shown on figure 3.7.3-1. Specific analysis locations used to assess changes in streamflow are also shown on figure 3.7.3-1.

Approach

Two separate modeling approaches were used to assess how the subsidence area and tailings storage facilities would affect runoff. Flood flows are often characterized by the "return period," i.e., a 2-year or 20-year flood event, which is just another way of expressing the probability of an event occurring. For example, a 2-year event has a 50 percent chance of occurring for any given storm, and a 20-year event has a 5 percent chance of occurring for any given storm. An approach developed by the USGS was used to analyze how reduced watershed

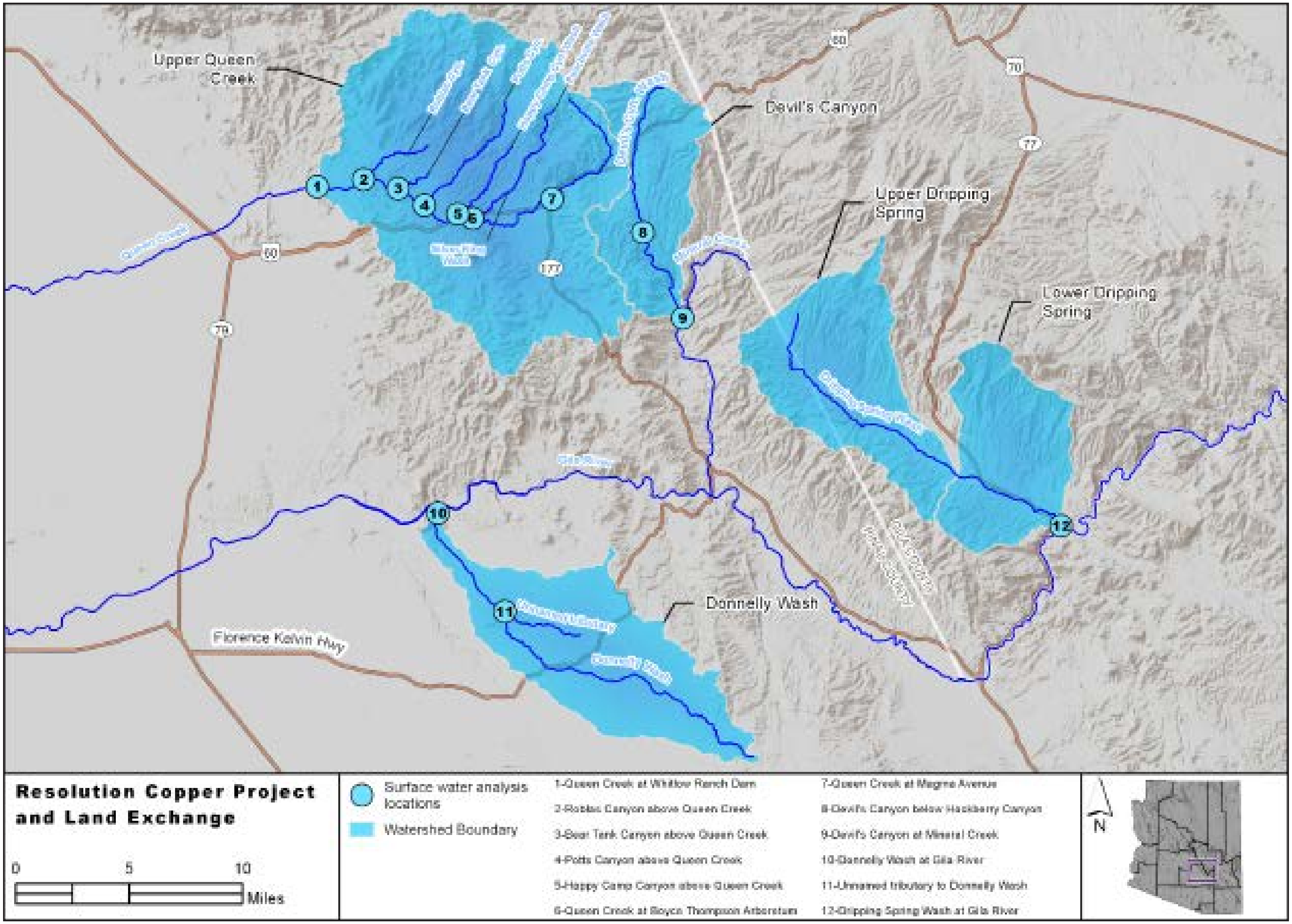


Figure 3.7.3-1. Surface water quantity analysis area

area would affect peak flood flows with different return periods (Lehman 2017, 2018).

In addition to changes to individual flood events, the loss of watershed area also would affect the overall volume of water flowing through a wash and available to wildlife, vegetation, and surface water users. A "monthly water balance" modeling approach was used to assess reductions in the overall volumes of water available to the natural system due to the subsidence area and the tailings storage facilities (BGC Engineering USA Inc. 2018c). Prior to use, the monthly water balance model was first calibrated using data from Pinto Creek. The modelers found Devil's Canyon, Queen Creek, and Dripping Spring Wash watersheds to be similar in nature to Pinto Creek, but note that Donnelly Wash is substantially different (less-steep gradient), which may introduce some uncertainty into the modeling (BGC Engineering USA Inc. 2018c). For a further overview of these two modeling approaches, and for additional citations for further information, see Newell and Garrett (2018d).

For much of the project area, 100-year floodplains have not been mapped, but have been estimated based on available geological mapping (Newell and Garrett 2018d).

3.7.3.3 Affected Environment

Relevant Laws, Regulations, Policies, and Plans

A number of laws, regulations, and policies are pertinent to surface water quantity and are summarized in Newell and Garrett (2018d). Two of these are worth noting here.

As discussed in section 1.5.3, the USACE would rely on this EIS to support issuance of a permit under Section 404 of the CWA, which regulates dredge and fill within waters of the U.S. Part of the USACE permitting responsibility would be to identify jurisdictional waters of the U.S., identify which alternative represents the least environmentally damaging practicable alternative, and to require adequate mitigation to compensate for impacts on waters of the U.S. This section summarizes the potentially jurisdictional waters associated with each alternative, and considers the mitigation proposed to compensate for impacts on waters of the U.S.

Primary Legal Authorities Relevant to the Surface Water Quantity Analysis

- Clean Water Act (Section 404)
- Executive Order 11988—Occupancy and modification of floodplains; Executive Order 11990—Destruction, loss, or degradation of wetlands
- Pinal County Floodplain Management Ordinance

In Arizona, jurisdictional waters of the U.S. often include both ephemeral washes and wetlands areas. Both types of jurisdictional waters are defined by specific technical guidance from the USACE. The Forest Service also considers wetlands under Executive Order 11990, which directs Federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial value of wetlands in carrying out programs that affect land use. Wetlands considered under Executive Order 11990 are not strictly defined and differ from the jurisdictional waters considered for a 404 permit. This section separately considers wetlands under Executive Order 11990, relying on the National Wetlands Inventory as a data source.

DOCUMENTATION SPECIFIC TO CLEAN WATER ACT SECTION 404 PERMIT ISSUANCE

Issuance of a permit under Section 404 of the CWA requires submittal of a permit application and supporting documentation to the USACE. Fundamental to those regulations is the principle that dredged or fill material cannot be discharged into the aquatic ecosystem unless it can be demonstrated that there is no less environmentally damaging practicable alternative that achieves an applicant's project purpose. In other words, only the least environmentally damaging practicable alternative can be permitted (40 CFR 230.10(a)).

The 404 permitting process includes submittal of a document called a "404(b)1 alternatives analysis." The purpose of the 404(b)1 alternatives analysis is to identify the least environmentally damaging practicable alternative. To determine the least environmentally damaging practicable alternative, each practicable alternative for the proposed mine must be fully analyzed in the 404(b)1 alternatives analysis to assess the relative magnitude of project impacts, including direct, secondary, and cumulative impacts.

Most of the impacts considered under the USACE process are identical to those considered in this EIS, describing physical effects on the environment caused by the mine. However, some impacts considered under the USACE process are specific only to that permitting process, which may have a different scope of analysis. For example, the analysis in sections 3.7.1 and 3.7.3 of this EIS considers the overall physical impacts on streams and the riparian ecosystems associated with streams, but in doing so does not look at acreage as a measure of impact. In contrast, the calculation of the exact acreage of impacts on jurisdictional waters (both direct and indirect) is a very specific requirement of the 404(b)1 alternatives analysis.

Because of these differences, the 404(b)1 alternatives analysis is a document strongly related to the EIS, but also separate. The 404(b)1 alternatives analysis submitted to the USACE by Resolution Copper for the preferred alternative is attached to the EIS as appendix C.

An additional requirement of the USACE process is for compensatory mitigation to offset the impacts on jurisdictional waters. Similar to the 404(b)1 alternatives analysis, this mitigation is pertinent to both the EIS and the USACE process but is handled differently in each. In the EIS, the focus is on whether mitigation would be effective at addressing impacts of any resources, and if so, what residual impacts would remain. This is often a qualitative assessment. For the USACE process, the calculations of the amount of mitigation required are quantitative and formulaic with specific acreage multipliers used for different types of impacts. The conceptual compensatory mitigation plan submitted to the USACE by Resolution Copper for the preferred alternative is attached to the EIS as appendix D.

Table 3.7.3-1. Watershed characteristics

Watershed	Minimum Elevation (feet amsl)	Maximum Elevation (feet amsl)	Mean Elevation (feet amsl)	Average Slope (percent)	Area (square miles)
Devil's Canyon	2,240	5,610	4,240	36	36
Dripping Spring Wash	2,025	7,645	3,670	33	117
Queen Creek	2,135	5,610	3,225	31	143
Donnelly Wash	1,615	3,900	2,900	7	60

Note: Watershed characteristics derived from USGS StreamStats application (U.S. Geological Survey 2018d)

The effectiveness of the conceptual mitigation is assessed in this section of the EIS in a manner similar to other resources and does not reflect USACE calculations or analysis.

Existing Conditions and Ongoing Trends

REGIONAL HYDROLOGIC SETTING

The analysis area includes the Queen Creek, Devil's Canyon, Dripping Spring Wash, and Donnelly Wash drainages: all of these watercourses are tributaries of the Gila River, as shown in figure 3.7.3-1. Watershed characteristics of these drainages are summarized in table 3.7.3-1.

QUEEN CREEK AND DEVIL'S CANYON WATERSHEDS (SUBSIDENCE AREA AND ALTERNATIVES 2, 3, AND 4)

The western part of the analysis area is drained by Queen Creek, which arises in the highlands around the Pinal Mountains and flows past Oak Flat and through the town of Superior. Queen Creek ultimately flows to Whitlow Ranch Dam, about 11 miles west of Superior. The dam is an ungated flood risk–management structure that was constructed in 1960 to reduce the risk of downstream flood damage to farmland and the communities of Chandler, Gilbert, Queen Creek, and Florence Junction. The dam includes a diversion structure to satisfy local water rights.

As discussed in Section 3.7.1, Groundwater Quantity and Groundwater-Dependent Ecosystems, Queen Creek is primarily ephemeral but exhibits perennial flow downstream of the town of Superior wastewater treatment plant, both from effluent and groundwater discharges from a nearby mine pit.

The ore body is located approximately 4,500–7,000 feet beneath Oak Flat in the upper Queen Creek basin. Devil's Canyon is located to the immediate east of Oak Flat with its headwaters located north of U.S. 60. Devil's Canyon cuts through the Apache Leap Tuff, forming a steep-sided canyon that flows in a southerly direction for approximately 9 miles. Devil's Canyon discharges into the reservoir of Big Box Dam. Mineral Creek, to the immediate east of Devil's Canyon, also discharges into the reservoir. Big Box Dam was constructed to divert flows from Devil's Canyon and Mineral Creek around the Ray Mine and into the Gila River. As discussed in section 3.7.1, much of upper Devil's Canyon is ephemeral, where runoff is driven by rainfall events. However, there are several perennial reaches that are sustained either by shallow, recharged groundwater systems or a regional groundwater system that discharges to the surface via seeps and springs.

The subsidence area would affect portions of the watershed for Queen Creek and Devil's Canyon, and the tailings storage facilities for Alternatives 2, 3, and 4 would affect tributaries to Queen Creek.

GILA RIVER WATERSHED (ALTERNATIVES 5 AND 6)

Alternative 5 – Peg Leg would impact Donnelly Wash, which flows north to join the Gila River downstream of Mineral Creek. Donnelly Wash flows through an alluvial valley and has more gentle slope gradients, compared with the other watersheds. The main stem channel of Donnelly Wash is entirely ephemeral, with no known perennial reaches.

Alternative 6 – Skunk Camp would impact Dripping Spring Wash. Dripping Spring Wash is located in the eastern part of the analysis area. Dripping Spring Wash flows to the southeast for approximately 18 miles before discharging into the Gila River downstream of the Coolidge Dam. The main stem channel of Dripping Spring Wash is entirely ephemeral, with no known perennial reaches.

Both Alternatives 5 and 6 would also affect flow to the Gila River itself, which is perennial between Coolidge Dam and Florence.

CLIMATE CONDITIONS

The climate of the project area is generally arid to semi-arid. Topography influences the spatial distribution of precipitation, being lowest in the valley bottoms (average annual totals of approximately 13 inches in the vicinity of Whitlow Ranch Dam), and greatest in the upper elevations of the Queen Creek watershed (26 inches). There are two separate rainfall seasons. The first occurs during the winter from November through March, when the area is subjected to occasional storms from the Pacific Ocean. The second rainfall period occurs during the July and August "monsoon" period when Arizona is subjected to widespread thunderstorm activity whose moisture supply originates in the Gulf of Mexico and Pacific Ocean.

Precipitation typically occurs as high-intensity, short-duration storms during the summer monsoon, and longer term storms of more moderate intensity that occur during the winter months. Summer storms, coupled with relatively impervious land surfaces, sparse vegetation, and steep topographic gradients, result in rapid increases in streamflow. Winter rains tend to produce runoff events of longer duration and with higher maximum flows than summer rains. This is a result of higher rainfall totals and wetter antecedent moisture conditions that tend to prevail in the winter months due to a significantly lower evapotranspiration demand. These wetter conditions result in less near-surface storage capacity in the winter and a larger proportion of any given rain event runs off rather than infiltrating. Regional gaging stations indicate that a majority of runoff occurs during the winter months (December to March) when evaporation rates are at a minimum.

Climate trends suggest that runoff could decrease in the future due to increased temperatures and reduced precipitation. Average temperatures in Arizona have increased about 2°F in the last century (U.S. Environmental Protection Agency 2016). In the Lower Colorado River basin, the annual mean and minimum temperature have increased 1.8°F–3.6°F for the time period 1900–2002, and data suggest that spring minimum temperatures for the same time period have increased 3.6°F–7.2°F (Dugan 2018). Annual average temperatures are projected to rise by 5.5°F to 9.5°F by 2070–2099, with continued growth in global emissions (Melillo et al. 2014).

While future projected temperature increases are anticipated to change mean annual precipitation to a small degree, the majority of changes to annual flow in the Lower Colorado River basin are related to changes in runoff timing. Increased temperatures are expected to diminish the accumulation of snow and the availability of snowmelt, with the most substantial decreases in accumulation occurring in lower elevation portions of the basin where cool season temperatures are most sensitive to warming (Dugan 2018).

Most precipitation falling within the watershed either evaporates or is transpired by vegetation, either from shallow surface soils (approximately 96 percent of precipitation) or along stream drainages and areas where the groundwater is relatively close to the surface and directly available to trees and shrubs (approximately 1 percent of precipitation). The remainder recharges to groundwater or leaves the basin as surface runoff (Montgomery and Associates Inc. 2018).[55]

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

Alternative 1 – No Action

Under the no action alternative, impacts on surface water runoff from the Resolution Copper Project and associated activities would not occur. However, impacts on a number of springs because of groundwater drawdown would occur under the no action alternative, as analyzed and discussed in section 3.7.1.

Impacts Common to All Action Alternatives

Table 3.7.3-2 summarizes locations where changes in average monthly and annual streamflow quantity were quantified for each the identified alternatives (BGC Engineering USA Inc. 2018c). Potential changes in streamflow have also been quantified for peak instantaneous flood flows and flows with durations of 1, 3, 7, 15, and 30 days (Lehman 2017, 2018). These changes in streamflow discharge-duration-frequency were assessed for annual exceedance probability (AEP) at 50, 20, 10, 4, 2, 1, 0.5, and 0.2 percent levels.

Streamflow discharge-duration-frequency analysis provides a detailed look at the dynamics of a stream under many conditions, and the full comparison is available for review (Newell and Garrett 2018d). For purposes of comparison in the EIS, two values from the discharge-duration-frequency analysis were selected to represent impacts at each location. The values selected are those that represent the peak instantaneous and the 30-day streamflows, each with a 50 percent probability of exceedance. The return period was selected because it represents flows that happen with relative frequency. The short duration (peak instantaneous streamflow) was selected to represent short, intense ephemeral flows that occur, typical of monsoon events. The long duration (30-day streamflow) was selected to represent streamflow

55. These percentages were calculated specifically for the Queen Creek watershed but in general would expect to be similar to the other watersheds in the analysis area, which are at similar elevations, with similar climate, and similar topography.

Table 3.7.3-2. Watershed locations where changes in streamflow for the project EIS action alternatives were analyzed

Location	Drainage Area (square miles)	Action Alternative
Devil's Canyon – downstream of confluence with Hackberry Canyon, roughly DC-8.1C.	19.0	All
Devil's Canyon – *confluence with Mineral Creek*	35.8	All
Queen Creek – *at Magma Avenue Bridge*	10.4	All
Queen Creek – at Boyce Thompson Arboretum	27.9	All
Queen Creek – *Upstream of Whitlow Ranch Dam*	143.0	All
Potts Canyon* – confluence with Queen Creek	18.1	Alternative 4
Happy Canyon* – confluence with Queen Creek	4.2	Alternative 4
Silver King Wash* – confluence with Queen Creek	6.7	Alternative 4
Roblas Canyon† – confluence with Queen Creek	10.2	Alternative 2, Alternative 3
Bear Tank Canyon† – confluence with Queen Creek	4.9	Alternative 2, Alternative 3
Unnamed Wash – *confluence with Gila River*	7.1	Alternative 5
Donnelly Wash – *confluence with Gila River*	59.9	Alternative 5
Gila River at Donnelly Wash	18,011	Alternative 5
Dripping Spring Wash – confluence with Gila River	117	Alternative 6
Gila River at Dripping Spring Wash	12,866	Alternative 6

Note: See process memorandum for more information on differences between analysis points (Newell and Garrett 2018d).
* Northern tributary impacted by Alternative 4 tailings storage facility.
† Northern tributary impacted by Alternative 2 and Alternative 3 tailings storage facility.

occurring over longer periods but at lesser volume, more typical of conditions affected by baseflow.

The locations analyzed by BGC Engineering USA Inc. (2018c) and Lehman (2017, 2018) differ slightly—coincident analysis locations are identified in italic font in table 3.7.3-2.

The total area of watershed removed from the system of each of the alternatives is summarized in table 3.7.3-3. These footprints reference the total watershed area where water losses would occur, either due to contact water being collected (tailings storage facilities or West Plant Site) or from the subsidence area.

Table 3.7.3-3. Watershed area lost for each mine component

Mine Component	Area of Watershed Lost (square miles)
Subsidence area – Queen Creek	1.76
Subsidence area – Devil's Canyon	0.94
West Plant Site	1.40
Near West tailings storage facility – Alternatives 2 and 3	6.90
Silver King tailings storage facility – Alternative 4	6.32
Peg Leg tailings storage facility – Alternative 5	11.88
Skunk Camp tailings storage facility – Alternative 6	12.15

EFFECTS OF THE LAND EXCHANGE

The land exchange would have effects on surface water quantity.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction. Several surface waters are located on the Oak Flat Federal Parcel, including Rancho Rio Canyon, Oak Flat Wash, and Number 9 Wash, and the parcel also is a portion of the watershed feeding both Queen Creek and Devil's Canyon. 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 these surface waters. 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.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. A number of ephemeral washes and perennial water features are located on these lands:

- Tangle Creek. Tangle Creek is an intermittent or perennial tributary to the Verde River and bisects the parcel. It includes associated riparian habitat with mature hackberry, mesquite, ash, and sycamore trees.
- Turkey Creek. Features of the Turkey Creek Parcel include Turkey Creek, which is an intermittent or perennial tributary to Tonto Creek and eventually to the Salt River at Roosevelt Lake. Riparian vegetation occurs along Turkey Creek with cottonwood, locus, sycamore, and oak trees.
- Cave Creek. Features of the Cave Creek Parcel include Cave Creek, an ephemeral to intermittent tributary to the Agua Fria River, with some perennial reaches in the vicinity of the parcel.
- East Clear Creek. Features of the East Clear Creek Parcel include East Clear Creek, a substantial perennial tributary to the Little Colorado River. Riparian vegetation occurs along East Clear Creek, including boxelder, cottonwood, willow, and alder trees.
- Lower San Pedro River. Features of the Lower San Pedro River Parcel include the San Pedro River and several large ephemeral tributaries (Cooper, Mammoth, and Turtle Washes). The San Pedro River itself is ephemeral to intermittent along the 10-mile reach that runs through the parcel; some perennial surface water is supported by an uncapped artesian well. The San Pedro is one of the few remaining free-flowing rivers in the Southwest and it is recognized as one of the more important riparian habitats in the Sonoran and Chihuahuan Deserts. The riparian corridor in

TABLE OF CONTENTS BACK

- the parcel includes more than 800 acres of mesquite woodlands that also features a spring-fed wetland.
- Appleton Ranch. The Appleton Ranch Parcels are located along ephemeral tributaries to the Babocomari River (Post, Vaughn, and O'Donnell Canyons). Woody vegetation is present along watercourses as mesquite bosques, with very limited stands of cottonwood and desert willow.
- Small ephemeral washes and unnamed drainages are associated with the Apache Leap South Parcel or the Dripping Springs Parcel.

Specific management of surface water resources on the offered lands would be determined by the agencies, but in general when the offered lands enter Federal jurisdiction, these surface waters would be afforded a level of protection they currently do not have under private ownership.

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). A number of standards and guidelines (22) were identified applicable to management of surface water resources. None of these standards and guidelines were found to require amendment because of 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 surface water quantity. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

In the GPO, Resolution Copper has committed to various measures to reduce impacts on surface water quantity:

- To the extent practicable, stormwater flows upgradient of the facilities would be diverted around the disturbed areas and returned to the natural drainage system;
- As much water as possible would be recycled for reuse;
- Permanent diversion channels would be designed for operations and closure; and
- Runoff from roads, buildings, and other structures would be handled through best management practices, including sediment traps, settling ponds, berms, sediment filter fabric, wattles, etc.

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

The proposed block-cave mining operation would result in the formation of a subsidence area at the surface. This subsidence area is estimated to cover an area of 2.7 square miles within the Queen Creek and Devil's Canyon watersheds. Once fully formed, precipitation within the subsidence area footprint would not be expected to report as runoff to either Queen Creek or Devil's Canyon, resulting in a decrease in streamflow in both drainages. Tables 3.7.3-4 and 3.7.3-5 summarize expected changes in average monthly streamflow at two locations on Devil's Canyon and three locations on Queen Creek. These tables also show the peak instantaneous and 30-day (50 percent exceedance) streamflows for Queen Creek at Magma Avenue and for Devil's Canyon at Mineral Creek. Note that tables 3.7.3-4 and 3.7.3-5 only reflect streamflow losses from mine components common to all action

Table 3.7.3-4. Estimated changes in average monthly streamflow and peak flood flows common to all action alternatives – Devil's Canyon

	DC-8.1C			Mineral Creek Confluence		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	13.73	13.01	−5.3	21.97	21.25	−3.3
February	11.23	10.61	−5.6	17.33	16.71	−3.6
March	6.60	6.25	−5.3	10.38	10.04	−3.4
April	1.64	1.56	−5.1	2.47	2.38	−3.4
May	0.48	0.45	−5.4	0.73	0.71	−3.5
June	0.17	0.17	−5.3	0.27	0.26	−3.4
July	0.53	0.48	−8.2	0.84	0.79	−5.2
August	1.36	1.27	−7.2	2.18	2.09	−4.5
September	1.18	1.09	−7.5	1.98	1.89	−4.5
October	1.04	0.97	−6.5	1.75	1.68	−3.9
November	1.96	1.84	−5.9	3.22	3.11	−3.6
December	5.32	5.04	−5.4	8.48	8.19	−3.4
Average	**3.74**	**3.53**	**−5.6**	**5.92**	**5.71**	**−3.5**
Peak instantaneous streamflow (50% exceedance)	–	–	–	666	657	−1.4
30-day streamflow (50% exceedance)	–	–	–	13.9	13.6	−2.2

Sources: BGC Engineering (2018c); Lehman (2018)

Notes: Numbers have been rounded for presentation.

cfs = cubic feet per second

Table 3.7.3-5. Estimated changes in average monthly streamflow and peak flood flows common to all action alternatives – Queen Creek

	Queen Creek at Magma Avenue			Queen Creek at Boyce Thompson Arboretum			Queen Creek above Whitlow Ranch Dam		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	5.63	4.61	−18.2	6.54	5.66	−13.4	23.90	23.02	−3.7
February	4.75	3.86	−18.6	5.50	4.75	−13.7	21.14	20.39	−3.6
March	2.61	2.12	−18.8	3.07	2.66	−13.5	12.11	11.69	−3.4
April	0.68	0.56	−17.8	0.81	0.71	−12.8	2.83	2.73	−3.7
May	0.20	0.16	−18.4	0.24	0.20	−13.4	0.87	0.84	−3.6
June	0.07	0.06	−18.5	0.08	0.07	−13.3	0.32	0.31	−3.5
July	0.31	0.25	−20.2	0.38	0.32	−14.3	1.50	1.44	−3.6
August	0.74	0.59	−19.6	0.98	0.84	−13.5	3.64	3.51	−3.6
September	0.64	0.51	−19.7	0.81	0.70	−13.6	3.27	3.16	−3.4
October	0.49	0.39	−19.5	0.63	0.54	−13.4	2.60	2.52	−3.2
November	0.83	0.67	−19.4	1.12	0.97	−13.0	5.07	4.93	−3.2
December	2.17	1.76	−18.6	2.68	2.33	−13.2	10.94	10.59	−2.9
Average	**1.58**	**1.28**	**−18.6**	**1.89**	**1.63**	**−13.4**	**7.28**	**7.03**	**−3.5**
Peak instantaneous streamflow (50% exceedance)	356	316	−11.2	–	–	–	–	–	–
30-day streamflow (50% exceedance)	4.4	3.9	−20.4	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Notes: Impacts shown are solely for effects from the subsidence area and West Plant Site. Combined impacts from the tailings storage facilities for Alternatives 2 and 3 (affecting Queen Creek above Whitlow Ranch Dam) and Alternative 4 (affecting Queen Creek at Boyce Thompson Arboretum and Queen Creek above Whitlow Ranch Dam) are detailed later in this section.

Numbers have been rounded for presentation.

cfs = cubic feet per second

alternatives, like the subsidence area and the West Plant Site. Additional losses occur under Alternatives 2, 3, and 4, shown later in this section.

IMPACTS ON SEDIMENT YIELDS AND GEOMORPHOLOGY OF STREAMS

Physical changes to watersheds can affect not just runoff, but also the sediment those flows carry downstream. One of the major functions of a stream is to transport sediment. All of the stream systems immediately downstream of project components are ephemeral in nature and only flow in response to precipitation. Ephemeral channels or washes have a cyclical pattern of infill and erosion. In this pattern, sediment movement usually occurs as pulses associated with flood events that push large amounts of coarse sediment through the system (Levick et al. 2008). The long-term stability of the downstream channel is based on the equilibrium between erosion and deposition of sediment delivered to the system. When that delivery system is disrupted or altered, changes to stream aggradation (the rising of the grade of a streambed) and scour (the erosive removal of sediment from a streambed) can occur until the system reaches equilibrium once again.

The beds of the downstream channels consist mostly of unsorted, unconsolidated sands, gravels, and cobbles. On smaller tributary washes higher in the watershed, particularly around the Near West (Alternatives 2 and 3) and Silver King (Alternative 4) sites, these sediments may be relatively shallow. Farther downstream, in Queen Creek (Alternatives 2, 3, and 4), Donnelly Wash (Alternative 5), or Dripping Spring Wash (Alternative 6), channels are often quite wide and sediments quite deep (Hart 2016).

All of these ephemeral washes are sediment transport–limited systems. This means that there is more sediment in the system than stormwater can transport. This is common in ephemeral streams due to the flashy (i.e., short duration) nature of flows. Flashy flows emanating from large precipitation events pick up sediment in a pulse of water and then deposit it quickly as flows recede.

Stormflows are expected to change both in the amount of flow and the magnitude of peak flows. For Queen Creek, a reduction in storm flow volume of roughly 19 percent is anticipated at Magma Avenue Bridge (all alternatives), dropping to 4 to 9 percent at Whitlow Ranch Dam (varies by alternative). These changes may result in both a reduced sediment supply to Queen Creek from impacted tributaries and less bedload transport in Queen Creek due to reduced tractive forces.

The potential reduction in sediment supply is not considered a significant impact because the system is sediment-transport limited. With respect to reduced sediment transport, such a reduction would be well within the natural variability of the system, as is evident from the historical data. The existing system already experiences significant variability in the potential for sediment transport for individual flood events. For example, the 2-year return period (50 percent annual probability) flood in Queen Creek for existing conditions is 1,280 cubic feet per second (cfs), compared with 15,830 cfs during a 100-year return period (1 percent annual probability) flood. That difference in peak flow is greater than an order of magnitude. Where the creek's banks are composed of alluvium, an expected response to reduced peak flows might be a slight narrowing of the channel width proportional to the magnitude of the predicted flow reduction.

Additionally, these systems do not frequently flow. Therefore, any adjustments to the channel geometry would be very slow to occur and difficult to detect. There are two GDEs present along Queen Creek, between km 17.4 and 15.6, and at Whitlow Ranch Dam.[56] Both of these systems are adapted to heavy sediment loads occurring now in ephemeral systems and their function would not be impacted.

Impacts are slightly greater for Donnelly Wash (Alternative 5), with reduction in storm flow volume of roughly 21 percent at the confluence with the Gila River. Reductions in flows in Dripping Spring Wash

56. Kilometers are referenced here because many of the stream descriptions used by Resolution Copper reference the distance upstream of the confluence, measured in kilometers. For instance, spring "DC-8.4W" is located 8.4 km upstream of the mouth of Devil's Canyon, on the west side of the drainage.

(Alternative 6) are roughly 13 percent at the confluence with the Gila River. These changes may result in both a reduced sediment supply to Donnelly Wash and Dripping Spring Wash from impacted tributaries and less bedload transport due to reduced tractive forces. As with Queen Creek, the potential reduction in sediment supply is not considered a significant impact for a sediment transport–limited system. No GDEs or aquatic habitat have been identified along either Donnelly Wash or Dripping Spring Wash. Tributaries upstream of the main stems of Queen Creek, Donnelly Wash, and Dripping Spring Wash exhibit greater changes; no aquatic habitat or GDEs exist in any of these tributaries.

IMPACTS ON WATER QUALITY FROM SEDIMENT CHANGES

Ground disturbance and removal of vegetation can increase sediment movement into downstream waters and affect water quality and aquatic habitat. Water quality is often characterized by the measurement of the amount of sediment per given amount of water (also known as the sediment concentration). As described in detail in section 3.7.2, during operations, stormwater controls would be in place for all major project components (West Plant Site, East Plant Site, tailings facilities, filter plant and loadout facility) to prevent stormwater that contacts tailings materials or processing areas from being discharged downstream. This prevents stormwater from moving downstream but also prevents any increases in sediment concentration from the disturbed areas. The remaining flows in the undisturbed part of the watershed would continue to move sediment at the concentrations found under normal conditions. The design storm event selected for sizing the stormwater management facilities at the East Plant Site, West Plant Site, and filter plant and loadout facility is the 100-year, 24-hour storm event, which Resolution Copper selected based on recommendations from the ADEQ Arizona Mining Guidance Manual BADCT (Arizona Department of Environmental Quality 2004; Resolution Copper 2016d). Note that tailings storage facilities themselves use much larger events in the design of their embankments, as discussed in section 3.10.1.

After closure and all reclamation has occurred, these stormwater controls would no longer be in place for most project components. Long-term revegetation is expected to be effective, and the reclaimed landforms stable without excessive erosion (see Section 3.3, Soils and Vegetation). Even with successful reclamation and revegetation, these areas would not return to pre-disturbance conditions; however, they would still meet a level of functioning condition as specified by the Forest Service. If desired long-term stability or revegetation conditions are not met, then financial assurance or bonds would not be released, and the Forest Service could maintain stormwater controls until revegetation is successful at stabilizing the disturbed ground surface. The long-term expectation is for most disturbed areas to return to the watershed in a condition without excess erosion or excess delivery of sediment.

Linear features, such as pipeline corridors, roads, and power line corridors, also result in ground disturbance but would not have operational stormwater controls in place to contain all runoff. Instead, stormwater permitting requirements under the AZPDES require that active stormwater controls remain in place until adequate site stabilization has occurred to minimize soil loss. Active stormwater controls typically are temporary measures that are designed and applied in a way specific to each location in order to prevent sediment movement into nearby water courses. Active controls require maintenance and eventually are removed once site stabilization has taken place. Active stormwater controls could include such items as silt fences, straw bales or rolls, dikes, sediment traps, or water bars; stabilization techniques could include such items as reseeding, soil treatment, or hardscaping. Provided adequate stormwater controls and best management practices are used, impacts from linear disturbance are generally minimal, since the amount of disturbance reporting to any one wash is relatively limited.

Stormwater and erosion controls applicable to each alternative are summarized in Newell and Garrett (2018d).

Alternative 2 – Near West Proposed Action

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Changes in runoff from the subsidence area and West Plant Site would reduce average flows in Queen Creek at Whitlow Ranch Dam by about 4 percent; these losses in combination with additional changes caused by the tailings facility for Alternative 2 would reduce average flows by about 7 percent. As well as impacting flows in Queen Creek, Alternative 2 would impact flows in Roblas Canyon, Bear Tank Canyon, and Potts Canyon. Estimated changes in average monthly streamflow for these drainages are presented in table 3.7.3-6. All streamflow in Bear Tank Canyon would either be diverted into Potts Canyon or captured within the tailings storage facility footprint, resulting in a total loss of surficial runoff at the canyon's mouth. Surface runoff diverted into Potts Canyon results in a slight increase in streamflow for this watershed.

Table 3.7.3-6 also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Queen Creek at Whitlow Ranch Dam. In percentages, changes in peak flows are similar to changes in average streamflow, with reductions from 3 to 7 percent.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

Section 404 of the CWA requires issuance of a permit for discharge of dredged or fill material within jurisdictional waters of the U.S. Waters of the U.S. generally consist of aquatic features such as streams/washes and wetlands. The determination of what aquatic features are considered jurisdictional is made by the USACE.

In 2012 and 2015, the USACE issued determinations that no jurisdictional waters exist within substantial portions of the Queen Creek watershed upstream of Whitlow Ranch Dam, which includes the footprint of Alternative 2 (U.S. Army Corps of Engineers 2012a, 2015). Therefore, no jurisdictional waters would be impacted by Alternative 2.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Mapped floodplains for Alternative 2 total 8.5 acres, where the eastern boundary of the West Plant Site overlaps the floodplain of a tributary to Queen Creek. Further information on floodplain acreages, including mapping coverage, is included in Newell and Garrett (2018d).

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d). Wetlands affected include

- xeroriparian vegetation along ephemeral washes (92.5 acres),
- stock tanks (5.1 acres for six separate tanks), and
- wetlands near Benson Spring and in the subsidence area (1 acre).

Alternative 3 – Near West – ultrathickened

Alternatives 2 and 3 have almost identical footprints; therefore, all streamflow impacts are the same as summarized in table 3.7.3-6. Impacts on potentially jurisdictional waters, floodplains, and wetlands would also be identical to Alternative 2.

Alternative 4 – Silver King

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Changes in runoff from the subsidence area and West Plant Site would reduce average flows in Queen Creek at Whitlow Ranch Dam by about

Table 3.7.3-6. Estimated changes in average monthly streamflow and peak flood flows for Queen Creek and northern tributaries – Alternative 2

	Queen Creek above Whitlow Ranch Dam*			Roblas Canyon			Bear Tank Canyon			Potts Canyon		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Increase (%)**
January	23.90	22.29	−6.8	2.91	2.70	−7.1	1.20	0.0	−100	8.19	8.55	+4.5
February	21.14	19.80	−6.3	2.38	2.22	−6.7	0.96	0.0	−100	6.81	7.11	+4.4
March	12.11	11.33	−6.4	1.37	1.27	−7.6	0.54	0.0	−100	3.64	3.80	+4.6
April	2.83	2.64	−6.7	0.32	0.30	−7.9	0.13	0.0	−100	1.01	1.05	+3.9
May	0.87	0.81	−6.4	0.10	0.09	−7.4	0.04	0.0	−100	0.29	0.30	+4.2
June	0.32	0.30	−6.5	0.04	0.03	−7.5	0.01	0.0	−100	0.10	0.11	+4.3
July	1.50	1.39	−7.3	0.19	0.17	−9.5	0.08	0.0	−100	0.45	0.48	+4.7
August	3.64	3.40	−6.7	0.40	0.37	−7.7	0.17	0.0	−100	1.19	1.24	+4.5
September	3.27	3.05	−6.5	0.38	0.35	−8.3	0.15	0.0	−100	1.04	1.09	+4.3
October	2.60	2.43	−6.4	0.29	0.26	−8.5	0.12	0.0	−100	0.78	0.81	+4.4
November	5.07	4.76	−6.2	0.58	0.53	−8.7	0.25	0.0	−100	1.41	1.47	+4.7
December	10.94	10.23	−6.5	1.25	1.14	−8.7	0.52	0.0	−100	3.34	3.48	+4.3
Average	**7.28**	**6.81**	**−6.5**	**0.84**	**0.78**	**−7.5**	**0.35**	**0.0**	**−100**	**2.33**	**2.44**	**+4.4**
Peak instantaneous streamflow (50 % exceedance)	1,280	1,238	−3.3	–	–	–	–	–	–	–	–	–
30-day streamflow (50 % exceedance)	34.8	32.4	−6.9	–	–	–	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Note: Numbers have been rounded for presentation.

* Calculations reflect the combined effects of subsidence, West Plant Site, and Alternative 2 tailings storage facility.

4 percent; these losses, combined with additional changes caused by the tailings facility for Alternative 4, would reduce average flows by about 9 percent. Alternative 4 also impacts flows at Boyce Thompson Arboretum, reducing average flows by about 20 percent. Additional flow losses would also occur under Alternative 4, with the proposed tailings storage facility impacting flows in Happy Canyon, Silver King Wash, and Potts Canyon. Estimated changes in average monthly streamflow are presented in table 3.7.3-7 (Queen Creek) and table 3.7.3-8 (northern tributaries). Whereas the tailings storage facility disturbance footprint within Silver King Wash is 0.21 square mile, portions of the Potts Canyon and Happy Canyon watersheds are diverted into Silver King Wash. As a result, the overall impact on streamflow in this wash is only 0.5 percent on average.

Table 3.7.3-7 also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Queen Creek at Whitlow Ranch Dam. In percentages, changes in peak flows are similar to changes in average streamflow, with reductions from 3 to 7 percent.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

As with Alternatives 2 and 3, the USACE issued determinations that no jurisdictional waters exist within substantial portions of the Queen Creek watershed upstream of Whitlow Ranch Dam, which includes the footprints of these alternatives. Therefore, no jurisdictional waters would be impacted by Alternative 4.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Floodplain impacts for Alternative 4 are identical to those for Alternatives 2 and 3. Further information on floodplain acreages, including mapping coverage, is included in Newell and Garrett (2018d).

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d). Wetlands affected include

- xeroriparian vegetation along ephemeral washes (86.2 acres),
- stock tanks (4.1 acres for five separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Alternative 5 – Peg Leg

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Streamflow at the mouth of Donnelly Wash and a smaller tributary to the immediate north (herein called “unnamed wash”) would be impacted by the Alternative 5 tailings storage facility footprint. Estimated changes in average monthly streamflow are presented in table 3.7.3-9.

Average monthly streamflows for the Gila River are based on USGS gage 09474000, “Gila River at Kelvin, AZ.” Streamflow records for this gage extend as far back as 1911. Monthly values reported in table 3.7.3-9 are averages for the 1981–2016 period. This USGS gage is located approximately 15 miles upstream of the Donnelly Wash confluence.

This table also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Donnelly Wash. Potential changes in streamflow discharge-duration-frequency for the Gila River have not been estimated for two reasons:

Table 3.7.3-7. Estimated changes in average monthly streamflow and peak flood flows for Queen Creek – Alternative 4

	Queen Creek at Boyce Thompson Arboretum			Queen Creek above Whitlow Ranch Dam		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	6.54	5.24	−19.8	23.90	21.66	−9.4
February	5.50	4.40	−20.0	21.14	19.25	−8.9
March	3.07	2.46	−19.9	12.11	11.08	−8.5
April	0.81	0.66	−18.8	2.83	2.57	−9.3
May	0.24	0.19	−19.7	0.87	0.79	−9.1
June	0.08	0.07	−19.6	0.32	0.29	−8.9
July	0.38	0.30	−21.3	1.50	1.36	−9.0
August	0.98	0.77	−20.7	3.64	3.29	−9.6
September	0.81	0.64	−20.4	3.27	2.98	−8.8
October	0.63	0.50	−20.2	2.60	2.38	−8.4
November	1.12	0.89	−20.3	5.07	4.68	−7.9
December	2.68	2.15	−19.7	10.94	10.03	−8.4
Average	**1.89**	**1.51**	**−19.9**	**7.28**	**6.64**	**−8.9**
Peak instantaneous streamflow (50% exceedance)	–	–	–	1,280	1,239	−3.2
30-day streamflow (50% exceedance)	–	–	–	34.8	32.4	−6.9

Sources: BGC Engineering (2018c); Lehman (2018)
Notes: Numbers have been rounded for presentation. Calculations reflect the combined effects of subsidence, West Plant Site, and Alternative 4 tailings storage facility.

Table 3.7.3-8. Estimated changes in average monthly streamflow and peak flood flows for Queen Creek tributaries – Alternative 4

	Silver King Wash			Happy Canyon			Potts Canyon		
Month	Existing (cfs)	Proposed (cfs)	Change (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)
January	3.23	3.23	−0.2	0.99	0.44	−55.3	8.19	6.49	−20.7
February	2.68	2.66	−0.6	0.84	0.38	−54.1	6.81	5.39	−20.7
March	1.48	1.48	−0.3	0.52	0.26	−50.6	3.64	2.88	−20.8
April	0.41	0.41	0.7	0.11	0.05	−58.0	1.01	0.82	−19.4
May	0.12	0.12	0.0	0.03	0.01	−57.1	0.29	0.23	−20.3
June	0.04	0.04	−0.1	0.01	0.01	−53.8	0.10	0.08	−20.4
July	0.19	0.19	−0.8	0.07	0.03	−51.5	0.45	0.36	−21.8
August	0.47	0.47	−1.4	0.18	0.09	−49.9	1.19	0.92	−22.6
September	0.41	0.41	−0.5	0.14	0.07	−51.4	1.04	0.83	−21.0
October	0.31	0.31	−0.9	0.11	0.05	−50.1	0.78	0.61	−21.4
November	0.53	0.53	−1.6	0.23	0.13	−45.1	1.41	1.10	−21.9
December	1.31	1.30	−0.7	0.46	0.23	−49.7	3.34	2.64	−20.8
Average	**0.93**	**0.92**	**−0.5**	**0.31**	**0.15**	**−52.5**	**2.33**	**1.85**	**−20.9**

Source: BGC Engineering (2018c)

Note: Numbers have been rounded for presentation.

Table 3.7.3-9. Estimated changes in average monthly streamflow and peak flood flows for Donnelly Wash, Unnamed Wash, and Gila River – Alternative 5

	Donnelly Wash at Mouth			Unnamed Wash at Mouth			Gila River at Donnelly Wash		
Month	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**	**Existing (cfs)**	**Proposed (cfs)**	**Decrease (%)**
January	13.19	10.23	−22.5	1.18	0.87	−26.1	746	743.2	−0.4
February	9.26	7.14	−22.9	0.82	0.60	−26.7	554	551.3	−0.4
March	5.27	4.09	−22.3	0.55	0.43	−22.0	852	850.3	−0.2
April	1.31	1.03	−21.0	0.13	0.10	−22.5	609	608.4	0.0
May	0.34	0.25	−24.8	0.03	0.02	−26.3	536	536.1	0.0
June	0.14	0.11	−22.7	0.01	0.01	−24.1	636	636.3	0.0
July	0.66	0.55	−15.8	0.05	0.04	−21.9	744	743.9	0.0
August	2.32	1.92	−17.2	0.19	0.14	−22.3	720	719.1	−0.1
September	1.49	1.21	−19.3	0.16	0.13	−18.9	345	344.5	−0.1
October	2.10	1.66	−20.9	0.22	0.18	−20.5	252	251.2	−0.2
November	3.13	2.53	−19.3	0.27	0.21	−23.0	61	60.5	−1.1
December	5.30	4.29	−19.1	0.54	0.43	−19.6	245	243.4	−0.5
Average	**3.69**	**2.90**	**−21.3**	**0.34**	**0.26**	**−23.7**	**526**	**525.0**	**−0.2**
Peak instantaneous streamflow (50 % exceedance)	866	784	−9.5	–	–	–	–	–	–
30-day streamflow (50 % exceedance)	10.9	8.9	−18.4	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Notes: Numbers have been rounded for presentation.

Some uncertainty has been noted for the monthly water balance model as used on Donnelly Wash, due to the difference in watershed characteristics, compared with Pinto Creek, which was used to calibrate the model.

- The upstream Coolidge/San Carlos Reservoir regulates flow, making it difficult to conduct a flood frequency analysis (Lehman 2018); and
- The total drainage area reductions are very small (<0.1 percent) for the Peg Leg alternative.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

Unlike locations within the Queen Creek watershed, the USACE has not made any determination on potentially jurisdictional waters for the Peg Leg location. However, based on discussions between the USACE and the Forest Service, it is believed that washes within the Donnelly Wash watershed would be considered jurisdictional waters of the U.S. and would be subject to permitting under Section 404 of the CWA.

It is estimated that approximately 759,064 linear feet of potentially jurisdictional waters are located within the footprint of the Alternative 5 tailings storage facility, potentially impacting 182.5 acres of waters of the U.S. (WestLand Resources Inc. 2018c). No potentially jurisdictional wetlands were noted within the footprint of Alternative 5 during field surveys. The USACE also considers indirect impacts from the "dewatering" of downgradient reaches through upgradient fills; these have not been estimated. Indirect impacts are generally considered to extend from the point of fill down to the confluence with the next substantial drainage.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Impacts on floodplains for Alternative 5 differ slightly by pipeline route, with impacts of 171 acres for the eastern pipeline corridor and tailings storage facility footprint, and 167 acres for the western pipeline corridor and tailings storage facility footprint. This includes 8.5 acres for the West Plant Site, identical to Alternatives 2, 3, and 4.

Floodplains are associated with Donnelly Wash and an unnamed tributary wash. The eastern pipeline corridor alternative crosses mapped floodplains associated with the Gila River and Walnut Canyon. The western pipeline corridor alternative crosses mapped floodplains associated with the Gila River and Cottonwood Creek.

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d).

Wetland impacts for the eastern pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (200.9 acres),
- the Gila River and Queen Creek crossings,
- stock tanks (8.6 acres for six separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Wetland impacts for the western pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (219.6 acres),
- the Gila River crossing,
- stock tanks (8.8 acres for five separate tanks), and
- a wetland in the subsidence area (0.2 acre).

Table 3.7.3-10. Estimated changes in average monthly streamflow and peak flood flows for Dripping Spring Wash and Gila River – Alternative 6

Month	Dripping Spring Wash at Mouth			Gila River at Dripping Spring Wash Confluence			Gila River at Donnelly Wash Confluence		
	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)	Existing (cfs)	Proposed (cfs)	Decrease (%)
January	43.66	35.06	−12.8	436	427.9	−2.0	746	740.9	−0.7
February	31.65	25.08	−13.5	384	377.5	−1.7	554	549.4	−0.8
March	16.89	13.34	−13.6	701	697.7	−0.5	852	849.3	−0.3
April	4.12	3.27	−13.4	562	561.1	−0.2	809	608.1	−0.1
May	1.11	0.87	−13.9	536	535.8	0.0	536	536.0	0.0
June	0.46	0.36	−13.5	642	642.0	0.0	636	636.3	0.0
July	1.44	1.16	−12.4	687	686.4	0.0	744	743.8	0.0
August	3.84	3.10	−12.5	602	601.3	−0.1	720	719.1	−0.1
September	3.27	2.63	−12.6	288	287.7	−0.2	345	344.4	−0.1
October	4.63	3.87	−10.6	153	152.7	−0.5	252	251.2	−0.2
November	7.92	6.44	−12.1	33	32.0	−4.4	61	60.2	−1.6
December	16.17	12.96	−12.9	179	175.5	−1.8	245	242.5	−0.9
Average	**11.18**	**8.94**	**−12.9**	**435**	**432.5**	**−0.5**	**526**	**524.4**	**−0.3**
Peak instantaneous streamflow (50% exceedance)	1,168	1,114	−4.7	–	–	–	–	–	–
30-day streamflow (50% exceedance)	36.2	32.7	−9.7	–	–	–	–	–	–

Sources: BGC Engineering (2018c); Lehman (2018)

Note: Numbers have been rounded for presentation.

Alternative 6 – Skunk Camp

IMPACTS ON SURFACE RUNOFF AND STREAMFLOW

Streamflow at the mouth of Dripping Spring Wash would be impacted both by the Alternative 6 tailings storage facility footprint and the northern diversion channels, which divert water into the Mineral Creek watershed. Estimated changes in average monthly streamflow are presented in table 3.7.3-10.

Average monthly streamflows for the Gila River are based on USGS gage 09469500, "Gila River below Coolidge Dam, AZ." Streamflow records for this gage extend as far back as 1899. Monthly values reported in table 3.7.3-10 are averages for the 1981–2016 period. This USGS gage is located approximately 20 miles upstream of the Dripping Spring Wash confluence.

Table 3.7.3-10 also shows the peak instantaneous and 30-day (50 percent exceedance) streamflows for Donnelly Wash. As with Alternative 5, potential changes in streamflow discharge-duration-frequency for the Gila River were not estimated.

IMPACTS ON JURISDICTIONAL WATERS OF THE U.S. (RELATED TO CLEAN WATER ACT SECTION 404 PERMIT)

Similar to the Peg Leg location, the USACE has not made any determination on potentially jurisdictional waters for the Skunk Camp location. However, based on discussions between the USACE and the Forest Service, it is believed that washes within the Dripping Spring watershed would be considered jurisdictional waters of the U.S. and would be subject to permitting under Section 404 of the CWA.

It is estimated that approximately 395,215 linear feet of potentially jurisdictional waters are located within the footprint of the Alternative 6 tailings storage facility, potentially impacting 120.0 acres of waters of the U.S. (WestLand Resources Inc. 2018c). No potentially jurisdictional wetlands were noted within the footprint of Alternative 6 during field surveys. The USACE also considers indirect impacts from the "dewatering" of downgradient reaches through upgradient fills; these have not been estimated. Indirect impacts are generally considered to extend from the point of fill down to the confluence with the next substantial drainage.

IMPACTS ON FLOODPLAINS (RELATED TO EXECUTIVE ORDER 11988)

Impacts on floodplains for Alternative 6 total 794 acres. This includes 8.5 acres for the West Plant Site, identical to Alternatives 2, 3, and 4.

Floodplains associated with Dripping Spring Wash and tributaries include Stone Cabin Wash and Skunk Camp Wash. Both pipeline corridor alternatives cross Devil's Canyon and Mineral Creek but do not impact mapped floodplains. The southern pipeline corridor alternative also crosses Queen Creek west of Superior; floodplains have not been mapped in this area but are likely to exist. The northern pipeline corridor alternative crosses Queen Creek east of Superior; floodplains are not mapped but are unlikely to exist in this area based on existing mapped segments.

IMPACTS ON WETLANDS (RELATED TO EXECUTIVE ORDER 11990)

As previously noted, assessing wetlands under Executive Order 11990 is different from assessing jurisdictional waters under a CWA Section 404 permit. For the analysis in this section, the FWS National Wetlands Inventory is used to identify potential wetlands. Details of the wetlands identified from the National Wetlands Inventory are found in Newell and Garrett (2018d).

Wetland impacts for the southern pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (232.9 acres),
- wetlands associated with Queen Creek, Devil's Canyon, and Mineral Creek (28.2 acres),
- stock tanks (11.9 acres for 15 separate tanks), and

- a wetland in the subsidence area (0.2 acre).

Wetland impacts for the northern pipeline corridor alternative include

- xeroriparian vegetation along ephemeral washes (229.6 acres),
- wetlands associated with Mineral Creek (25.4 acres),
- stock tanks (12.7 acres for 17 separate tanks), and
- a wetland in the subsidence area (0.2 acre).

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 surface water quantity. 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. While impacts are foreseen with Pinto Creek, these actions are in an entirely different watershed than could be affected by Resolution Copper Mine–related activities (Pinto Creek ultimately flows to Roosevelt Lake), and there are unlikely to be cumulative effects with the Resolution Copper Project.
- *Ripsey Wash Tailings Project.* Mining company 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. This project is estimated to result in a reduction of recharge to the Gila River of 0.2 percent. This would be cumulative with losses from either Alternative 5 (estimated reduction in flow in the Gila River at Donnelly Wash of 0.2 percent) or Alternative 6 (estimated reduction in flow in the Gila River at Donnelly Wash of 0.3 percent).
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* AK Mineral Mountain, LLC, NL Mineral Mountain, LLC, POG Mineral Mountain, LLC, SMT Mineral Mountain, LLC, and Welch Mineral Mountain, LLC are proposing to build a municipal solid waste landfill on private property surrounded by BLM land (Middle Gila Canyons area). Site access would require crossing BLM land. An unnamed ephemeral wash passing through the landfill site would be impacted by the landfill's construction. No proposed landfill may be located within 0.5 mile of a 100-year floodplain with flows in excess of 25,000 cfs; however, the hydrologic analysis generated a 100-year peak flow on Cottonwood Canyon Wash of less than 3,800 cfs. Cottonwood Canyon is tributary to Queen Creek, but much of the flow is lost to overland flow as it exits the mountains east of the Salt River valley, and there are unlikely to be cumulative effects with Resolution Copper Project–related impacts.
- *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 details are currently available as to potential environmental effects, including to surface waters, resulting from this possible future mining operation. Given the location of this activity, impacts on water could potentially be cumulative with Resolution Copper Project–related impacts on the Gila River for Alternatives 5 and 6.

- *LEN Range Improvements.* This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- *Millsite Range Improvements.* This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon troughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape and are within the same geographic area where some water sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project–related tailings storage facility construction.

Other projects and plans are certain to occur or to be in place during the foreseeable life of the Resolution Copper Mine (50–55 years). These, combined with general population increase and ground-disturbing activities, may cumulatively contribute to future changes to surface water quantity.

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.

This section contains an assessment of the effectiveness of mitigation and monitoring measures found in appendix J that are applicable to surface water quantity.

MITIGATION MEASURES APPLICABLE TO SURFACE WATER QUANTITY

Compensatory mitigation plan (RC-217): One mitigation measure is contained in appendix J that would be applicable to surface water quantity and is contained in full in appendix D. In May 2019, the Forest Service received from Resolution Copper a document titled "Draft Resolution Copper Project, Clean Water Act Section 404, Conceptual Mitigation Plan" (WestLand Resources Inc. 2019). This document outlines the concepts being proposed to the USACE for compensatory mitigation required under Section 404 of the CWA.

The document includes a detailed functional assessment of the types of ephemeral washes and xeroriparian habitat found at the Alternative 6 location, and then identifies six off-site mitigation opportunities to address these losses. No on-site mitigation opportunities were identified.

The six off-site opportunities are as follows:

- *The Gila River Indian Community MAR-5 Recharge Project.* This project involved a 3-year pilot study to discharge water back into the Gila River on the Gila River Indian Community. The pilot project resulted in a five-fold increase in total vegetation volume and a six-fold increase in total herbaceous cover, and at the end of the pilot study the site was populated with desirable riparian species including cattails and willow. Tamarisk density at the site also increased substantially and any ecological lift may be negatively impacted by the presence and density of tamarisk. The project would involve enhancement and continuation of the project.
- *The Lower San Pedro River Wildlife Area In-lieu Fee Project.* In-lieu fee programs allow impacts on surface water features to be mitigated through funds paid to a governmental or non-profit natural resources management entity. The Lower San Pedro River Wildlife Area in-lieu fee project consists of converting over 100 acres of agricultural fields to native pasture grasses to reduce groundwater consumption and help restore base flows and riparian habitat. Additionally, the restoration project will involve substantial exotic species removal and subsequent plantings to establish native woody vegetation within the 2,116-acre site.
- *The Olberg Road Restoration Site Project.* This is a proposed 23-acre restoration site located along the south bank of the Gila River just east of the Olberg Bridge, immediately upstream of the MAR-5 site. Restoration would consist of exotic tree species (principally tamarisk) removal and control, combined with native plant species reseeding.
- *The Queen Creek Project.* This project consists of actions to improve the ecological condition of a stretch of Queen Creek near Superior, Arizona, including the removal of tamarisk to allow riparian vegetation to return to its historic composition and structure and promote more natural stream functions. Additionally, a conservation easement would be established, covering approximately 150 acres along 1.8 miles of Queen Creek to restrict future development of the site and provide protected riparian and wildlife habitat.
- *The Arlington Wildlife Area In-lieu Fee Project.* This is a 1,500-acre wetland and riparian habitat restoration project along the west bank of the Gila River in Maricopa County, southwest of the Phoenix metropolitan area.
- *The Lower San Pedro River BHP Parcel Preservation Project.* This would involve the preservation through a conservation easement (or similar instrument) of land parcels currently owned and managed by BHP that encompass the San Pedro River riparian corridor and adjacent bosque habitat along an approximately 5-mile stretch of the San Pedro River east of San Manuel, Arizona.

MITIGATION EFFECTIVENESS AND IMPACTS

Effectiveness of Mitigation

The exact type and amount of mitigation is not yet quantified, but all of the conceptual mitigations would be effective at enhancing, increasing, or improving the overall riparian habitat within the state of Arizona. How pertinent these improvements would be to the impacts from the Resolution Copper Project is primarily a reflection of their location.

The Queen Creek Project is on the same stream that would be impacted by reduced surface flows, as well as groundwater drawdown. Mitigation at this location would represent a direct offset of any lost riparian function.

The MAR-5 and Olberg Road projects are both on the Gila River, but no loss in riparian function is anticipated on the Gila River, as the reductions in average flow are relatively small (0.3 to 0.5 percent). In addition, the Gila River flow is largely diverted upstream of Florence and any impacts would be unlikely to be noticed on the Gila River Indian Community at the locations of these mitigation projects. These projects would not reflect a direct offset of impacts but would still reflect a replacement of riparian function on the same stream system.

The two Lower San Pedro projects and the Arlington Wildlife Area project both would help replace riparian function, but in different watersheds. Conceptually, the Lower San Pedro projects are upstream of any impacts that would be seen on the Gila River and potentially could be considered direct offsets, although there is a substantial distance between these locations and the Gila River. The Arlington Wildlife Area project is on the Gila River but far downstream and removed from the potential impacts. These projects most likely would not reflect a direct offset of impacts but would still reflect a replacement of riparian function in the greater Gila River watershed.

Impacts from Mitigation Actions

The exact type and amount of improvement is not yet quantified, nor are any additional ground disturbance or physical effects that would result from these actions.

UNAVOIDABLE ADVERSE IMPACTS

The primary impact described in the analysis (in this section, as well as section 3.7.1) is the loss of surface water flow to riparian areas (including xeroriparian vegetation along ephemeral washes) and loss of surface flow to any GDEs that are associated with these drainages. With the possible exception of the Queen Creek project, the conceptual mitigation proposed under the CWA would not be effective at avoiding, minimizing, rectifying, or reducing these impacts. Rather, the proposed conceptual mitigation would be mostly effective at offsetting impacts caused by reduced surface water flows by replacing riparian function far upstream or downstream of project impacts.

As the subsidence area is unavoidable, the loss of runoff to the watershed due to the subsidence area is also unavoidable, as are any effects on GDEs from reduced annual flows. The loss of water to the watershed due to the tailings facility (during operations, prior to successful reclamation) is unavoidable as well, due to water management and water quality requirements. Direct impacts on wetlands, stock tanks, and ephemeral drainages from surface disturbance are also unavoidable.

Other Required Disclosures

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Desert washes, stock tanks, and wetland areas in the footprint of the subsidence area and tailings storage facility would be permanently impacted. In the short term, over the operational life of the mine, precipitation would be lost to the watershed. In the long term, most precipitation falling at the tailings facility would return to the watershed after closure and successful reclamation. There would be a permanent reduction in the quantity of surface water entering drainages as a result of capture of runoff by the subsidence area.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

With respect to surface water flows from the project area, all action alternatives would result in both irreversible and irretrievable commitment of surface water resources. Irreversible commitment of surface water flows would result from the permanent reduction in stormwater flows into downstream drainages from the subsidence area. Changes to wetlands, stock tanks, and ephemeral drainages caused by surface disturbance would also be irreversible. Irretrievable commitment of surface water resources would be associated with additional

Overview

Many species—including birds, amphibians, fish, and mammals—rely in some way on the habitat that could be impacted by the proposed action or alternatives. This habitat is important for forage, mating, protective cover, nesting and denning, and travel. Some species in the area have special protection, such as under the Endangered Species Act or the Migratory Bird Treaty Act, and other species have been given special status by the Forest Service. Wildlife impacts can occur not just from habitat loss and fragmentation, but also from artificial lighting, noise, vibration, traffic, loss of water sources, or changes in air or water quality or quantity.

temporary diversion, storage, and use of stormwater during active mining, but that would be restored to the watershed after closure and reclamation.

3.8 Wildlife and Special Status Wildlife Species

3.8.1 Introduction

This section documents and analyzes the occurrence and distribution of wildlife species within the analysis area, including wildlife movement corridors, general wildlife, and special status wildlife species. Special status wildlife species are those listed under the ESA, and Tonto National Forest Sensitive species, as well as BLM Sensitive species, migratory birds, other species that are afforded protection within the analysis area, and species that AGFD focuses on for conservation efforts. A description of vegetation communities that serve as habitat are included in Section 3.3, Soils and Vegetation.

This section includes descriptions of the affected environment, including the occurrence and distribution of general wildlife and game species, descriptions of special habitat areas (such as important bird areas, caves, and springs), wildlife connectivity across the larger landscape, special status wildlife species, and management indicator species (which are a specific Forest Service concern). Impacts analyzed include general impacts on wildlife occurring from construction, operation, and reclamation and closure, additional impacts that are specific to wildlife groups (mammals, birds, reptiles, amphibians, and invertebrates), and impacts on special status wildlife species. Some aspects of the analysis are briefly summarized in this section. Additional details not included are captured in the project record (Newell 2018j).

3.8.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.8.2.1 Analysis Area

The analysis area covers the project footprint plus a 1-mile buffer, as well as areas along Queen Creek and Devil's Canyon where groundwater drawdown or reductions in surface water could change habitat (figure 3.8.2-1). Much of the impact on species and habitat is caused by direct disturbance of the land and vegetation. The 1-mile buffer and areas of Queen Creek and Devil's Canyon was determined by using the areas where the noise analyses, water analyses (i.e., groundwater and surface water quantity/quality analyses), fugitive dust distance affecting air quality, and noxious weed introduction and spread (Foxcroft et al. 2007) indicate the potential for impacts.

According to the air quality analysis, ambient air quality standards would be achieved at the project footprint boundaries; therefore, any potential air quality impacts are encompassed within the 1-mile buffer. The noise modeling shows that for all action alternatives, noise levels at 1 mile would be at or below the level of normal human conversation; as such, the 1-mile buffer is sufficient to address potential impacts from noise-producing activities. We also expect light associated with project

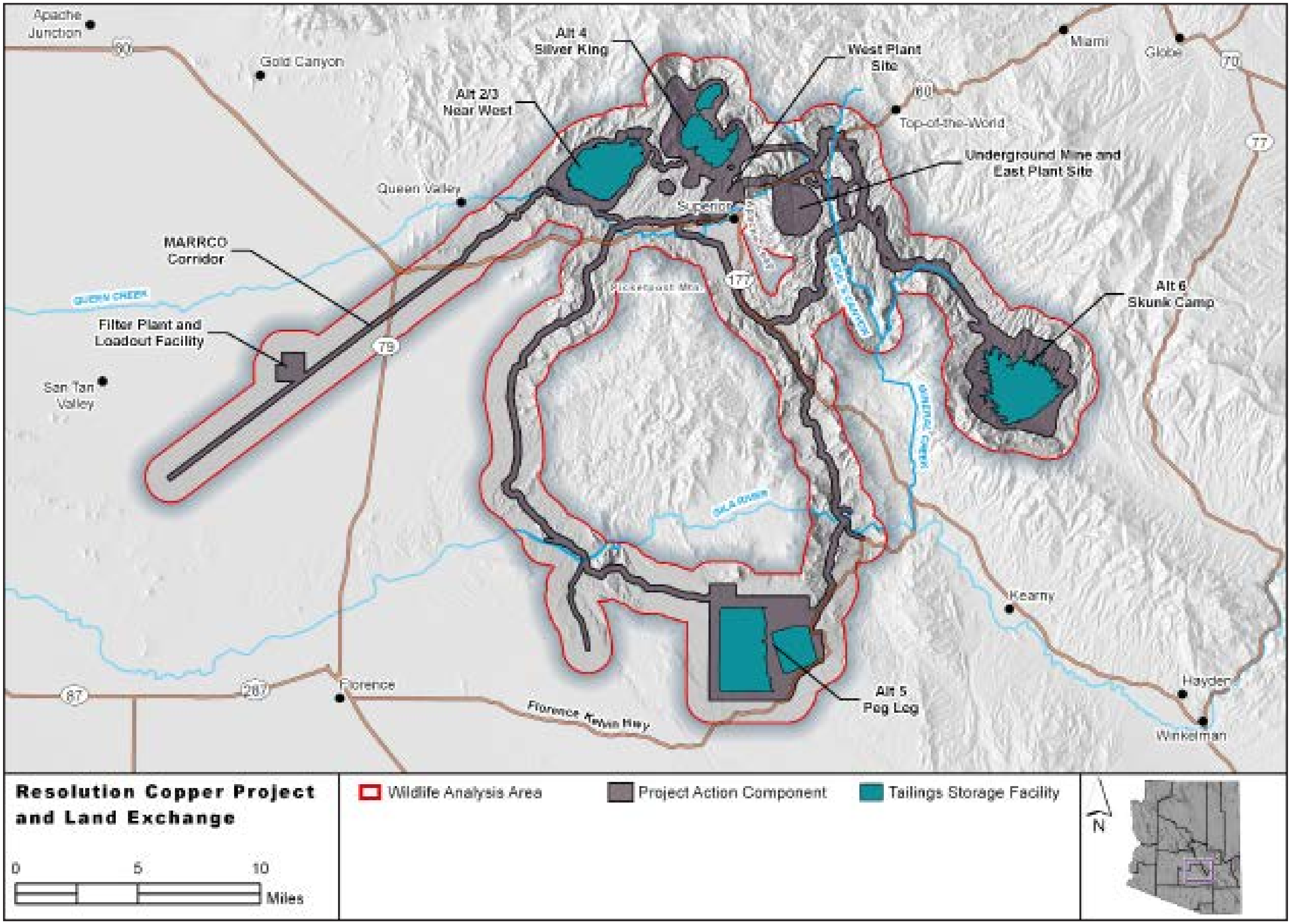


Figure 3.8.2-1. Wildlife analysis area

construction and facilities to increase night-sky brightness from 1 to 9 percent (Dark Sky Partners LLC 2018). Light impacts would occur across the landscape but available research suggests any substantial impacts would occur within the 1-mile buffer (Newell 2018j). Species' movement corridors include areas outside the 1-mile buffer; we address potential impacts on those corridors at a landscape level.

AGFD is a cooperating agency and made species records and other information available to the Forest Service for use in the analysis. AGFD searched for records within the project footprint plus a 5-mile buffer; this information was used to determine the likelihood of occurrence of each species. This search area is greater than the analysis area and thus errs on the side of including more species records rather than less. Although the analysis area is a 1-mile buffer, data provided by the AGFD was within a 5-mile buffer and could not be clipped to the 1-mile buffer. This larger 5-mile buffer is clearly noted when it has been used.

The temporal parameters for this analysis involved the time frames for (1) construction: mine years 1 through 9, (2) operation: mine years 6 through 46, and (3) post-closure/reclamation: mine years 46 through 51 to 56, plus any additional years that are identified in other resource analysis (e.g., the groundwater analysis used to inform this section predicts out to 200 years). Construction activities would overlap operations activities for approximately 6 years.

3.8.2.2 Analysis Methodology

The goal of this analysis is to identify the potential impacts on wildlife and special status wildlife species and their habitats, from all activities associated with each project alternative. Several elements constitute the core of this analysis: (1) the factors for analysis identified during the NEPA scoping process, (2) survey and records data provided as part of this project, and (3) a scientific examination using current literature on species and how environmental changes (human or natural) affect species and their habitat.

Additional information and details, including analysis methods, species accounts, occurrence records, etc., on wildlife resources discussed in this section can be found in the background documentation (see appendix A in Newell (2018j)). The uncertainties and unknown information, as well as assumptions, of this analysis include (1) limitations in the use of GIS data (e.g., mapping data may have inaccuracies and calculations could be an over- or underestimation); (2) lack of current scientific data on how certain environmental changes affect species; and (3) reliance on other resource analyses also furthers the assumptions, uncertainties, and unknown information stated in those sections into this analysis.

3.8.3 Affected Environment

3.8.3.1 Relevant Laws, Regulations, Policies, and Plans

The primary Federal, State, and local policies, regulations, and guidelines used to analyze potential impacts on wildlife in the project analysis area are shown in the accompanying text box and further detailed in Newell (2018j).

3.8.3.2 Existing Conditions and Ongoing Trends

General Wildlife

A wide variety of general wildlife and associated habitats is found in or within 5 miles of the analysis area of all action alternatives. Section 3.3, Soils and Vegetation, describes the associated habitats. Many of the non-game wildlife species are considered by AGFD to be Species of Greatest Conservation Need (SGCN).[57] These species mostly overlap species with Federal special status (ESA, Tonto National Forest, or BLM) and are included under the "Special Status Wildlife Species" section. Several SGCN species that do not otherwise overlap Federal special status wildlife species are also included in the "Special Status Wildlife Species" section. We used biological surveys, as well as observations pulled from the AGFD's Heritage Data Management System data, to determine which SGCN species have occurrence records within 5 miles of the action alternatives. We then evaluated SGCN for their likelihood of occurrence in Alternatives 2 and 3 (39 known to occur, 9 possible to occur); Alternative 4 (13 known to occur, 29 possible to occur); Alternative 5 (20 known to occur, 31 possible to occur); and Alternative 6 (19 known to occur, 30 possible to occur).

Laws, Regulations, Policies, and Guidelines Used in the Wildlife Effects Analysis

- Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)
- Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703–711)
- National Forest Management Act implementing regulations (36 CFR 219.19(a)(1))
- Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. 668–668c)
- Bureau of Land Management – Phoenix Resource Management Plan, Las Cienegas National Conservation Area Resource Management Plan, and San Pedro Riparian National Conservation Area Resource Management Plan
- Arizona Game and Fish Department determinations of Species of Greatest Conservation Need (SGCN) occurring within the wildlife analysis area

Game Species

A wide variety of Species of Economic and Recreational Importance (SERI), game species, and associated habitat occur within 5 miles of the action alternatives and are primarily addressed in the "Recreation" and "Socioeconomics" resource sections of this chapter. Section 3.3, Soils and Vegetation, shows the associated habitats. The footprint of the analysis area is located within AGFD's Game Management Unit (GMU) 24A and 24B, where nine game species are present. Those species

57. Species of Greatest Conservation Need is a designation used by AGFD, as a means to focus planning and conservation efforts, particularly in the State Wildlife Action Plan.

include Gambel's quail (*Callipepla gambelii*), javelina (*Pecari tajacu*), cottontail (*Sylvilagus* spp.), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), mountain lion (*Puma concolor*), bighorn sheep (*Ovis canadensis*), and tree squirrel (*Sciurus* spp.). Elk (*Cervus canadensis*) is also present in GMU 24A, but not in the portion of the GMU near or within the analysis area. Additionally, there are 10 SERI species with predicted occurrences within 5 miles of the project footprint. These species include mule deer, white-tailed deer, javelina, elk, black bear, mountain lion, Gambel's quail, mourning dove (*Zenaida macroura*), white-winged dove (*Zenaida asiatica*), and band-tailed pigeon (*Patagioenas fasciata*).

Special Habitat Areas

Special habitat areas include wildlife waters; Important Bird Areas; caves, mines, and karst features; and springs (figure 3.8.3-1). More information on caves/mines/karst features and springs is available in the "Geology, Minerals, and Subsidence" and "Groundwater Quantity and Groundwater-Dependent Ecosystems" sections of this chapter, respectively, and the habitats are described by biotic community in the "Soils and Vegetation" section. The Boyce Thompson Arboretum/Arnett-Queen Creeks Important Bird Area is located within 5 miles of the action alternatives but is only within the footprint of pipeline corridor options associated with Alternative 5 (see figure 3.8.3-1).

There are 15 wildlife waters (waters built or improved specifically for wildlife such as stock tanks and wildlife guzzlers) within 5 miles of the project footprint. Of these 15 wildlife waters, three would be within the project footprint. These wildlife waters include the Benson Spring, which would be within the footprint of the tailings facility for Alternatives 2 and 3; Silver King, which would be within the tailings facility area for Alternative 4; and Mineral Mountain, which would be within the west pipeline option for Alternative 5. Additionally, the Florence #1 wildlife water is about 50 feet south of the footprint for the south pipeline option of Alternative 6.

Caves, abandoned mines, and karst features in the analysis area may provide suitable roosting habitat for bat species. There are four caves, two mines, and four karst features within 5 miles of the project footprint. Only one of these, the Bomboy Mine, is within the project footprint. It is located within the footprint of the proposed tailings facility for Alternatives 2 and 3 (see figure 3.8.3-1). All of the remaining features are within 5 miles of all action alternatives and include the Umbrella Cave and the Superior High School Cave. Some of these features have been closed and bat gates have been installed to allow bat use of the features.

There are 338 springs mapped within 5 miles of the project footprint (see figure 3.8.3-1). This includes 24 springs and several stream segments that are considered to be groundwater dependent with the potential to be impacted by the project (see table 3.7.1-2); the specific list of groundwater-dependent ecosystems, including springs, perennial waters, and riparian areas that are believed to have a connection to regional aquifers and could potentially be impacted by the action alternatives, is the focus of the "Groundwater Quantity and Groundwater-Dependent Ecosystems" section of this chapter. Unlike the subset of springs analyzed in the "Groundwater Quantity and Groundwater-Dependent Ecosystems" section, the vast majority of springs shown in figure 3.8.3-1 were identified from available databases or literature sources and may or may not be physically present on the landscape, or they represent local seeps or springs without persistent water or a connection to regional aquifers. The wider springs inventory is included in this section because these water sources are still important to wildlife; however, many of these springs would not be impacted by project activities unless directly within the project footprint.

Wildlife Connectivity

Through resource management planning in recent years, agencies, organizations, stakeholders, academia, private citizens, and non-profit organizations all aided in identifying the important wildlife movement corridors throughout the state. During the development of the 2006 "Arizona's Wildlife Linkages Assessment" (Arizona Wildlife Linkages Workgroup 2006) and the 2013 "Pinal County Wildlife Connectivity Assessment: Report on Stakeholder Input" (Arizona Game and Fish

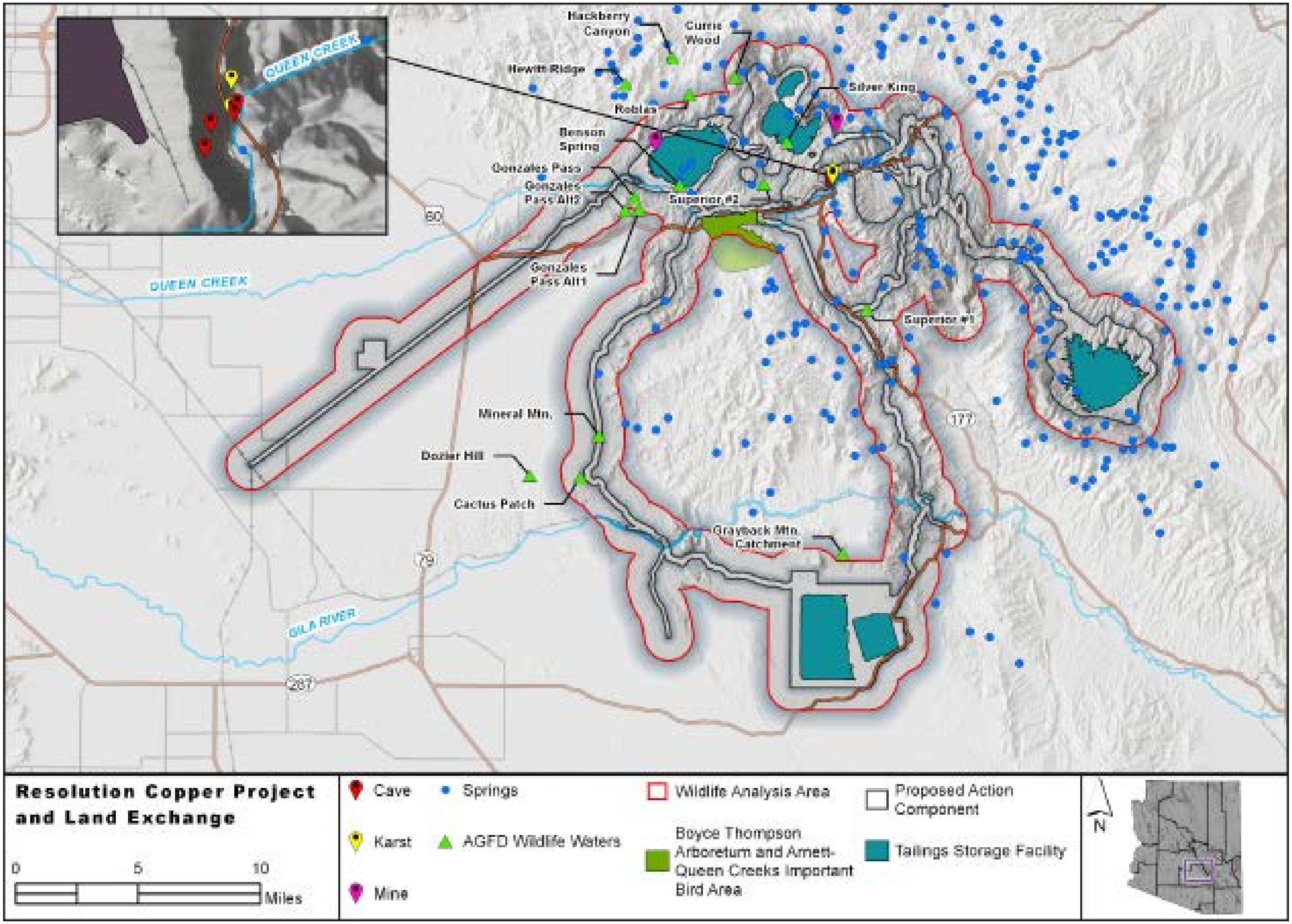


Figure 3.8.3-1. Special habitat areas, caves, mines, springs, and karst features

Department 2013), stakeholders identified numerous wildlife movement corridors, as well as natural topographic features such as canyons and washes that are used as animal movement corridors, as important to the conservation of species and their populations. Other researchers further analyzed and modeled some of these animal movement corridors to refine the best biological corridors (Beier et al. 2007). Additionally, habitat block areas were identified statewide as areas important for wildlife movement and landscape-scale connectivity. Category 1 blocks are the most intact and have no measurable human modification; Category 2 blocks are intact but may have some feature running through (Perkl 2013). Figure 3.8.3-2 depicts details of wildlife movement corridors within the vicinity of the analysis area and their geographical placement in the surrounding region. Figure 3.8.3-3 depicts landscape integrity in the vicinity of the analysis area. Additional detail can be found in the background documentation (see the “Wildlife Connectivity” section in Newell (2018j)).

Special Status Wildlife Species

For each action alternative, Federal and State special status wildlife species lists were analyzed, including the following:

- Federal
    - Endangered Species Act wildlife species listed in Pinal and Gila Counties
    - Migratory Bird Treaty Act (MBTA) species
    - Bald and Golden Eagle Protection Act (BGEPA) species
    - Tonto National Forest
        - Sensitive species
        - Migratory Bird Species of Concern
        - Management indicator species (MIS)
    - Bureau of Land Management
        - Sensitive species for the Tucson Field Office
- State
    - Arizona Game and Fish Department
        - Species of Greatest Conservation Need, if they had other status listings; two SGCN-only species were addressed at the request of the cooperating agency.

Additional detail regarding which species are known to occur or may possibly occur in the analysis area can be found in the background documentation (see table 3 in Newell (2018j)).

Management Indicator Species

The Forest Service is required to maintain viable populations of native and desired non-native species by evaluating a project’s effects on selected MIS as set forth in the National Forest Management Act. Management indicator species are defined as follows: “Plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent” (FSM 2620.5) (U.S. Forest Service 1991).

In order to meet the National Forest Management Act requirement to maintain viable populations of native and desired non-native species, MIS were selected based on a variety of criteria. In general, MIS were selected to serve as barometers of management effects on other species with similar habitat requirements. The Tonto National Forest has 30 MIS, which consist mostly of birds, to represent 30 habitat features (see table 4 in Newell (2018j)). Section 3.8.4 represents an analysis of current habitat and population trends of each MIS population within the Tonto National Forest, conducted as an interpretation of changes in populations and habitat trends since implementation of the 1985 forest plan for potential effects on MIS resulting from implementation of Tonto National Forest–approved projects. A forest-wide assessment titled

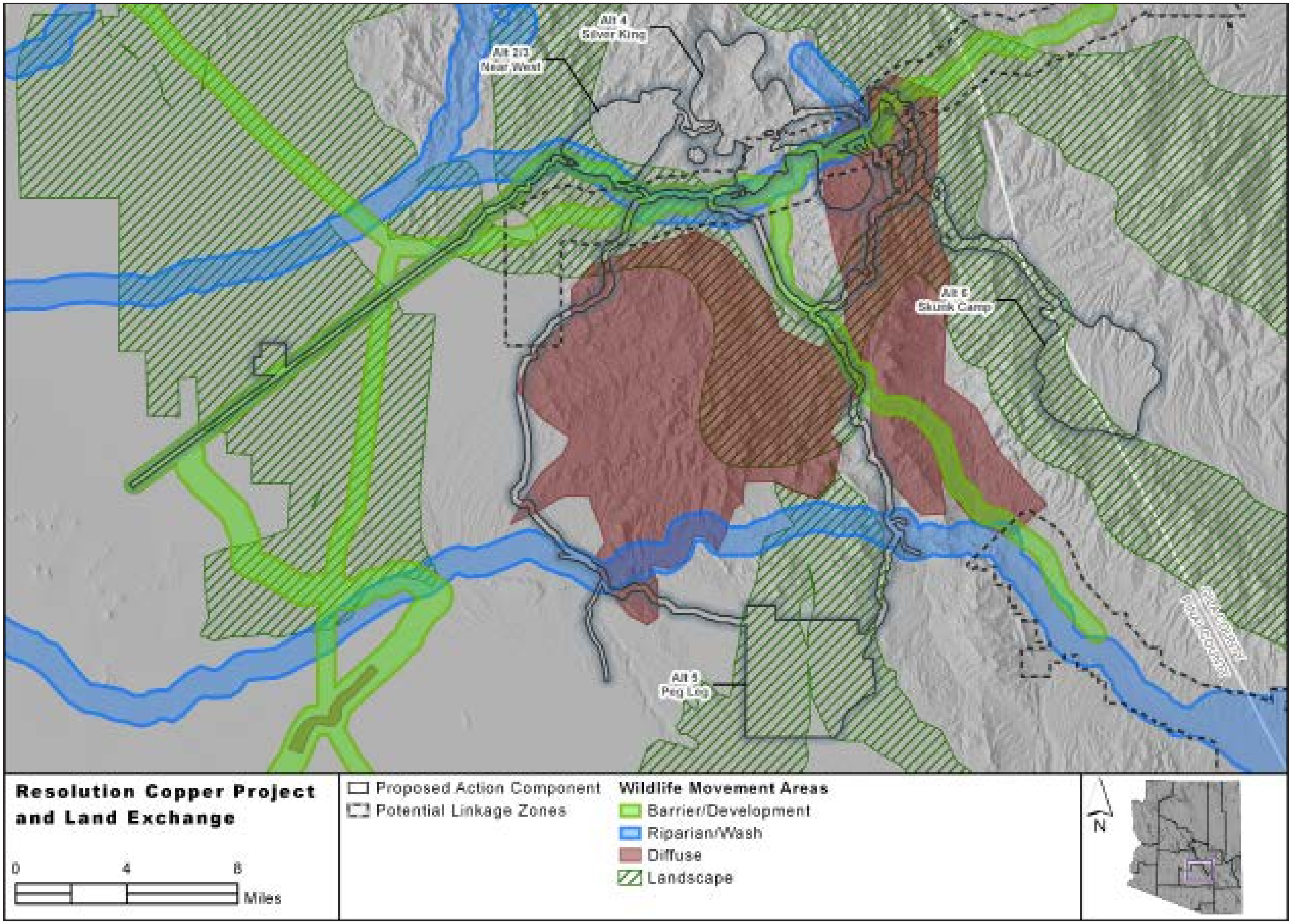


Figure 3.8.3-2. Wildlife movement areas

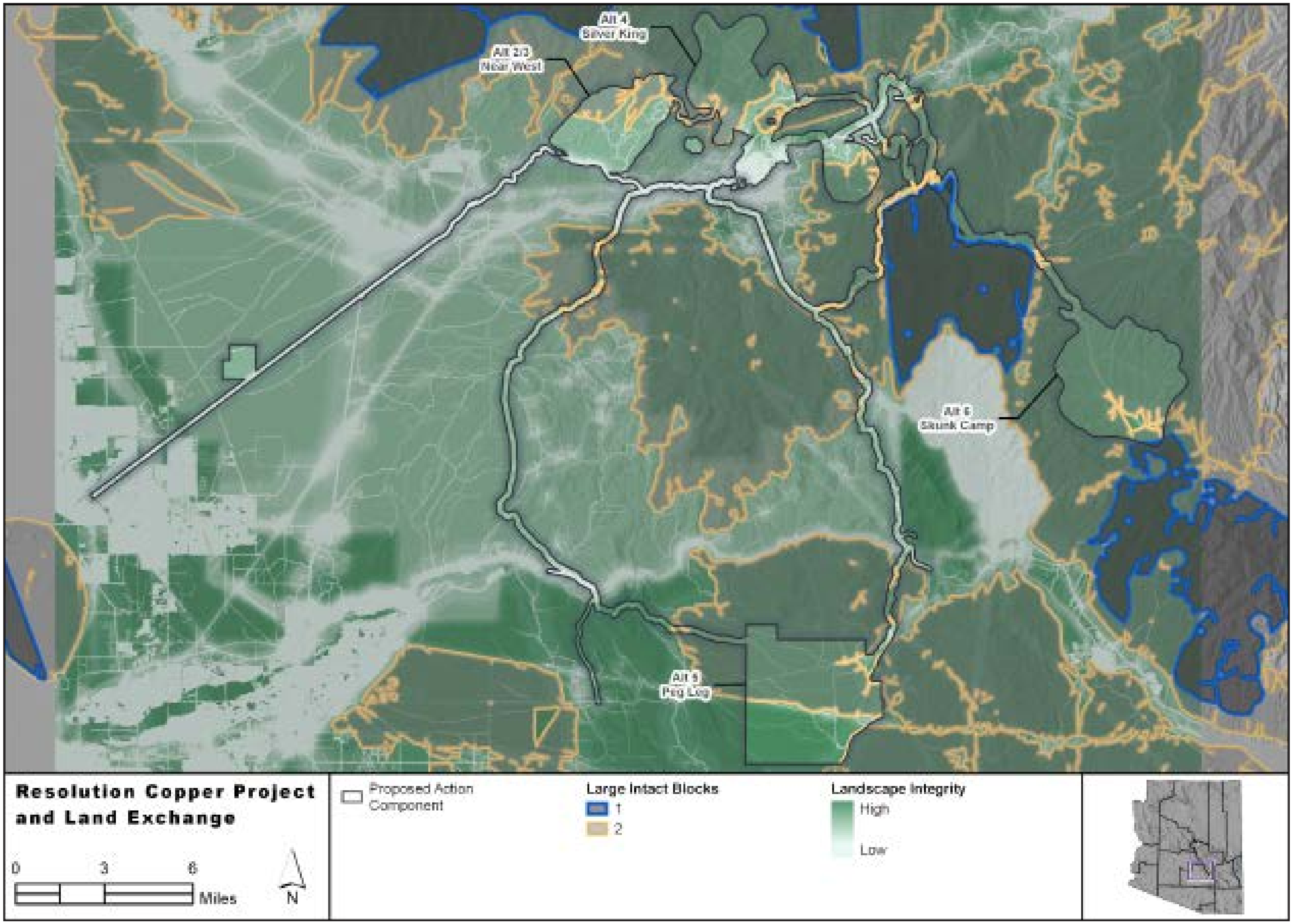


Figure 3.8.3-3. Landscape integrity

"Tonto National Forest Management Indicator Species Status Report" (Klein et al. 2005) summarizes current knowledge of population and habitat trends for MIS on the Tonto National Forest.

Habitats for a number of the Tonto National Forest MIS occur in the project area. As most MIS are not rare species, it is assumed that some individuals of each MIS associated with the habitat types in the project area are also present. Additionally, we expect that individuals of MIS associated with habitat not present within the project area have the potential to occur.

Additional detail regarding which MIS species are associated with each vegetation type or series, species trends, total acres on Tonto National Forest, and acres within the analysis area can be found in the background documentation (see table 4 in Newell (2018j)).

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

3.8.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, the proposed project would not be constructed and potential impacts on wildlife resources (species and habitat) would not occur. Impacts on wildlife resources from existing disturbances (e.g., recreation, livestock grazing, mining and development, wildfires) would continue.

3.8.4.2 Impacts Common to All Action Alternatives

Effects of the Land Exchange

The selected 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 National Forest System surface resources; this includes effects on the wildlife resources that may occur on the Oak Flat Federal Parcel. 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 or manage them to achieve desired conditions.

The offered lands would come under Federal jurisdiction. Specific management of the wildlife resources of those parcels would be determined by the agencies to meet desired conditions or support appropriate land uses. In general, these parcels contain a variety of ecosystems similar to those that support wildlife species in the analysis area, including riparian, xeroriparian, semi-desert grassland, and desert ecosystems, that would come under Federal jurisdiction.

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). Of all resources, wildlife have the greatest number of standards and guidelines identified in the forest plan for consideration (37). None of these standards and guidelines were found to require amendment to the proposed project, either on 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 wildlife. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

In the GPO, Resolution Copper has committed to a variety of measures to reduce potential impacts on wildlife, including those outlined in Section 4.7, "Wildlife," and Appendix X, "Wildlife Management Plan," of the GPO (Resolution Copper 2016c).

- Electric power transmission and distribution line towers (power poles) that serve the Resolution Copper Project facilities will be designed and constructed to avoid raptor electrocutions.
- Some additional non-lethal harassment and scare devices to deter and disperse wildlife from the PAG tailings, non-contact and contact stormwater catchment basins, and process water ponds may also be considered and could include the following:
    - Plastic ball covers, vehicle lights and horns, motion-sensor lights, flags, perch deterrents, shell crackers, bird bangers, screamers, distress cries/electronic noise systems, bird scare balloons, propane cannons, and mylar scare tape.
    - A bird hazing protocol would be developed for Resolution Copper employees and would include a combination of harassment techniques. Additional hazing techniques may be adjusted or added as necessary based on field observations and ongoing research efforts. The protocol would include an inspection schedule, acceptable harassment techniques, a field log procedure, and incident reporting procedures. Resolution Copper staff responsible for implementing the bird hazing program would be trained on the protocol prior to its initiation.
- Vegetation growth within the contact and non-contact stormwater catchment basins and process water ponds would be monitored and periodically removed as often as necessary to further discourage the presence of wading birds.

Other applicant-committed environmental protection measures by Resolution Copper to reduce impacts on wildlife include measures adapted from previous investigations on the Tonto National Forest:

- Conducting pre-construction surveys for Sonoran desert tortoise (*Gopherus morafkai*) and Gila monster (*Heloderma suspectum*) before surface ground-disturbing activities start. A biological monitor would monitor for Sonoran desert tortoise and Gila monster during construction activities. The monitor would flag Sonoran desert tortoise and Gila monster shelter sites/burrows. These flagged areas would be inspected, and any Gila monsters and tortoises discovered would be relocated outside of project activity areas;
- Informing project crews of the potential to encounter Sonoran desert tortoise and Gila monster within the surface project area. Work crews would be instructed to check below equipment prior to moving, and to cover and/or backfill holes that could potentially entrap these species. If these species are observed, work crews would stop work until the biological monitor has relocated these species out of harm's way; and
- Establishing tortoise crossings for concentrate and tailings pipeline corridors in areas containing habitat.

General Construction Impacts

Potential construction-related impacts from all action alternatives common to all wildlife groups, including special status wildlife species, would involve the loss, degradation, and/or fragmentation of breeding, rearing, foraging, and dispersal habitats; collisions with and crushing by construction vehicles; loss of burrowing animals in burrows in areas where grading would occur; increased invasive and noxious weed establishment and spread; increased edges of vegetation blocks; and impacts from increased noise/vibration levels. Proposed construction activities would include the loss, degradation, and fragmentation of habitat for wildlife and special status wildlife species during ground-clearing activities. Ground-clearing activities include construction of access roads, pipeline corridors, tailings facilities, and other project facilities. Construction activities would also affect adjacent habitats and connectivity between habitats as project features would create barriers to wildlife movement and dispersal.

Ground disturbance associated with construction activities may increase the potential for the introduction and colonization of disturbed areas by noxious and invasive plant species. This may lead to changes in vegetation communities and thus habitat for wildlife, including a possible shift over time to more wildfire-adapted non-native vegetation. These potential changes would impact species as habitat is modified and degraded and could decrease suitability of areas to support breeding, rearing, foraging, and dispersal of wildlife and special status wildlife species.

Temporary impacts associated with the presence of workers and equipment may cause species to avoid using work areas or adjacent habitats during construction activities. Some construction activities would overlap operations for approximately 6 years, during which noise- and vibration-producing activities would be ongoing. Potential impacts related to noise and vibration would be temporary and would diminish with the completion of construction activities.

Noise and vibration associated with construction activities may temporarily change habitat use patterns for some species. Many wildlife species rely on meaningful sounds for communication, navigation, finding food, and to avoid danger (Federal Highway Administration 2004). Some individuals would likely move away from the source(s) of the noise/vibration to adjacent or nearby habitats, which may alter or affect competition for resources within these areas. Noise/vibration and other disturbances may also lead to increased stress on individuals, impacting their overall fitness due to increased metabolic expenditures.

Additional noise and vibration impacts may include decreased immune response, hearing damage, diminished intraspecific communication, increased predation risk, and reduced reproductive success (NoiseQuest 2011; Pater et al. 2009; Sadlowski 2011). These effects would be temporary and of short duration and would diminish with the completion of construction activities. Some species could see impacts on local populations in the action area, but no regional population level impacts are likely.

The proposed project would increase the amount of edge habitat along areas to be disturbed, especially along linear features such as pipeline corridors, electrical distribution lines, and access roads. Effects from increased amounts of edge would include decreased habitat block size. Decreased habitat block size may negatively impact those species that require large blocks of contiguous habitat and benefit other species that use edge habitats or have more general habitat requirements. In areas where there is higher vegetation density, the potential impacts from habitat fragmentation and edge effects would be greatest.

Artificial lighting associated with the construction phase of the proposed project is less defined but is assumed to be less intense that associated with the operations phase, and to vary in location and intensity through the 1- to 9-year time period. Specific impacts would be similar to those describe in the "General Operations Impacts" section; impacts on species groups are discussed in subsequent sections.

General Operations Impacts

Potential impacts on wildlife and special status wildlife species during the operations phase of all action alternatives would be associated with subsidence; potential reduction in surface water flows and groundwater availability to support riparian habitats; habitat changes from ongoing noxious and invasive weed establishment and spread; and the ongoing presence of workers and equipment.

During the operations phase of the proposed mine, there would be impacts on wildlife and special status wildlife species from subsidence. Subsidence of the ground surface is anticipated to occur at approximately 6 years after initiation of mining activities and is anticipated to continue until 41 years after initiation of mining activities (see Section 3.2, Geology, Minerals, and Subsidence).

Within the cave limit, the development of a subsidence area would change the slope, aspect, surface water flow direction and rate; surface elevation; and would impact habitat on approximately 1,329 acres. This could lead to mortality of wildlife species individuals within the subsidence area during caving/fracture events. Within the fracture limit (1,579 acres) the potential impacts would be similar to the cave limit; however, the intensity would be decreased as this area would have reduced surface impacts. The continuous subsidence limit (1,687 acres) would have limited potential for localized impacts on vegetation communities as it would have minimal surface impacts. The entire subsidence area would be fenced for public safety and would remove the subsidence area as habitat for some wildlife and special status wildlife species. Smaller species and avian species would be able to use the subsidence area as habitat.

Potential water usage associated with operation of all action alternatives would reduce water in the regional aquifer and may reduce surface water and groundwater levels downstream of the mine in Devil's Canyon and Queen Creek. Surface water amounts would be reduced, and timing/ persistence of surface water would decrease. These potential decreases in groundwater and surface water would occur over a long period of time but could cause changes in riparian vegetation extent or health, and the potential reduction in stream flow could impact species that use these riparian areas during portions of their life cycle. Potential impacts may reduce or remove available habitat for wildlife and special status wildlife species and impact individuals in localized areas along Devil's Canyon and Queen Creek, or around springs. These impacts are not anticipated to affect flow regimes or riparian habitat along the Gila River (see section 3.7.1 for a more detailed discussion of impacts on groundwater-dependent ecosystems and riparian areas).

We do not anticipate any impacts on wildlife or special status wildlife species from water quality impacts at any of the tailings locations during operations, as any stormwater that comes in contact with the tailings piles would be contained in the tailings facilities or in seepage ponds downstream. It is possible that avian species could use the seepage ponds. We expect concentrations of some constituents in the seepage ponds to be above chronic exposure limits and some acute exposure limits from some constituents under all action alternatives (cadmium, copper, nickel, selenium, zinc, and silver). This could lead to short- and long-term impacts on some avian species if they are exposed to water from the seepage ponds; the potential to impact these species would be greatest if they were exposed over an extended period of time. See the "Screening of Geochemistry Predictions for Effects on Wildlife Process Memorandum" for more information (Newell 2018k).

Potential impacts on wildlife and special status wildlife species habitat from increased noxious and invasive weed establishment and spread would be similar in nature to those described above for construction; however, as ground-disturbing activities would be reduced during operations, the magnitude of potential impacts would be reduced.

Potential impacts on wildlife and special status wildlife species from the presence of workers and equipment would be similar in nature to those described above for construction. However, the magnitude of impacts would be reduced as the numbers of workers and equipment would be less than during the construction phase.

Lighting associated with the operations phase of the proposed project may lead to changes in the interaction between pollinators and some plant species (Bennie et al. 2016). This may lead to decreases in forage resources for some species. Light may attract insects and increase the density of forage for some insectivorous bat species. These impacts would be greatest near light sources and would decrease with distance from the sources.

Artificial lighting associated with the operations phase of the proposed project would increase overall brightness in the night sky by 1 percent to 9 percent; therefore, impacts on wildlife species may occur. However, these impacts are not well understood or researched in current literature since much of the literature focuses on non-LED lights. Additionally, the potential impacts, if realized, would be associated within the direct vicinity of the main operations areas, i.e., where the most lights are concentrated to increase overall night-sky brightness. The potential impacts from light would reduce with distance from the light source and could lead to changes in migration or dispersal behavior including species avoiding the lighted area. It is likely that species would be avoiding the lit areas for multiple reasons, such as loss or degradation of habitat and human presence. Specific impacts on species groups are provided in subsequent sections.

General Closure and Reclamation Impacts

Closure and reclamation activities would increase vegetative cover in areas of project-related disturbance to some extent, depending on reclamation success (discussed in more detail in Section 3.3, Soils and Vegetation). Within reclaimed/revegetated areas there would be a greater potential for an improvement in habitat conditions from the increase in vegetative cover, native vegetative cover, and a reduction in soil erosion potential. While vegetative cover would likely increase, there are constraints that make it unlikely to fully meet desired conditions for the landscape, or for pre-project conditions to be achieved through reclamation/revegetation activities. Wildlife and special status wildlife species habitat in these areas would not return to pre-project conditions.

Additional Impacts Specific to Wildlife Groups

MAMMALS

Small mammals that shelter underground would be susceptible to being crushed or struck by construction equipment.

Artificial night lighting can increase the risk of predation and decrease food consumption for small, herbivorous, nocturnal mammals. Circadian rhythm and melatonin production in mammals are likely affected by artificial night lighting. Increased artificial night lighting may also increase roadkill and disrupt mammalian dispersal movements and wildlife corridor use (Beier 2006). Project-related light may attract insects and increase the density of forage for some insectivorous bat species. These impacts would be greatest near light sources and would decrease with distance from the sources. The proposed use of LED lights may impact fast-flying species—like Brazilian free-tailed bats (*Tadarida brasiliensis*), California leaf-nosed bat (*Macrotus californicus*), and spotted bat *(Euderma maculatum*)—more than slower flying species, like cave myotis (*Myotis velifer*) (Stone et al. 2012). The increased artificial lighting at night may result in a lower food intake for some bat species and possibly lower reproductive success for some species of aerial-hawking bats (i.e., prey is pursued and caught in flight). Conversely, there is the potential that increased artificial night lighting may be beneficial to some bat species, for at least some aspects of their natural history (Fenton and Morris 1976). Moth capture rate may increase since the moth's bat detection system is turned off in light (Frank 2006; Rydell 2006).

Bat species could experience effects from removal of foraging habitat and impacts on roosts and breeding activities by noise and vibration from blasting activities (Siemers and Schaub 2011). Potential impacts on bat species may include causing adult bats to leave maternity roosts during daytime hours. This could lead to infant bats being dropped or knocked to the ground, resulting in mortalities.

BIRDS

Additional impacts on special status bird species would include temporary disturbance from noise as well as changes to habitat use. Noise-related construction activities could affect nesting, roosting, and foraging activities. Changes to behavior could include increased alertness, turning toward the disturbance, fleeing the disturbance, changes in activity patterns, and nest abandonment. Raptors could be especially susceptible to noise disturbance early in the breeding season, through nest abandonment and reduction in overall success.

Potential impacts from operations and maintenance would be from potential electrocution of birds and from striking electrical distribution lines. While some individuals could be impacted, these impacts would be minor and long term and unlikely to reach population levels. Small and mobile bird species would be anticipated to have a very low potential for collisions. The presence of electrical distribution poles would provide perches (for perching and foraging) as well as nesting habitat for some species and could increase impacts on prey species nearby. Unintentional take from these impacts would not significantly impact local, regional, or overall populations of migratory birds.

The increased amount of edge habitat created by the proposed project would allow for an increase in species potential for nest parasitism and depredation due to increased diversity of species and less nest concealment in the edge habitat (Paton 1994; Winter et al. 2000). Other species that use edge habitats or have more general habitat requirements would benefit from the increased amount of edge habitat. In areas where there is higher vegetation density, the potential impacts from habitat fragmentation and edge effects would be greatest. This would change the species composition near project facilities and impact species that use larger blocks of habitat, as they would be subject to increased predation and potential for nest parasitism. Unintentional take from these impacts would not significantly impact local, regional, or overall populations of migratory birds.

Impacts on migrating birds from artificial light increases at night can range from death or injury from collisions with structures, to reduced energy stores due to delays or altered routes, and delayed arrival at breeding grounds (Gauthreraux Jr. and Belser 2006). Unintentional take from these impacts would not significantly impact local, regional, or overall populations of migratory birds.

For all impacts on migratory birds from construction, operations, and maintenance activities of each alternative, unintentional take would likely impact local migratory bird populations, yet would vary by species due to life history traits and habitat use. However, impacts on regional and overall migratory bird populations would likely be negligible. The potential acreages of impacts on migratory bird priority habitats are provided in table 3.8.4-2 later in this section. Additionally, the Boyce Thompson Important Bird Area (see figure 3.8.3-1) is located within the analysis area.

FISH

Additional impacts on fish species include mortality from loss or modification of habitat due to changes in surface water levels or flows, including changes due to changes in groundwater elevation and contribution to surface flows. These impacts would occur for all action alternatives and would have the greatest potential to impact fish species along areas of Devil's Canyon and Queen Creek that currently have surface flows. Any impacts would be to non-native fish populations as no native fish are known to occur in sections of Devil's Canyon and Queen Creek that have surface flows. This is not anticipated to impact habitat for longfin dace (*Agosia chrysogaster*) and other species in Mineral Creek (WestLand Resources Inc. 2018a) as no reductions in flows from the proposed project are anticipated.

Artificial light increases at night are not likely to impact fish since lighting is unlikely to increase in the analysis area near their habitats; however, the exact project lighting layout is not yet known. Potential impacts on fish from artificial light could include breakdowns in niche portioning, changes in migratory patterns, temporary blindness, alternations of predator–prey relations, and changes to foraging behavior (Nightingale et al. 2006).

REPTILES

Reptile species that shelter underground would be susceptible to being crushed by construction equipment. Construction-related trash may attract reptile predators such as ravens (*Corvus corax*) and other predators. The presence of the electrical distribution lines and poles could provide perching and nesting habitat for ravens and other species, which may increase raven and other reptile predator numbers along electrical distribution lines. Knowledge of potential negative effects from artificial light on most reptile species, other than sea turtles, is limited and somewhat speculative. Potential impacts include an extended photoperiod, which can also be positive for some species like geckos and possibly the Bezy's night lizard (*Xantusia bezyi*) (Perry and Fisher 2006).

AMPHIBIANS

Amphibian species would also be affected by changes to water quality and quantity. These impacts would occur for all action alternatives and would have the greatest potential to impact amphibian species along areas of Devil's Canyon and Queen Creek that currently have perennial surface flows that would be reduced by changes in runoff or groundwater contribution. Artificial light increases at night are not likely to impact amphibians since lighting is unlikely to increase in the analysis area near their habitats; however, the exact project lighting layout is not yet known. Possible impacts could include changes to predator–prey relationships, changes in reproduction, and inter-specific (between different species) competition and intra-specific (between individuals of same species) competition for prey (Buchanan 2006).

INVERTEBRATES

Potential impacts on invertebrates from the proposed project would include those described earlier in this section as "Impacts Common to All Action Alternatives." Aquatic invertebrate species would also be affected by changes to water quality and quantity. These impacts would occur for all action alternatives and would have the greatest potential to impact aquatic invertebrate species along areas of Devil's Canyon and Queen Creek that currently have surface flows. Invertebrates that use vibrational communication systems would also be affected by increases in ground-borne vibrations through substrates and soils. These impacts would occur for all action alternatives near any blasting and heavy machinery operations. Artificial light at night may lead to changes in the interaction between pollinators and some plant species, such as cacti (Bennie et al. 2016). This may lead to decreases in forage resources for some species in all groups. In addition, artificial light may increase moth (Order Lepidoptera) predation by bats and birds (Frank 2006).

Wildlife Connectivity

Impacts on animal movement corridors from any of the action alternatives would include direct effects due to a long-term loss of movement habitat from construction and mining activities and/or the construction of project facilities within those corridor areas, as well as a long-term movement habitat loss along pipeline corridors since vegetation would be expected to eventually reestablish in the disturbed areas but would be unlikely to return to pre-construction conditions. Project activities could potentially change predator–prey interactions and would increase the degree of habitat fragmentation within the species' ranges, which in turn can disrupt localized and long-distance dispersal and migration events. In addition, increased human presence in the region from mining activities would lead to temporary disturbances of individual species, affecting movement patterns. Furthermore, indirect impacts on gene flow and biodiversity could occur from any of the action alternatives; however, these impacts would be temporary and insignificant since these biological processes occur over multi-generational time periods, which are typically longer for most species than the proposed life of the mine (Brown Jr. and Gibson 1983; Slatkin 1987). Some of these alternatives would result in minor impacts with others resulting in major impacts. Potential impacts on habitat blocks are given in table 3.8.4-1 and are broken out by alternative and project components.

Differences Between Alternatives 2 through 6

Potential impacts on wildlife species from the action alternatives would generally be as described earlier in this section. Table 3.8.4-2 presents special status wildlife species that potentially occur within the analysis area of each action alternative. (The directions in the alternative options [i.e., "West," "East," "South," and "North" in table 3.8.4-2] refer to the proposed pipeline corridor alignments under consideration for each alternative.) These impacts are discussed more in the next section, "Impacts on Special Status Wildlife Species."

Table 3.8.4-3 provides the MIS species trends, total acres on Tonto National Forest, and acres associated with each action alternative. (The directions in the alternative options [i.e., "East," "West," "South," and "North" in table 3.8.4-3] refer to the proposed pipeline corridor alignments under consideration for each alternative.) The action alternatives are not anticipated to change the current MIS species trends based on the low percentage of acres that would be impacted.

Table 3.8.4-1. Acres of habitat blocks potentially affected for all action alternatives

Alternative	Alternative Component	Habitat Block 1 Acres Affected	Habitat Block 2 Acres Affected
2	East Plant Site/Subsidence areas	–	1,226
2	Near West fence line	–	487
2	Tailings facility	–	789
2	Near West tailings corridor	–	56
2	West Plant Site	–	20
3	East Plant Site/Subsidence areas	–	1,226
3	Fence and tailings storage facility	–	1,275
3	Near West fence line	–	457
3	Tailings facility	–	819
3	Near West tailings corridor	–	56
3	West Plant Site	–	20
4	East Plant Site/Subsidence areas	–	1,226
4	Silver King tailings corridor	–	24
4	Silver King fence line	–	2,880
4	Tailings facility	–	1,849
4	West Plant Site	–	20
5 east option	East Peg Leg tailings corridor	–	118
5 east option	East Plant Site/Subsidence areas	–	1,226
5 east option	Peg Leg fence line	–	2,843
5 east option	Tailings facility	–	3,264
5 east option	West Plant Site	–	20
5 west option	East Plant Site/Subsidence areas	–	1,226
5 west option	Peg Leg fence line	–	2,843
5 west option	Tailings facility	–	3,264
5 west option	West Peg Leg tailings corridor	–	295
5 west option	West Plant Site	–	20
6 north option	Access roads	3	44
6 north option	North Skunk Camp tailings corridor	60	966
6 north option	Skunk Camp transmission line corridor	22	320
6 north option	Skunk Camp fence line	59	5,827
6 north option	East Plant Site/Subsidence areas	–	1,226
6 north option	Tailings facility	–	3,750

continued

Table 3.8.4-1. Acres of habitat blocks potentially affected for all action alternatives *(cont'd)*

Alternative	Alternative Component	Habitat Block 1 Acres Affected	Habitat Block 2 Acres Affected
6 north option	West Plant Site	–	20
6 south option	Access roads	3	41
6 south option	Skunk Camp transmission line corridor	22	320
6 south option	Skunk Camp fence line	59	5,827
6 south option	South Skunk Camp tailings corridor	60	941
6 south option	East Plant Site/Subsidence areas	–	1,226
6 south option	Tailings facility	–	3,750
6 south option	West Plant Site	–	20

Source: Morey (2018a)

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Amphibians								
Lowland leopard frog (*Lithobates yavapaiensis*)	TNF: S AGFD: SGCN 1A	139,011	151,795	153,738	277,160	288,425	268,300	252,059
Birds								
Northern goshawk (*Accipiter gentilis*)	TNF: S, MBSC AGFD: SGCN 1B MBTA: Yes	0	0	545	0	0	9,962	9,962
Western burrowing owl (*Athene cunicularia hypugaea*)	BLM: S AGFD: SGCN 1B MBTA: Yes	150,167	150,829	150,280	223,443	160,847	145,064	144,532
Golden eagle (*Aquila chrysaetos*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes BGEPA: Yes	169,976	182,775	184,327	305,938	299,168	298,884	282,643
Juniper titmouse (*Baeolophus ridgwayi*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	90,252	92,912	105,271	84,679	106,106	188,677	178,356
Ferruginous hawk (*Buteo regalis*)	BLM: S AGFD: SGCN 1B MBTA: Yes	63,718	63,739	70,094	79,557	71,092	113,242	113,490
Swainson's hawk (*Buteo swainsoni*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	23,076	23,076	29,451	25,555	30,459	72,609	72,857
Common black hawk (*Buteogallus anthracinus*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	45,492	51,126	46,368	44,552	46,346	73,813	73,813
Costa's hummingbird (*Calypte costae*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	254,041	267,466	259,021	434,175	406,218	366,813	350,571
Northern beardless-tyrannulet (*Camptostoma imberbe*)*	TNF: MBSC AGFD: N/A MBTA: Yes	8,517	8,517	9,348	16,023	15,664	15,803	15,334

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Western yellow-billed cuckoo (Distinct Population Segment) (*Coccyzus americanus*)	ESA: T (All Arizona counties) TNF: MBSC AGFD: SGCN 1A MBTA: Yes	18,804	18,860	19,177	50,948	54,785	43,101	43,101
Gilded flicker (*Colaptes chrysoides*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes BLM: S	240,199	252,812	241,561	420,375	392,419	340,300	323,811
Olive-sided flycatcher (*Contopus cooperi*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	503	1,006	611	590	646	1,420	1,324
Broad-billed hummingbird (*Cynanthus latirostris*)	AGFD: SGCN 1B MBTA: Yes BLM: S	195,997	209,318	199,917	375,907	347,951	314,209	297,967
Cordilleran flycatcher (*Empidonax occidentalis*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	0	0	0	0	0	9,749	9,749
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA: E (All AZ counties except Navajo) AGFD: SGCN 1A MBTA: Yes BLM: S	32,605	34,233	46,463	125,488	146,541	151,143	138,834
Gray flycatcher (*Empidonax wrightii*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	56,471	60,690	61,494	96,201	108,705	132,158	127,975
Prairie falcon (*Falco mexicanus*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	8,517	8,517	9,348	16,023	15,664	15,803	15,334
American peregrine falcon (*Falco peregrinus anatum*)	TNF: S, MBSC AGFD: SGCN 1A MBTA: Yes	259,841	273,266	274,192	439,319	411,363	388,746	372,504
MacGillivray's warbler (*Geothlypis tolmiei*)*	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	8,331	16,660	7,889	15,750	15,408	7,625	7,168

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Pinyon jay (*Gymnorhinus cyanocephalus*)*	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	0	0	0	0	0	2	22
Bald eagle (*Haliaeetus leucocephalus*)	TNF: MBSC AGFD: SGCN 1A MBTA: Yes BGEPA: Yes	206,000	218,910	219,310	258,082	272,946	330,810	318,662
Lewis's woodpecker (*Melanerpes lewis*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	7,955	15,909	7,509	15,356	15,015	7,187	6,748
Gila woodpecker (*Melanerpes uropygialis*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	254,994	267,606	266,142	435,079	407,122	374,336	358,095
Canyon towhee (*Melozone fusca*)	TNF: MBSC MBTA: Yes	8,517	8,517	9,347	16,023	15,664	15,803	15,334
Elf owl (*Micrathene whitneyi*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	251,610	264,222	256,590	431,743	403,787	366,909	350,668
Lucy's warbler (*Oreothlypis luciae*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	259,841	273,266	274,192	439,319	411,363	384,321	368,079
Phainopepla (*Phainopepla nitens*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	7,955	15,909	7,509	15,357	15,015	7,187	6,748
Desert purple martin (*Progne subis hesperia*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	238,577	252,002	253,304	418,431	390,475	365,426	349,184
Flammulated owl (*Psiloscops flammeolus*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	0	0	0	0	0	9,962	9,962
Black-throated gray warbler (*Setophaga nigrescens*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	9,347	9,347	8,517	16,023	15,664	15,803	15,334

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Yellow warbler (*Setophaga petechia*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	164,318	177,476	177,930	219,315	233,585	259,434	247,906
Red-naped sapsucker (*Sphyrapicus nuchalis*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	72,919	74,408	89,410	100,948	106,449	167,307	167,840
Black-chinned sparrow (*Spizella atrogularis*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	92,698	95,358	107,717	88,994	108,945	196,103	185,249
Bendire's thrasher (*Toxostoma bendirei*)*	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	6,907	13,812	7,576	14,317	13,937	12,250	11,805
Arizona Bell's vireo (*Vireo bellii arizonae*)	TNF: MBSC AGFD: SGCN 1B MBTA: Yes	226,931	240,317	241,282	376,364	374,734	355,528	339,287
Gray vireo (*Vireo vicinior*)	TNF: MBSC AGFD: SGCN 1C MBTA: Yes	94,700	99,713	109,719	86,104	108,197	197,403	187,251
Fish								
Gila longfin dace (*Agosia chrysogaster*)	AGFD: SGCN 1B	18,848	20,252	24,618	61,308	69,802	58,380	47,108
Gila chub (*Gila intermedia*)	ESA: E (Cochise, Coconino, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai Counties) BLM: S AGFD: SGCN 1A	1,323	1,323	1,323	1,148	1,334	1,416	1,369
Insects								
Monarch butterfly (*Danaus plexippus* pop. 1)*	TNF: OSI BLM: S	8,380	16,760	9,217	15,807	15,472	15,566	15,109
Mammals								

continued

Table 3.8.4-2. Acres of modeled habitat for special status wildlife species that potentially would be impacted under each action alternative *(cont'd)*

Common Name (Scientific Name)	Status	Alternative 2	Alternative 3	Alternative 4	Alternative 5 West Pipeline Option	Alternative 5 East Pipeline Option	Alternative 6 South Pipeline Option	Alternative 6 North Pipeline Option
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	TNF: S AGFD: SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Spotted bat (*Euderma maculatum*)	TNF: S AGFD: SGCN 1B	259,841	273,266	274,192	434,871	409,139	386,522	370,280
Greater western mastiff bat (*Eumops perotis californicus*)	BLM: S AGFD: SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Allen's lappet-browed or big-eared bat (*Idionycteris phyllotis*)	TNF: S AGFD: SGCN 1B	5,914	5,914	9,809	5,524	5,524	6,275	6,505
Western red bat (*Lasiurus blossevillii*)	TNF: S AGFD: SGCN 1B	120,106	128,252	132,605	160,078	176,133	214,056	211,036
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	BLM: S AGFD: SGCN 1A	259,298	272,723	264,428	438,824	410,867	378,219	361,978
California leaf-nosed bat (*Macrotus californicus*)	AGFD: SGCN 1B	247,233	260,658	250,771	416,698	399,455	354,650	338,161
Cave myotis (*Myotis velifer*)	BLM: S AGFD: SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Brazilian free-tailed bat (*Tadarida brasiliensis*)†	SGCN 1B	259,841	273,266	274,192	439,319	411,363	388,746	372,504
Reptiles								
Sonoran Desert tortoise (*Gopherus morafkai*)	TNF: S AGFD: SGCN 1A BLM: S	240,569	253,991	252,751	420,098	392,699	362,054	345,812
Bezy's night lizard (*Xantusia bezyi*)	TNF: S AGFD: SGCN 1B	122,542	128,630	136,893	122,956	154,511	244,038	227,966

Status Definitions

Tonto National Forest (TNF):

S = Sensitive. Species identified by a Regional Forester for which population viability is a concern, as evidenced by: a) significant current or predicted downward trends in population number or density; b) significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

OSI = Other Species of Interest. A plant or animal that was included in the analysis for which there are concerns about potential impacts in the region.

MBSC = Migratory Bird Species of Concern

Endangered Species Act (ESA):

E = Endangered. Endangered species are those in imminent jeopardy of extinction. The ESA specifically prohibits the take of a species listed as endangered. Take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to engage in any such conduct.

T = Threatened. Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Arizona Game and Fish Department (AGFD):

SGCN 1A = Species of Greatest Conservation Need Tier 1A; Species for which the AGFD has entered into an agreement or has legal or other contractual obligations or warrants the protection of a closed season.

SGCN 1B = Species of Greatest Conservation Need Tier 1B; Vulnerable species.

SGCN 1C = Species of Greatest Conservation Need Tier 1C; Species for which insufficient information is available to fully assess the vulnerabilities and therefore need to be watched for signs of stress.

Bureau of Land Management (BLM):

S = Sensitive. Species that could easily become endangered or extinct in the state.

Note: Although the analysis area is a 1-mile buffer, data provided by the AGFD were for a 5-mile buffer and could not be calculated for the 1-mile buffer.

* AGFD was unable to provide data for this species so analysis was conducted based on available data about species' habitat requirements.

† Not all SGCN-listed species are addressed as part of this analysis; however, this species was added to the analysis at the request of the AGFD, a cooperating agency.

Table 3.8.4-3. Tonto National Forest vegetation type, trends, and acreages for management indicator species

Vegetation Type	Acres on Tonto National Forest	1985–2005 Vegetation Trend	Alternative 2 acres (% change)	Alternative 3 acres (% change)	Alternative 4 acres (% change)	Alternative 5 East acres (% change)	Alternative 5 West acres (% change)	Alternative 6 South acres (% change)	Alternative 6 North acres (% change)
Ponderosa pine/ Mixed conifer	283,204	Static	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Pinyon/Juniper (woodland)	1,155,722	Static	16.9 0.001	16.9 0.001	58.9 0.01	37.1 0.003	20.3 0.002	44.8 0.004	42.0 0.004
Chaparral	265,480	Static	1,017.5 0.4	1,017.5 0.4	1,089.2 0.4	957.7 0.4	957.7 0.4	1,186.3 0.5	1,416.5 0.5
Desert grassland	316,894	Upward/ Static	51.2 0.02	51.2 0.02	1,372.3 0.4	51.4 0.02	47.8 0.02	69.5 0.02	69.8 0.02
Desertscrub	774,220	Downward/ Static	7,025.3 0.9	7,025.3 0.9	5,568.3 0.7	1,783.4 0.2	1,754.9 0.2	1,922.0 0.3	1,485.9 0.2
Riparian (low elevation)	41,379	No change	4.5 0.01	4.5 0.01	21.8 0.05	2.0 0.01	2.2 0.01	2.0 0.01	0.4 0.001
Aquatic	29,000	Not applicable*	14.6 0.05	14.6 0.05	14.6 0.05	14.7 0.05	14.7 0.05	14.7 0.05	14.7 0.05

Source: Data used for these calculations were a crosswalk between the Forest Service Potential Natural Vegetation metadata and the SWReGAP vegetation metadata.

* Vegetation trend not applicable, but see also analysis of aquatic trends in Devil's Canyon (Garrett 2019d), which indicates static trends in Devil's Canyon between roughly 2003 and 2017.

Impacts on Special Status Wildlife Species

ENDANGERED SPECIES ACT–LISTED WILDLIFE SPECIES

Yellow-billed Cuckoo *(Coccyzus americanus)*

The yellow-billed cuckoo, listed as threatened with proposed critical habitat for the western distinct population segment, has the potential to occur within the analysis area for all action alternatives along Devil's Canyon and Mineral Creek north of the existing Ray Mine. The species may also occur where the two Alternative 5 pipeline option routes would cross the Gila River. Proposed critical habitat for yellow-billed cuckoo is present at the proposed pipeline corridor crossings of the Gila River in the project footprint (figure 3.8.4-1).

Potential impacts on the species include a loss or modification of habitat under all action alternatives along Devil's Canyon and Mineral Creek (downstream of Devil's Canyon) north of the existing Ray Mine. These potential impacts include changes to riparian habitat from reduced surface flows due to the upstream watershed decreasing in size as well as potential reductions in inputs of groundwater from project-related pumping. Potential habitat changes include loss of riparian habitat and a conversion of habitat to a drier, xeroriparian habitat. This could cause habitat to become unsuitable for nesting by the species.

Under Alternative 5, habitat for the yellow-billed cuckoo and proposed critical habitat would be removed as needed where the proposed pipeline routes would cross the Gila River. Potential impacts on habitat and proposed critical habitat would occur on up to 17.9 acres of the 2,232.1 acres of proposed critical habitat within the analysis area. The primary constituent elements (PCEs) of the proposed critical habitat include the following (U.S. Fish and Wildlife Service 2014):

1. Primary Constituent Element 1—Riparian woodlands. Riparian woodlands with mixed willow-cottonwood vegetation, mesquite-thorn forest vegetation, or a combination of these that contain habitat for nesting and foraging in contiguous or nearly contiguous patches that are greater than 100 m (325 feet) in width and 81 hectares (200 acres) or more in extent. These habitat patches contain one or more nesting groves, which are generally willow-dominated, have above-average canopy closure (greater than 70 percent), and have a cooler, more humid environment than the surrounding riparian and upland habitats.
2. Primary Constituent Element 2—Adequate prey base. Presence of a prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies) and tree frogs for adults and young in breeding areas during the nesting season and in post-breeding dispersal areas.
3. Primary Constituent Element 3—Dynamic riverine processes. River systems that are dynamic and provide hydrologic processes that encourage sediment movement and deposits that allow seedling germination and promote plant growth, maintenance, health, and vigor (e.g., lower gradient streams and broad floodplains, elevated subsurface groundwater table, and perennial rivers and streams). This allows habitat to regenerate at regular intervals, leading to riparian vegetation with variously aged patches from young to old.

The proposed removal of vegetation and impacts from workers and equipment being present could lead to avoidance of the disturbed area and vicinity by the species. In addition, potential impacts on proposed critical habitat include removal of riparian woodlands, including potentially suitable nesting, foraging, and dispersal habitat and a corresponding localized reduction in the prey base for the species.

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

The southwestern willow flycatcher is listed as endangered with designated critical habitat and has the potential to occur within the analysis area where the two Alternative 5 pipeline option routes would cross the Gila River. Designated critical habitat for the species is present

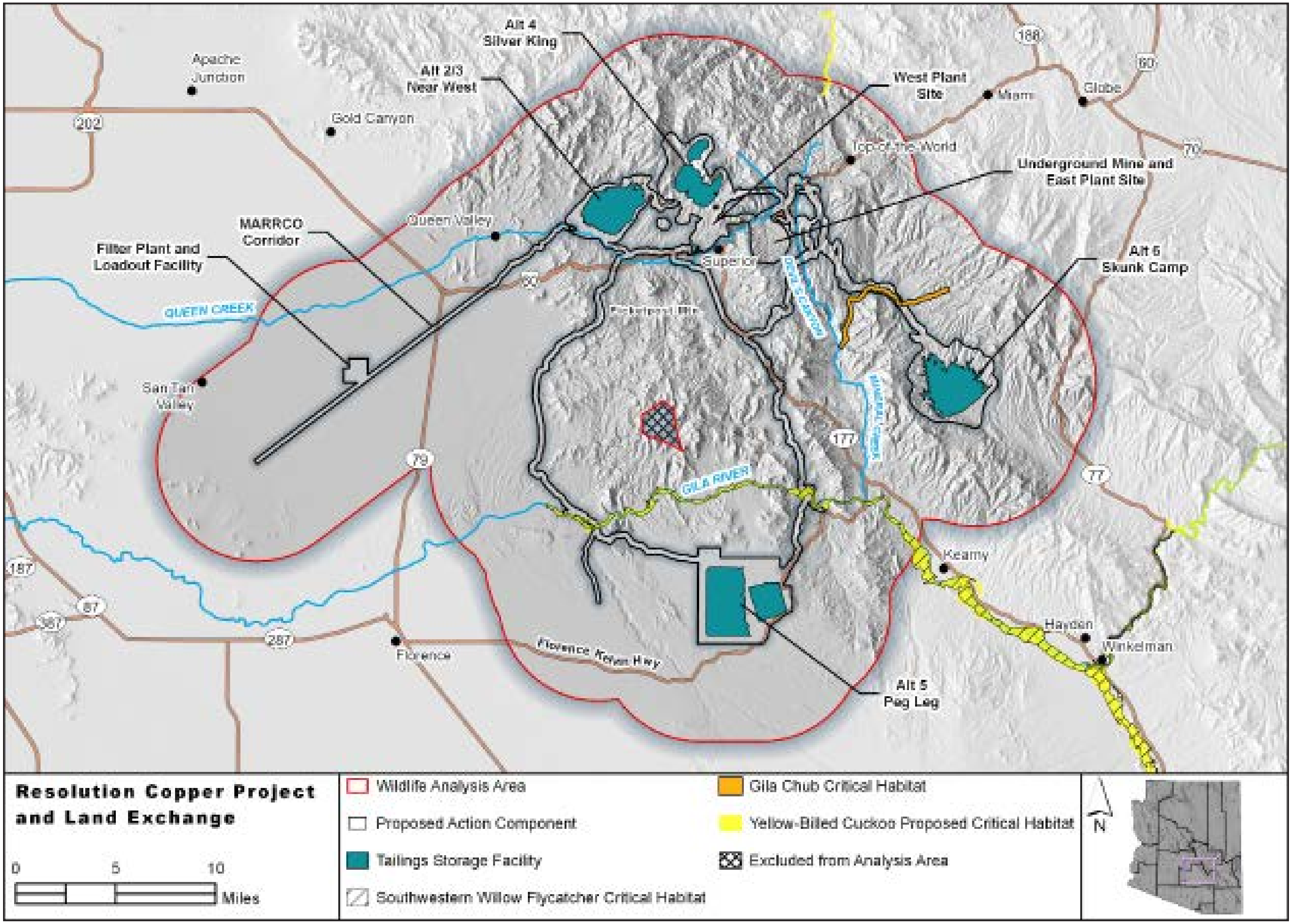


Figure 3.8.4-1. Critical habitats

at the proposed pipeline corridor crossings of the Gila River in the project footprint (see figure 3.8.4-1).

Under Alternative 5, habitat for the southwestern willow flycatcher and designated critical habitat would be removed where the proposed pipeline routes would cross the Gila River. Potential impacts on habitat and proposed critical habitat would occur on up to 12.8 acres of the 2,234.0 acres of designated critical habitat within the analysis area. The PCEs for southwestern willow flycatcher critical habitat include the following (U.S. Fish and Wildlife Service 2013):

- Primary Constituent Element 1—Riparian vegetation. Riparian habitat along a dynamic river or lakeside, in a natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that comprises trees and shrubs and some combination of:
    - Dense riparian vegetation with thickets of trees and shrubs that can range in height from about 2 to 30 m (about 6–98 feet). Lower stature thickets (2–4 m or 6–13 feet tall) are found at higher elevation riparian forests, and tall-stature thickets are found at middle- and lower elevation riparian forests; and/or
    - Areas of dense riparian foliage at least from ground level up to approximately 4 m (13 feet) aboveground or dense foliage only at the shrub or tree level as a low, dense canopy; and/or
    - Sites for nesting that contain a dense (about 50–100 percent) tree or shrub (or both) canopy; and/or
    - Dense patches of riparian forests that are interspersed with small openings of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.1 hectare (0.25 acre) or as large as 70 hectares (175 acres).
- Primary Constituent Element 2—Insect prey populations. A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, which can include flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies, moths, and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

The proposed removal of vegetation and impacts from workers and equipment being present could lead to avoidance of the disturbed area and vicinity by the species. In addition, potential impacts on critical habitat could include removal of riparian vegetation, including potentially suitable nesting, foraging, and dispersal habitats and a corresponding localized reduction in insect prey populations used by the species.

Gila Chub *(Gila intermedia)*

Designated critical habitat for the Gila chub is found along Mineral Creek above the confluence with Devil’s Canyon. The PCEs for Gila chub critical habitat include the following (U.S. Fish and Wildlife Service 2005):

- Perennial pools, areas of higher velocity between pool areas, and areas of shallow water among plants or eddies all found in small segments of headwaters, springs, or cienegas of smaller tributaries.
- Water temperatures for spawning ranging from 20 degrees Celsius (°C) to 26.5°C with sufficient dissolved oxygen, nutrients, and any other water-related characteristics needed.
- Water quality with reduced levels of contaminants or any other water quality characteristics, including excessive levels of sediments, adverse to Gila chub health.
- Food base consisting of invertebrates, filamentous (threadlike) algae, and insects.

- Sufficient cover consisting of downed logs in the water channel, submerged aquatic vegetation, submerged large tree root wads, undercut banks with sufficient overhanging vegetation, large rocks and boulders with overhangs.
- Habitat devoid of nonnative aquatic species detrimental to Gila chub or habitat in which detrimental nonnatives are kept at a level which allows Gila chub to continue to survive and reproduce. For example, the Muleshoe Preserve Gila chub and the Sabino Canyon Gila chub populations are devoid of nonnative aquatic species. The O'Donnell Canyon Gila chub population has continued to survive and reproduce despite the current level of nonnative aquatic species present.
- Streams that maintain a natural unregulated flow pattern including periodic natural flooding. An example is Sabino Canyon that has experienced major floods. If flows are modified, then the stream should retain a natural flow pattern that demonstrates an ability to support Gila chub.
- 300-foot riparian zone adjacent to each side of the stream.

The AGFD surveyed this area and found Gila chub in Mineral Creek in 2000; however, additional surveys in 2002, 2006, 2007, 2009, and 2013 found no Gila chub. Therefore, AGFD assumed the creek to be fishless in 2007 (Robinson 2007; Robinson et al. 2010). Additionally, WestLand Resources surveyed Mineral Creek in 2017 but did not find any Gila chub (WestLand Resources Inc. 2018a). As this area is not currently occupied habitat, potential impacts on surface water and groundwater would have no potential impact on the species. Potential impacts on critical habitat include reduction of perennial pools and a conversion of vegetation toward xeroriparian species; however, groundwater modeling for the action alternatives does not indicate that impacts from groundwater drawdown would significantly impact Mineral Creek in the area of designated critical habitat.

TONTO NATIONAL FOREST SENSITIVE WILDLIFE SPECIES

Potential impacts on Tonto National Forest Sensitive Wildlife Species would be as described earlier in this section in "Impacts Common to All Action Alternatives." The acres of potential impacts on modeled habitat for these species is given in table 3.8.4-2. The project-related disturbance would decrease available habitat for these species. However, given that the proposed project would impact a small portion of the overall habitat in the project vicinity for these species under all action alternatives, the proposed project may adversely impact individuals, but is not likely to result in a loss of viability in the analysis area, nor cause a trend toward federal listing of these species as threatened or endangered.

BLM SENSITIVE SPECIES

Potential impacts on BLM Sensitive Species would be as described earlier in this section in "Impacts Common to All Action Alternatives." The acres of potential impacts on modeled habitat for these species is given in table 3.8.4-2. The project-related disturbance would decrease available habitat for these species. However, given that the proposed project would impact a small portion of the overall habitat in the project vicinity for these species under all action alternatives, the proposed project may adversely impact individuals, but is not likely to result in a loss of viability in the analysis area, nor cause a trend toward federal listing of these species as threatened or endangered.

3.8.4.3 Cumulative Effects

The Tonto National Forest has identified the following list of reasonably foreseeable future actions as likely to occur in conjunction with development of the Resolution Copper Mine. The projects described below are expected, or have potential, to contribute to incremental changes in wildlife or habitat 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 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 Corporations) and extend the life of the mine to 2039. EIS impact analysis is pending; however, this project would cause approximately 1,011 acres of existing wildlife habitat to be lost. Some portions of these areas may later be successfully reclaimed and revegetated, but other areas would remain permanently altered.
- *Ripsey Wash Tailings Project.* Mining company 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. Effects on wildlife would include the direct loss of existing habitat, as well as habitat fragmentation. Impacts on threatened, endangered, and sensitive species such as southwestern willow flycatcher (endangered) and the yellow-billed cuckoo (threatened) would be expected to be indirect and minor. Cumulative effects would be most noticeable in the vicinity of Alternative 5 – Peg Leg, as both the Ripsey Wash Tailings Project and the Resolution Copper Project would remove large portions of habitat from the same general area.
- *Wildlife Water Source Improvements*. Two key projects geared toward improving wildlife access to water sources include the Government Springs Pipeline Project and the AGFD Wildlife Water Catchment Improvement Project. The Government Springs Pipeline Project would replace about 12,000 linear feet of pipeline between two existing water storage tanks and would charge the system with well water instead of an inconsistently wet spring. The stored water would be available for wildlife such as elk and deer. The AGFD water catchment project includes construction of four discrete catchments at various locations on the Tonto National Forest, with functional lifespans of about 35 years. Each catchment would include a water storage tank, a large "apron" to gather and direct precipitation to the storage tank, a drinking trough, and fencing, and would disturb no more than 0.5 acre. The AGFD catchments would be designed primarily to benefit mule deer, although they would also benefit other species such as elk, javelina, and Gambel's quail.
- *Herbicide Treatments to Control Vegetation*. There are two primary vegetation management programs proposing to use herbicides in the vicinity of Resolution Copper Mine: APS's herbicide use within their right-of-way on NFS lands, and ADOT's vegetation treatment along various road rights-of-way. APS is proposing to include Forest Service–approved herbicides as a vegetation management tool on its existing rights-of-way within five National Forests: Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto National Forests. If approved, the use of herbicides would become part of the APS's 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. ADOT plans annual herbicide treatments using EPA-approved herbicides. ADOT would apply herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. Herbicide application could have short- and long-term, indirect, minor adverse impacts and short- and long-term, direct, negligible adverse impacts on the Mexican spotted owl (*Strix occidentalis lucida*), southwestern willow flycatcher, yellow-billed cuckoo, narrow-headed gartersnake (*Thamnophis rufipunctatus*), and northern Mexican gartersnake (*Thamnophis eques megalops*) and their respective habitats.

- *Bighorn Sheep Capture and Relocation*. The Tonto National Forest is intending to capture and relocate bighorn sheep over the next 3 to 5 years in order to improve forest-wide health and genetic viability of the species. The project would involve the use of helicopters and occur in five wilderness areas within the Tonto National Forest: Four Peaks, Hellsgate, Mazatzal, Salt River Canyon, and Superstition. Endangered, threatened, candidate, and proposed ESA species identified within this project area include Mexican spotted owl, Sonoran desert tortoise, bald eagle (*Haliaeetus leucocephalus*), and golden eagle (*Aquila chrysaetos*). Impacts on protected wildlife species would occur as the result of helicopter use, but effects would be minor and short-term. The overall effect on bighorn sheep would be positive, as sheep translocation would help control the population of bighorn sheep to densities less likely to succumb to communal diseases.
- *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, there would likely be total loss of existing wildlife habitat in areas where high and moderate habitat potential intersect with foreseeable mining uses. BLM sensitive species would no longer be assessed on the selected lands. BLM would acquire new potential wildlife habitat through the offered lands.
- *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. This document will have substantial impacts on current recreational uses of NFS lands and transportation routes, which in turn would have some impact on disturbance of soils and vegetation for new road construction or decommissioning of other roads. On the Tonto National Forest as a whole, these changes should be beneficial to wildlife species, as one focus of travel management is avoidance of sensitive habitat; however, short-term disturbances would occur and potentially be cumulative with disturbances from the Resolution Copper Project.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private land lies entirely within an area of BLM-administered lands and cannot be accessed without crossing Cottonwood Canyon Road, located on BLM lands. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009, and a BLM right-of-way grant in 2017. The firm's proposed construction on Cottonwood Canyon Road and on the landfill property may increase the potential for introduction and/or spread of noxious weeds and invasive plants. Approximately 4 acres of creosotebush-bursage

vegetation and 11 acres of Arizona upland desertscrub would be removed to expand Cottonwood Canyon Road. Development of the landfill would result in the clearing of 350 acres of vegetation on private lands. This is some distance from Resolution Copper Project impacts, except for the Alternative 5 west pipeline option, but on a landscape scale it would contribute to loss of habitat and be cumulative with Resolution Copper Project impacts.

- *LEN Range Improvements.* This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities and would be beneficial to wildlife as well. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- *Millsite Range Improvements.* This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon troughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape and are within the same geographic area where some water sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project tailings storage facility construction.

Other future projects not yet planned, such as large-scale mining, pipeline projects, power transmission line projects, and future grazing permits, 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 would contribute to changes in wildlife and their respective habitats by either reducing available habitats areas, reducing habitat quality, or acting to fragment existing habitats.

3.8.4.4 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.

This section contains an assessment of the effectiveness of mitigation and monitoring measures found in appendix J that are applicable to wildlife.

Mitigation Measures Applicable to Wildlife

Follow AGFD and FWS guidance for mitigation of impacts on wildlife (GP-125): Follow guidance from the AGFD and FWS regarding avoidance, minimization, and mitigation measures for wildlife. The AGFD's Heritage Data Management System (HDMS) and Project Evaluation Program work together to provide current, reliable, objective information on Arizona's plant and wildlife species to aid in the environmental decision-making process. The information can be used to guide preliminary decisions and assessments for the Resolution Copper Project. Similarly, the FWS provides guidance for planning for wildlife. This measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Implement a wildlife management plan for stormwater ponds, including wildlife exclusion fencing (GP-131). This measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Reptile and Sonoran Desert Tortoise (ESA-CCA) Plan (CA-191): Implement conservation actions detail in the Candidate Conservation Agreement. The Candidate Conservation Agreement would be a formal agreement between the FWS and Resolution Copper to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened. Resolution Copper would voluntarily commit to conservation actions that would help stabilize or restore the species with the goal that listing would become unnecessary. This measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Mitigate for loss of abandoned mine or cave habitats for bats (CA-172): Mitigate impacts on bat habitat by conducting pre-closure surveys over multiple years and multiple visits per year, to document species presence/absence and develop appropriate closure methods in coordination with AGFD, Bat Conservation International, and Forest Service biologists; implement wildlife exclusion measures pre-closure to minimize wildlife entrapment and mortality during closure; consider seasonal timing of closure on any sites with suitable maternity roosts; and identify mines, adits, and/or shafts with known bat roosting areas. If activities are adjacent to bat roosting/maternity sites, develop best management practices to reduce human encroachment. This measure would only be applicable to Alternatives 2, 3, and 4. It would be noted in the ROD/Final Mining Plan of Operations and required by the Forest Service via 36 CFR 228.8 (Forest Service Authority to regulate mining to minimize adverse environmental impacts on NFS resources).

Maintain or replace access to stock tanks and AGFD wildlife waters (CA-175): Resolution Copper would maintain or replace access to stock tanks and AGFD wildlife waters impacted by the project. Stock tanks are used to provide drinking water for livestock. AGFD constructs wildlife water developments to support a variety of wildlife, including game species. Benefits of AGFD wildlife water developments include a long lifespan; year-round, acceptable water quality for wildlife use; require no supplemental water hauling, except in rare or exceptional circumstances; minimal visual impacts and blends in with the surrounding landscape; accessible to and used by target species and excludes undesirable/feral species to the greatest extent possible; and minimized risk of animal entrapment and mortality. This measure would be applicable to all alternatives, noted in the ROD/Final Mining Plan of Operations, and required by the Forest Service. Additional ground disturbance would not be required, as it is within the disturbance disclosed in the DEIS.

Use of best management practices during pipeline construction and operations (CA-176): Resolution Copper would adhere to best management practices during pipeline construction and operation. During pipeline construction, Resolution Copper would cover open trenching; inspect trenches routinely for entrapped wildlife and remove; provide wildlife escape ramps; inspect under construction equipment prior to use and remove any wildlife seeking cover. Resolution Copper would also include wildlife crossing structures along the pipeline corridor (overpass or underpass) and coordinate with AGFD to determine the location, frequency, and design of wildlife crossing structures. This measure 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 is required as it is within the disturbance disclosed in the DEIS.

Mitigation Effectiveness and Impacts

Mitigation would be effective at reducing or offsetting some impacts on wildlife. Most water sources potentially impacted by the project would be replaced, impacts on cave habitat would be minimized, and impacts from ground disturbance, traffic, noise, and light would be minimized through best practices but not eliminated. However, overall a large acreage of habitat would be impacted. This loss of habitat would not be replaced in the immediate project area, though it would be offset by the exchanged lands and some mitigation proposals being developed through the Clean Water Act permitting program (see Section 3.7.2, Surface Water Quantity).

Unavoidable Adverse Impacts

Biological resources would be impacted by direct surface disturbance, noise, vibration, light, dust, air pollutants, and traffic. Adverse impacts that cannot be avoided or completely mitigated include changes in cover, changes in foraging efficiency and success, changes in reproductive success, changes in growth rates of young, changes in predator–prey relationships, increased movement, habitat fragmentation and disruption of dispersal and migration patterns through animal movement corridors, and increased roadkill.

3.8.4.5 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Impacts on wildlife and wildlife habitat would primarily be short term and would include destruction of habitat for mine construction, disturbance from mining and associated activities, and direct mortality from increased mine-related vehicle traffic. Disturbance and direct mortality would cease at mine closure, and reclamation would eventually allow wildlife habitat to reestablish itself. However, this could take many decades or longer. Portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would be long term or permanent. Impacts on wildlife and aquatic habitat due to drawdown that affects streams and springs would represent a permanent loss in productivity.

Irreversible and Irretrievable Commitment of Resources

The direct loss of productivity of thousands of acres of various habitat from the project components would result in both irreversible and irretrievable commitment of the resources that these areas provide for wildlife (i.e., breeding, foraging, wintering, and roosting habitat; animal movement corridors, etc.). Some habitat could reestablish after closure, which would represent an irretrievable commitment of resources, but portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would likely be irreversible.

Overview

The lands around Superior, Arizona, and in particular the Oak Flat area above and directly east of the Apache Leap escarpment, have for decades been a popular recreation destination for camping, hiking, rock climbing, OHV driving, and other pursuits. Development of the project, along with pipelines, power lines, and other associated infrastructure, and a large, permanent tailings storage facility in the general vicinity of the mine, would inevitably result in the loss of some of the area's natural features and recreational opportunities. Some recreational opportunities would be permanently lost, while others would be displaced to other parts of the state. This section of the EIS is an effort to quantify, when possible, these anticipated changes.

3.9 Recreation

3.9.1 Introduction

Local, State, and Federal agencies provide opportunities for recreation throughout and adjacent to the project area. Recreation activities range from individual, casual, and dispersed use to organized, permitted events and designated recreation sites, for both motorized and nonmotorized recreation. Typical recreation in the project area includes driving for pleasure/vehicle touring, off-highway vehicle (OHV) use, hiking, rock climbing (including technical climbing and bouldering), camping, wildlife viewing and bird watching, horseback riding, mountain biking, and hunting (bird, small game, and big game).

One specific recreation concern has been the land exchange, and the subsequent loss of the Oak Flat Campground. Resolution Copper would keep the campground open as long as it is safe to do so (this is required by the NDAA), but eventually this area would be closed to public access. Another specific recreation concern is the loss of recreation opportunities and access from the large acreage of the tailings storage facility on Federal land, which for the duration of the mine operations would be closed to all non-mining uses and displace recreation to other locations.

This section discusses the general recreation setting and opportunities, special use activities, management for recreation (Forest Service, BLM, and Arizona State lands), hunting, recreation sites, and recreation opportunities specific to the project footprint, including motorized routes and rock climbing.

3.9.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.9.2.1 Analysis Area

The spatial analysis area for potential direct and indirect effects on recreation resources includes the following: the East Plant Site and subsidence area, West Plant Site, MARRCO corridor, filter plant and loadout facility, tailings storage facility, transmission line corridors, pipeline corridors, the Silver King alternative (Alternative 4) and proposed pipelines and emergency slurry ponds, the Peg Leg alternative and proposed pipelines (Alternative 5), and the Skunk Camp alternative and proposed pipelines (Alternative 6). The analysis area for potential indirect and cumulative effects also extends to Management Area (MA) 2F of the Globe Ranger District of the Tonto National Forest; Passages 15, 16, 17, and 18 of the Arizona National Scenic Trail; and Game Management Units (GMUs) 24A, 24B, and 37B, as shown in figure 3.9.2-1. The temporal analysis area for direct and indirect effects is divided into three general phases: construction (mine life years 1 through 9), operations (years 6 through 45), and closure/reclamation (years 46 through 51 to 56).

3.9.2.2 Methodology

Recreation activities are interrelated and connected to other natural and social resources and resource uses. Therefore, changes to other resources (e.g., access or scenic resources) can affect recreational opportunities and use. In the following analysis we discuss actions that would alter or change the recreation settings in the analysis area or that

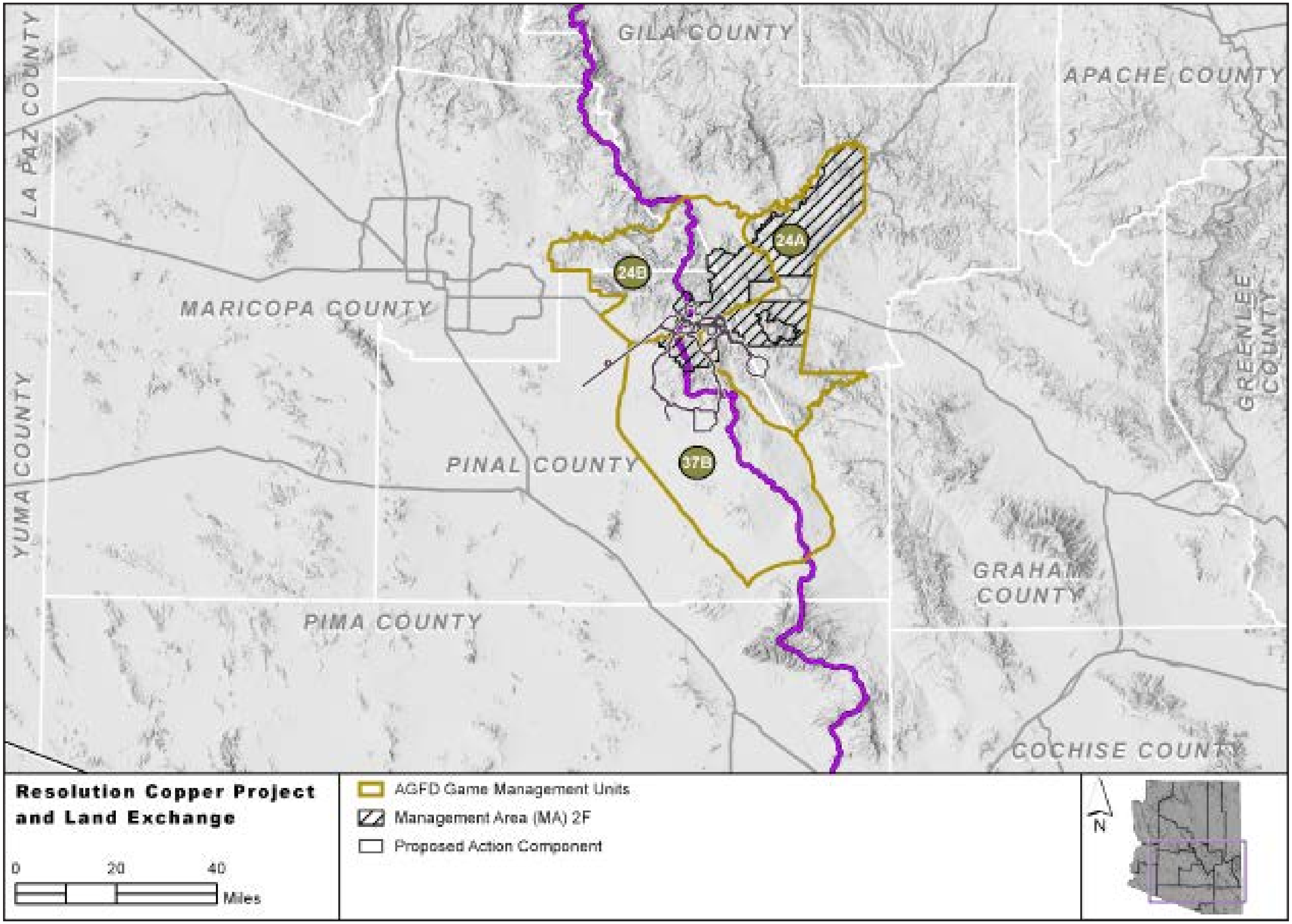


Figure 3.9.2-1. Recreation analysis area

could affect the capacity of that landscape setting to provide certain recreational opportunities. We quantify effects where possible.

Short-term impacts would primarily be associated with the construction of project infrastructure, would last as long as a particular construction activity, and would largely cease after roughly mine year 9. Long-term impacts would primarily be associated with mine operation, closure, reclamation, and post-closure, and depending on the impact, could last from mine year 9 to perpetuity.

3.9.3 Affected Environment

3.9.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance used in this recreation effects analysis may be reviewed in Newell (2018e).

Primary Legal Authorities Relevant to the Recreation Effects Analysis

- Secretarial Order 3373
- Multiple-Use Sustained-Yield Act of 1960, as amended (16 U.S.C. 528)
- Wilderness Act of 1964 (16 U.S.C. 1131–1136), as amended by the Arizona Wilderness Act of 1984
- National Trails System Act of 1968 (PL 90-543; 16 U.S.C. 1244(a)), as amended by the Arizona National Scenic Trail Act
- National Forest Management Act of 1976 (16 U.S.C. 1600)
- Tonto National Forest Land and Resource Management Plan

3.9.3.2 Existing Conditions and Ongoing Trends

General Setting

Major recreational attractions in the analysis area include the Apache Leap escarpment, Oak Flat, Picketpost Mountain, Boyce Thompson Arboretum, Arizona Trail, Queen Creek Canyon, Devil's Canyon, Hewitt Station Road, Reavis Canyon, Gila River, and Dripping Spring Mountains. A number of developed and dispersed campgrounds, day-use areas, trailheads, roads, and trails exist for both motorized and nonmotorized recreational use in the analysis area. With private funding from multiple sources, the Tonto Recreation Alliance maintains the Hewitt Station OHV trails in cooperation with the Forest Service. Dispersed and developed recreation in the analysis area is managed by the Forest Service, BLM, State of Arizona, Gila County, and Pinal County. Tonto National Forest lands (Globe Ranger District) dominate the northern portion of the analysis area, and BLM lands (Tucson Field Office) dominate the southern portion of the analysis area (figure 3.9.3-1).

NFS roads are located throughout the analysis area. Tonto National Forest is currently preparing a draft Supplemental EIS in compliance with the Final Travel Management Rule, which requires that all NFS lands designate roads, trails, and areas for motor vehicle travel. This would restrict off-road motor vehicle use and designate roads and motorized trails open to the public, in addition to designating OHV areas, big-game harvesting retrieval rules, fuelwood collection rules, and dispersed camping rules (U.S. Forest Service 2016f). NFS roads will be shown on the Tonto National Forest Motor Vehicle Use Map. The Motor Vehicle Use Map is anticipated to be released to the public once the Final Supplemental EIS is released and final ROD is signed by the Forest Supervisor.

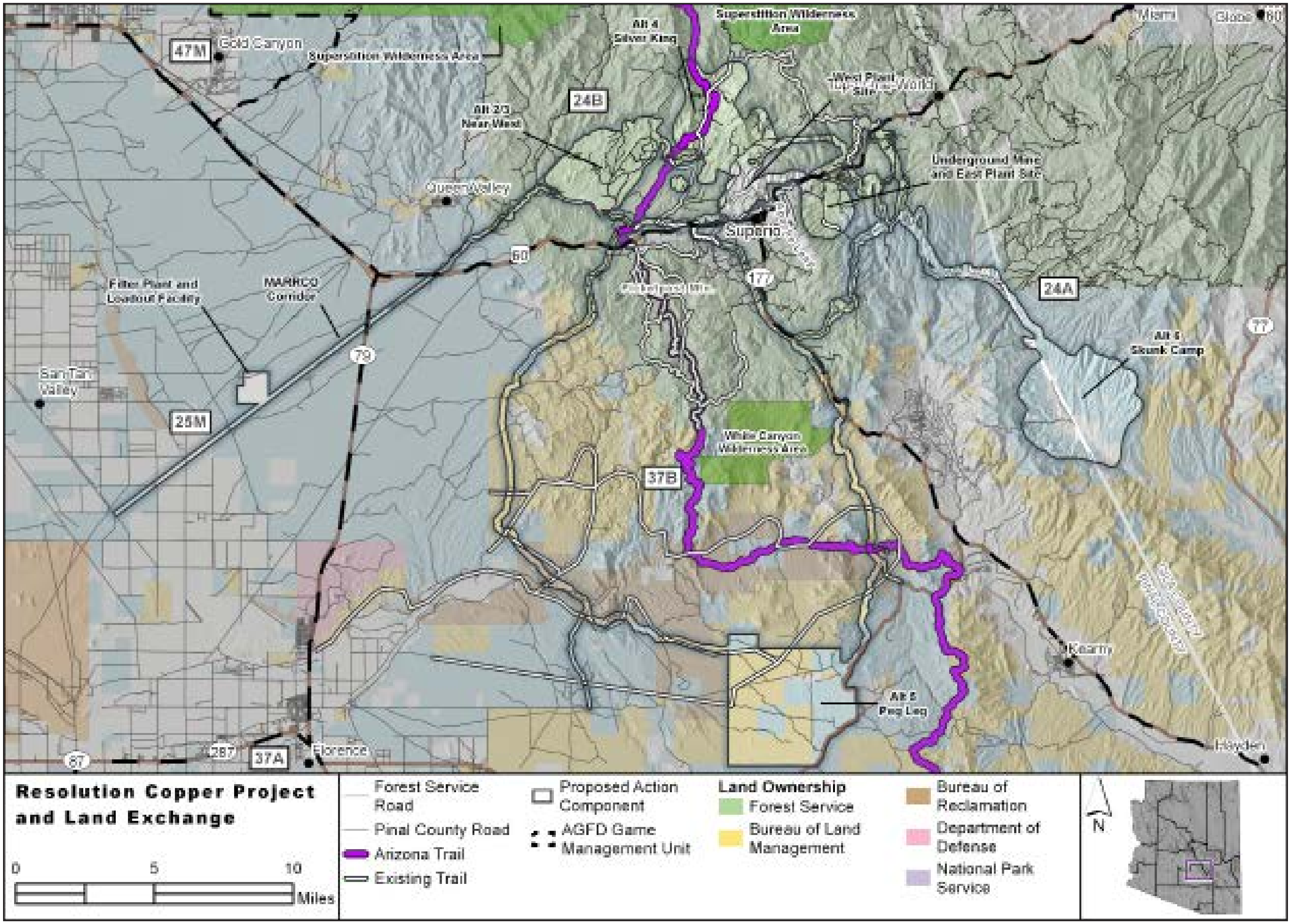


Figure 3.9.3-1. Existing recreation setting overview

The Gila-Pinal Scenic Road is a designated Scenic Byway, running along U.S. 60 from Superior to Miami, Arizona. ADOT designated the Gila-Pinal Scenic Road as a scenic road on June 20, 1986. The route travels throughout the Sonoran Desert life zone at the desert floor and moves upward through four biotic communities. Riparian woodlands are found along the many features such as Queen Creek, Arnett Creek, and Pinto Creek (America's Scenic Byways 2018).

The Legends of Superior Trails (LOST) are located along U.S. 60, providing a connection from the Arizona Trail to Superior. A portion of LOST is on lands owned by Resolution Copper. LOST is 6 miles long (with a few short side trails) and includes interpretive signage along the route (U.S. Forest Service 2013a).

Pinal County has proposed features and designations in their 2007 Open Space and Trails Master Plan, some of which would occur within the analysis area. OHV trails, trail corridors, as well as planned or proposed open space designations are intended to provide reception opportunity and connectivity throughout Pinal County. In addition, a local user group has proposed a recreation plan that coincides with part of the analysis area; this plan features new trailheads, motorized roads, motorized trails, and non-motorized trails (figure 3.9.3-2).

Special Use Activities

The Tonto National Forest manages its special use permit pursuant to 36 CFR 251, and the analysis area is used by a number of permitted recreation and commercial special use activities. Recreation events are commercial activities requiring temporary, authorized use of NFS land. Commercial activities may consist of outfitter and guide services, filming, photography, or campground management. Commercial activity on Tonto National Forest lands occurs when an entry or participation fee is charged by the applicant, and the primary purpose is the sale of a good or service. Most of these applicants offer guided tours that provide the safety, knowledge, and experience of qualified guides with quality equipment, while others provide in-demand equipment and basic instruction for visitors to explore on their own. Activities include hiking, camping, climbing, canyoneering, horseback riding, jeep tours, motorcycle riding, utility task vehicle (UTV), OHV, and ATV tours, road biking, and mountain biking. Each company follows strict operating procedures, safety practices, and Forest Service regulations to protect the environment. Additionally, group recreation events may also require a special use permit (U.S. Forest Service 2013b).

Recreation Opportunity Spectrum

The recreation setting varies on the Tonto National Forest lands throughout the analysis area, illustrated by the different recreation opportunity spectrum (ROS) classifications that occur within the analysis area: semiprimitive nonmotorized, semiprimitive motorized, roaded natural, and urban. Table 3.9.3-1 and figure 3.9.3-3 give an overview of the ROS in the analysis area.

Table 3.9.3-1. Recreation opportunity spectrum acreages

ROS Class	Acres in the Analysis Area
Semiprimitive nonmotorized	5,576
Semiprimitive motorized	21,226
Roaded natural	10,213
Urban	10,180

Note: Acreages may not total due to rounding and/or unclassified lands; acreages that are common among alternatives are not double-counted.

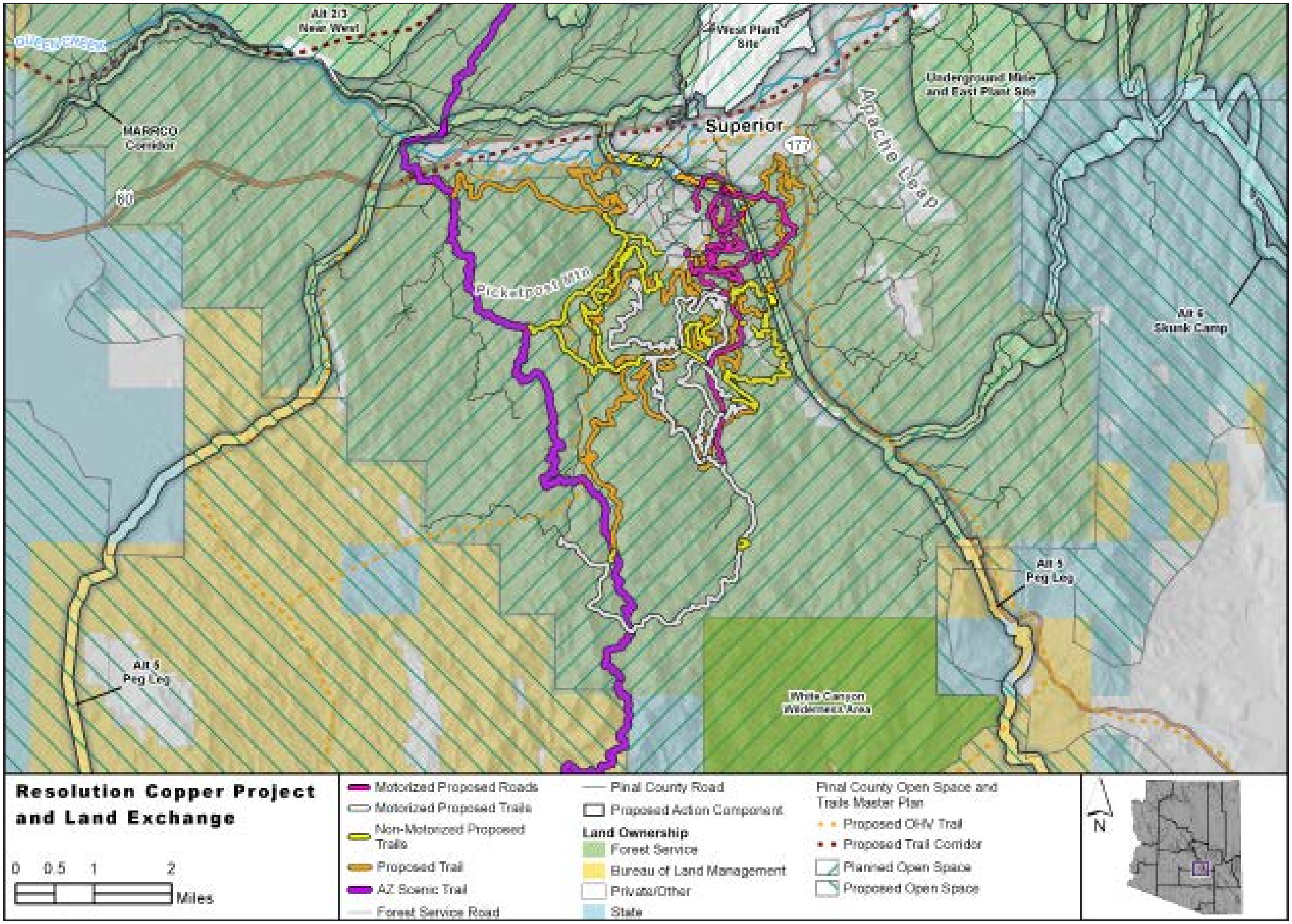


Figure 3.9.3-2. Proposed recreation setting overview

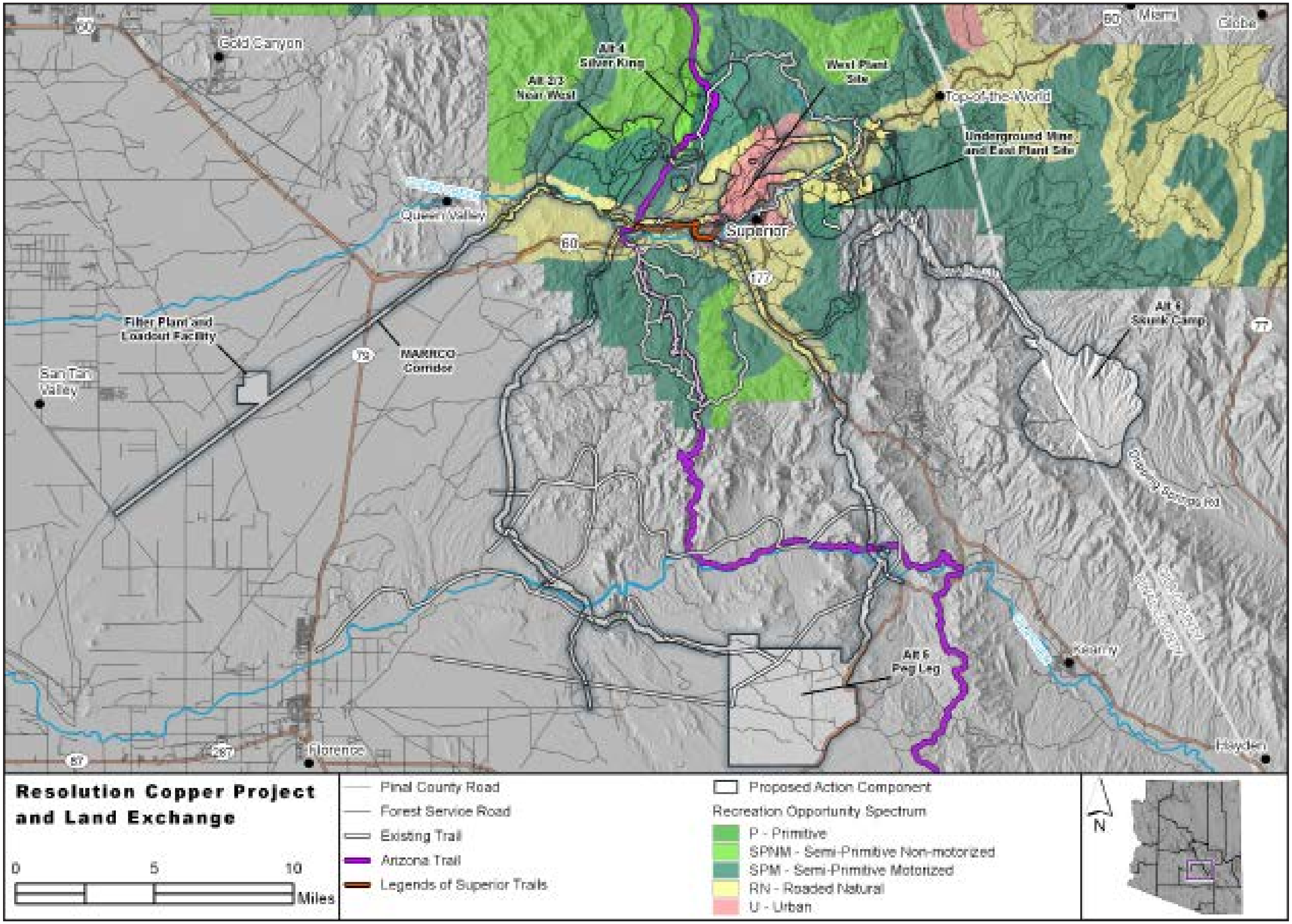


Figure 3.9.3-3. Existing recreation opportunity overview

BLM Recreation Management

The BLM currently uses an outcomes-focused recreation management framework that focuses on targeted outcomes gained from visitors engaging in recreational experiences (see BLM Handbook H-8320-1, "Planning for Recreation and Visitor Services" (Bureau of Land Management 2014)). The BLM-managed public lands provide visitors with a wide variety of outdoor recreation opportunities (activities and settings) to attain desired experiences and personal benefits. Public lands are designated as a Special Recreation Management Area (SRMA) or Extensive Recreation Management Area (ERMA). ERMAs constitute all public lands outside specially or administratively designated areas (e.g., National Land Conservation System units or ACECs, respectively), typically areas where recreation is non-specialized, dispersed, and does not require intensive management. Recreational activities are typically subject to fewer restrictions in ERMAs. There are no SRMAs in the analysis area; the nearest SRMA is the Gila River SRMA, located 10 miles to the east. All BLM-managed lands within the analysis area are managed as ERMAs.

Similar to the Forest Service, special recreation permits are another tool the BLM uses to manage recreational use of public lands. Special recreation permits are authorizations that allow for commercial, competitive, and group recreation uses of BLM-managed public lands and related waters.

BLM routes are located within the analysis area. These routes are used similar to the frequency and conditions as described for NFS routes. The BLM Tucson Field Office is currently preparing a draft travel management plan to designate roads, trails, and areas for motor vehicle travel (i.e., open, limited, or closed).

State Trust Land

Arizona State Trust land is present throughout portions of the analysis area. ASLD lands are not public lands; they are lands managed by ASLD to generate revenue for State purposes. However, recreational uses are allowed by permit and are open to hunting and fishing with a valid license. Recreation (such as hiking, camping, or motorized travel) may be allowed with a recreational permit available through the ASLD. However, some trails (such as the Arizona Trail) are available for public use without a permit.

Hunting

Hunting opportunities are available on public lands and lands managed by the ASLD within the analysis area, including AGFD GMUs 24A, 24B, and 37B (see figure 3.9.2-1). Hunted species vary greatly due to the high diversity of habitat in the analysis area, from Sonoran desertscrub to chaparral and conifer forests on the highest elevations. Commonly hunted species include but are not limited to: mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), javelina (*Pecari tajacu*), mountain lion (*Puma concolor*), black bear (*Ursus americanus*), bighorn sheep (*Ovis canadensis nelsoni*), cottontail rabbit *(Sylvilagus audubonii*), dove (*Zenaida asiatica* [white-winged]; *Streptopelia decaocto* [collared]), and Gambel's quail (*Callipepla gambelii*) (Arizona Game and Fish Department 2018b, 2018c, 2018d). Hunting primarily occurs in the fall and winter.

Hunting is permitted throughout most of the analysis area under AGFD laws and rules, established in ARS 17, Chapter 3, "Game and Fish," Article 17-309. It is unlawful for a person to discharge a firearm within 0.25 mile of an occupied farmhouse or other residence, cabin, lodge, or building without permission of the property owner or resident. Specifically, hunting is not permitted within 0.25 mile of occupied private parcels throughout the unit(s).

Recreation Sites

ARIZONA NATIONAL SCENIC TRAIL

The Arizona Trail, which is more than 800 miles long, was designated a national scenic trail in a 2009 amendment to the 1968 National Trails System Act (Arizona Trail Association 2018). The National Trails System Act of 1968, as amended, establishes national scenic trails to provide maximum outdoor recreation potential and for the conservation and enjoyment of scenic, historic, natural, or cultural qualities of the areas which they traverse. The Arizona Trail is a primarily primitive, nonmotorized long-distance route that preserves and showcases the unique and diverse scenic, natural, historic, and cultural treasures of Arizona and our nation. The Arizona Trail experience provides opportunities for quality recreation, self-reliance, and discovery within a corridor of open space defined by the spectacular natural landscapes of the state (U.S. Forest Service 2018b).

Four trail "passages" are located within the analysis area, stretching from the Tortilla Mountains in the south to the Superstition Mountains in the north (see figure 3.9.3-1). The four passages of the Arizona Trail total approximately 84 miles of trail through the analysis area. These are Passage 15 – Tortilla Mountains; Passage 16 – Gila River Canyons; Passage 17 – Alamo Canyon; and Passage 18 – Reavis Canyon.

APACHE LEAP SPECIAL MANAGEMENT AREA

The Apache Leap SMA straddles the Apache Leap escarpment, covering 839 acres (figure 3.9.3-4; also see figure 2 of "Apache Leap Special Management Area Management Plan"), and was established in 2017 (U.S. Forest Service 2017c). The plan components form strategic direction programmatic in nature and do not authorize specific projects or activities. The plan may constrain the agency from authorizing or carrying out certain projects and activities within the SMA or dictate the manner in which they may occur. The plan would not regulate use by the public but may guide future project or activity decisions that regulate use by the public under 36 CFR Part 261 Subpart B (prohibitions in areas designated by orders). Future proposed actions within the Apache Leap SMA would be subject to the appropriate level of environmental review and analysis, public involvement, and pre-decisional administrative review procedures.

No mining activities are proposed within the SMA. However, authorized activities under the NDAA include installing seismic monitoring equipment, as well as signage and other public safety notices, and operating an underground tunnel and associated workings between the

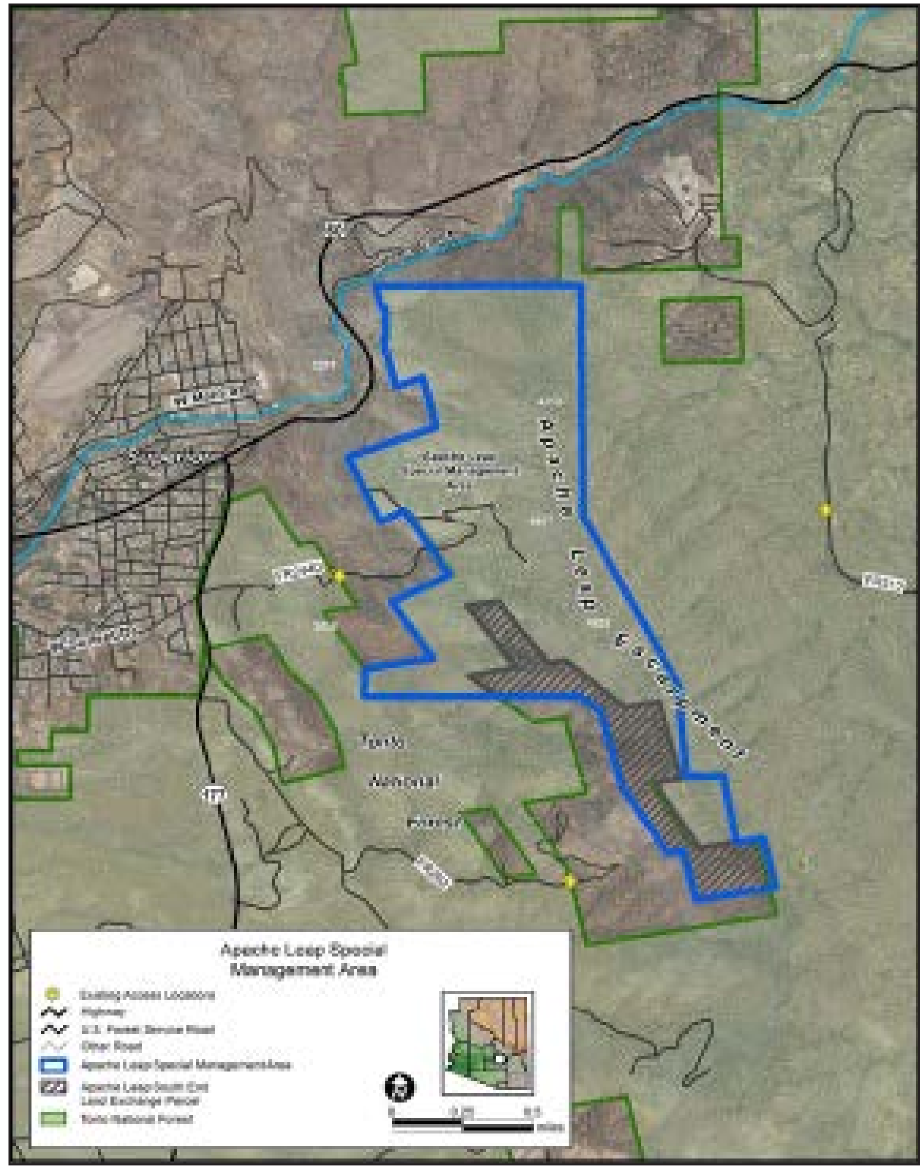


Figure 3.9.3-4. Overview of Apache Leap Special Management Area

East Plant Site and West Plant Site, which would extend beneath the Apache Leap escarpment.

OAK FLAT CAMPGROUND

The Tonto National Forest manages the Oak Flat Campground, which provides approximately 20 campsites (available first come, first served) and two vault toilets (U.S. Forest Service 2018c). The campground is situated along the Gila-Pinal Scenic Road in the rolling hills near Devil's Canyon (figure 3.9.3-5) and hosts a large stand of mature oak trees that provide natural shade. The surrounding area is known for its numerous recreational bouldering opportunities. Families and individuals like to come to this site for its natural desert beauty and rock climbing. Oak Flat Campground is also an important birding destination and considered an eBird "hotspot" with approximately 183 different species reported by birders to eBird (Arizona Game and Fish Department 2018e).

Mine Area and Associated Infrastructure

MOTORIZED ROUTES

The analysis area comprises portions of both the Mesa and Globe Ranger Districts. Generally, recreation opportunities in these areas are the same, ranging in elevation from a low point of approximately 1,500 feet along the western boundary of the analysis area (the terminus of the MARRCO corridor) up to the high point of the analysis area, King's Crown Peak (north of the East Plant Site) at approximately 5,500 feet. Commonly used NFS roads within the analysis area are described here (see also figure 3.9.3-1).

NFS Road 2440—NFS Road 2440, also known as the Cross Canyon Road, extends approximately 1.75 miles from SR 177 on the east side of Superior, Arizona, into the western portion of the Apache Leap SMA. The road is gated at its junction with private land approximately 0.5 mile from SR 177. Public users park at this gate and walk the roadbed, through the private land parcel owned by Resolution Copper, for the remaining 1.25 miles to enter the western portion of the Apache Leap SMA. From various points along this route, users leave the roadway and travel overland farther into the Apache Leap SMA for dispersed recreation opportunities.

Resolution Copper holds a permit for the use of NFS Road 2440 to access two groundwater monitoring wells (MB-03 and QC-04) within the Apache Leap SMA, as permitted by the Resolution Copper pre-feasibility plan (U.S. Forest Service 2010b). Resolution Copper conducts minimal maintenance on the road to provide the level of access necessary to collect monitoring data and maintain the wells.

NFS Road 282—NFS Road 282 extends approximately 1.75 miles from SR 177 toward the southwestern portion of the Apache Leap SMA. The road is gated at its junction with private land. Users park vehicles at this gate and access the southwestern portion of the Apache Leap SMA on undesignated user-created routes that cross private lands.

U.S. 60/Queen Creek Corridor—Users access the northern and northwestern portion of the Apache Leap SMA from several undesignated nonmotorized access routes that originate along U.S. 60 east of Superior, Arizona. Users navigate the steep slopes to climb out of the Queen Creek drainage and can also access the Apache Leap SMA to the south via undesignated trails. Access from these points requires users to cross private (owned by Resolution Copper) lands to enter the area. Scenic driving is also common along this corridor, which is designated as the Gila-Pinal Scenic Road.

NFS Road 315—NFS Road 315 is the primary access into Oak Flat and the Oak Flat Campground. Several undesignated parking areas along NFS Road 315 provide access to the eastern portion of the Apache Leap SMA. Users travel overland on multiple, nonmotorized undesignated user-created routes to the top of the Apache Leap escarpment. These routes provide the primary access for rock climbing in the Apache Leap area, as well as Lower Devil's Canyon, Hackberry Canyon, and the Refuge.

NFS Road 357/NFS Road 650 (aka Hewitt Station Road/Happy Camp Road)—NFS Road 357 and NFS Road 650 are the primary access to the Tonto National Forest lands north of Superior and south of the

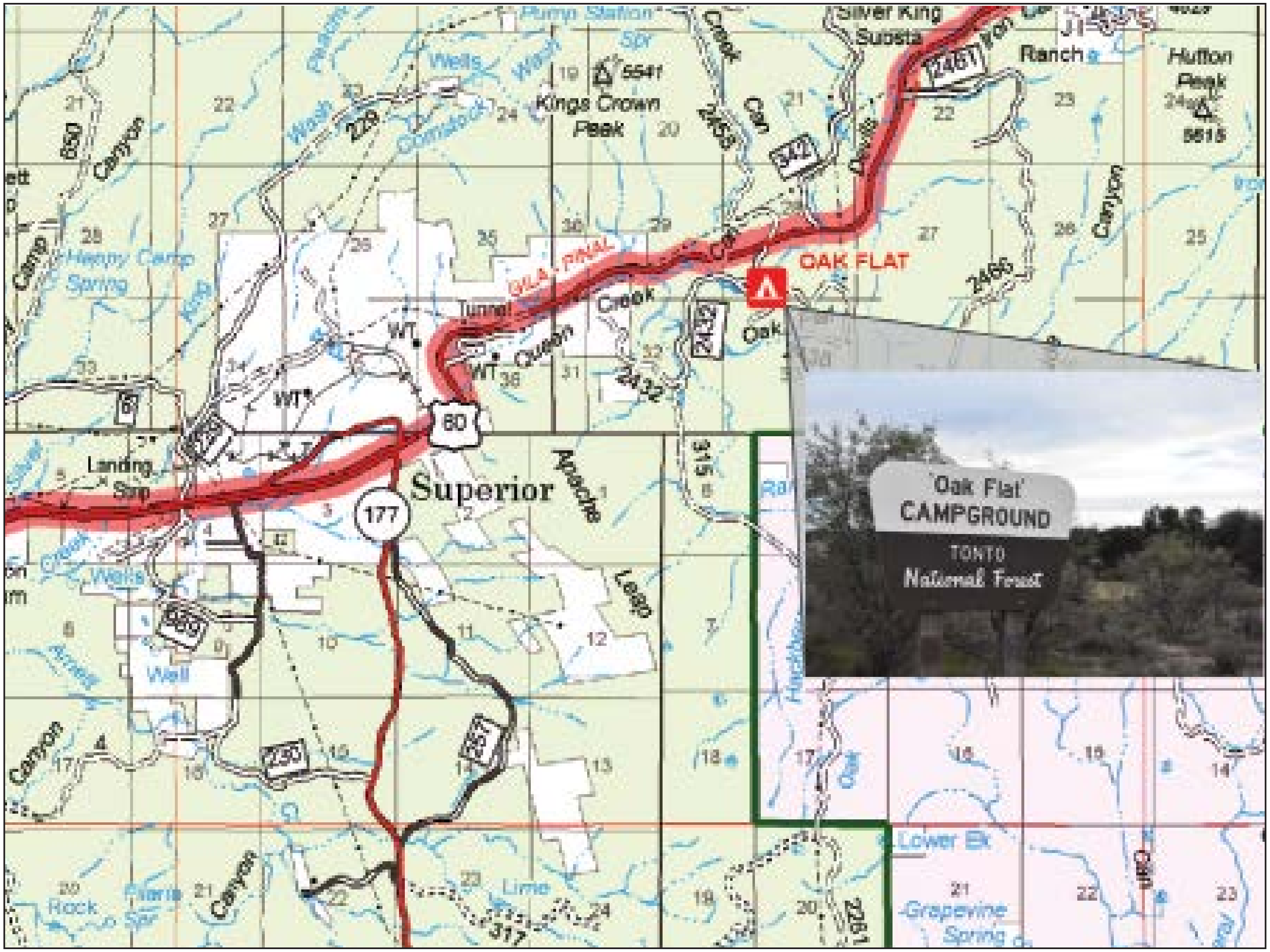


Figure 3.9.3-5. Location of Oak Flat Campground

Superstition Wilderness. These routes are often combined with other nearby routes to form a loop, popular for OHV users; however, access via NFS Road 357 has been restricted by gated entry at the private property boundary. These routes also provide the primary access to the Arizona Trail, and lead to trailheads to the popular Roger's and Reavis Canyon trails.

NFS Road 342—NFS Road 342 is a popular OHV route that may also be used in conjunction with NFS Road 650 for a loop route accessed from U.S. 60 (see figure 3.9.3-1).

ROCK CLIMBING

The analysis area includes unique geological features that offer bouldering as well as technical, sport, traditional ("trad"), and top-rope rock climbing opportunities (Karabin Jr. 1996; Oliver 2017). Before 2004, the public could drive vehicles and park unimpeded along the Magma Mine Road and the area that is now the East Plant Site to access climbing areas in Oak Flat and Apache Leap. A portion of this area is now closed to public access due to safety concerns; however, limited parking is still available along the Magma Mine Road near Euro Dog Valley, the Mine Area, and Apache Leap. Resolution Copper has been working with local climbing groups since 2004 to establish legal access to their private lands that would still be available for climbing. A final agreement was signed that keeps the Pond and Atlantis climbing areas, which are on Resolution Copper–owned property, perpetually open for public use. Figure 3.9.3-6 illustrates the known climbing opportunities in the analysis area.

Oak Flat and Euro Dog Valley

The Oak Flat bouldering area is 0.5 to 1 mile southwest of Oak Flat Campground, east of Magma Mine Road (NFS Road 315) (see figure 3.9.3-6) and is managed by the Forest Service. Euro Dog Valley, Oak Flat East, and Oak Flat West all offer freestanding boulders and small cliff-lined canyons, with over 1,000 documented boulder routes and problems. The Phoenix Bouldering Contest and Phoenix Boulder Blast were held in Oak Flat from 1989 through 2004, and various other climbing and/or bouldering competitions have been held in this area as recently as 2016, including the Queen Creek Boulder Competition. These events drew competitive climbers from all over the world.

Mine Area

The Mine Area is immediately south of the East Plant Site and east (above) Apache Leap (see figure 3.9.3-6) and is on lands owned by Resolution Copper. Public access to the Mine Area has been limited since operations resumed at the former Magma Mine in the mid-2000s. Public users are not permitted beyond the security gate along Magma Mine Road. The Mine Area contains over 100 documented short sport routes (25–50 feet). Some portions of the Mine Area (nearest U.S. 60) are available to registered users.

Devil's Canyon

Northern Devil's canyon is located north of U.S. 60 (see figure 3.9.3-6). Upper Devil's Canyon is accessed from Oak Flat Campground by way of NFS Road 2438. Lower Devil's Canyon is accessed from Oak Flat Campground by way of NFS Road 315. There are over 400 documented climbing routes in Devil's Canyon, with a mixture of sport and trad routes on walls (including the 200-foot tall Nacho Wall), as well as numerous freestanding pinnacles and towers.

Apache Leap

Apache Leap contains many of the tallest climbing routes in the Queen Creek area. Climbing opportunities consist of mostly traditional routes, but also 80 bolted routes and 16 boulder problems. Popular established routes include the Lectra Area, Lost Horizon, Rim Gym, Staging Area, Punk Rock, Headstone, Citadel, The Draw, Musicland Wall, Geronimo Area, Skyscraper Area, and The Fin (Queen Creek Coalition 2015). Climbing routes in the Apache Leap area are accessed by way of Magma Mine Road (NFS Road 315). The majority of these routes are located on the escarpment (see figure 3.9.3-6) and are accessed from parking areas

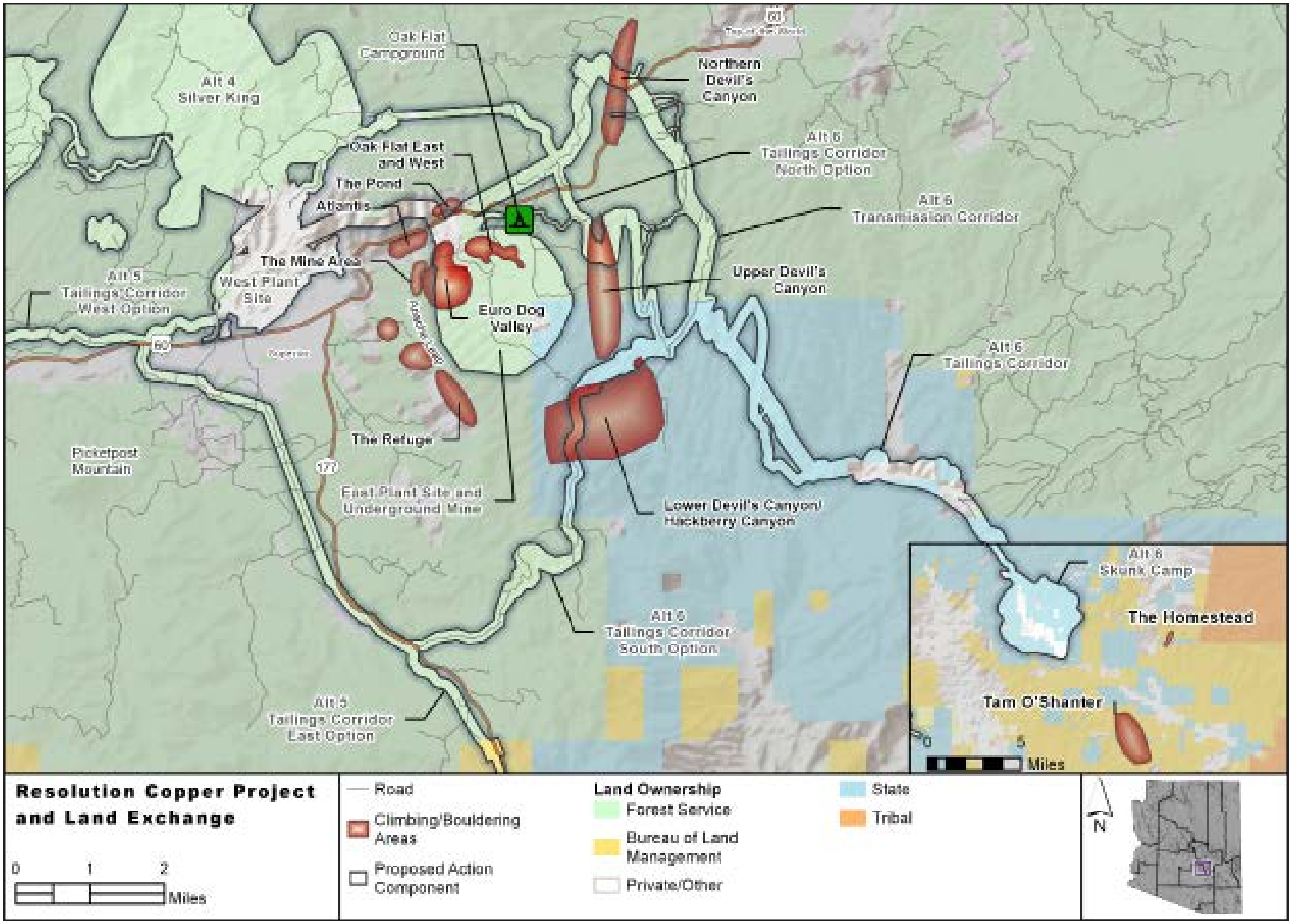


Figure 3.9.3-6. Climbing opportunities overview

on NFS Road 315. Climbers hike to the east side of the Apache Leap SMA via overland undesignated routes and rappel into the climbing areas. Other areas in the central portion of the Apache Leap SMA, including a popular route called The Fin, are accessed via NFS Road 2440 and overland undesignated routes (U.S. Forest Service 2017c).

Resolution Copper Private Land (Queen Creek Canyon)

Generally, popular sport, crack, and crag climbing routes are available along or accessed from U.S. 60 northbound from the bridge and underground tunnel, north to the top of the canyon (a stretch of approximately 2 miles). The Pond and Atlantis can be accessed from within Queen Creek Canyon, along U.S. 60 (see figure 3.9.3-6). These areas, along with the Mine Area and other climbing areas containing established climbing routes, are on Resolution Copper property and now require that users register and sign a waiver via a free, online registry to gain legal access (Resolution Copper 2018). Parking is located along U.S. 60 at various pull-offs along the highway, particularly on the north side of the tunnel.

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

Impacts that occur under more than one alternative are discussed under the first applicable alternative and are then referenced under other pertinent alternatives.

3.9.4.1 Alternative 1 – No Action

Under the no action alternative, the project would not be developed, and existing recreational uses would continue under current conditions. The settings, landscape, recreation sites, roads, and trails within the analysis area would continue to be affected by current conditions and ongoing actions. Oak Flat would remain open to public use. Routine maintenance of NFS roads, the Arizona Trail, and other recreation resources would continue.

Access to public land in the area would continue; rock climbing and bouldering opportunities in the Mine Area, Euro Dog Valley, and Oak Flat would remain available. Recreation opportunities in the analysis area would continue to be managed consistent with the ROS setting indicators and objectives of the forest plan. Hunting opportunities would not change in the analysis area. Motorized routes would not be closed as a result of any Resolution Copper mining activities, subject to existing rights and permits.

3.9.4.2 Impacts Common to All Action Alternatives

Impacts that would occur under each of the action alternatives are presented in this section. Regardless of action alternative, the principal adverse impact on recreational users of public lands as a result of the proposed action or alternatives would be through closure of lands to public access, meaning both direct loss of recreational use of the lands themselves and potential loss of access to adjacent lands because movement across these areas would become prohibited. Other impacts on recreational users may occur through increased traffic, increased noise, changes to the scenery or visual qualities of certain areas, and other mine-induced effects. Such effects are noted in the following text and addressed in greater detail in the portions of chapter 3 relevant to each of those resources.

A number of existing Resolution Copper–owned properties in the recreation analysis area are, by and large, already closed to public access: these include the privately held portions of the East Plant Site, the West Plant Site, and the filter plant and loadout facility. Thus, in the impact analyses presented in the sections that follow, loss of access to or across these private lands is not considered as a change from current, existing conditions. However, potential expansion of any of these facilities onto Tonto National Forest or other public lands as a result of project approval is considered a change from current conditions and thus an impact. So, too, is potential development of new facilities or physical alteration of lands that would result in closure of lands to recreational use or through-access, such as construction at any of the tailings storage facility locations or development of the anticipated subsidence area at Oak Flat.

The following project components that are common to all action alternatives are considered in the impact analyses: tailings storage facility including fence line boundary; subsidence area; East Plant Site expansion onto Tonto National Forest lands; MARRCO corridor; and conveyance of the Oak Flat Federal Parcel to Resolution Copper through the NDAA-mandated land exchange. It should be noted that tailings pipelines corridors and power transmission line corridors, though part of mine facilities under any alternative, are not considered in this analysis as closed to public crossing or other access.

Components or differing configurations of components that are unique to one or more alternatives are described and addressed in the portions of the analysis specific to each alternative.

Effects of the Land Exchange

The land exchange would have significant effects on recreation. The Oak Flat Federal Parcel would leave Forest Service jurisdiction, and with it myriad recreational opportunities currently available and used by the public. The Oak Flat bouldering area offers freestanding bounders and small cliff-lined canyons with over 1,000 documented boulder routes and problems. The area has held various bouldering and climbing competitions as recently as 2016 and the Phoenix Bouldering Contests and Phoenix Boulder Blasts through 2004; all climbing and bouldering areas would be lost when the Oak Flat Federal Parcel transfers out of Federal ownership. Additional recreational activities that would be lost include camping at the Oak Flat Campground, picnicking, and nature viewing. The campground currently provides approximately 20 campsites and a large stand of native oak trees. It also is boasted as an important birding destination with approximately 183 different species reported by birders.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. The eight parcels would have beneficial effects; they would become accessible by the public and would be managed by the Federal Government for multiple uses, which could include recreational activities. Some parcels, specifically Cave Creek, Tangle Creek, and Turkey Creek, all have trails leading directly into them. Under Federal management, these parcels could provide an extension of current recreational activities in those areas. Specific uses would be identified by the respective agency upon conduction of the land exchange; however, the Forest Service and BLM have the capacity to also plan for dispersed, developed, and wilderness recreation opportunities on the offered lands parcels.

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). A number of standards and guidelines (18) were identified applicable to management of recreation resources. None of these standards and guidelines were found to require amendment to the proposed project, either on a forest-wide or management area-specific basis. For additional details on specific rationale, see Shin (2019).

While standards and guidelines were not found to require amendment, the project would have effects on the recreation resources within the Tonto National Forest by modifying the acres under ROSs. Table 3.9.4-1 lists the acres of the project footprint that would fall within each ROS category within each of the affected management areas. Also shown is the percentage this acreage represents of the total ROS category in each management area. Overall, for the semi-primitive category most likely to be affected by mining impacts (note there is no primitive acreage within

Table 3.9.4-1. Effect of the project on the recreation opportunity spectrum within Management Areas 2F and 3I (acres)

Management Area/ROS*	Alternative 2 and 3	Alternative 4	Alternative 5 (East Option)	Alternative 5 (West Option)	Alternative 6 (North Option)	Alternative 6 (South Option)
2F						
R	–	–	–	–	–	
RN	1,488 (1.5%)	1.950 (2%)	1,849 (1.9%)	1,325 (1.4%)	1,612 (1.7%)	1,926 (2%)
SPM	2,012 (<1%)	5,548 (2.4%)	986 (<1%)	1,173 (<1%)	1,665 (<1%)	1,617 (<1%)
SPNM	–	3 (<1%)	1,209 (1.8%)	–	2 (<1%)	2 (<1%)
U	1,126 (8.6%)	1,829 (14%)	–	1,153 (8.8%)	1,261 (9.6%)	1,209 (9.2%)
3I						
R	–	–	–	–	–	–
RN	727 (1.1%)	128 (<1%)	128 (<1%)	128 (<1%)	128 (<1%)	128 (<1%)
SPM	3,276 (2.6%)	–	–	–	–	–
SPNM	–	–	–	–	–	–
U	–	–	–	–	–	–

Note: Table presents acres of project footprint within each ROS, and percentage of that ROS that could be changed by the project (in parentheses)
* ROS classifications: R = roaded, RN = roaded natural, SPM = semiprimitive motorized, SPNM = semiprimitive nonmotorized, U = urban

these management areas), changes range up to 2 percent for MA 2F (non-motorized category), and up to 2.6 percent for MA 3I (motorized category). Implementation of the project would require amending the forest plan by changing the percentages of areas with semi-primitive ROS categories within management areas 2F and 3I.

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 recreation. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper include the following:

- Developing traditional and sport climbing open to the public on Resolution Copper property outside of the mining footprint through agreement with Queen Creek Coalition. Further detail can be found on the Queen Creek Coalition website and the agreement with REI.
- Developing a concentrate pipeline corridor management plan to reestablish crossing on the Arizona Trail after construction. Further detail can be found in the Concentrate Pipeline Corridor Management Plan (M3 Engineering and Technology Corporation 2019b).

To prevent exposure of the public to geological hazards, Resolution Copper would use fencing, berms, locking gates, signage, natural barriers/steep terrain (25 to 30 percent or greater), and site security measures to limit access roads and other locations near areas of heavy recreational use.

General Setting

It is possible that users could be displaced or opportunities for public recreation activities could be diminished in portions of the action alternatives area where public access is restricted. The subsidence area (approximately 1,560 acres of NFS lands, prior to the land exchange) would be lost for public access in perpetuity. Based on current knowledge, the steep and unstable slopes of the subsidence area are projected to be unsafe for future public access.

The removal of covering vegetation during pre-mining and mining operations would have an indirect impact on adjacent recreational users in the analysis area from diminishing the quality of the recreational setting. The recreation setting would be changed as a result of the visual contrast these activities introduce to the existing landscape. Although the sight of mining activities may not affect some recreational users (e.g., hunting or OHV driving), those seeking the features of a natural setting may see the change to the existing landscape as an obstacle to their chosen recreation activity.

Mining-related activities associated with each alternative (East Plant Site, subsidence area, power lines, and West Plant Site [where permitted by private landowners]) would lead to increased traffic (including large trucks) on U.S. 60 (the Gila-Pinal Scenic Road) during construction and delivery of heavy equipment. This additional activity would change the experience for some visitors driving on the scenic road, and it would affect visitor safety when visitors encounter these activities. As many as 44 round-trip truck traffic shipments would occur per day. Major deliveries requiring road shutdown would be coordinated to reduce the amount of time closures consistent with current Resolution Copper practices. However, the increase in heavy-truck traffic is expected to contribute to increased traffic noise and intermittent traffic slowdowns on this scenic portion of U.S. 60. The recreation experience for those visitors and locals who currently use U.S. 60 and the Gila-Pinal Scenic Road would change due to the increase in large truck traffic.

Special Use Activities

Existing permitted outfitter and guide services for recreation or hunting would continue to operate throughout the analysis area but would no longer be permitted to use areas within the East Plant Site (including Oak Flat), and, depending upon the alternative, the proposed tailings storage facility and tailings corridors would not be permitted in areas that are closed to public access. Future special uses would be considered on a case-by-case basis as applications are received. Special use activities are not analyzed in the following text for each alternative; supporting analysis is in the project record.

Recreation Opportunity Spectrum

A direct loss of acreage available for recreation activities would occur under all action alternatives. Each of the action alternatives would result in the direct removal of differing amounts of acres from public entry, which represents the area that would be enclosed by perimeter fencing for public safety purposes. It is assumed that all areas on NFS land (and certain ASLD, BLM, and private lands), other than that excluded for safety around the subsidence area, would eventually be opened to public access post-mining. The subsidence area (approximately 1,560 acres of NFS lands, prior to the land exchange) would be lost for public access in perpetuity. Based on current knowledge, the steep and unstable slopes of the subsidence area are projected to be unsafe for future public access. However, the exact area and timing of opening areas to public access would need to be evaluated at the end of mining activities. While not anticipated, some areas (other than the subsidence area—e.g., pipelines, rail lines, or power lines) may be not be safe for public access, while others may require public access restrictions until reclamation activities have been successfully completed.

In addition to the direct loss of acreage available for recreation activities and opportunities, a change from the existing undeveloped nature of the analysis area (semiprimitive settings) and surrounding area to a more developed, industrialized setting would occur under all action alternatives. During construction, active mining and operations, and closure and final reclamation, the affected areas would not be compatible with the established setting indicators for any of the ROS settings present.

The industrialized setting of the East Plant Site would include increased industrial noise, mine-related traffic, and equipment operation (including backup alarms). Traffic, construction, and equipment operation within the project area would result in increased noise, ranging from 80 to 30 dBA at the fence line surrounding mining operations. A noise level of 80 dBA is comparable to the sound of a forklift or front-end loader from 50 feet away. A noise level of 30 to 40 dBA is comparable to the sound of a quiet suburban area at night (Tetra Tech Inc. 2019).

Although these increased noise levels associated with operations would not be readily apparent to motorized recreational users over the sound of their personal vehicles, sounds during mine operations may be audible to campers, hikers, mountain bikers, and equestrians from the fence line surrounding mining operations or along access roads. In particular, campers using dispersed sites in close proximity to mining operations and daytime visitors to Apache Leap could be impacted by increased noise levels resulting from facility operations. However, the degree of impact from noise on dispersed recreation is largely dependent on timing, terrain shielding, open landscapes, and mining noise attenuation and dispersion.

Mining operations lighting would result in changes to the nighttime recreational setting on lands surrounding the East Plant Site by increasing sky glow and direct visible glare both from facilities and vehicles; design features would minimize the impact but would not eliminate it (Dark Sky Partners LLC 2018). These changes may contribute to displacement of dispersed, nonmotorized recreation activities and opportunities from lands within and surrounding the analysis area.

The location of the new power line corridors between Oak Flat Substation, East Plant Site, West Plant Site, and the MARRCO corridor would be the same under all action alternatives. During and following construction, the presence of a new power line would contribute to diminishing the recreation setting (classified as roaded natural) along the power line corridor but would be consistent with the management objectives for the area. The impacts on ROS that are specific to each alternative are discussed in the following text.

Hunting

Hunting opportunities (for both big and small game) could be displaced by mining activities. This would be a minor impact on hunting overall and would not completely eliminate hunting opportunities in the affected GMUs, since the areas within GMUs that are outside of the alternatives' footprints would remain available for hunting, subject to applicable laws and regulations. Resolution Copper would post signs in accordance with the laws and regulations for hunting to indicate the areas that would be closed to hunting to accommodate mining activities. Nonetheless, impacts on individual hunters may be moderate or even major if public use of an individual hunter's preferred hunting grounds is eliminated. As shown in a recent AGFD report (Arizona Game and Fish Department 2018c), hunter valuation surveys found that a moderate to high number of hunters found the areas west of Superior, Arizona, to be of high value for hunting mule deer, white-tailed deer, javelina, quail, dove, and predator species.

In addition, human presence and mining activities would likely cause some wildlife species to temporarily avoid these areas. Many of the wildlife species being hunted would likely not be present during mining activities due to increased noise, light, and human activity. Following mining activities, disturbed areas would return to preexisting conditions to the extent practicable. It is expected that wildlife would no longer avoid areas but return to the extent that the native habitats return. Active impacts on hunting would cease and hunting opportunities would likely improve over time as wildlife habitats return to disturbed areas. Mining activities would not avoid hunting seasons in some instances and there would be site-specific, localized, moderate impact on individual hunters (or hunting groups and outfitters) during mining activities if their preferred access is temporarily or permanently closed or restricted. This impact would not extend to hunting overall, but could represent a long-term obstacle to an individual hunter's preferred access to a particular area. Coordination with the AGFD would attempt to avoid and minimize these impacts. The number of Arizona hunting permits that are issued in individual GMUs would not change as a result of any of the action alternatives being implemented. The availability to hunt in the analysis area's GMUs and the number of hunting permits per GMU would not be affected under any action alternative. Further, hunter days would not change under any alternative, since hunting could persist elsewhere in the GMU. Hunting is not analyzed for each alternative.

Recreation Sites

There would be no direct impacts on designated wilderness as a result of any of the action alternatives. Visitors to the Superstition Wilderness would have foreground and background views of the East Plant Site from trails and overlooks, which would be similar to the existing views of the East Plant Site but with a larger visual effect. The most affected views would be from the several trails that provide both motorized and nonmotorized access to mountain and ridgetop summits and would afford direct, superior (from above and oriented downward), and unadulterated views of mining operations (e.g., north of Superior or north of Oak Flat). Similarly, views from Apache Leap and Picketpost Mountain would have unadulterated views of the East Plant Site. Although the location and size of the different elements of the project vary by alternative, because of the distance and angle of views, the impacts on the public visiting the wilderness, Apache Leap, and Picketpost Mountain would be similar for all action alternatives. Views of the East Plant Site would contribute to a slightly more diminished sense of solitude and primitive setting for some wilderness visitors (see Section 3.11, Scenic Resources).

Activities from mine operations that produce sound (as described in Section 3.4, Noise and Vibration) would be noticeable to users of adjacent dispersed recreation areas. The degree of impact from noise on the recreation setting is largely dependent on the chosen recreation activity, terrain shielding, open landscapes, and mining noise dispersion.

Because recreationists would no longer have access to the lands within the areas of mining operations, it is likely that increased use would occur on other nearby lands that provide similar experiences, depending upon the recreational user type. A minor to moderate increase in user activity would be expected to occur in recreational use areas similar to those displaced by the project elsewhere in the Globe Ranger District, as well as on other Federal, State, and County lands.

Under all alternatives, Passage 18 of the Arizona Trail, as well as several other proposed trail corridors (Logan Simpson Design Inc. 2007), would be crossed by the new slurry line that would be constructed within the MARRCO corridor. Crossing of the Arizona Trail would interfere with the nature and purposes of the Arizona Trail. Each alternative discussion presented here provides a relative degree to which each alternative interferes with the Arizona Trail. There would be short-term impacts on trail users during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but these would only occur during the activity, and when conditions are safe for hikers, cyclists, and equestrian users, the impact would cease. Contractors would provide necessary detours or signage for Arizona Trail user awareness during these activities. The recreation setting for this portion of Passage 18 would not change. This area of Passage 18 that is intersected by the MARRCO corridor is previously disturbed, including the railroad corridor, parking lot, and Hewitt Station Road.

Motorized Recreation

Under all alternatives, certain NFS roads would be closed to public use, either because the route would be covered or removed as a result of the construction of the East Plant Site or the West Plant Site, or because the route would no longer be safe for the public to use (e.g., the subsidence area), or both. In many cases, the route is crossed by a linear feature such as the MARRCO corridor or the power line corridor and would be closed during construction, and after that time only closed for brief periods of maintenance when not safe for public use. Site-specific impacts on motorized recreation would occur but would cease when the route is safe for public use. Table 3.9.4-2 presents the NFS roads that would be impacted under all action alternatives.

Table 3.9.4-2. National Forest System roads that would be impacted under all action alternatives

NFS Road No.	Distance (miles)	Location
2432	0.78	East Plant Site/Subsidence area
2433	0.23	East Plant Site/Subsidence area
2434	0.29	East Plant Site/Subsidence area
2435	0.28	East Plant Site/Subsidence area
2438	0.32	East Plant Site/Subsidence area
315	2.28	East Plant Site/Subsidence area
3153	1.19	East Plant Site/Subsidence area
3791	0.01	East Plant Site/Subsidence area
1933	0.07	MARRCO corridor
229	0.01	MARRCO corridor
2396	0.01	MARRCO corridor
252	0.01	MARRCO corridor
293	0.01	MARRCO corridor
3454A	0.01	MARRCO corridor
3454C	0.01	MARRCO corridor
357	0.40	MARRCO corridor
8	0.01	MARRCO corridor
1010	0.37	West Plant Site
229	1.10	West Plant Site
229	1.07	Silver King Mine Road realignment
2401	0.01	Silver King Mine Road realignment

Site-specific and localized moderate impact on individual motorized users (or groups or permitted guides/outfitters) during mining activities would occur if their preferred access is temporarily or permanently closed or restricted. Indirect impacts of the loss of routes shown in table 3.9.4-2 include changes in how users must reach destinations (i.e., a change to a user's recreation experience). If closed, a given route's destination may still be reachable but from a different ingress point and potentially a sequence of connected but much longer routes. This impact would not extend to motorized recreation in the analysis area overall but could represent an obstacle or change to an individual motorized user's preferred access to a particular area.

Rock Climbing

Rock climbing opportunities at Euro Dog Valley, Oak Flat, and portions of the Mine Area would be lost under all action alternatives. Table 3.9.4-3 provides a breakdown of the climbing opportunities that would be lost under all alternatives due to the development of the East Plant Site.

The loss of Euro Dog Valley and Oak Flat would be a major, long-term impact on the climbing opportunities of central Arizona, particularly bouldering. There are no other developed climbing areas that are as specific to bouldering and that offer as numerous opportunities as Euro Dog Valley and Oak Flat in the analysis area; the nearest bouldering opportunities that even come close to the bouldering opportunities that are available at Euro Dog Valley and Oak Flat are located in northwest Phoenix (Icecapades and South Mountain); Prescott, Arizona; and Mount Lemmon near Tucson.

3.9.4.3 Alternative 2 – Near West Proposed Action

The analysis for potential impacts on recreation resources of Alternative 2 where implemented only applies to the tailings storage facility location; all other project components and activities and their potential to impact recreation resources remain identical to those described earlier in this section under "Impacts Common to All Action Alternatives."

Table 3.9.4-3. Climbing resources that would be lost under all action alternatives

Climbing Area	Roped Climbing Routes	Boulder Problems
Oak Flat (East and West)	Sport routes: 2 Trad routes: 0 Top-rope routes: 3 Aid routes: 0 Total: 5	Boulder problems: 527 Top-rope boulder problems: 268 Total: 795
Euro Dog Valley	Sport routes: 37 Trad routes: 8 Top-rope routes: 2 Aid routes: 1 Total: 48	Boulder problems: 179 Top-rope boulder problems: 99 Total: 278
The Mine Area	Sport routes: 100 Trad routes: 27 Top-rope routes: 23 Aid routes: 0 Total: 150	Boulder problems: 41 Top-rope boulder problems: 0 Total: 41

Source: Oliver (2017)

General Setting

The tailings storage facility would be located in an area of the Tonto National Forest that experiences high use (particularly during the fall and winter seasons) for both dispersed and motorized recreation. All public access would be eliminated on approximately 7,788 acres, the area to be fenced surrounding the tailings storage facility and tailings corridor, the borrow area, the East Plant Site, land exchange boundary, and subsidence area. Though the analysis area has a long history of mining, the current recreation setting would change in the tailings storage facility and immediately adjacent lands. Activities involving hiking or driving to ridgetops increase the likelihood that the tailings storage facility would be visible and change the recreation setting. The Arizona Trail is approximately 1 mile east of the tailings storage facility, paralleling the eastern boundary of the tailings storage facility for 3 miles. Dispersed recreation activities would be temporarily affected as noises, visual disturbances, and/or the presence of other humans could detract from their chosen recreation opportunities and activities. Recreation users who seek opportunities for solitude commonly seek areas where they would be less likely to see other humans.

The changes to public motorized access could permanently change the OHV use patterns in the area, subject to Federal, State, and local OHV and traffic laws and regulations. New private access roads would be signed and would be closed to the public, but illegal OHV use may not be entirely preventable on the new access roads. Existing and new OHV users may be drawn to the tailings storage facility and tailings corridor through curiosity and interest in mining. Design features such as locked gates and signage indicating road status would decrease the magnitude of these impacts. Illegal and/or unauthorized use of access roads would be enforceable by Forest Service law enforcement, or other local jurisdiction law enforcement (e.g., County or State).

Recreation Opportunity Spectrum

The Alternative 2 tailings storage facility, borrow area, and tailings pipeline corridor would result in the direct removal of up to approximately 4,994 acres of Tonto National Forest lands from public entry, which represents the area that would be enclosed by perimeter fencing for public safety purposes. Access to lands within the perimeter fence would be closed to the public for safety concerns from perimeter fence construction through closure and final reclamation.

None of the tailings storage facility would occur within the semiprimitive nonmotorized setting. Approximately 4,239 acres of the tailings storage facility would be within the semiprimitive motorized setting, and approximately 664 acres within the roaded natural setting; these areas would be unavailable for public use. Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility and tailings corridor would result in a change from the existing undeveloped, semiprimitive nonmotorized and motorized recreation setting on lands surrounding the tailings storage facility to a developed setting, visible from superior views for miles in all directions. People currently use these areas for a wide variety of recreation activities. This change would result in a reduction of approximately 13 percent of the available semiprimitive nonmotorized setting, 17 percent of the available semiprimitive motorized setting, and 5 percent of the available roaded natural setting within the Globe Ranger District. While most of these lands would still be available for these uses after closure of the mine, the recreation opportunity available to the public would change. For instance, once deemed safe, reclaimed tailings facilities could become opened to non-motorized or motorized recreation. The proposed borrow area would also be closed to the public, representing a loss of approximately 90 acres of semiprimitive motorized areas.

The activities proposed under Alternative 2 would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the Alternative 2 facilities from trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility were visible. The tailings storage facility would be located 3.75 miles from the Superstition Wilderness, 3 miles from Picketpost Mountain, and 5.25 miles from Apache Leap.

In the Passage 18 segment, 0.07 mile of the proposed tailings pipeline corridor would intersect the Arizona Trail, interfering with the nature and purpose of Passage 18 of the Arizona Trail. The intersection of the Arizona Trail occurs in two separate locations, approximately 4 miles north of the beginning (i.e., trailhead) of Passage 18, and approximately 14 miles south of the ending of Passage 18, where the Arizona Trail transitions to another passage at the southern boundary of the Superstition Wilderness.

The area of these intersections is in highly variable topography. At the point of intersections with Alternative 2, the Arizona Trail is located on the bottom of drainages associated with Potts and Whitford Canyons, flanked by steep canyon walls on all sides in an area that is relatively undisturbed, but does show signs of motorized uses and mining activities, such as traffic on NFS Road 982. NFS Road 982 shares the same point of intersection with the proposed Alternative 2 tailings corridor as the Arizona Trail. This area is currently managed under the ROS classification of semiprimitive motorized.

Because Alternative 2 would result in substantial interference with the nature and purpose of the Arizona Trail, Resolution Copper is proposing substantial design features. Resolution Copper would construct an "overpass" for the tailings corridor that would span the Arizona Trail, as shown on Figure 3.0-1h of the GPO. Recreation access along Passage 18 would be maintained during construction, and the span would not impede Arizona Trail access during operation or maintenance. There would be short-term impacts on trail users during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but these would only occur during the activity, and when conditions are safe for hikers, cyclists, and equestrian users, the impact would cease. Contractors would provide necessary detours or signage for Arizona Trail user awareness during these activities. Because the area is managed by the Tonto National Forest as semiprimitive motorized, the activities proposed under Alternative 2, while representative of a change to the recreation setting, would not change the setting in a manner that would change the recreation setting of Passage 18.

Motorized Recreation

The tailings storage facility would intersect 27 NFS roads. Appendix K of the GPO provides a breakdown of the NFS roads that would be impacted by Alternative 2. Not all NFS roads impacted by project activities would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the proposed Alternative 2 tailings storage facility or along the tailings corridor; opportunities to develop new climbing resources would not be available. This tailings facility location would not have additional impacts on climbing resources outside of the impacts common to all.

3.9.4.4 Alternative 3 – Near West Ultrathickened

The impacts would be the same as described under Alternative 2.

3.9.4.5 Alternative 4 – Silver King

General Setting

The recreation setting is similar to that described under Alternative 2. The area currently experiences slightly less use than Alternative 2 and 3 because access (both nonmotorized and motorized) requires traveling farther distances or more difficult routes than Alternatives 2 and 3.

Recreation Opportunity Spectrum

A total of approximately 3 acres of tailings storage facility, fence line, and tailings pipeline corridor would be within semiprimitive nonmotorized settings, approximately 4,654 acres within the semiprimitive motorized setting, and approximately 528 acres within the roaded natural setting; these areas would be unavailable for public use. In addition, approximately 566 acres of urban areas (or unclassified areas) would be unavailable for public use. Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility and tailings corridor would result in a change from the existing undeveloped, semiprimitive nonmotorized and motorized recreation setting on lands surrounding the tailings storage facility to a developed setting, visible from superior views for miles in all directions. People currently use these areas for a wide variety of recreation activities. This change would result in a reduction of approximately 17 percent of the available semiprimitive nonmotorized setting, 16 percent of the available semiprimitive motorized setting, and 7 percent of the available roaded natural setting within the Globe Ranger District. While most of these lands would still be available for these uses after closure of the mine, the recreation opportunity available to the public would change. After mine closure and reclamation, it is anticipated that the ROS value of semiprimitive nonmotorized would be restored to the Silver King area to the extent practical. The proposed borrow area would also be closed to the public, representing a loss of approximately 90 acres of semiprimitive motorized areas.

The activities proposed under Alternative 4 would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

Visitors to the Superstition Wilderness, Picketpost Mountain, and Apache Leap would have foreground and background views of the tailings storage facility from trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility were visible. The tailings storage facility would be located approximately 0.6 mile from the southern boundary of the Superstition Wilderness, 4 miles from Picketpost Mountain, and 1.95 miles from the north end of Apache Leap.

The Arizona Trail is located within the Alternative 4 proposed tailings storage facility. This would result in substantial interference to the nature and purpose of the Arizona Trail. Implementation of Alternative 4 would require 3.05 miles of the Arizona Trail to be closed and relocated to an area that would be safe for public use, which would meet the intent of the National Trails System Act and fulfill the nature and purpose of the Arizona Trail. Relocation of the Arizona Trail would require identification, environmental studies, and construction to replace the approximately 4 to 5 miles of existing trail that would be impacted under Alternative 4. The new construction would require a different trailway approach and exit in addition to the 3.05-mile direct loss of Arizona Trail. A temporary route may be required for Arizona Trail through-hikers for approximately 1 to 2 years until a permanent reroute location is identified, studied, and designated. In addition to the Arizona Trail, the Silver King alternative also intersects multiple other proposed NFS trail corridors.

Motorized Recreation

The tailings storage facility would intersect 26 NFS roads. Not all NFS roads impacted by this alternative would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the Alternative 4 tailings storage facility or along the tailings corridor; opportunities to develop new climbing resources would not be available. This tailings facility location would not have additional impacts on climbing resources outside of the impacts common to all.

3.9.4.6 Alternative 5 – Peg Leg

General Setting

The majority of the tailings storage facility and tailings corridor for this alternative would be located on BLM-administered lands that experience low to moderate dispersed recreation. Recreation is generally concentrated on lands adjacent to the Gila River, north of where the tailings storage facility would be located. BLM-administered lands within and adjacent to the tailings storage facility are managed as an

ERMA, where typically recreation is non-specialized, dispersed, and does not require intensive management. All public access would be eliminated on 10,781 acres (6,484 acres of which is BLM-administered and open to public recreation), the area to be fenced surrounding the tailings storage facility. The remaining 4,267 acres located within the fenced area of the tailings storage facility are private and Arizona State Trust lands. The Arizona Trail is located approximately 2 miles east of the tailings storage facility, roughly paralleling the eastern boundary of the tailings storage facility for approximately 4 miles. Recreational users that seek opportunities for solitude commonly seek areas where they would be less likely to see other humans. Dispersed recreation activities would be temporarily affected as noises, visual disturbances, and/or the presence of other humans could detract from their chosen recreation opportunities and activities during the approximately 50-year mine life.

Only 7.7 miles of the east pipeline corridor and 8.8 miles of the west pipeline corridor would be located on Tonto National Forest land south of the town of Superior, where they pass east and west of Picketpost Mountain and Boyce Thompson Arboretum. This area of the Tonto National Forest experiences high-use dispersed and motorized recreation and nonmotorized use on the LOST trails. The main segment of the LOST trails would be crossed by the west pipeline corridor and would include impacts similar to those described under Alternative 2 for the Arizona Trail. Impacts on recreation on Tonto National Forest lands and OHV use patterns on public lands would be similar to those described for Alternative 2.

Recreation Opportunity Spectrum

Only some portions of this alternative are located on Tonto National Forest land; therefore, only the acres of ROS that could be impacted by the tailings storage facility pipeline corridor rights-of-way described above are quantitively discussed in this section. Impacts on recreation on BLM-administered and State Trust lands are described under “General Setting.”

None of the tailings storage facility would be within the identified ROS settings, and only portions of the tailings corridor would be within the identified ROS settings. The west tailings corridor option would include 210 acres of roaded natural, 189 acres of semi-primitive motorized, and 32 acres of urban; while the east tailings corridor option would include 434 acres of roaded natural, 2 acres of semi-primitive motorized, and 88 acres of urban. Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility pipeline corridors would result in a change from the existing undeveloped recreation setting on lands surrounding the tailings storage facility pipeline corridor right-of-way to a more developed setting. People currently use these areas for a wide variety of recreation activities. The activities proposed under Alternative 5 pipeline routes would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

Visitors to the White Canyon Wilderness would have background views of the tailings storage facility east pipeline corridor from some trails and overlooks, and the recreation setting from certain site-specific views would change if the tailings storage facility east pipeline corridor were visible. The White Canyon Wilderness is located approximately 0.6 mile from the tailings storage facility east pipeline corridor at its nearest point.

The Arizona Trail is within the Alternative 5 proposed tailings storage facility east (for approximately 0.13 mile) and west (for approximately 0.18 mile) pipeline corridor rights-of-way; the portion of the Arizona Trail Passage 18 intersected by the west pipeline corridor right-of-way is located within the MARRCO corridor and impacts would be the same as those discussed in “Impacts Common to All Action Alternatives.” Impacts on the Arizona Trail Passage 16 (Gila River Canyons) as a result of the intersection with the east pipeline corridor are discussed in more detail in the following text.

The Arizona Trail would be intersected by 0.18 mile of the proposed tailings storage facility east pipeline corridor, in the Passage 16 segment. The intersection with the Arizona Trail is approximately 20 miles south of the beginning (i.e., trailhead at the Tonto National Forest boundary) of Passage 16, and approximately 6 miles north of the ending of Passage 16, where the Arizona Trail transitions to another passage when it crosses the Kelvin–Riverside Bridge.

The area of this intersection is in the uplands adjacent to the Gila River on BLM-administered land, with sweeping views of the Gila River Canyon and mountains to the south. At the point of intersection with the Alternative 5 tailings storage facility east pipeline corridor, the Arizona Trail is located on the southern flank of uplands north of the Gila River floodplain and just southeast of The Spine, a prominent geological feature. The area is largely undisturbed; with the exception of the Southern Pacific rail line located on the south side of the Gila River; there is very little to no motorized access to the area.

Because Alternative 5 would result in substantial interference with the nature and purpose of the Arizona Trail, Resolution Copper is proposing substantial design features. Resolution Copper would construct an "overpass" for the tailings corridors that would span the Arizona Trail, as shown on Figure 3.0-1h of the GPO. Recreation access along Passage 16 would be maintained during construction, and the span would not impede Arizona Trail access during operation or maintenance. There would be short-term impacts on trail users during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but these would only occur during the activity, and when conditions are safe for hikers, cyclists, and equestrian users, the impact would cease. Contractors would provide necessary detours or signage for Arizona Trail user awareness during these activities. The Peg Leg alternative also intersects several proposed Pinal County trail corridors and OHV trails, as well as one planned OHV trail (Logan Simpson Design Inc. 2007).

Both the east and west tailings pipeline corridors would be visible from trails and overlooks on Picketpost Mountain. Resolution Copper anticipates burying the pipelines through these areas.

The BLM manages the area as Visual Resource Management Class III (see Section 3.11, Scenic Resources, for a detailed discussion of BLM Visual Resource Management classes) which allows for a moderate amount of visual change to the landscape, to which the activities proposed under Alternative 5 would conform. The presence of the tailings storage facility east pipeline corridor in the area would result in long-term impacts on the undisturbed and natural character of the landscape, resulting in a change to the recreation setting of that portion of Passage 16. The west pipeline corridor would be located partially within the previously disturbed MARRCO corridor. Therefore, it would have a reduced effect on recreation relative to the east pipeline corridor option, which is largely undisturbed.

Motorized Recreation

The tailings storage facility west pipeline corridor right-of-way would intersect 14 NFS roads and the tailings storage facility east pipeline corridor right-of-way would intersect 18 NFS roads. The tailings storage facility would intersect three named roads (Tea Cup Road, Tea Cup Ranch Road, Peg Leg Road) and an unknown number of unnamed roads and trails. There would be approximately 23 miles of BLM routes that would be intersected by the tailing storage facility. Not all NFS and BLM roads impacted by this alternative would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the tailings storage facility or tailings corridors.

3.9.4.7 Alternative 6 – Skunk Camp

General Setting

The majority of the tailings storage facility for this alternative would be located on Arizona State Trust and private lands that experience low levels of public dispersed recreation. The tailings corridor crosses Forest

Service, Arizona State Trust and private lands with low levels of public dispersed recreation. The area shows evidence of OHV recreation, and numerous unnamed jeep trails are present throughout valley bottoms and along ridges; however, the majority of the area is undisturbed. BLM-administered lands adjacent to the tailings storage facility are managed as an ERMA, where typically recreation is non-specialized, dispersed, and does not require intensive management. All public access would be eliminated on 8,647 acres, the area to be fenced surrounding the tailings storage facility, of which 2,132 acres is private and 6,515 acres is State Trust land.

Recreation users that seek opportunities for solitude commonly seek areas where they would be less likely to see other humans. Dispersed recreation activities would be temporarily affected as noises, visual disturbances, and/or the presence of other humans could detract from their chosen recreation opportunities and activities.

Only 7.7 miles of the north pipeline corridor and 10.8 miles of the south pipeline corridor would be located on Tonto National Forest land adjacent to the town of Superior, where the south pipeline corridor passes south of Superior and east of Picketpost Mountain and Boyce Thompson Arboretum and the north pipeline corridor passes east of Oak Flat. The main segment of the LOST trails would be crossed by the south pipeline corridor and would include impacts similar to those described under Alternative 2 for the Arizona Trail. The north pipeline corridor also crosses multiple sections of Devil's Canyon. These areas of the Tonto National Forest experiences high-use dispersed and motorized recreation.

Recreation Opportunity Spectrum

Similar to Alternative 5, only some portions of this alternative are located on Tonto National Forest land (none of the tailings storage facility would be located on areas of ROS classifications). Impacts on recreation on BLM-administered and State Trust lands are described under "General Setting."

Figure 3.9.3-3 shows the ROS settings that would be impacted by all action alternatives. The ground disturbance and installation of facilities associated with the tailings storage facility, tailings corridor, and new powerline would result in a change from the existing undeveloped, recreation setting on lands surrounding the tailings storage facility to a developed setting. People currently use these areas for a wide variety of recreation activities. The activities proposed under Alternative 5 pipeline routes would represent a change to the existing recreational setting; however, it is anticipated that changes would be consistent with the designated ROS classification of semiprimitive motorized.

Recreation Sites

No designated recreation sites or scenic trails are located within the tailings storage facility or tailings corridors, nor would the tailings storage facility be visible from any designated wilderness areas. However, the portions of this alternative in Pinal County are designated Open Space suitable for recreation purposes (Logan Simpson Design Inc. 2007). The southern tailings pipeline corridor would be visible from trails and overlooks on Picketpost Mountain, and the northern tailings pipeline corridor would be visible from the Superstition Wilderness.

Motorized Recreation

The tailings storage facility north pipeline corridor right-of-way would intersect 23 NFS roads, the tailings storage facility south pipeline corridor right-of-way would intersect 24 NFS roads, and the transmission line corridor right-of-way would intersect four NFS roads.

The tailings storage facility would intersect three named roads (Dripping Springs Road, Troy Ranch Road, and Looney Springs Trail) and an unknown number of unnamed roads and trails within the Dripping Springs basin. There would be approximately 15 miles of BLM routes that would be intersected by the tailing storage facility. Not all NFS and BLM roads impacted by this alternative would be rerouted. However, where motorized access along connecting roads would be interrupted by the tailings storage facility, roads would be rerouted to maintain connectivity across the landscape. More detail can be found in Section 3.5, Transportation and Access.

Rock Climbing

There are no known or documented climbing resources within the fence line of the Alternative 6 tailings storage facility; however, the tailings storage facility pipeline corridors and power line corridor for Alternative 6 cross three areas of high-quality climbing resources. The north pipeline corridor crosses Upper Devil's Canyon, the south pipeline corridor crosses Lower Devil's Canyon, and the tailings storage facility power line corridor crosses Northern Devil's Canyon. There would be short-term impacts on recreators during construction activities when disturbance precludes use for safety reasons (e.g., active grading, transport of heavy equipment, active construction), but this would only occur during the project-related activity, and when conditions are safe for climbing, the impact would cease. The presence of the tailings storage facility pipeline corridors and transmission line infrastructure across the canyons may block or eliminate climbing routes, as well as change the dispersed recreation setting of the areas. Under this alternative, there would be temporary impacts on climbing resource access in the area.

3.9.4.8 Cumulative Effects

The Tonto National Forest has identified the following reasonably foreseeable future actions as likely, in conjunction with development of the Resolution Copper Mine, to contribute to cumulative changes to recreational opportunities and use patterns in the greater vicinity of the town of Superior and the "Copper Triangle" region. 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. Although the Tonto National Forest is still evaluating the potential environmental effects of this proposed action, it is assumed that additional mine-related haul traffic along U.S. 60 between Top-of-the-World and the Miami–Globe area may conflict with recreational users traveling to or through this part of the Tonto National Forest.
- *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. The Ripsey Wash area has been a popular area, in particular, for mountain biking and OHV enthusiasts. With construction of the tailings storage facility, recreational use of this area south of the Gila River would be lost and most likely displaced to other locations. In addition, construction of the Ripsey Wash tailings storage facility would require relocation of an existing portion of the Arizona Trail farther to the east, with about 6.4 miles of new trail construction primarily along the eastern slopes of the Tortilla Mountains and about 0.2 miles of shared use along Riverside Drive. Cumulative impacts with the Resolution Copper Project are primarily related to the disruption of recreation opportunities associated with Alternative 5 – Peg Leg, which would impact some of the same general recreation lands south of the Gila River.
- *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 mining operation in the scenic "Copper Butte" area west of the Ray Mine. The Copper Butte area, which lies just to the east and adjacent to the BLM-managed White Canyon Wilderness, has long been a popular location for hikers, rock climbers, horseback riders, OHV treks, and camping. It is unclear at this time how mining development would adversely affect recreational use of this area, but there would likely be an effect, which would likely be a reduction in recreational opportunities.

- *Central Arizona Project (CAP) Trail Plan*. The U.S. Bureau of Reclamation and Pinal County, in coordination with Maricopa County, are planning to develop a continuous, non-motorized, 10- to 20-foot-wide recreation corridor along the length of the CAP canal in Pinal County; this system would tie in to the Maricopa County Regional Trail System. This project would create additional recreational opportunities along the CAP canal in both counties.
- *Tonto National Forest Plan Amendment and Travel Management Plan.* The Tonto National Forest is currently in the process of revising its Forest Plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Both documents will have substantial impacts on current recreational uses of NFS lands. The Supplemental EIS 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 Tonto National Forest, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products.
- *Bighorn Sheep Capture and Relocation.* The Tonto National Forest is intending to capture and relocate bighorn sheep over the next 3 to 5 years in order to improve forest-wide health and genetic viability of the species. The project would involve use of helicopters, including in five wilderness areas within the Tonto National Forest (Four Peaks, Hellsgate, Mazatzal, Salt River Canyon, and Superstition). It is expected that improvements in bighorn sheep numbers would benefit many types of recreational users of NFS lands.
- *Copper King Exploratory Drilling/Superior West Exploration.* This project combines the environmental review of two mineral exploration projects proposed by Bronco Creek Exploration, Copper King, and Superior West. While Bronco Creek Exploration is the mining claimant, the exploration would be funded and bonded by Kennecott Exploration Company (part of the Rio Tinto Group), which would be the operator of record for both plans of operations. The combined projects result in a total of 106 unique drill site locations identified, of which the proponent would be authorized to select up to 43 to be drilled over a 10-year period. Existing roads and helicopters would be used to access drill sites. The use of helicopters could interfere with recreational opportunities for recreationists seeking solitude and a natural setting; however, these impacts would be temporary and short lived and would be unlikely to cumulatively add to Resolution Copper Project impacts.
- *ADOT Vegetation Treatment.* ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can be reasonably assumed that ADOT would continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected

life of the Resolution Copper Mine (50–55 years) for safety reasons. The vegetation treatment could impact motorized use along roads from additional traffic and road use, but impacts would be minimal and would be unlikely to cumulatively add to Resolution Copper Project impacts.

- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private land lies entirely within an area of BLM-administered lands and cannot be accessed without crossing Cottonwood Canyon Road, located on BLM lands. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. This project would improve and maintain road conditions on Cottonwood Canyon Road for landfill haul truck traffic. As a result, the road would be made more reliable for use by road and street vehicles used by recreational visitors. The proposed action would result in the loss of recreation parking areas on BLM land. A new parking area for the public is proposed on the landfill property, but does not appear to be sufficient for current recreational users. As a result, recreational users are likely to lead to resource damage by creating new turnouts or enlarging existing turnouts on BLM land east of the Sandman Road intersection. Recreational access would be temporarily impacted along Cottonwood Canyon Road during construction. Recreational users would be detoured and would be likely to impact existing parking areas along Mineral Mountain Road.
- *Wild and Scenic River Eligibility.* Segments of Arnett Creek and Telegraph Canyon were evaluated for their eligibility for inclusion in the National Wild and Scenic Rivers System in October 2017 as part of the forest plan revision process. These river segments were identified as eligible for inclusion because they possess unique and outstandingly remarkable values for both scenery and fisheries. The eligible river segments of Arnett Creek and Telegraph Canyon will be managed to protect their outstandingly remarkable values (scenery and fisheries) and to retain their classification as Recreational until such time as they are formally designated, or because of changed circumstances, no longer meet wild and scenic river eligibility criteria. Eligibility status and public recognition of the outstandingly remarkable values may attract additional recreational use of the river segments or adjoining national forest area, potentially cumulative with displaced recreation caused by Resolution Copper Project impacts.
- *Recreation Special Use Permits.* The Tonto National Forest manages their recreation special use permits pursuant to 36 CFR 251, and the analysis area is used by a number of permitted recreation and commercial special use activities. Recreation events are commercial activities requiring temporary, authorized use of NFS land. Commercial activity on Tonto National Forest lands occurs when an entry or participation fee is charged by the applicant, and the primary purpose is the sale of a good or service. Most of these applicants offer guided tours that provide the safety, knowledge, and experience of qualified guides with quality equipment, while others provide in-demand equipment and basic instruction for visitors to explore on their own. Activities include hiking, camping, climbing, canyoneering, horseback riding, jeep tours, motorcycle riding, UTV and ATV tours, road biking, and mountain biking. Each company follows strict operating procedures, safety practices, and Forest Service regulations to protect the environment. Special use permits are likely to positively contribute toward recreational activities and access. These are cumulative with Resolution Copper Project impacts on recreation and access, which are overall adverse, from displacement of recreation and loss of roads. Some mitigation activities undertaken by Resolution Copper would offset some of these losses, and may be beneficial to special use permit holders, providing greater opportunities and access.

Recreational uses on the Tonto National Forest, BLM-administered public lands, Arizona State Trust lands, and private lands in this part of south-central Arizona will no doubt continue to evolve during the foreseeable future life of the Resolution Copper Mine (50–55 years). Some changes in recreational use may be driven by issuance of new Federal and State land management policies and planning decisions, whereas others may develop more organically through shifting population distribution, newly emerging patterns of tourism or other visitation, or by evolving technology. For example, OHV use on public lands was not a popular pursuit several decades ago, and conflicts or potential conflicts between motorized and non-motorized forms of recreation was not a prominent issue; today, however, this issue is an ongoing concern to land-management agencies responsible for ensuring both public access and resource protection.

3.9.4.9 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.

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 recreation resources.

Mitigation Measures Applicable to Recreation

Relocation of Arizona National Scenic Trail (RC-212): Resolution Copper has proposed to fund the relocation of a segment of the Arizona Trail as well as the construction of new trailheads. Approximately 9 miles of new trail would need to be built between U.S. 60 and NFS Road 650 near Whitford Canyon . Resolution Copper proposed this measure and seeks to mitigate impacts on recreational opportunities on the trail. This measure is only applicable to Alternatives 2, 3, and 4. Relocating the trail and constructing new trailheads would require additional ground disturbance but the exact area of new disturbance has yet to be determined, although it is assumed the new trail would be about 2 to 3 feet in width and totaling approximately 3 acres in area. If any of the applicable alternatives are selected, this measure would be required by the Forest Service and would be noted in the ROD/Final Mining Plan of Operations.

Mitigate loss of bouldering at Oak Flat by establishing access to the “Inconceivables” (RC-213): To mitigate impacts on recreation through the loss of bouldering areas at Oak Flat, Resolution Copper has proposed to establish access to an alternative area known as “Inconceivables.” This area extends along cliffs for approximately 3 miles on Tonto National Forest land and is located off SR 177. This mitigation measure is applicable to all alternatives. It would be required by the Forest Service and noted in the ROD/Final Mining Plan of Operations. Additional ground disturbance is required, but the exact area has not been identified at this time.

Implement Recreation User Group and Superior Trail Network Plan (RC-214): Resolution Copper has proposed to implement the Recreation User Group (RUG) and the Superior Trail Network Plan to offset loss of public roads at Oak Flat. The RUG was formed to develop a recreational trail design in the town of Superior area. The RUG has developed a conceptual plan for a trail system on the Tonto National Forest that would meet the needs and interests of different stakeholders as well as the management priorities of the Tonto National Forest. Within the vicinity of Superior, there is a network of unpaved roads and trails, many of which are not authorized by the Tonto National

Forest, that are contributing to ongoing resource degradation. The development of a trail system would help with reducing continued development of unauthorized trails. The purposes of the RUG and Superior Trail Network Plan are to provide recreation opportunities for hikers, equestrians, mountain bicyclists, and OHV enthusiasts; provide readily accessible recreation opportunities to the Superior and Phoenix metropolitan areas; offer long-term, sustainable economic benefits to the local community through recreation and ecotourism; protect soil resources in the area from erosion; and provide access to uniquely beautiful viewsheds within Tonto National Forest that are not currently accessible by authorized trails. The full plan, if implemented, would require 66.5 acres of additional ground disturbance and would be applicable to all alternatives. It would be required by the Forest Service and noted in the ROD/Final Mining Plan of Operations.

Provide replacement campground (RC-215): Resolution Copper has proposed to establish an alternative campground site, known as Castleberry, to mitigate the loss of Oak Flat Campground. The development of the new campground as well as access to the property would require additional ground disturbance of 41 acres. This measure is applicable to all alternatives and would be required by the Forest Service and noted in the ROD/Final Mining Plan of Operations.

Develop access to Oak Flat Campground while safe per MSHA regulations (RC-216): To mitigate the future permanent loss of Oak Flat Campground, Resolution Copper has proposed to develop an access plan for the campground as long as it is safe per MSHA regulations. This would allow access to Oak Flat Campground after the land exchange has occurred and the parcel is privately owned by Resolution Copper. The exact duration and extent of access would be determined later per safety requirements by MSHA. This measure would mitigate both losses to recreation as well as impacts on tribal values, would be applicable to all alternatives, and would require no additional ground disturbance. The measure would be noted in the ROD/Final Mining Plan of Operations and would be required by the Forest Service.

Arizona Trail construction considerations (GP-230): To effectively mitigate interference with through-hikers and riders who are doing the entire Arizona Trail in one trip, work that shuts down the trail should be done when use on that section is least likely to occur, which is June through August.

Burying the pipeline on either side of the Arizona Trail overpass and naturalizing the overpass and pipeline corridor in scenic areas within 0.5 mile of the trail would help to avoid substantial interference with the nature and purposes of the trail.

Mitigation Effectiveness and Impacts

The RUG plan would provide effective mitigations for the loss of motorized recreation opportunities and would improve access conditions in the immediate area with the development of three new trailheads. Other mitigations would be effective at partially replacing climbing and camping opportunities, though not in the same location or with the same characteristics.

Impacts for all the mitigations could result in roughly an additional 110 acres of ground disturbance.

Unavoidable Adverse Impacts

Recreational use of the area would be permanently adversely impacted. Unavoidable adverse impacts on recreation include long-term displacement from the project area; and the loss of public access roads throughout the project area. These impacts cannot be avoided or fully mitigated.

3.9.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Recreation would be impacted in both the short and long term. Public access would be restricted within the perimeter fence until mine closure, which is considered to be a short-term impact. However, much or all of the tailings and subsidence area may not be available for uses such as OHV or other recreational use in the future, depending on the final stability and revegetation of these areas.

Irreversible and Irretrievable Commitment of Resources

In general, there would be irretrievable and irreversible impacts as a result of displaced recreational users and adverse effects on recreation experiences and activities. There would be irretrievable impacts on recreation with all action alternatives. Alternatives 2, 3, and 5 with the west corridor option would cross the Arizona Trail. Alternative 4 would require rerouting of the trail.

Each action alternative would result in the permanent removal of off-highway routes, resulting in a permanent loss of recreation opportunities and activities. Public access would only be permitted outside the mine perimeter fence. Although routes through the project area might be reestablished after closure of the East Plant Site, West Plant Site, filter plant and loadout facility, and the MARRCO corridor, routes through the subsidence area and tailings storage facility likely would not be reestablished. Therefore, impacts on OHV routes are considered irretrievable for those that would be reestablished following mine closure, and irreversible for those that would be permanently affected.

Even after full reclamation is complete, the post-mine topography of the project area may limit the recreation value and potential for future recreation opportunities.

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

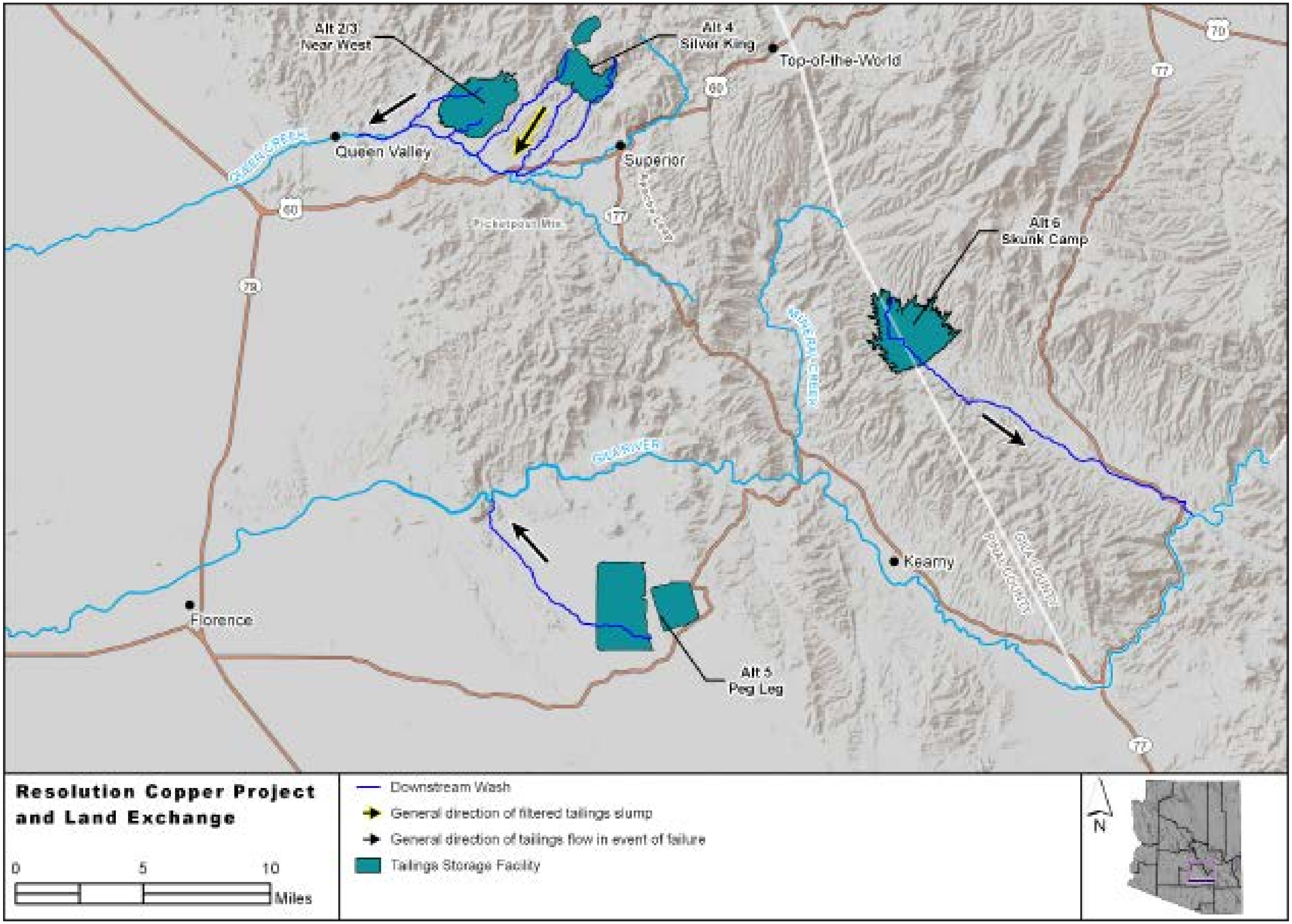


Figure 3.10.1-1. Overview of tailings safety analysis areas

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									
Develop written operating and maintenance procedures	III.D.1.b-c (FEMA 93)	3.5.4.5	X	X	X	X	X	X	X

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)
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.

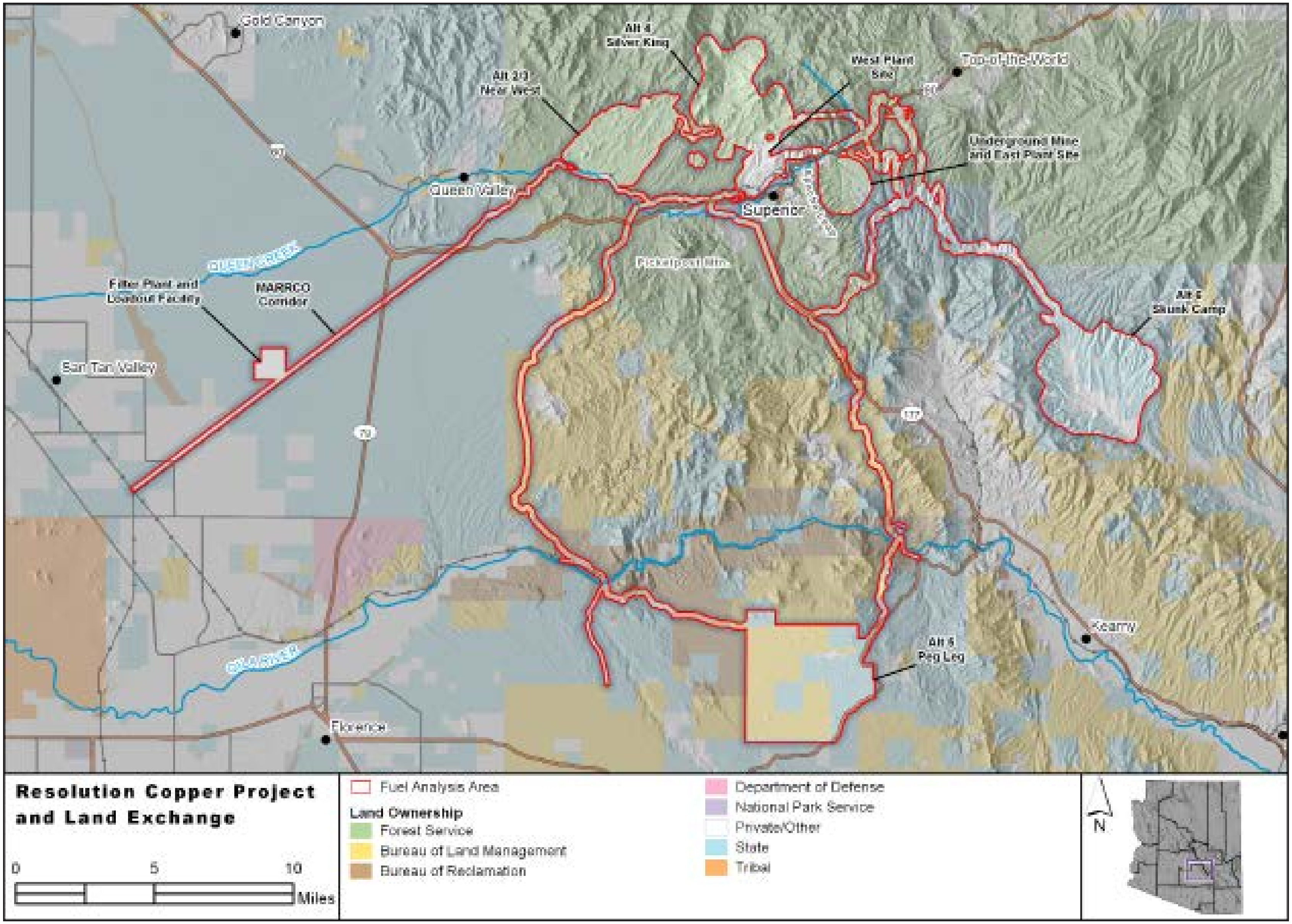


Figure 3.10.2-1. Fuels and fire management analysis area

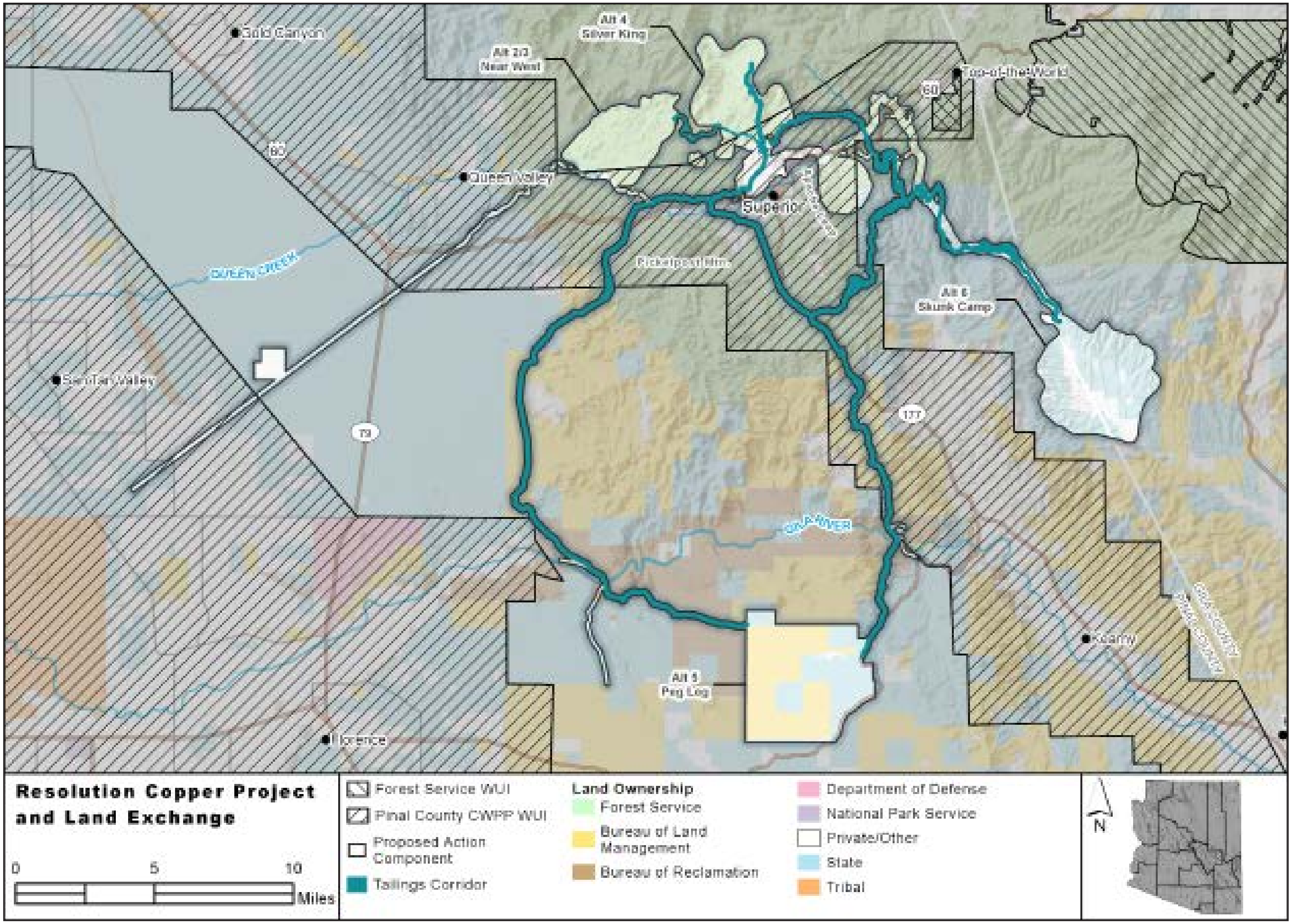


Figure 3.10.2-2. Wildland-urban interface delineation for the project area, comprising Forest Service–delineated and Pinal County CWPP–delineated WUI

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

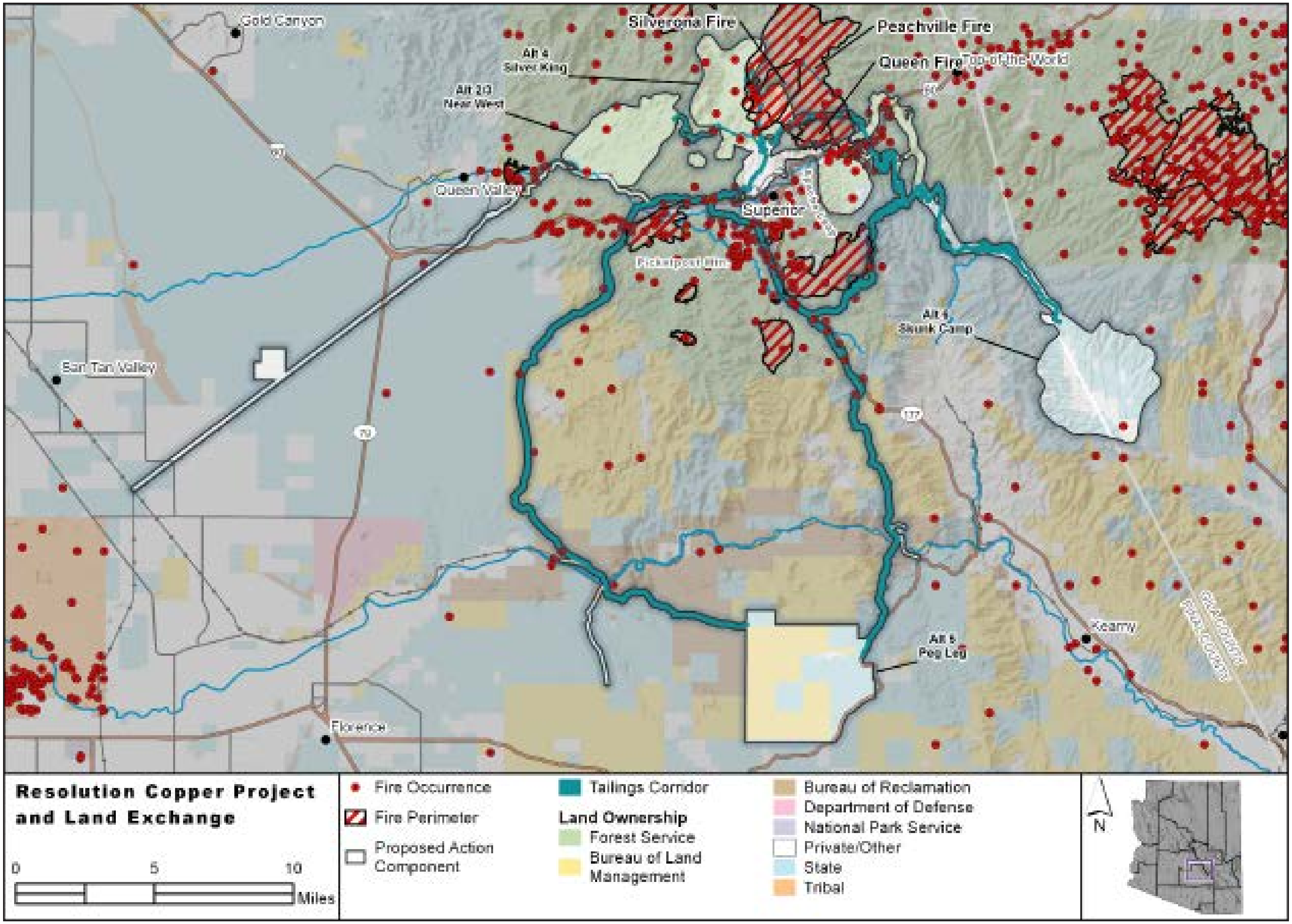


Figure 3.10.2-3. Fire occurrence history for the project area and surrounding lands

> 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.

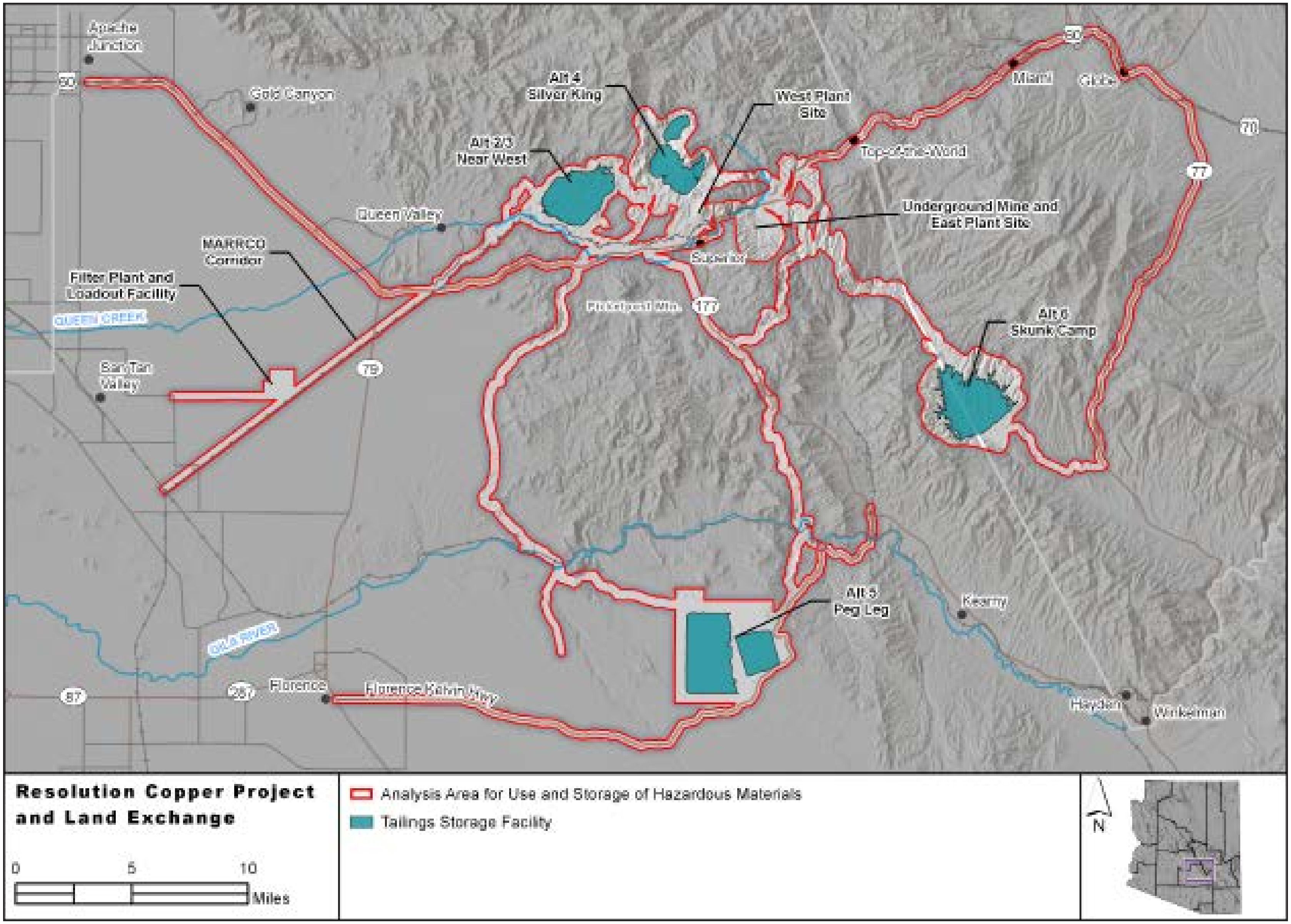


Figure 3.10.3-1. Hazardous materials analysis area

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.

Overview

Potential scenery impacts of the proposed action and its alternatives are assessed using two different but complementary analysis systems: the Forest Service Visual Management System and the BLM Visual Resource Management system. Each involves an evaluation of likely changes to the visual landscape from key observation points, or KOPs, which are points in the landscape determined to be most representative of what viewers may see before and after development of the GPO-proposed project or its alternatives. KOP view analyses focus in particular on anticipated landscape-scale changes in form, line, color, and texture, and on how contrasting changes in the landscape may affect viewers.

3.11 Scenic Resources

3.11.1 Introduction

This section addresses the existing conditions of scenic resources (including dark skies) in the area of the proposed action and alternatives. It also addresses the potential changes to those conditions from construction and operation of the proposed project. The information contained in this section reflects the analysis information in the process memorandum (Newell and Grams 2018).

Scenery resources are the visible physical features on a landscape; they include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. The variety and intensity of the landscape features and the four basic elements—form, line, color, and texture—make up the landscape character. These factors give an area a unique quality that distinguishes it from its immediate surroundings. Usually, if the elements coexist harmoniously, the more variety of these elements a landscape has, the more interesting or scenic the landscape becomes. Scenic quality is the relative value of a landscape from a visual perception point of view.

The scenery resources analysis area (figure 3.11.1-1) lies within the Mexican Highland section of the Basin and Range physiographic province. The province is generally characterized by roughly parallel mountain ranges separated by semi-flat valleys. The analysis area, located at the northern end of the Basin and Range area, includes classic Basin and Range characteristics, with rugged mountains to the north, east, and south, combined with broad basin valleys. Elevations in the area range from 1,520 feet amsl (western terminus of MARRCO corridor) to 5,520 feet amsl (Montana Mountain).

3.11.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.11.2.1 Analysis Area

We considered the potential viewsheds of different proposed project components and alternatives to develop an overall analysis area for impacts on scenery resources (see figure 3.11.1-1). We based the analysis area on specific distance buffers for the proposed action and alternatives components. We assumed that impacts would be accounted for within these project component buffers.

3.11.2.2 Expected Scenery Changes

Our analysis presents the scenery changes and impacts that we expect based on the mine plans and design, and we present these for each mine component. Further, the analysis includes a qualitative discussion on anticipated changes in contrast between the existing landscape and the proposed activities and facilities. We also discuss the analysis in terms of sensitive viewers in the analysis area. The distance zones and scenery contrast definitions are presented in the accompanying text box. The distance zones differ from those found in the Forest Service Visual Management System (U.S. Forest Service 1974) to reflect the potential views in the desert landscape relative to the scale of the proposed project.

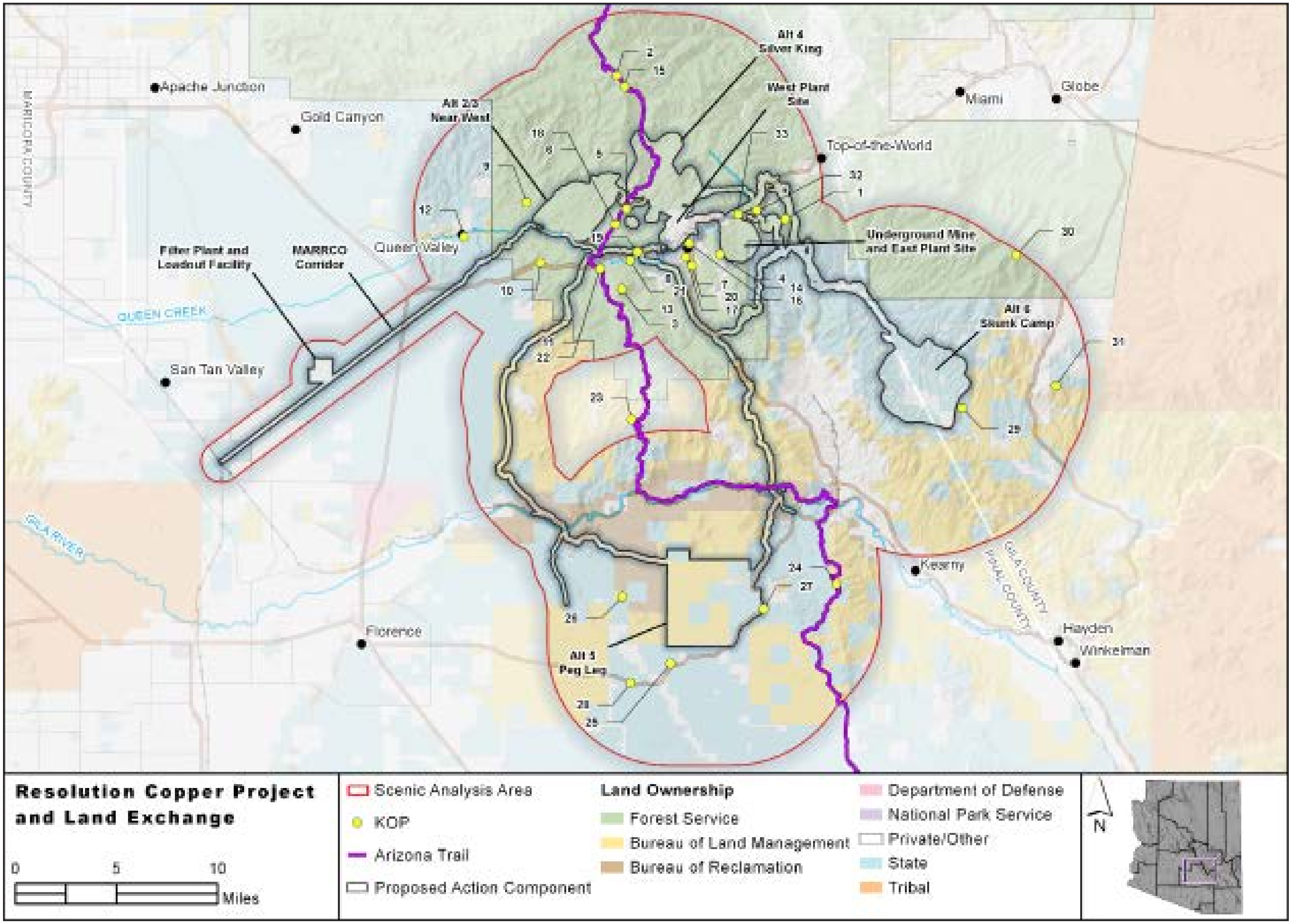


Figure 3.11.1-1. Scenic resources analysis area

Scenery Analysis Area Project Component Buffers
• 6 miles – Tailings facility alternatives
• 2 miles – Slurry pipeline corridor alternatives
• 2 miles – East Plant Site and subsidence area
• 2 miles – West Plant Site
• 2 miles – Transmission lines
• 1 mile – MARRCO corridor
• 1 mile – Filter plant and loadout facility

3.11.2.3 Viewshed Analysis

The Forest Service and NEPA team developed the viewshed analysis of the tailings facilities for the proposed action and alternatives to illustrate where the facilities would theoretically be visible. We modeled the approximate heights of the tailings facilities and determined, based upon landform and elevation, where the facilities would potentially be visible in the surrounding landscape. The viewshed model does not account for vegetation, structures, and other landscape elements that could obstruct views, but it does provide an approximation of the facility visibility within the analysis area. The viewshed analysis also includes miles of sensitive linear corridors from which the facilities would potentially be visible. The viewshed analyses for each alternative tailings facility are in the process memorandum (Newell and Grams 2018).

Distance Zones
Foreground : Up to 1 mile
Middle Ground: 1 to 3 miles
Background: Beyond 3 miles

Contrast Impact Definitions
None: The contrast is not visible or perceived.
Weak: The element contrast can be seen but does not attract attention.
Moderate: The element contrast begins to attract attention and begins to dominate the characteristic landscape.
Strong: The element contrast demands attention, would not be overlooked, and is dominant in the landscape.

3.11.2.4 Key Observation Points and Contrast Rating Analysis

Contrast analysis is a method that measures potential project-related changes to the landscape. The Forest Service and the BLM use this methodology to analyze the impacts on scenic quality and describe landscapes. The method allows for a level of objectivity and consistency in the process and reduces subjectivity associated with assessing landscape character and scenic quality impacts. We used the BLM's Visual Resource Contrast Rating system, as outlined in BLM Manual 8431 – Visual Resource Contrast Rating (Bureau of Land Management 1986a), for the contrast analysis. The system determines the degree to which a proposed project would affect the scenic quality of a landscape based on the visual contrast created between the proposed project and the existing landscape. The method measures contrast by comparing the proposed project features with the major features in the existing landscape using basic design elements of form, line, color, and texture.

We conducted the contrast rating analysis for 33 key observation points (KOPs) representing sensitive views from residential areas, travel routes, and recreation areas of the proposed action and alternative tailings facilities, transmission lines, and pipeline corridors (see figure 3.11.1-1). The contrast rating worksheets for each KOP are in the process memorandum Newell and Grams (2018). To support the contrast rating analysis and disclose potential visibility of the proposed action and alternative tailings facilities, we provide photographic simulations of the theoretical views of the proposed action and alternatives from the KOPs (Newell and Grams 2018). The simulations are intended to provide a theoretical view of the tailings facilities post-reclamation. We completed most of the simulations with on-site photography. Some simulations were completed using a "block model" process that illustrates the model of the tailings facility with Google Earth imagery.

3.11.3 Affected Environment

3.11.3.1 Relevant Laws, Regulations, Policies, and Plans

Federal

FOREST SERVICE VISUAL MANAGEMENT SYSTEM

The Tonto National Forest Land and Resource Management Plan (1985b) uses the Visual Management System (U.S. Forest Service 1974) for management of forest scenery resources. The Visual Management System establishes Visual Quality Objectives (VQOs) for the forest and designates an acceptable degree of alteration of the characteristic landscape (table 3.11.3-1). This method measures the degree of alteration in terms of visual contrast with the surrounding landscape generated by introduced changes in form, line, color, and texture.

Table 3.11.3-1. Forest Service Visual Quality Objective classification descriptions

VQO Category	Description
Preservation	Allows ecological change only and management activities that are not noticeable to observers. Applies to wilderness areas, primitive areas, other special classified areas.
Retention	Allows management activities that are not evident to the casual forest visitor. Under Retention, activities may only repeat form, line, color, and texture which are frequently in the characteristic landscape. Changes in their qualities of size, amount, intensity, direction, pattern, etc., should not be evident.
Partial Retention	Allows management activities that may be evident to the observer but must remain subordinate to the characteristic landscape. Activities may repeat form, line, color, or texture common to the characteristic landscape but changes in their qualities of size, amount, intensity, direction, pattern, etc., remain visually subordinate to the characteristic landscape.
Modification	Allows management activities that may dominate the characteristic landscape but that must, at the same time, use naturally established form, line, color, and texture. Activities which are predominately introduction of facilities such as buildings, signs, roads, etc., should borrow naturally established form, line, color, and texture so completely and at such scale that their visual characteristics are compatible with the natural surroundings.
Maximum Modification	Allows management activities of vegetative and landform alterations that dominate the characteristic landscape. When viewed as foreground or middle ground, they may not appear to borrow completely from naturally established form, line, color, or texture.

BUREAU OF LAND MANAGEMENT VISUAL RESOURCE MANAGEMENT

The BLM uses the Visual Resource Management (VRM) system to manage visual resources on public lands (Bureau of Land Management 1984, 1986a, 1986b). The VRM system provides a framework for managing visual resources on BLM-administered lands. The four VRM class objectives describe the different degrees of modification allowed to the basic elements of the landscape (i.e., line, form, color, and texture) (table 3.11.3-2).

State of Arizona Scenic Road Designation

Arizona Revised Statutes 41-512 through 41-518 provide for the establishment of parkways, historic roads, and scenic roads. ADOT implements and administers the law. The "Scenic Road" designation includes a roadway (or segment of a roadway) that offers a memorable visual impression, is free of visual encroachment, and forms a harmonious composite of visual patterns. The analysis area contains the Gila-Pinal Scenic Road and the Copper Corridor Scenic Road West, described in section 3.11.3.2.

Local Lighting Ordinances

The Pinal County Outdoor Lighting Code and the Gila County Outdoor Light Control Ordinance contain guidelines and lighting requirements for projects that are proposed in the counties.

3.11.3.2 Existing Conditions and Ongoing Trends

Forest Service and BLM Scenery Management Designations

The number of acres under Tonto National Forest VQO and BLM VRM designations for the scenery resources analysis area are presented in table 3.11.3-3 and illustrated in figure 3.11.3-1.

Table 3.11.3-2. Visual Resource Management class descriptions

VRM Class	Description
I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention.
II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape.

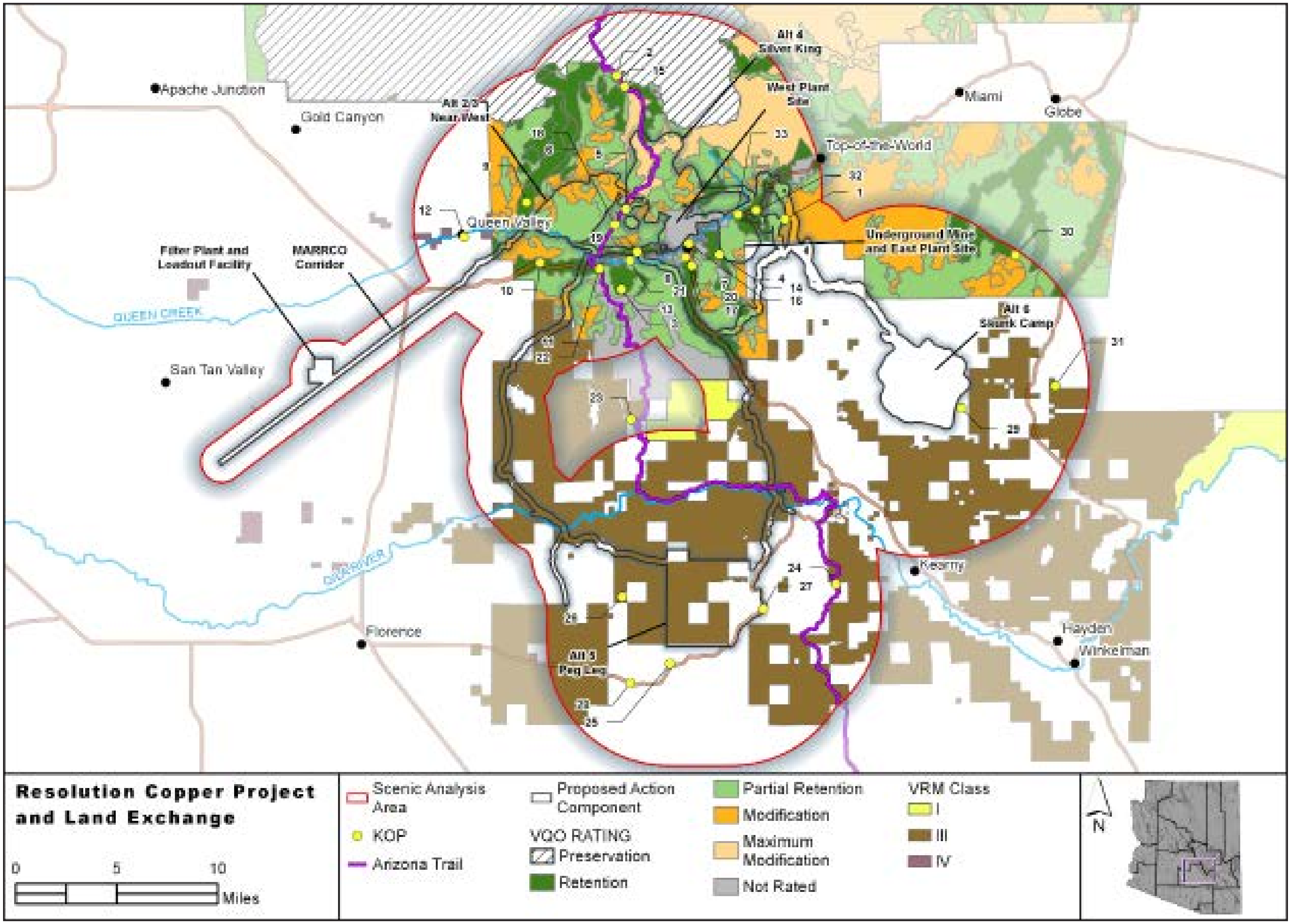


Figure 3.11.3-1. Forest Service and BLM scenery management designations (VQO and VRM)

Table 3.11.3-3. Acreages by scenery management designation

Scenery Designation	Acres
Forest Service VQO	
Preservation	25,410
Retention	26,902
Partial Retention	53,379
Modification	32,638
Maximum Modification	15,014
BLM VRM Class	
Class I	2,607
Class II	0
Class III	124,429
Class IV	738

Scenery Resources in the Analysis Area

The analysis area contains multiple types of scenic resources that could be impacted by construction of the proposed action or alternatives.

- **Arizona National Scenic Trail.** The Arizona Trail extends 800 miles across the state of Arizona from the U.S. border with Mexico to the state of Utah. The trail was designated a National Scenic Trail by Congress in 2009 (U.S. Forest Service 2018a). Approximately 55 miles of the trail—including Passage 15 Tortilla Mountains, Passage 16 Gila River Canyons, Passage 17 Alamo Canyon, and Passage 18 Reavis Canyon—are in the scenery analysis area. The high visual quality of scenery from these passages is diverse and includes steep rocky canyons, high-point vistas, riparian riverways, and developed trailheads and trail facilities. Passage scenery is described in more detail in the process memorandum (Newell and Grams 2018).
- **Apache Leap.** The Apache Leap escarpment is a geographically, culturally, and historically unique feature in the analysis area. The dramatic escarpment visually dominates the eastern skyline from the basin below and provides a scenic backdrop for the town of Superior. Climbers and hikers access the top of Apache Leap by climbing routes and undesignated trail routes. Views from the top of Apache Leap include broad long-distance views of the expansive valley below and more confined views to the east toward the Oak Flat area.

Apache Leap South End parcels, looking east from Donkey Canyon toward the Apache Leap escarpment

- **Picketpost Mountain.** Picketpost Mountain is a prominent mountain feature in the analysis area. At 4,377 feet amsl, it rises dramatically above the valley with rugged geological features and rock cliffs and outcrops. Hikers climb the rugged mountain using undesignated routes. Views from the top of the mountain include broad and expansive views into the valley to the north and views to the south toward the White Canyon Wilderness and the Gila River, including rugged and rolling desert mountains.

Picketpost Mountain, looking east from the Arizona Trail trailhead

View overlooking the town of Superior and the West Plant Site

- **Superstition Mountains.** The Superstition Mountains are a popular mountain range providing a scenic desert mountain backdrop in the northern portion of the analysis area. They include many heavily used roads and trails. Views from locations in the analysis area include broad and expansive views into the valley below and farther south to Picketpost Mountain and the Gila River valley in the background.
- **Pinal Mountains.** The Pinal Mountains, located south of Globe, Arizona, on the east side of the analysis area, provide popular high-elevation recreation to the surrounding region. Recreationists visit the mountain forest during the hot summer months to enjoy the cooler temperatures. The highest point, Pinal Peak (rising to 7,848 feet amsl), is accessible by dirt road and is frequently visited by recreationists. From Pinal Peak scenic views include background views of the Gila River valley to the east and the wide desert landscapes to the west. Middle ground views include the surrounding Pinal Mountains rugged terrain, including the Dripping Springs Valley.
- **Town of Superior, Arizona.** Located in the northern portion of the analysis area, the town of Superior is surrounded by the Tonto National Forest and the natural forest landscape, including Apache Leap and the Superstition Mountains, providing a scenic backdrop to the town. Scenic views from the town include middle ground views of surrounding desert rolling hills and canyons, with background views of rugged mountains, including Apache Leap, Picketpost Mountain, and the Superstition Mountains.
- **Queen Valley, Arizona.** Queen Valley, a residential community located in the eastern portion of the analysis area, lies south and east of the Tonto National Forest. Views of the national forest include background views of rolling desert hills and canyons as well as the rugged and scenic Superstition Mountains.
- **Gila-Pinal Scenic Road (U.S. 60).** The Gila-Pinal Scenic Road is a 35-mile route following U.S. 60 between Forest Junction and Globe, Arizona (Arizona Department of Transportation

2018). The road travels from the western Sonoran Desert habitats through canyons and up to higher ponderosa pine forests in the Globe area. Scenic features along the route include views of the Superstition Mountains, Apache Leap escarpment, the Boyce Thompson Arboretum, Picketpost Mountain, and the town of Superior. The history of copper mining in the region is evident along the eastern portion of the route.

- **Copper Corridor Scenic Road West (U.S. 177).** The Copper Corridor Scenic Road West is a 20-mile route following U.S. 177 between Kearny and Superior, Arizona (Arizona Department of Transportation 2018). The road travels through rugged mountains and river valleys and passes by the vast Ray Mine operations. The Dripping Spring Mountains are on the east side of the road and the White Canyon Wilderness is located to the southwest of the route. Upon the northern approach to Superior, the scenery is dominated by the Superstition Mountains, Apache Leap, and Picketpost Mountain.
- **Florence-Kelvin Highway.** The Florence-Kelvin Highway is a partially paved, partially graded dirt road that extends approximately 32 miles from outside of Florence, Arizona, eastward to U.S. 177. Views along the road include classic Sonoran Desert vegetation of creosote, cholla, ocotillo, and saguaro cactus. Unique rock outcrops appear near the Cochran Road intersection. The road travels northeast and crosses the Gila River, where it joins U.S. 177.
- **Off-Highway Vehicle Recreation Roads.** Dozens of miles of OHV recreation roads are located within the analysis area (see Section 3.9, Recreation, for more detailed information on OHV roads). These roads are used to travel through the Tonto National Forest, BLM-managed lands, and Arizona State Trust lands to visit recreation sites and as scenic tours. Views from these roads include a broad array of scenery, including natural desert rolling hills and canyon, mountain backdrops, and specific scenic features. A heavily used set of OHV roads is located in the northern portion of the analysis area on the Tonto National Forest. The Cochran Road in the southern portion of the analysis area is a popular road on State of Arizona–managed and BLM-managed lands that has views of the White Canyon Wilderness mountains to the north, the Gila River, and an open desert landscape. The Dripping Springs Road, located in the eastern portion of the analysis area, is a moderately used OHV recreation road with views of the Pinal Mountains, rural ranches, and rugged desert rolling hills.
- **Climbing Areas.** Climbing areas are described in detail in Section 3.9, Recreation. The Apache Leap area (described above in this list) represents a climbing area that could be impacted by construction of the proposed action and alternatives, as are the climbing areas located on Oak Flat.
- **Boyce Thompson Arboretum.** The Boyce Thompson Arboretum is located in the northern portion of the analysis area south of U.S. 60. It was established in 1924 and is a popular regional destination with thousands of annual visitors. The arboretum includes a visitor center, demonstration gardens, picnic area, and trails that lead visitors through exhibits of unique vegetation and desert ecosystems. Views from the area range from confined foreground views of rugged rock outcrops, desert vegetation, and canyons to views of expanded vistas of the surrounding Tonto National Forest, Picketpost Mountain, the Superstition Mountains, and Apache Leap.
- **Regional Dark Skies.** Current dark sky conditions in the analysis area are described in the report titled "Impact Assessment of the Proposed Resolution Copper Mine on Night Sky Brightness" (Dark Sky Partners LLC 2018). The report illustrates that current dark sky conditions in the analysis area are influenced by lighting in developed communities and current mining operations. In general, light sources that influence dark skies in the analysis area include the Phoenix metropolitan area (western portion of analysis area), the town of Superior, the Ray Mine, and Florence, Arizona. Specifically,

the study measured current lighting using light-measurement cameras from four locations in the analysis area: Queen Valley, Boyce Thompson Arboretum, town of Superior, and Oak Flat Campground.

Selected Lands

Scenery in the Oak Flat Federal Parcel consists of rolling to steep hillslopes with rounded boulder outcrops, interspersed with high desert vegetation. Background views include the eastern slopes of Apache Leap and the steep and rugged Queen Creek canyon hillslopes. Visitors to Oak Flat Campground, rock climbers climbing the numerous boulder features, OHV recreationists, and hikers represent the sensitive viewers that frequent the Oak Flat Federal Parcel. VQO designations for the Oak Flat Federal Parcel are as follows: Retention—785 acres, Partial Retention—1,416 acres, and Modification—137 acres, with the remaining acres not rated.

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

3.11.4.1 Alternative 1 – No Action

Under the no action alternative, the proposed action or alternatives would not be constructed and therefore no changes to scenery would occur. There would be no impacts on scenic resources.

IMPACTS COMMON TO ALL ACTION ALTERNATIVES

Some components of the project would occur under all action alternatives. The “common to all” components and their associated scenery impacts are described in table 3.11.4-1.

Effects of the Land Exchange

The selected 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 effects on the scenery resources that occur on the Oak Flat Federal Parcel. The Oak Flat Federal Parcel would become private at the completion of the NEPA process, and the current VQOs (Retention, Partial Retention, Modification), which provide protection to scenery resources, would be removed. The Forest Service would not have the ability to require mitigation for effects on scenery resources on the lands; thus, effects on scenery could be greater than if the parcel retained the VQO designation.

The offered lands parcels would come under Federal jurisdiction. Specific management of the scenery resources of those parcels would be determined by the agencies to meet desired conditions or support appropriate land uses. In general, these parcels contain a variety of scenery resources similar to those found in the analysis area, that would come under Federal jurisdiction.

Effects of Forest Plan

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). A number of standards and guidelines were identified as applicable to management of scenery resources.

Table 3.11.4-1. Impacts on scenic resources common to all action alternatives

Mine Facility and Phase	Visual Impact Assessment
East Plant Site Facilities	
Construction	Visual disturbance from construction equipment movement and activity, fugitive dust, and overall change in contrast in form and color from the existing landscape would occur. Areas in the East Plant Site vicinity that remain open to future public visitation are limited. Because of this and the landscape topography, the East Plant Site would be visible from a limited number of locations on the national forest; primarily, visibility would be from high points to the east on NFS Road 2466, approximately 2.5 miles from the East Plant Site. The visual dominance of construction would be short term with intensity of views varying based upon distance and topography, resulting in overall moderate impact on scenery.
Operations	Long-term impacts on scenery would result from a change in contrast from existing landscape conditions from new development. Because of existing facility development at the East Plant Site and the limited visibility from the area, the anticipated change in contrast is moderate. The scenery impact would be long term in duration; however, visual dominance and intensity of scenery impacts would be reduced as a result of limited visibility from sensitive viewers.
Closure and Reclamation	Mine facilities at the East Plant Site would be largely removed, and the area would be reclaimed to natural conditions to the maximum amount possible. Headframes and hoists and some roads would remain in place for use in post-closure groundwater monitoring. Long-term visual dominance and intensity from development of the East Plant Site to the scenery would move from moderate to minor with increased site revegetation and successful site reclamation.
Subsidence Area	
Operations	Subsidence breakthrough is anticipated to begin at approximately mine year 12. Subsidence would expand slowly to the maximum width and depth at approximately mine year 47. As described earlier in this section, because of limited public access and visibility, visual dominance from changes in form, line, color, and texture of the subsidence area would be limited to small portions of the adjacent Tonto National Forest. KOP 1 (NFS Road 2466, east of the subsidence area) illustrates long-term scenery impacts from subsidence. The visual simulation shows the anticipated change in contrast from the existing landscape expected from ground subsidence (Newell and Grams 2018). Because of distance and angle of view to the subsidence area, the anticipated visual dominance and intensity to scenery from this KOP is weak (visible, but does not attract attention). Figure 3.11.4-1 presents a visual simulation of anticipated subsidence at end of mining from an aerial perspective using Google Earth imagery.
Closure and Reclamation	At the end of mine operations, a fence or berm would be constructed around the continuous subsidence area and no reclamation activities, including revegetation, would occur because of safety hazards. Long-term impacts on scenery would remain weak from KOP 12. Views of the subsidence area are most accessible from the elevated viewpoints in the air. Visualizations of the subsidence area from these elevated viewpoints that illustrate the different fracture zones are presented in the visual simulation package (Newell and Grams 2018). Visual dominance and intensity impacts on views from the air would be strong; however, there would be very few people viewing from this angle and elevation.

continued

Table 3.11.4-1. Impacts on scenic resources common to all action alternatives *(cont'd)*

Mine Facility and Phase	Visual Impact Assessment
West Plant Site Facilities	
Construction	Impacts on scenery in the area would result from the construction activity, including heavy equipment operation, traffic and heavy truck transportation, fugitive dust from ongoing land disturbance, and power line construction. Areas within 2 miles of the West Plant Site could be impacted by construction activities by a change in landscape form, line, color, and texture and the dominance of new landscape features in the view. This area includes the town of Superior and recreation roads on the Tonto National Forest. The overall impact on scenery from these construction activities would be strong because of the visual dominance related to changes in form, line, color, and texture, and intensity of views in the landscape foreground.
Operations	During operations, impacts on scenery would continue to be strong within 2 miles of the area.
Closure and Reclamation	Mine operation facilities would be largely removed and the area would be reclaimed to natural conditions to the maximum amount possible. Some facilities and roads would remain to support long-term monitoring at the site. Visual dominance and intensity of impacts, after facility removal and successful restoration and revegetation, would potentially go from strong to moderate, depending upon reclamation success. Because of the scale of the facility ground disturbance, the site contrast would likely remain visible for many years post-reclamation.
Transmission Lines	
3.5-mile 230-kV line from existing Silver King substation to new Oak Flat substation at East Plant Site. Follows existing line.	Construction: Scenery impacts from construction activities would include active construction equipment and traffic, land clearing, and fugitive dust emissions. Construction activity visual disturbances would temporarily impact viewers adjacent to the transmission corridors. Travelers on Gila-Pinal Scenic Road (U.S. 60) would view transmission line construction activities, specifically in areas where the line is directly adjacent to and crossing over the highway in the steep, rocky section of the highway near the East Plant Site. Operations: The upgraded towers and wires would be visible from the Gila-Pinal Scenic Road (U.S. 60). Although there is an existing line in this corridor, the new adjacent line would be larger and more visible than the existing line. Depending upon the angle of view and exact locations of the transmission towers, the contrast would range from moderate to strong. In areas where the transmission line has potential to "skyline" (i.e., to be visible on high landscape features with sky in the background), the transmission line would present strong contrast. In areas where there are landscape features in the background of the view, contrast would be moderate. Where the transmission line corridor crosses U.S. 60 near the East Plant Site, the structures would present a strong contrast, depending upon their siting relative to the steep canyon walls. Visual dominance and intensity, related to changes in form and line would be increased relative to the existing transmission lines in the corridor, particularly in the Oak Flat area along U.S. 60. KOP 33 (U.S. 60 transmission lines) illustrates scenery impacts from transmission line construction in the vicinity of Oak Flat on U.S. 60 and shows the anticipated change in contrast relative to the existing landscape expected from transmission line operation ((Newell and Grams 2018). The new transmission line would dominate the view for sensitive viewers traveling on U.S. 60, the designated Gila-Pinal Scenic Road. The transmission line also would present strong contrast and visual dominance relative to the existing landscape from changes in line and color from the wires and poles at the top of the canyon walls. Closure and Reclamation: The closure and reclamation plan for the transmission facilities is currently unknown. If a post-mining use for the power facilities and transmission lines is identified, the facilities would remain on the landscape. If not, the structures would be removed and the area reclaimed.

continued

Table 3.11.4-1. Impacts on scenic resources common to all action alternatives *(cont'd)*

Mine Facility and Phase	Visual Impact Assessment
3.5-mile 230-kV line from new Oak Flat substation (East Plant Site) to new West Plant Site substation.	Construction: General construction impacts are the same as described above. This line segment also is adjacent to and crosses the Gila-Pinal Scenic Road (U.S. 60) and would have similar impacts on that area. This segment traverses the hills above the town of Superior and is approximately 0.5 to 1.0 mile from the community. Construction disturbance could temporarily impact scenery resources in the town, including operation of construction equipment and fugitive dust.
New line.	Operations: Operations impacts are similar to those described above. The new towers and wires would be visible from the town of Superior and in areas where the angle of view creates "skylining," and where new roads are constructed the contrast would be strong. In areas without new road construction and where the line contrast is absorbed by a landscape background, the contrast would range from moderate to weak. Closure and Reclamation: Same as described above.
Tailings Facility	
Construction	General construction impacts on scenery resources for each tailings facility alternative would be similar. During initial tailings facility development (mine years 0 to 6), activities would include construction of perimeter fencing, access roads, drainage control structures, containment ponds, monitoring wells, and an office and equipment storage facility. Construction of these facilities would impact scenery resources in the area surrounding the tailings in the foreground, middle ground, and background through facility development and ground disturbance. Large areas of ground disturbance, vegetation removal, and fence construction would create a strong change in contrast with the background landscape that would be visible by a range of viewers extending from the foreground to the background (beyond 3 miles). Viewers in the vicinity would be impacted by the change in contrast created by land disturbance and vegetation removal, fugitive dust emissions from traffic and land-disturbing activities, and construction equipment operation, and the impact on these users would be strong (demands attention). The tailings facility would dominate long-term views in the vicinity of the tailings facility from intense changes in form, line, color, and texture related to the existing landscape.
Operation	General operation impacts on scenery resources for each tailings facility alternative would be similar. The facility would slowly grow to the full facility. Prior to reclamation activities, as the embankment grows, the facility would become increasingly visible from sensitive viewpoints in the region surrounding the tailings facility. In general, the tailings facility would become more and more visible over time, and the color of the tailings stockpile would be a medium gray color. Concurrent reclamation activities vary and are described for each alternative. The tailings facility would dominate long-term views in the vicinity of the tailings facility with increasing intensity as the facility grows and dominates the view with changing form, line, color, and texture.
Closure and Reclamation	The tailings facility would be revegetated during closure and reclamation. Contrast would be reduced as vegetation grows on the tailings embankment faces and other parts of the facility. Contrast would continue to be strong in the middle ground and foreground after revegetation because of the change in landform. The tailings facility would continue to dominate the views of the landscape with obvious difference in form, line, color, and texture from the surrounding landscape.

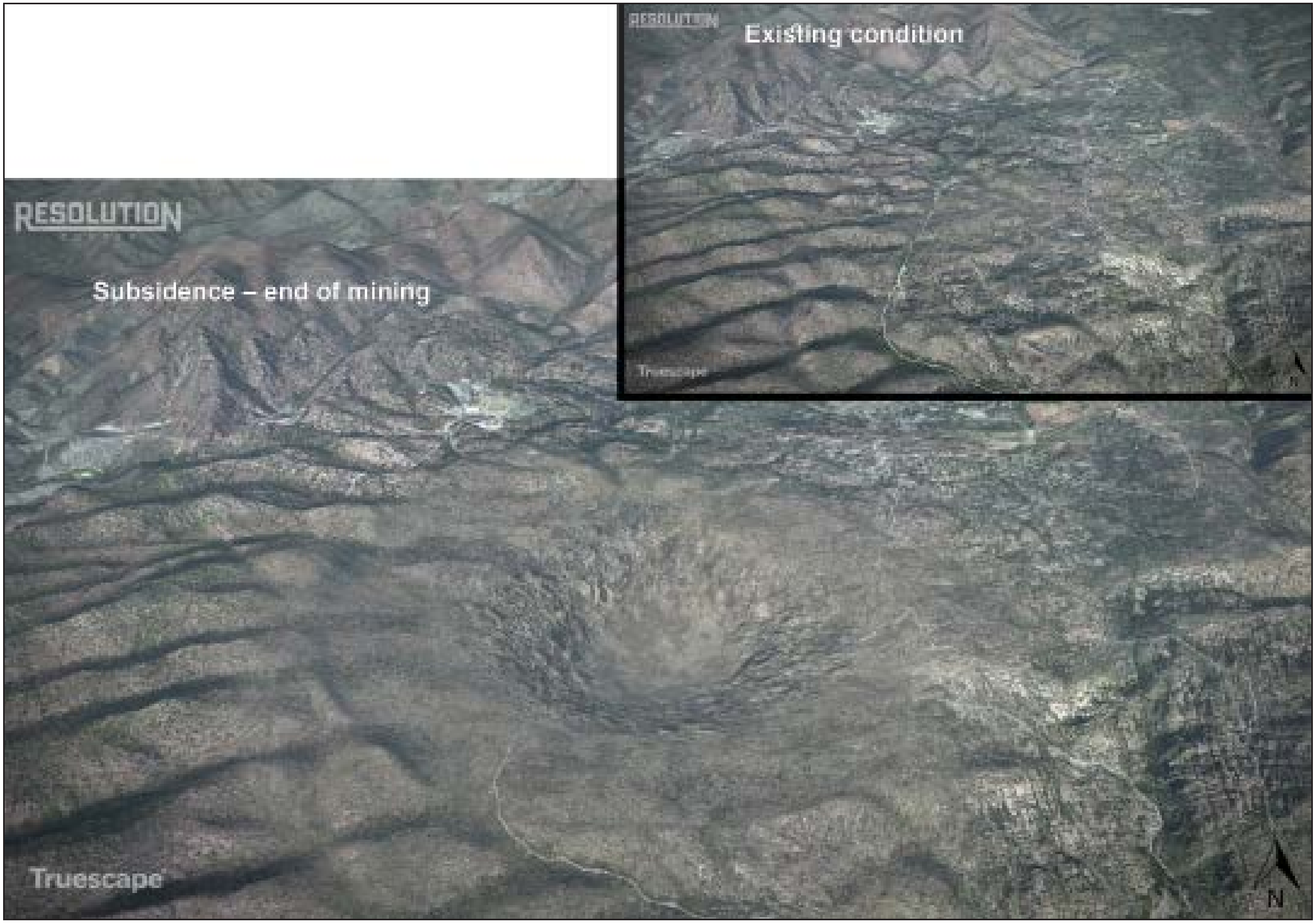


Figure 3.11.4-1. Subsidence area visual simulation from aerial perspective at end of mining using Google Earth imagery

The project would have effects on the scenery resources within the Tonto National Forest by modifying the current forest plan VQO designations. In general terms, Retention and Partial Retention do not allow for the proposed project activities as a whole. Retention requires that activities be "not visually evident." Partial Retention requires that activities be "visually subordinate" to the characteristic landscape. The Modification designation allows for activities to visually dominate the original character of the landscape, but vegetation and landform should mimic the natural landscape. With adequate mitigation, including revegetation, the project as proposed could meet the Modification designation. Implementation of the project would require amending the forest plan by changing the areas designated Retention and Partial Retention to the Modification VQO category.

Table 3.11.4-2 lists the VQO designation acres for each alternative within each of the affected management areas. It presents the total acres for Retention and Partial Retention that would be changed to Modification by alternative and the percentage change in acreage for each category in the scenery resources analysis area.

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 scenic resources. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper include those outlined in the dark skies analysis (Dark Sky Partners LLC 2018):

- Implement an outdoor lighting plan that would reduce potential impacts from artificial night lighting.
- Reduce illumination levels where appropriate while still meeting MSHA requirements for lighting sufficient to provide safe working conditions.
- Adhere to the Pinal County Outdoor Lighting Code.
- Use control systems that can turn off lights at particular times of night or are activated by detecting motion while still meeting MSHA requirements for lighting sufficient to provide safe working conditions.

Additional applicant-committed environmental protection measures by Resolution Copper include the following:

- Use non-reflective earth-tone paints on buildings and structures to the extent practicable.
- Bury concentrate pipelines to the extent practicable. Concentrate pipelines will have approximately 3.3 feet (1 m) of cover over buried sections. See detailed concentrate pipeline protection plan for further information.
- Build rust colored towers or use wooden poles on transmission lines.
- Use shafts constructed of rust colored metal headframes that blend with the scenery.
- Bury tailings and other pipelines to the extent practicable.
- Perform concurrent reclamation of tailings embankment beginning at approximate year 10 of tailings operations.
- Use a reclamation seed mix of weed-free native species consistent with surrounding vegetation.
- Build concentrator building behind mountain terrain to screen views from the town of Superior.
- Use colors that blend in with the desert environment.

Table 3.11.4-2. Scenery management designations by management area and alternative (acres)

Management Area/VQO	Alternatives 2 and 3	Alternative 4	Alternative 5 (East)	Alternative 5 (West)	Alternative 6 (North)	Alternative 6 (South)
MA 2F						
Retention*	**343**	**343**	**663**	**502**	**648**	**743**
Partial Retention*	**2,413**	**4,583**	**1,825**	**1,744**	**1,963**	**2,145**
Modification	523	1,159	203	352	573	511
Maximum Modification	0	1,847	0	0	0	0
MA 3I						
Retention*	**50**	**28**	**28**	**28**	**28**	**28**
Partial Retention*	**2,771**	**80**	**80**	**80**	**80**	**80**
Modification	1,182	19	19	19	19	19
Maximum Modification	0	0	0	0	0	0
Acres of VQO changed from Retention and Partial Retention to Modification for both management areas	**5,577**	**5,034**	**2,596**	**2,354**	**2,719**	**2,996**
Percent Change (decrease) of Retention and Partial Retention†	**−6.9**	**−6.3**	**−3.2**	**−2.9**	**−3.4**	**−3.7**
Percent Change (increase) in Modification†	**17.1**	**15.4**	**8.0**	**7.2**	**8.3**	**9.2**

* Under the action alternatives, these Retention and Partial Retention acreages would change to a Modification management designation.

† Calculated using data from table 3.11.3-3. Total acres in analysis area for Partial Retention and Retention equals 80,281, and Modification equals 32,638.

Table 3.11.4-3. Impacts on scenic resources under Alternative 2

Mine Facility and Phase	Visual Impact Assessment
Tailings Pipeline Corridor	
Construction	Impacts on the area scenery from construction activities would affect sensitive users on the Arizona Trail (Passage 18 Reavis Canyon) and NFS OHV roads in the vicinity of the pipeline corridor (up to 2 miles). The corridor crosses NFS Road 650, a popular OHV road. NFS Road 982 parallels the corridor near the Arizona Trail and provides access to this area near the western end of the pipeline corridor. Scenery impacts from construction activities on these users would include fugitive dust from ground disturbance, and visual disturbance from construction equipment, including construction vehicles accessing the area on NFS Roads 650 and 982. For forest users in the vicinity of the construction activities, impacts on scenery would be strong.
Operations	Impacts on scenery would result from linear mine support facilities in the corridor causing a strong change in contrast with the existing landscape. A strong contrast from vegetation removal in the 150-foot-wide corridor would be visible from 2 miles or more, depending on the vantage viewpoint. The 34.5-kV transmission line following the corridor would include approximately 35-foot-tall transmission line structures. The structures would present strong contrasting horizontal and vertical lines from associated towers and wires. Long-term visual dominance from prominent changes in form and line would occur in areas where recreation facilities cross the corridor. Impacts on sensitive viewers using OHV roads in the vicinity of the tailings would occur in areas where the roads cross or are parallel to the corridor. KOP 5 (Arizona Trail Barnett Camp) was established to illustrate long-term scenery impacts on the Arizona Trail from the tailings pipeline corridor. The visual simulation presents views of the elevated pipeline bridge from the Arizona Trail in the Barnett Camp area approximately 800 feet from the facilities (Newell and Grams 2018). The bridge presents dominant contrasting horizontal and vertical lines in light and dark gray colors in the foreground of the view. The pipeline bridge would dominate the view from this KOP for the long term with strong visual contrast (demands attention and is dominant in the landscape).
Closure and Reclamation	The tailings corridor and associated infrastructure would be removed and the corridor area would be regraded to mimic the natural condition and planted with native vegetation. Long-term impacts on scenery would be expected to persist because revegetation of disturbed landscapes in this type of desert ecosystem is difficult. The tailings corridor would likely be visible and present a permanent linear corridor contrast across the background landscape. Initial scenery impacts would be strong and would potentially reduce to moderate as vegetation growth increases in the corridor over many years. Intensity and dominance of the corridor form and line in the scenic landscape would be reduced over time.

continued

Table 3.11.4-3. Impacts on scenic resources under Alternative 2 *(cont'd)*

Mine Facility and Phase	Visual Impact Assessment
MARRCO Corridor	
Construction	Temporary impacts on scenery from construction equipment operation and traffic, facility construction, land disturbance, and fugitive dust emissions would occur. Sensitive viewers in the area around the MARRCO corridor include travelers on U.S. 60, Queen Valley Road, Hewitt Station Road, OHV roads in the vicinity, and hikers on the Arizona Trail (Passage 18 Reavis Canyon). These areas close to the corridor would experience strong contrast (demands attention) from the construction activities. This impact would be temporary as construction activities moved down the corridor. The construction activities would dominate landscape views for sensitive viewers in the foreground with changes in form, line, and color.
Operations	New facilities in the MARRCO corridor would result in a change in scenery contrast in areas adjacent to the facilities. Although the corridor is currently disturbed, the addition of several pipelines and road improvement would increase the visual contrast to a moderate to strong level because of the change. Sensitive areas in the vicinity include the Arizona Trail as it parallels and then crosses the corridor, Hewitt Station Road and a portion of Queen Valley Road, and the Gila-Pinal Scenic Road (U.S. 60). Moderate to strong changes in contrast would result. Facilities in the corridor would introduce changes in form, line, and color that would create long-term dominant changes in the landscape.
Closure and Reclamation	The closure and reclamation plan for the MARRCO corridor facilities and utilities is unknown at this time. It is known that the copper concentrate lines would be removed and the area around the lines recontoured and revegetated. Other facilities, including transmission lines, water lines, and the upgraded railroad facility, may be left in place. The impact on scenery in the area around the facilities would continue to be moderate to strong.
Filter Plant and Loadout Facility	
All mine phases	Impacts on scenery would be from construction equipment operation and traffic, facility construction, fugitive dust emissions, and rail line traffic on-site. However, sensitive viewers in the area around the facility are few as the parcel is isolated, and impacts on viewers and scenery in the area would therefore be minimal. Overall impacts on scenery would be weak.

3.11.4.2 Alternative 2 – Near West Proposed Action

Impacts on scenery specific to Alternative 2, in addition to the impacts common to all action alternatives (see table 3.11.4-1), are described in table 3.11.4-3.

Tailings Facility

Sensitive viewers in the foreground (within 1 mile) under Alternative 2 that would be impacted are users of the Arizona Trail (Passage 18 Reavis Canyon) and OHV users on the area NFS roads (Hewitt Station Road, NFS Roads 982, 1904, 1903). These users would be impacted by the change in contrast created by land disturbance and vegetation removal, fugitive dust emissions from traffic and land-disturbing activities, and construction equipment operation, and the impact on these users would be strong (demands attention). The scope and scale of the tailings facility would visually dominate the existing landscape features and scenery with highly visible, long-term changes in landscape form, line, color, and texture. During mine operations, the tailings facility would slowly grow to the full facility size of approximately 4,864 acres and 520 feet high. The tailings embankment would be constructed at a 4H:1V slope and reclamation/revegetation of the embankment would begin in approximately mine year 28.[68] Concurrent reclamation (beginning in mine year 28) would begin to reduce the contrast as vegetation grows on the tailings embankment faces.

Viewshed Analysis. The viewshed for Alternative 2 is presented in the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Viewshed analysis for the linear features in the analysis area is presented in table 3.11.4-4.

KOP Scenery Analysis. The Forest Service and NEPA team identified sensitive viewpoints around the tailings facility to analyze impacts on the area's scenery resources (see figure 3.11.1-1). An Alternative 2 impact summary for these KOPs is presented in table 3.11.4-3. The contrast rating analysis process (described in section 3.11.2.4) was conducted for each KOP and is presented in table 3.11.4-5. More detail on the KOPs, along with the related contrast rating worksheets and the visual simulations, is provided in the process memorandum (Newell and Grams 2018).

Dark Skies

The proposed mining activities under Alternative 2 would increase lighting at the East Plant Site, West Plant Site, and tailings facility, which would impact current dark sky conditions in the analysis area; see "Impact Assessment of the Proposed Resolution Copper Mine on Night Sky Brightness" (Dark Sky Partners LLC 2018). The report states,

> When considering the areas of the sky in directions toward the proposed RC facilities, the proposed RC lighting will increase sky brightness between 40% and 160%. Such increases are likely to be obvious to even casual observers. (Dark Sky Partners LLC 2018)

Based on this analysis, the mine operation facilities would be visible and noticeable at night from the town of Superior, U.S. 60, Boyce Thompson Arboretum, the Arizona Trail, and the surrounding national forest landscape. The GPO states that exterior lighting would be kept to the minimum required for safety and security purposes and that lighting would be directed downward and hooded where practicable.

The mine facility lighting plan would comply with the Pinal County Outdoor Lighting Code as long as mine safety and operations are not compromised and there are not conflicts with MSHA regulations (M3 Engineering and Technology Corporation 2019a). The mine facilities would be regulated by the code's Lighting Zone 3 (the most restrictive

68. There is a possibility that the embankment could be constructed at a 3H:1V slope rather than the steeper 4H:1V slope as designed and that reclamation could begin approximately in mine year 22; this analysis assumes the steeper slope and later commencement of reclamation.

Table 3.11.4-4. Viewshed analysis for linear features (roads and trails) in Alternative 2

Linear Viewshed Component	Total Miles in Analysis Area	Total Miles within Viewshed	Scenery Impact Discussion
U.S. 60	32.5	21.2	Views of the facility would vary and would depend on landscape feature such as structures and vegetation. Visible locations closest to the facility would be most impacted and would have strong to moderate changes in contrast relative to distance, angle of view, and potential visual obstructions. The tailings facility would visually dominate views, compared with the existing landscape, as a result in changes in form, line, and color. The intensity and dominance would be greater in areas in the foreground and middle ground with unobstructed views. Specific views from the road are described in the KOP analysis in table 3.11.4-5.
SR 177	2.9	2.5	Although the viewshed illustrates that the tailings facility would be visible from a majority of the road, landscape features such as structures and vegetation could obstruct some views. With distance to the facility ranging from 4.75 to 5 miles, the tailings feature would appear in the background landscape when visible. Visual dominance would be minimal because changes in form, line, and color would be less visible due to the distance to the tailings facility. Specific views from the road are described in the KOP analysis in table 3.11.4-5.
Arizona Trail	23.0	11.0	For persons traveling on the Arizona Trail, scenic views would be impacted by the proposed tailings facility. As described above, landscape features may obstruct views. The tailings facility would visually dominate views, compared with the existing landscape, as a result in changes in form, line, and color. The intensity and dominance would be greater in areas in the foreground and middle ground with unobstructed views. Specific views along the trail are described in the KOP analysis in table 3.11.4-5.

Table 3.11.4-5. Alternative 2 key observation point descriptions and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
1	NFS Road 2466 east of subsidence area	Analysis presented earlier in this section under the subsidence operation analysis in *table 3.11.4-3*.
2	Arizona Trail northwest of Montana Mountain*	The tailings facility would be visible from this location and would present a change in contrast ranging from moderate to strong. As the facility grows, contrast would increase with the strongest contrast presented at the end of mining operations, but before closure and reclamation is complete.
3	Picketpost Mountain*	The tailings facility would be highly visible from this KOP and would present prominent changes in the middle ground and background views in form, line, color, and texture. The changes would result in strong contrast.
4	Apache Leap*	The tailings facility would be moderately visible from this KOP and would present changes in background views in line and color. The changes would result in moderate contrast because the distance and angle of view of the facility would potentially blend with the background landscape.
5	Arizona Trail – Barnett Camp†	Analysis presented earlier in this section under the tailings corridor operation analysis in *table 3.11.4-3*.
6	Arizona Trail – Ridge†	The facility would be located in the foreground and middle ground views of the KOP and would present a strong change in form, line, color, and texture in the landscape. As the facility develops, it would become increasingly visible due to the changes in landscape color and form, with the facility presenting a gray tone and new line features within the rolling terrain. The facility would be most visible prior to commencement and implementation of successful concurrent reclamation activities. It is anticipated that concurrent reclamation would begin to mitigate visual contrast in approximately mine year 30.
7	SR 177 from Kearny†	Because of distance and angle of view, the tailings facility would be minimally visible to persons traveling on SR 177. The change in contrast in form and color would be weak.
8	Picketpost House – (Boyce Thompson Arboretum)†	The tailings facility would be visible in the KOP's middle ground view. Prior to concurrent reclamation activities, contrast would be moderate to strong for changes in form, line, and color in the landscape. The facility's gray color would be visible from the KOP. Upon implementation of successful concurrent reclamation, the contrast would be reduced to moderate.
9	NFS Road 172†	The tailings facility would be visible in the foreground to middle ground of this KOP. Impacts on scenery are similar to the discussion presented for KOP 6.
10	U.S. 60 Milepost 219†	The tailings facility would be visible in the middle ground and background views of the KOP. As the tailings facility grows, it would become increasingly visible from this KOP because of the color, line, and form changes in the landscape. The facility would be most visible prior to successful concurrent reclamation. The contrast would be strong but could become moderate with successful concurrent reclamation. The visual simulation for KOP 10 is presented in figure 3.11.4-2.

continued

Table 3.11.4-5. Alternative 2 key observation point descriptions and contrast rating analysis *(cont'd)*

KOP Number	KOP Name	View Description and Contrast Rating Analysis
11	Arizona Trail at Picketpost Trailhead†	The tailings facility would be visible in the middle ground view of the KOP. Existing terrain features and angle of view reduce the visibility and noticeability of the facility from trail users. Changes in contrast would be weak to moderate prior to concurrent reclamation and potentially weak after successful reclamation.
12	Queen Valley, North Charlotte Street†	The tailings facility is minimally visible within the background views of the KOP. The terrain features a low saddle between higher hills in the background. A small part of the highest portion of the tailings facility would be visible from this KOP. However, it would not be noticeable to the casual viewer, and the anticipated change in contrast from this location is weak.

* Block model Google Earth visual simulation

† Photograph visual simulation

Figure 3.11.4-2. Visual simulation of Alternative 2 tailings facility from KOP 10 – U.S. 60 Milepost 219

zones) that allows the maximum lumen density (amount of light) as 19 lumens per square foot from all light sources.

3.11.4.3 Alternative 3 – Near West – Ultrathickened

The differences in impacts on scenery between Alternatives 2 and 3 are described in the following text.

Tailings Facility

Unlike the proposed action that includes concurrent reclamation of the tailings facility beginning in mine year 28, Alternative 3 would not include concurrent reclamation activities. Reclamation of the tailings embankment face would not occur until construction of the tailings embankment face is complete at the end of mining operations (mine year 46). Under Alternative 3, the tailings facility would present strong contrast in the region's scenery for all sensitive viewers for approximately 20 additional years, compared with Alternative 2. The scope and scale of the tailings facility would visually dominate the existing landscape features and scenery with highly visible, long-term changes in landscape form, line, color, and texture. The tailings facility would create a strong contrast in the landscape that would increase over many years, with the strongest contrast occurring when the mining operations are complete (mine year 46) and successful reclamation has occurred at the facility (approximately mine year 50 to 55).

Dark Skies

General impacts on the area's night skies would be the same as described under Alternative 2.

3.11.4.4 Alternative 4 – Silver King

The differences in impacts on scenery between Alternatives 2 and 4 are described in the following text.

West Plant Site

Under Alternative 4, the filter plant and loadout facility would be moved to the West Plant Site. However, the addition of this facility would result in generally the same scenery impacts as presented in "Impacts Common to All Action Alternatives" earlier in this section.

Tailings Pipeline Corridor

Tailing slurry would be delivered from the West Plant Site to the Silver King tailings facility via pipelines approximately 1.5 miles long. General impacts on scenery related to pipeline construction are described under Alternative 2. Under Alternative 4, an overall reduction in the length of tailings slurry pipeline, a consolidation of mine operations facilities, and reduced footprint would result in reduced impacts on scenery from tailings pipeline construction and operation.

Tailings Facility

Although there are differences between the proposed action tailings facility and the Silver King tailings facility in terms of design and processing, general scenery impacts from the two are the same as described under "Impacts Common to All Action Alternatives" and Alternative 2. Additions of two filter plants, mechanical conveyers, and emergency slurry overflow ponds, while adding to the facilities, would not change the general impacts described previously. However, the Silver King facility would be the tallest at over 1,000 feet in height and approximately double the height of the Alternative 2 and 3 facilities. The height of the facility increases the visual dominance of the overall form in the existing canyon landscape and increases visibility from sensitive viewing locations.

Reclamation and contouring of the filtered tailings would occur concurrently during mining operations. However, it is unknown at this time what year the concurrent reclamation would occur. Assuming it is similar to the reclamation timing under Alternative 2 (concurrent reclamation beginning in mine year 28) impacts would be same as described earlier in this section.

Table 3.11.4-6. Viewshed analysis for linear features (roads and trails) in Alternative 4

Linear Viewshed Component	Total Miles in Analysis Area	Total Miles within Viewshed	Scenery Impact Discussion
U.S. 60	26.3	18.3	Viewing distance to the facility ranges from approximately 2 to 6 miles. This alternative contains approximately 2 fewer miles of highway within the viewshed than Alternative 2. Impacts are similar to those described under Alternative 2. Specific views from the road are described in the KOP analysis in table 3.11.4-7.
SR 177	4.2	3.6	Viewing distance to the facility ranges from approximately 2 to 6 miles. This alternative contains approximately 1 more mile of highway within the viewshed than Alternative 2. Impacts are similar to those described under Alternative 2. Specific views from the road are described in the KOP analysis in table 3.11.4-7.
Arizona Trail	21.0	16.3	This alternative contains approximately 5.3 more miles of the Arizona Trail within the viewshed than Alternative 2. Impacts are similar to those described under Alternative 2. Specific views from the trail are described in the KOP analysis in table 3.11.4-7.

Viewshed Analysis. The viewshed for Alternative 4 is presented the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Viewshed analysis for the linear features in the analysis area is presented in table 3.11.4-6.

KOP Scenery Analysis. We identified sensitive viewpoints (KOPs) in the area around the Silver King tailings facility to analyze impacts on the area's scenery resources (see figure 3.11.1-1). The contrast rating analysis process (described in section 3.11.2.4) for each KOP is presented in table 3.11.4-7. The related contrast rating worksheets and the visual simulations are provided in the process memorandum (Newell and Grams 2018).

MARRCO Corridor

Under Alternative 4, active railcars would transport copper concentrate via the MARRCO corridor instead of pipelines. The two 50-railcar trains would follow the upgraded rail corridor twice a day. Construction impacts on scenery would be similar to those described under Alternative 2. During the operations phase, railcars passing two times per day would present a weak to moderate impact on scenery. Although the trains would be noticeable to viewers along the corridor, the visibility and impact are transitory in nature.

Dark Skies

General impacts on the area's night skies would be the same as described under Alternative 2.

3.11.4.5 Alternative 5 – Peg Leg

The differences in impacts on scenery between Alternatives 2 and 5 are described in the following text.

Tailings Pipeline Corridor

The general scenery impacts described for the tailings pipeline corridor construction, operation, and closure/reclamation would be the same as those described under Alternative 2. However, the pipeline would be in a different location, and there are two options for the pipeline—west

Table 3.11.4-7. Alternative 4 key observation point descriptions and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
13	Picketpost Mountain*	The tailings facility would be highly visible from this KOP as presented in the visual simulation package (Newell and Grams 2018). The facility would present prominent changes in the middle ground and background views in form, line, color, and texture. The changes would result in strong contrast and would be highly visible from this KOP.
14	Apache Leap – Tailings*	The tailings facility would be moderately visible from this KOP as presented in the visual simulation package (Newell and Grams 2018). The facility would present changes in background views in line and color and result in moderate contrast because the distance and angle of view of the facility would potentially blend with the background landscape and hill slopes in the foreground of the facility.
15	Arizona Trail – Montana Mountain (Silver King view)*	The tailings facility would be visible from this location and would present a change in contrast ranging from moderate to strong. The foreground hills hide a large portion of the facility. As the facility grows, contrast would increase with the strongest contrast presented at the end of mining operations, but before closure and reclamation is complete.
16	Town of Superior, South Stone Avenue†	The tailings facility would be visible from this location in the middle ground and background. Prior to successful reclamation, the tailings facility would present a strong contrast in the landscape. After reclamation, the contrast would be moderate to weak, depending on the success of revegetation.
17	Town of Superior, Baseball Field†	The tailings facility would be visible from this location in the background view. The facility would obscure a portion of the background ridgeline and present a strong change in form, line, and color. The change in contrast would be most strong and prominent prior to successful concurrent reclamation activities. After reclamation is complete, the facility would be less visible and present a moderate change in contrast. The visual simulation for KOP 17 is presented in figure 3.11.4-3.
18	Arizona Trail – Ridge†	The tailings facility would be visible from this KOP in the middle ground to background landscape, although it would be obscured by some hill slopes in the foreground. Prior to reclamation, the contrast would be strong and would decrease with post-reclamation activities, as described above.
19	U.S. 60 – Near Silver King Wash†	The tailings facility would be visible in the middle ground and background and present strong contrast to viewers traveling the highway. The facility is not obscured by the foreground landscape. The strong contrast would be as described above.
20	SR 177 from Kearny†	The tailings facility would be visible with strong contrast presented in the middle ground to background landscape. The change in form, line, and color would obscure the existing ridgeline. Changes in contrast over time are described above.
21	Picket Post House – (Boyce Thompson Arboretum)†	The tailings facility would be visible with strong contrast presented in the in the background landscape. Changes in contrast related to reclamation and contrast over time are described above.
22	Arizona Trail at Picketpost Trailhead†	The tailings facility would not be visible from this KOP.

* Block model Google Earth visual simulation

† Photograph visual simulation

Figure 3.11.4-3. Visual simulation of Alternative 4 tailings facility from KOP 17 – Town of Superior baseball field

and east. Scenery impacts for both pipeline options are described in the following text.

West Tailings Pipeline Corridor Option—The west pipeline corridor option would be visible from U.S. 60 (at the crossing and parallel segments), NFS OHV roads, Boyce Thompson Arboretum, and Cochran Road (at the crossing).

East Tailings Pipeline Corridor Option—The east pipeline corridor option would be visible from U.S. 60 (at the crossing), NFS OHV roads, Boyce Thompson Arboretum, SR 177, the Arizona Trail (Gila River Canyon Passage 16), and the Florence-Kelvin Highway. Miles of corridor for each visual resource inventory category are given in table 3.11.4-7.

A representative KOP analysis for pipeline impacts is presented under Alternative 6 at KOP 32 – Tailings Pipeline U.S. 60.

Tailings Facility

Although there are differences between the proposed action tailings facility and the Peg Leg tailings facility in terms of design, general impacts on scenery from the facility are similar to those described under Alternative 2. A major difference is that concurrent reclamation would not occur, and reclamation of the tailings embankment face would not begin until mining operations are complete (approximately mine year 46). Without concurrent reclamation, the tailings facility would present strong contrast, with contrast increasing as the facility grows. At mining closure, the facility would be most visible.

Viewshed Analysis. The viewshed for Alternative 5 is presented in the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Viewshed analysis for the linear features in the analysis is presented in table 3.11.4-8.

Table 3.11.4-8. Viewshed analysis for linear features (roads and trails) in Alternative 5

Linear Viewshed Component	Total Miles in Analysis Area	Total Miles within Viewshed	Scenery Impact Discussion
U.S. 60	27.7	1.5	Although the viewshed model shows that the Peg Leg tailings facility could potentially be viewed from U.S. 60, the facility is too far away to be visible.
SR 177 East Pipeline Option	11.6	1.4	Although the viewshed model shows that the Peg Leg tailings facility could potentially be viewed from SR 177 east pipeline route option, the facility is too far away to be visible.
Arizona Trail	37.2	8.7	This alternative contains approximately 2 fewer miles of the Arizona Trail within the viewshed than Alternative 2. Specific views from the trail are described in the KOP analysis in table 3.11.4-9.

KOP Scenery Analysis. Sensitive viewpoints (KOPs) in the area around the Peg Leg tailings facility were identified to analyze impacts on the area's scenery resources (see figure 3.11.1-1). The contrast rating analysis process (described in section 3.11.2.4) was conducted for each KOP and is presented in table 3.11.4-9. The related contrast rating worksheets and the visual simulations are presented in the process memorandum (Newell and Grams 2018).

Dark Skies

General impacts on night skies from the mining operations facilities would generally be the same as those described under Alternative 2. However, lighting at the tailings facility would be in a different location. Lighting from the tailings facility would be seen and noticed by nighttime recreationists in the area, Arizona Trail users, and persons

Table 3.11.4-9. Alternative 5 key observation point description and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
23	Arizona Trail – Peg Leg North*	The tailings facility would be visible in the background landscape. Because of distance and angle of view, the change in contrast would be moderate. The facility would be noticeable to the casual observer but would not dominate the view.
24	Arizona Trail – Tortilla Mountains*	The tailings facility would be visible in the background landscape view. Because of distance and angle of view, the change in contrast would be moderate. The facility would be noticeable to the casual observer but would not dominate the view.
25	Cochran OHV Parking†	The tailings facility would be visible from this KOP. Although the foreground landscape topography shields the view of the lower portion of the facility, the upper portion would be visible and present a moderate to strong contrast to the existing landscape. The facility would be most visible at the end of mine life and prior to reclamation and revegetation activities. After successful reclamation, the contrast could be reduced to moderate. The visual simulation for KOP 25 is presented in figure 3.11.4-4.
26	Cochran Road OHV Dispersed Site†	The tailings facility would be visible from this KOP. A strong contrast in form, line, and color would dominate the middle ground view. The facility would be most visible at the end of mine life and prior to reclamation and revegetation activities. After successful reclamation, the contrast could be reduced to moderate.
27	Florence-Kelvin Highway – East Side†	The tailings facility would be visible from this KOP in the foreground. A strong contrast would be present in form, line, and color, with strong straight lines dominating the view. The facility would be most visible at the end of mine life and prior to reclamation and revegetation activities. After successful reclamation, the contrast could be reduced to moderate.
28	Florence-Kelvin Highway –South†	The tailings facility would not be visible from this location.

* Block model Google Earth visual simulation
† Photograph visual simulation

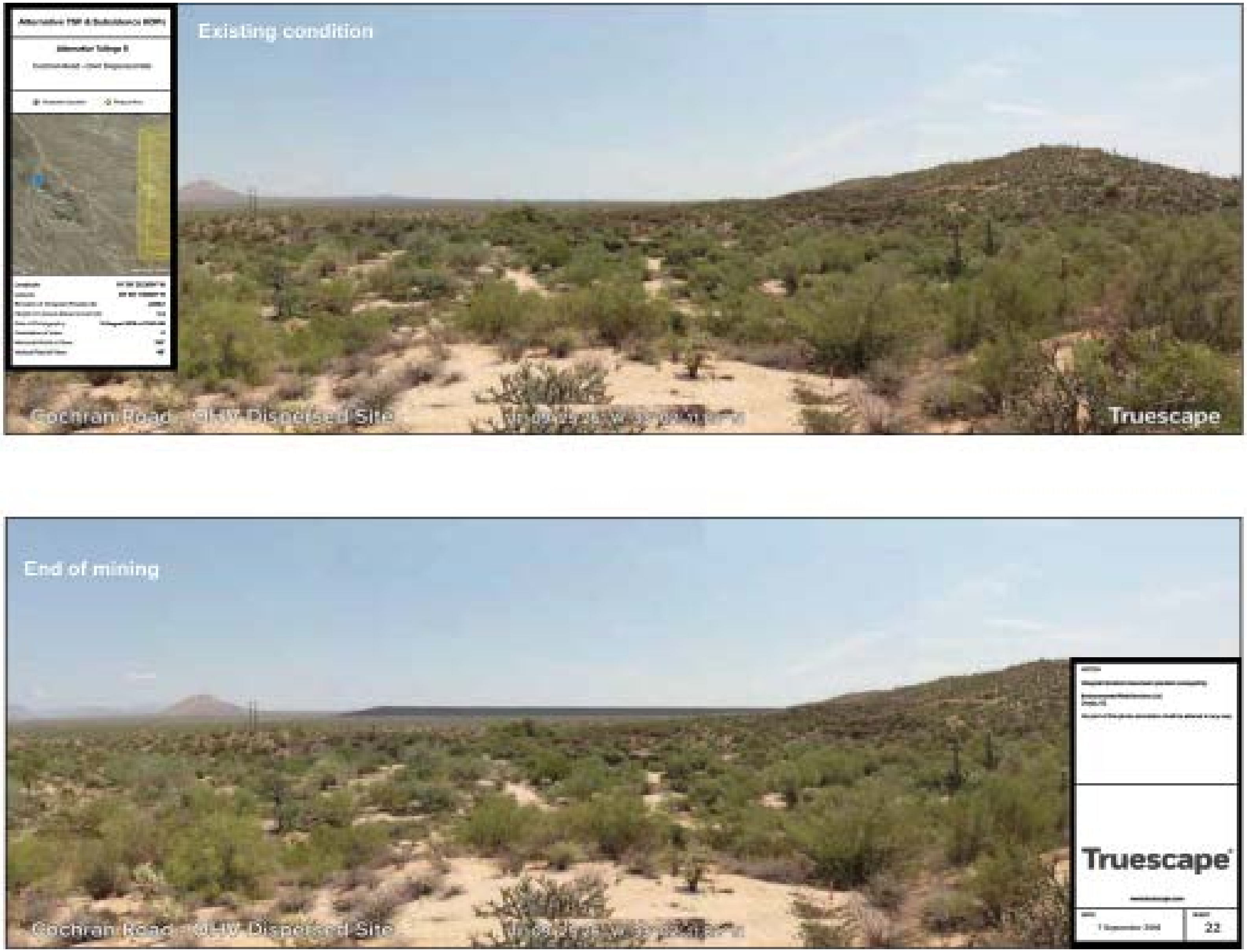


Figure 3.11.4-4. Visual simulation of Alternative 5 tailings facility from KOP 25 – Cochran OHV parking

traveling on the Florence-Kelvin Highway. This alternative would also comply with the Pinal Outdoor Lighting Code as described under Alternative 2.

3.11.4.6 Alternative 6 – Skunk Camp

The differences in impacts on scenery between Alternatives 2 and 6 are described in the following text.

Tailings Pipeline Corridor

The general scenery impacts described for the tailings pipeline corridor construction, operation, and closure/reclamation would be the same as those described under Alternative 2. However, the pipeline would be in a different location. There are two options for the pipeline (north and south); scenery impacts are described in the following text.

North Tailings Pipeline Corridor Option—The north pipeline corridor option contains the pipeline corridor and access roads as described in chapter 2, section 2.2.8. The corridor would be visible from U.S. 60 (at the crossing), NFS Road 2466, and Dripping Springs Road. KOP 32 (Tailings Pipeline U.S. 60) illustrates scenery impacts from construction and operation of the tailings pipeline in the vicinity of U.S. 60, the designated Gila-Pinal Scenic Road, and the Oak Flat area. The visual simulation shows the anticipated change in contrast from the existing landscape expected from tailings pipeline operation (Newell and Grams 2018). The tailings pipeline corridor would be visible in the vicinity of the crossing with U.S. 60 at the crossing and on the north and south side of the highway. The visual dominance and contrast would be strong in line, color, and texture. Post-reclamation contrast would be moderate upon successful revegetation and reclamation.

South Tailings Pipeline Corridor Option—The south pipeline corridor option follows the northern portion of the Peg Leg east pipeline corridor option, and impacts in that portion are the same as those described for Alternative 5. It also follows a portion of the Skunk Camp north pipeline corridor option. Additional locations with views of the pipeline corridor not described previously include NFS Road 315.

Transmission Line Corridor

A new power line, approximately 11.5 miles in length, would be constructed between the Silver King substation, north of U.S. 60, and the Skunk Camp tailings facility. Impact on scenery from transmission line construction would generally be the same as described under Alternative 2. This line would be visible from U.S. 60, NFS Road 2466, and Dripping Springs Road.

Tailings Facility

Although there are differences between the proposed action tailings facility and the Skunk Camp tailings facility in terms of design, general impacts on scenery from the facility are similar as those described under Alternative 2. Concurrent reclamation would occur, but the mine year that reclamation would begin is not yet defined. Strong contrast would be visible at the facility until concurrent reclamation is started and successful revegetation of the facility occurs. Although the visual simulations, as described in table 3.11.4-10, illustrate strong to moderate contrast from the tailings facility, in general, impacts on scenery and sensitive viewers in the Skunk Camp area are less than for the other alternatives. This is because there are limited areas where the facility would be visible and fewer sensitive viewers in the vicinity.

Viewshed Analysis. The viewshed for Alternative 6 is presented in the process memorandum (Newell and Grams 2018). It illustrates the general visibility of the tailings facility across the landscape within the analysis area and shows the high points and location where the facility could be most visible. Linear facilities (U.S. 60, SR 177, and the Arizona Trail) are not visible within the viewshed model for the Skunk Camp tailings facility.

KOP Scenery Analysis. Sensitive viewpoints (KOPs) in the area around the Skunk Camp tailings facility were identified to analyze impacts on the area's scenery resources (see figure 3.11.1-1). The contrast rating analysis process (described in section 3.11.2.4) was conducted for each KOP and is presented in table 3.11.4-10. The related contrast rating

Table 3.11.4-10. Alternative 6 key observation point description and contrast rating analysis

KOP Number	KOP Name	View Description and Contrast Rating Analysis
29	Dripping Springs Road*	The tailings facility would be highly visible from this KOP and the contrast in form, line, color, and texture would be strong. The facility would dominate the foreground view and obscure the mountains and ridgeline views of the background. Because of proximity and angle of view, the contrast would remain strong and dominate the view after closure and reclamation. The visual simulation for KOP 29 is presented in figure 3.11.4-5.
30	Pinal Peak†	The tailings facility would be visible from this KOP in the background valley below. The contrast would be strong in form, line, and color until reclamation is complete. Post-reclamation contrast would be moderate upon successful revegetation and reclamation of the facility.
31	San Carlos†	The tailings facility would be visible from this KOP in the background valley below. The contrast would be strong in form, line, and color until reclamation is complete. Post-reclamation contrast would be moderate upon successful revegetation and reclamation of the facility.
32	Tailings Pipeline U.S. 60*	The tailings pipeline corridor would be visible in the vicinity of the crossing with U.S. 60 at the crossing and on the north and south side of the highway. It would also be intermittently visible to persons travelling east on U.S. 60. The visual dominance and contrast would be strong in line, color, and texture. Post-reclamation contrast would be moderate upon successful revegetation and reclamation.

* Photograph visual simulation

† Block model Google Earth visual simulation

worksheets and the visual simulations are presented in the process memorandum (Newell and Grams 2018).

Dark Skies

General impacts on night skies from the mining operations facilities would generally be the same as described under Alternative 2. However, lighting at the tailings facility would be in a different location. The facility would be lit and visible from the surrounding area. There would be few observers of the night sky in the area because of the remote location of the facility. This alternative would also comply with the Pinal Outdoor Lighting Code as described under Alternative 2. The Skunk Camp tailings facility would be located in Gila County and the lighting plan for this component would be designed in compliance with the Gila County Outdoor Light Control Ordinance.

3.11.4.7 Forest Service and BLM Scenery Management Designations

Table 3.11.4-11 presents the Tonto National Forest and the BLM scenery management designation acreages by project area alternative component. The acreages represent areas where the proposed project components cross Federal lands. Total acreages vary, depending upon the amount of private or State lands included in the project area alternatives.

The majority of project area alternatives on NFS lands are designated Retention, Partial Retention, and Modification. In general terms, Retention and Partial Retention do not allow for the proposed project activities as a whole. Retention requires that activities be "not visually evident." Partial Retention requires that activities be "visually subordinate" to the characteristic landscape. The Modification designation allows for activities to visually dominate the original character of the landscape, but vegetation and landform should mimic the natural landscape. With adequate mitigation, including revegetation, the project as proposed could meet the Modification designation. Under Alternative 4, 1,847 acres of the project area are designated Maximum

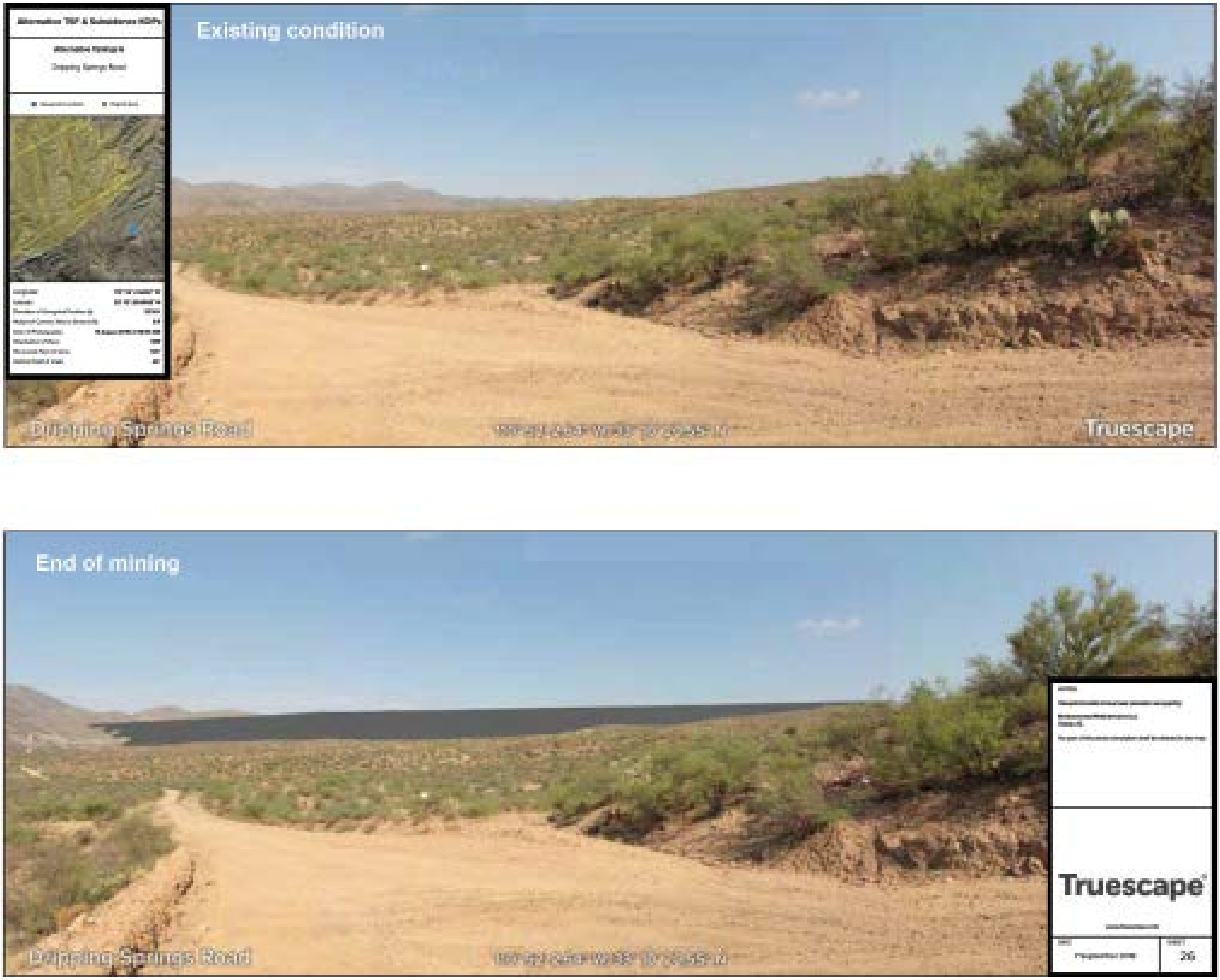


Figure 3.11.4-5. Visual simulation of Alternative 6 tailings facility from KOP 29 – Dripping Springs Road

Table 3.11.4-11. Project area alternative scenery management designation acreage

	Alternatives 2 and 3	Alternative 4	Alternative 5 (East)	Alternative 5 (West)	Alternative 6 (North)	Alternative 6 (South)
VQO						
Preservation	0	0	0	0	0	0
Retention	393	371	691	530	676	771
Partial Retention	5,184	4,663	1,905	1,824	2,043	2,225
Modification	1,705	1,178	222	371	592	530
Maximum Modification	0	1,847	0	0	0	0
VRM						
Class III	0	0	7,086	7,558	0	0
Class I, II, IV	0	0	0	0	0	0
Total Acreage	**7,282**	**8,059**	**9,904**	**10,283**	**3,311**	**3,526**

Modification. With mitigation, this designation would allow for the proposed project activities.

Portions of NFS lands that would not meet the VQO designations include the following:

- Retention Acres—Alternatives 2 and 3 (393), Alternative 4 (371), Alternative 5 East (691), Alternative 5 West (530), Alternative 6 North (676), Alternative 6 South (771)
- Partial Retention Acres—Alternatives 2 and 3 (5,184), Alternative 4 (4,663), Alternative 5 East (1,905), Alternative 5 West (1,824), Alternative 6 North (2,043), Alternative 6 South (2,225)

Alternatives 2 and 3 have the least acres designated Retention, with Alternative 6 (south option) having the most. Alternative 5 (west option) has the least acres designated Partial Retention with Alternatives 2 and 3 having the most.

Alternative 5 is the only alternative on BLM lands, and it intersects with BLM VRM Class III designation (Alternative 5 [east option] 7,086 acres, and Alternative 5 [west option] 7,558 acres). The designation does not preclude mining activities but does require that activities not dominate the view of the casual observer. The level of change to the characteristic landscape from Alternative 5 would likely be deemed too great to meet the requirements of the Class III designation because the tailings facility would dominate the view from several viewpoints.

3.11.4.8 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. These RFFAs may contribute to cumulative changes in scenic resources in the assessment area, including in the vicinity of the proposed Resolution Copper Mine and its project alternative components, as well as in the visual landscape viewed from distant locations, where the viewshed could include proposed project components along with RFFA project components, resulting in a cumulative scenic resources impact. 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.

- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. As approved, the proposed tailings storage facility project would occupy 2,627 acres of private lands and 9 acres of BLM lands and be situated within the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to 750 million tons of material (tailings and embankment material). The tailings facility would include two starter dams, new pipelines to transport tailings and reclaimed water, a pumping booster station, a containment pond, a pipeline bridge across the Gila River, and other supporting infrastructure. 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. A segment of the Arizona Trail would be relocated east of the tailings storage facility. If the Alternative 5 – Peg Leg tailings storage facility location is selected as the agency-preferred alternative, then the proximity of Ripsey Wash tailings storage facility and the Peg Leg tailings storage facility would have cumulative effects on scenic resources. The Ripsey Wash tailings storage facility would be located within the same viewshed as the Peg Leg facility. Both facilities would cumulatively affect the areas scenic quality. The Ripsey Wash tailings storage facility would result in large-scale, permanent changes in the landscape that would create strong visual contrasts and cause major and highly noticeable changes to the area's existing character. The Ripsey Wash tailings storage facility at full build-out would be visible from portions of the Florence-Kelvin Highway, SR 177, the Arizona Trail, and various OHV routes in the vicinity. The facility would also be visible in the background view from the White Canyon Wilderness, although views of the Ripsey Wash tailings storage facility from the wilderness would be from relatively inaccessible areas with rugged and steep terrain that are expected to have limited public visitation.
- *Ray Land Exchange and Proposed Plan Amendment.* ASARCO is 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 an open-pit copper mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to specific mine development plans and how these would affect scenic resources in this popular recreation area and from surrounding viewpoints.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. AK Mineral Mountain, LLC, NL Mineral Mountain, LLC, POG Mineral Mountain, LLC, SMT Mineral Mountain, LLC, and Welch Mineral Mountain, LLC proposed to build a municipal solid waste landfill on private property surrounded by BLM land in an area known as the Middle Gila Canyons area. There is no way to access the proposed landfill without crossing BLM land. The owners/developers and Pinal County have applied for a BLM right-of-way grant and Temporary Use Permit for two temporary construction sites to obtain legal access to the private property and authorization of the needed roadway improvements. The proposed action includes improving a portion of the existing Cottonwood Canyon Road and a portion of the existing Sandman Road in order to accommodate two-way heavy truck traffic to and from the proposed landfill. The access road on BLM-administered land would be widened to 44 feet as needed. The overall life of the proposed landfill is 50 years. The slight widening of the road to

accommodate drainage would not have an impact on the overall characteristics of the landscape; however, the proposed landfill would be visible from SR 79, U.S. 60, and Cottonwood Canyon Road. Visual impacts would be greatest on Cottonwood Canyon Road.

- *ADOT Vegetation Treatment.* ADOT plans to conduct annual treatments using EPA-approved herbicides to contain, control, or eradicate noxious, invasive, and native plant species that pose safety hazards or threaten native plant communities on road easements and NFS lands up to 200 feet beyond road easement on the Tonto National Forest. It can be reasonably assumed that ADOT will continue to conduct vegetation treatments along U.S. 60 on the Tonto National Forest during the expected life of the Resolution Copper Mine (50–55 years) for safety reasons. The vegetation treatment could measurably impact cumulative scenic resources.
- *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. This document will have substantial impacts on current recreational uses of NFS lands and transportation routes, which in turn would have some impact on disturbance of scenery resources from new road construction or decommissioning of other roads.

Other future projects not yet planned, such as large-scale mining activity, pipeline projects, power transmission line projects, and other utility infrastructure development, 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 cumulatively contribute to future changes in scenic resources in the region.

3.11.4.9 Mitigation Effectiveness

Mitigation Measures Applicable to Scenic Resources

Minimize visual impacts from transmission lines (FS-03). Resolution Copper would use best management practices or other guidelines (when on NFS lands) that would minimize visual impacts from transmission lines. Measures could include using non-specular transmission lines, transformers, and towers; avoiding use of monopole transmission structures; avoiding “skylining” of transmission and communication towers and other structures (i.e., consider topography when siting transmission structures to avoid “skylining” of structures on high ridges in the landscape); and in areas of the highest visual sensitivity with difficult access, use of air transport capability to mobilize equipment and materials for clearing, grading, and erecting transmission towers. These measures would reduce and minimize the scenery impacts and project contrast of mining operations in the surrounding landscape and impacts upon sensitive viewers. The power line corridors occur mainly on Forest Service–managed lands, and the mitigation measures can be required within those areas, regardless of alternative.

Mitigation Effectiveness and Impacts

Applying mitigation to transmission lines would be effective in reducing impacts on scenery resources and sensitive viewers on NFS lands through reducing impacts from increased contrast from form and line introduced into the landscape. In particular, avoiding “skylining” of structures would reduce visual dominance relative to the existing landscape through increased screening of views and reduce impacts on sensitive viewers. Impacts related to this mitigation would be related to air transport of equipment and materials. This would cause noise and scenery impacts on national forest visitors in the vicinity of the transmission line. However, these impacts would only occur during construction and would be temporary.

Unavoidable Adverse Impacts

The subsidence area and residual tailings storage facility would constitute a permanent adverse impact that cannot be avoided or completely mitigated. While night brightness from mine facility lighting would be mitigated to a large degree, residual impacts would remain that are not avoidable and cannot be completely mitigated.

3.11.4.10 Other Required Disclosures

Short-Term Use and Long-Term Productivity

Impacts on visual resources would be both short and long term. While impacts associated with processing plant buildings and structures such as utility lines and fences would cease when they are removed at closure, the subsidence area and tailings storage facility would permanently alter the scenic landscape and affect the scenic quality of the area in perpetuity. Impacts on dark skies from night lighting would cease after mine closure and reclamation.

Irreversible and Irretrievable Commitment of Resources

For all action alternatives, there would be an irretrievable loss of scenic quality from increased activity and traffic during the construction and operation phases of the mine. The size and extent of the tailings facilities would create losses of scenic quality until rock weathering and slope revegetation have reduced color, form, line, and texture contrasts to a degree that they blend in with the surrounding landscape; revegetation would occur relatively soon after closure, but weathering would take such a long time scale as to be considered permanent. Due to the geological time frame necessary for these processes to occur, the loss of scenic quality associated with the tailings facilities would effectively be irreversible.

For each action alternative, the visual contrasts that would result from the introduction of facilities associated with the project would be an irretrievable loss of the undeveloped, semiprimitive setting until the project is closed and full reclamation is complete. Under all of the action alternatives, existing views would be irreversibly lost behind the tailings storage facility because of the height and extent of the piles.

There would be an irretrievable, regional, long-term loss of night-sky viewing during project construction and operations because night-sky brightening, light pollution, and sky glow caused by mine lighting would diminish nighttime viewing conditions in the direction of the mine. Impacts on dark skies due to night lighting would cease after mine closure and reclamation. Regional dark skies would continue to brighten due to other development factors in the region throughout the mine life. Therefore, it is unlikely that a return to current dark sky conditions would occur after mine closure.

Overview

Applicable laws that oversee cultural resources management in the United States include the National Historic Preservation Act, Archaeological Resources Protection Act, and numerous other laws and regulations at various levels of government. Despite the host of laws in place to mandate and oversee the detailed cultural resources surveys undertaken on behalf of Resolution Copper, it is likely that some portion of currently buried or otherwise undetected prehistoric (Native American only) and historic (Native American and Euro-American) artifacts and resources could be lost to mine-related construction and operation. This is especially true in areas such as Oak Flat, the Queen Creek watershed, and the Superior area, which have long histories of human habitation. Even those sites and artifacts that researchers have recorded and archived would be irrevocably altered.

3.12 Cultural Resources

3.12.1 Introduction

Cultural resources consist of the physical aspects of the activities of past or present cultures, including archaeological sites, historic buildings and structures, trails, roads, infrastructure, traditional cultural properties, and other places of traditional, cultural, or religious importance. Cultural resources can be human-made or natural features and are, for the most part, unique, finite, and nonrenewable. Cultural resources are often discussed in terms of historic properties under the National Historic Preservation Act (NHPA); however, the term "historic properties" has a very specific definition that may omit other resources that are critical to NEPA analysis but do not qualify as historic properties. This analysis is designed to capture potential impacts on cultural resources within the project area; however, it focuses on the potential impacts on historic properties (i.e., cultural resources that are listed in or have been determined eligible for listing in the National Register of Historic Places [NRHP]) and cultural resources that have not been evaluated for their NRHP status. The numbers and types of historic properties and those resources that may be historic properties represent the best possible information about cultural resources that can be verified and quantified.

3.12.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.12.2.1 Analysis Area

There are three distinct analysis areas for this discussion: the direct impacts analysis area, the indirect impacts analysis area, and the atmospheric impacts analysis area. The direct impacts analysis area for each alternative consists of the complete footprint of all project elements, including the lands leaving Federal management under the land exchange. The analysis areas for cultural resources for the GPO correspond to the Section 106 of the NHPA direct and indirect areas of potential effects, defined by 36 CFR 800.16(d) as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties."

For the direct analysis area, the analysis assumes that all areas within those boundaries or fence lines would be disturbed. Indirect impacts include visual impacts from project elements. The direct analysis area for the proposed project is defined by several factors: the acreage of ground disturbance expected for each mine component described in the GPO and the acreage of land leaving Federal stewardship as a result of the land exchange. The direct analysis area for the proposed action (GPO and land exchange) is approximately 40,988 acres and consists of the following, which includes access roads and other linear infrastructure:

- East Plant Site and subsidence area, including the reroute of Magma Mine Road

(1,539 acres that is partially within the Oak Flat Federal Parcel and includes private, NFS, and ASLD lands);

- 2,422-acre Oak Flat Federal Parcel of NFS land to be exchanged with Resolution Copper;
- 940-acre West Plant Site;
- 6.96-mile Silver King to Oak Flat transmission line;
- 169-acre MARRCO railroad corridor and adjacent project components;
- 553-acre filter plant and loadout facility; and
- Alternatives 2–6 tailings storage facilities and tailings corridors: tailings storage facility and tailings corridor for Alternatives 2 and 3; and Alternative 4 – Silver King, Alternative 5 – Peg Leg, and Alternative 6 – Skunk Camp, which have different locations and overall footprints from the GPO tailings storage facility and tailings corridor.

The indirect impacts analysis area consists of a 2-mile buffer around all project and alternative components. The 2-mile buffer is designed to account for impacts on resources not directly tied to ground disturbance and outside the direct analysis area. Potential indirect impacts include, but are not limited to, inadvertent damage, vandalism, unsanctioned collecting, and impacts caused by vibration from mine construction and operations.

The atmospheric impacts analysis area (including visual and auditory impacts) consists of a 6-mile buffer around all project and alternative components, which has been split into three distance zones: less than 1 mile, 1 to 3 miles, and greater than 3 miles from the project area. This distance is consistent with the indirect analysis area for visual impacts (see section 3.11), which is based on BLM visual guidance and Forest Service guidance for assessing visual effects. The atmospheric impacts analysis area encompasses approximately 729,674 acres for all project components under all alternatives. The analysis area for cultural resources is shown in figure 3.12.2-1.

Various permitted archaeological contractors over the past 15 years collected data through Class I records searches (records check at local, State, and Federal levels) and Class III pedestrian surveys (field crews systematically walk the analysis area and record resources). As of June 2019, crews had surveyed the direct analysis areas for cultural resources, except for portions of Alternative 6 – Skunk Camp and the pipeline routes not within previously surveyed areas. In addition, although previously surveyed, the East Plant Site underwent additional sample surveys in 2018. As many of the data that were available were used in this analysis. Please note that some survey results are preliminary and may change after the DEIS is published.

3.12.2.2 Impact Indicators

Direct impact on a historic property would consist of damage, loss, or disturbance caused by ground disturbance that would alter the characteristic(s) that make the property eligible for listing in the NRHP. Indirect impacts would consist primarily of visual impacts from alterations to setting, feeling, or association of a resource where setting is a significant component of its NRHP eligibility; however, other indirect impacts such as auditory impacts or inadvertent disturbance are also assessed.

Impact indicators for this analysis include the following:

- Loss, damage, or disturbance to resources listed in State or Federal registers;
- Loss, damage, or disturbance to resources that are eligible or may be eligible for State or Federal registers;
- Loss, damage, or disturbance to traditional cultural properties (TCPs); and
- Alterations to setting, feeling, or association for a historic property listed in or eligible to be listed in the National or State register under Criteria A, B, and/or C.

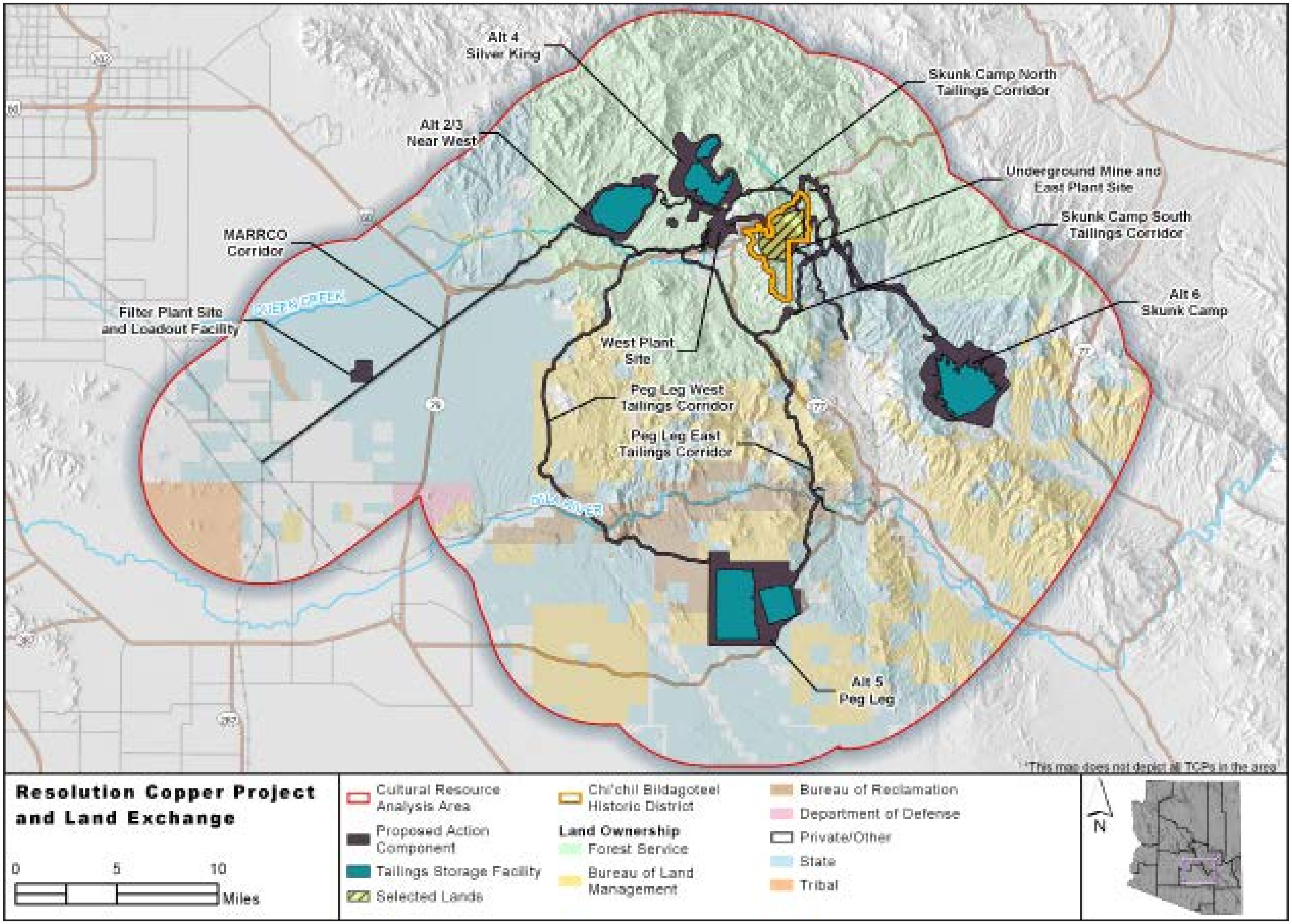


Figure 3.12.2-1. Direct and indirect analysis areas for cultural resources

Adverse impacts on historic properties would be avoided, minimized, or mitigated through the NHPA Section 106 process.

3.12.3 Affected Environment

3.12.3.1 Relevant Laws, Regulations, Policies, and Plans

The primary Federal, State, and agency regulations, policies, and guidelines used to analyze potential impacts on cultural resources in the project analysis area are shown in the accompanying text box.

A complete listing and brief description of the legal authorities and agency guidance used in this cultural resources impacts analysis may be reviewed in Newell (2018a).

Regulations, Policies, and Guidelines Used in the Cultural Resources Effects Analysis

- National Historic Preservation Act (NHPA) of 1966 (54 U.S.C. 300101 et seq.)
- Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. 470aa–470mm)
- American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. 1996)
- Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 U.S.C. 3001–3013)
- Executive Order 13007 (May 24, 1996), “Indian Sacred Sites”
- Executive Order 13175 (November 6, 2000), “Consultation and Coordination with Indian Tribal Governments”
- Arizona Antiquities Act of 1960 (ARS 41-841 through 41-844)
- State Historic Preservation Act of 1982 (ARS 41-861 through 41-865)
- Tonto National Forest Land and Resource Management Plan

3.12.3.2 Existing Conditions and Ongoing Trends

Human occupation of east-central Arizona spans from the Paleoindian period to today, with the primary occupation in the project area vicinity from the Formative era to the Late Historic period. Detailed summaries of the cultural history of the area can be found in many reference reports (see, for example, Lindeman and Whitney (2005) and Buckles (2009)). The following section is a brief overview to provide context for discussing potential impacts from the proposed project.

Cultural History

PALEOINDIAN PERIOD

The earliest human occupation of the Southwest and Arizona is known as the Paleoindian tradition and associated with hunters living in the end of the Pleistocene glaciations (9500–8500 B.C.). The Paleoindian tradition is defined by a series of large projectile (spear) points that are often found in association with late Pleistocene megafauna such as the mammoth and bison. Clovis, the earliest Paleoindian complex, is characterized by distinctive lanceolate points. Following Clovis is the

Folsom complex (8900–8200 B.C.), identified by a smaller fluted point most commonly found in association with bison remains. Most Folsom finds in Arizona come from the Colorado Plateau. The Folsom tradition is followed by a series of other poorly dated and sometimes overlapping complexes, including the Plainview, Agate Basin, and Cody complexes. Most of the point types (Plainview, Agate Basin, Eden, and Scottsbluff) associated with these complexes have also been found on the Colorado Plateau.

ARCHAIC PERIOD

The Archaic period spans roughly from 8000 B.C. to A.D. 300 in the Southwest, beginning around the time of the Pleistocene-Holocene transition and the extinction of the Pleistocene big game. Archaeologists divide the Archaic period based on projectile point styles: Early Archaic (8000–5000 B.C.), Middle Archaic (5000–ca. 2000 B.C.), and Late Archaic–Early Agricultural (ca. 2000 B.C. up to A.D. 250). Archaic groups were hunter-gatherers specializing in exploiting small-game and plant resources. They traveled in a seasonal pattern exploiting specific resources in their territory as those resources became available or ripe. Archaic remains are represented by campsites or resource procurement and/or processing sites.

The Late Archaic is also referred to as the Early Agricultural period. The introduction of agriculture transformed cultures in the Southwest, but there is still debate about when and how this transformation occurred. Maize was introduced from Mexico before A.D. 1, and possibly as early as 2100 B.C. The Late Archaic–Early Agricultural period sees the beginning of village life, with agricultural communities appearing on floodplains. However, while maize and other crop cultivation became increasingly important over time, wild resources continued to play a large role in Late Archaic–Early Agricultural subsistence patterns. The end of the Late Archaic–Early Agricultural period is signaled by the adoption of ceramic vessels.

FORMATIVE PERIOD

Hohokam

The Formative era begins with the appearance of pottery in the archaeological record. In central Arizona, the best-documented and most common archaeological remains are attributed to the Hohokam culture. The Hohokam lifeway was characterized by a mixed subsistence pattern of wild resources and agricultural products, pottery (both plain and decorated red-on-buff wares), pit houses, and canal irrigation. Later Hohokam participated in large exchange networks and constructed ball courts and platform mounds. However, by the Late Formative, the Hohokam were in decline due to overpopulation, loss of agricultural production, and droughts.

Salado

During the Late Formative, Salado ceramics began to appear in central Arizona. The Salado culture was centered on the Tonto Basin in the Late Formative, and, while heavily influenced by Hohokam culture, developed with a unique set of traits and patterns. Salado culture is characterized by polychrome pottery and aboveground masonry structures within compounds. Evidence of trade networks can be seen in the spread of polychrome pottery in southern Arizona. At the end of the Formative, a reorganization of Salado sites can be seen, with many villages abandoned in favor of a smaller number of larger settlements, possibly due to conflicts. The Salado went into decline likely due to environmental factors and population pressure, and by the end of the Formative period most Salado sites were abandoned.

PROTOHISTORIC AND HISTORIC NATIVE AMERICAN

The project area is within the traditional territories of the Western Apache, the Yavapai, and the Akimel O’odham or Upper Pima. The histories of the Western Apache—a group that includes ancestors of the White Mountain, San Carlos, Cibecue, and Tonto Apache—tell of migrations into Arizona where they encountered the last inhabitants of villages along the Gila and San Pedro Rivers. The Western Apache practiced a mixed subsistence strategy of farming in the summer in the north, and hunting and gathering in the winter in the south. In the 1870s, the Apache were forced onto reservations, which curtailed much of their seasonal round. However, not all Apache stayed on the reservations, and some continued to use the vicinity of the project area into the twentieth century. Like the Western Apache, the Yavapai practiced a mixed subsistence strategy with an emphasis on hunting and gathering. Yavapais had little contact with Euro-Americans until the 1860s, and also like the Apache, after silver was discovered in Arizona, they were forced onto reservations in the 1870s. The Akimel O'odham were primarily farmers who also practiced hunting and gathering of wild resources. They and other O'odham groups are the likely descendants of the Hohokam, and like the Hohokam, lived along the Gila River to the west of the project area. The year-round source of water allowed them to settle large villages and cultivate more crops with irrigation agriculture than some of the other O'odham groups in harsher areas of the desert while still gathering resources from the surrounding areas.

HISTORIC EURO-AMERICAN

Spanish, Mexican, and Euro-American settlers began to arrive in appreciable numbers in the eighteenth century. The ensuing period of historical exploitation was marked by mining, ranching, and homesteading interests. These historical pursuits included the construction of new canals, as well as the reuse of prehistoric ones. With the acquisition of southern Arizona from Mexico in 1853, the United States became the most current heir to the American Southwest. The discovery of gold in California, the 1862 Homestead Act, and development of gold and silver mines in western and central Arizona heralded the arrival of a large number of Euro-American settlers by the mid-1870s. During the late 1800s, cattle and mining industries were established. Technological innovations (such as pumps) and improvements in irrigation methods led to intensified agricultural development and population growth into the twentieth century.

Inventories of the Direct Impacts Analysis Area

To date, 33 cultural resource surveys, inventories, or monitoring projects have been completed within the direct analysis area.[69] Fourteen surveys have been conducted in the selected lands and/or East Plant Site (Benz 2006; Buckles 2008; Buckles and Granger 2009; Chamorro 2014a, 2015; Deaver 2010, 2017; Dolan and Deaver 2007; Lindeman 2003; Lindeman and Whitney 2005; Prasciunas and Chamorro 2012; WestLand Resources Inc. 2009). Five surveys or inventories were conducted within the West Plant Site (Chamorro 2015; Deaver 2012; Steely 2011). Five surveys or monitoring projects were conducted within the tailings storage facility and corridor (Chamorro 2014b; Chamorro et al. 2016; Hooper 2014; Hooper and Tinseth 2015). Seven surveys were conducted within the MARRCO corridor and the filter plant and loadout facility (Buckles 2007; Buckles and Jerla 2008; Buckles et al. 2012; Cook 2007a, 2007b; King and Buckles 2015; Ryden et al. 2004). Surveys of the Silver King and Peg Leg sites have been completed or partially completed (Chamorro, Brown, et al. 2019; Chamorro, Tinseth, et al. 2019). Please note that these reports are still in draft form; any changes in the final report will be reflected in the FEIS. The surveys of Skunk Camp and Peg Leg pipeline routes are still underway. Reports are not available, but preliminary data for completed areas are available and have been used in the DEIS. These surveys and inventories have resulted in the recordation of 721 archaeological sites and three historical buildings or structures within the direct analysis area.

69. Two of the surveys listed cover more than one mine facility. Readers should note that while all references and citations for the EIS are made available via the EIS website, reports containing locational information of cultural resources are considered to be sensitive; therefore, only redacted versions may be made available, subject to the decision of the Forest Supervisor.

Incomplete or Missing Information

Survey of Alternative 5 – Peg Leg pipeline route options and some small areas of other project components that have moved as a result of design changes will occur in 2019. The results will be updated in the FEIS.

Inventory of the Indirect Impacts Analysis Area

For the indirect impacts analysis area, SWCA Environmental Consultants (SWCA) conducted a Class I records search of the area. The cultural resources team searched AZSITE—the online cultural resources database that contains records from the SHPO, BLM, and the ASLD—as well as records housed at the Tonto National Forest Phoenix Office and the BLM Tucson and Lower Sonoran Field Offices, for all recorded archaeological sites within 2 miles of the direct analysis area. The NRHP database was also searched for historic properties listed within 2 miles of the direct analysis area.

Inventory of the Atmospheric Impacts Analysis Area

For the atmospheric impacts analysis area, SWCA conducted a Class I records search of the area. The cultural resources team searched AZSITE, the Tonto National Forest Phoenix Office records, and the BLM Tucson and Lower Sonoran Field Offices records. Personnel also searched the NRHP for resources listed in or eligible for listing in the NRHP (historic properties) under Criteria A, B, and/or C. Historic properties eligible for the NRHP under Criteria A, B, and/or C are more likely to be sensitive to impacts on setting than properties determined to be eligible under Criterion D.

Direct Analysis Area

ARCHAEOLOGICAL SITES

Within the direct impacts analysis area, 721 archaeological sites have been recorded. This total includes preliminary data from the Silver King, Peg Leg, and Skunk Camp alternatives. Of the 721 sites, 523 are recommended or determined eligible for the NRHP, 118 are recommended or determined not eligible for the NRHP, 78 are undetermined, and two are exempt from Section 106 compliance.

The archaeological sites range in age from the Archaic to Historic periods and several sites have two or more temporal components. Cultural site components are attributed to Archaic peoples (19), Hohokam (81), Hohokam-Salado (73), Salado (330), Apache-Yavapai (25), Native American (116), Euro-American (189), and unknown (4). Archaeological sites found in the analysis area represent short- and long-term habitations, agricultural sites, resource procurement and processing sites, campsites, a historic-age campground, communication sites, ranching sites, mining sites, soil conservation, utilities, transportation (roads and trails), recreation activities, water management, and waste management.

TRADITIONAL CULTURAL PROPERTY

One NRHP-listed TCP is located within the direct analysis area: the *Chí'chil Biłdagoteel* Historic District. The *Chí'chil Biłdagoteel* Historic District was listed on the NRHP in 2016 as an Apache TCP and its boundaries contain 38 archaeological sites that contribute to the overall eligibility of the district, in addition to sacred places, springs, and other significant locations. See Section 3.14, Tribal Values and Concerns, for a more detailed discussion of the resource. Of the 38 archaeological sites within the TCP, six are found within the direct impacts analysis area.

HISTORIC BUILDINGS AND STRUCTURES

Twenty-one historic buildings or structures have been recorded within the direct analysis area. Seventeen of the historic buildings or structures are associated with the Magma Mine; however, all but three have been demolished as part of a reclamation plan. No formal recommendation or determination of eligibility has been made for the Magma Mine resources. The remaining four resources are in-use historic-era linear resources (roads and utility lines). All four are found in the Peg Leg alternative and are recommended not eligible for the NRHP.

Indirect Analysis Area

The Class I records search of the indirect analysis area resulted in 568 cultural resources. Of the 568, eight are listed in the NRHP, 257 are eligible for listing in the NRHP, 245 are unevaluated, and 58 are not eligible. The majority of the eligible resources are Prehistoric and Historic archaeological sites eligible under Criterion D for their information potential. The eight listed resources are the Gabel House, The Eleven Arches, the Erskine P. Caldwell House, the Magma Hotel, the Boyce Thompson Arboretum, the Butte-Cochran Charcoal Ovens, the Queen Creek Bridge, and the Devil's Canyon Bridge.

Atmospheric Analysis Area

The Class I records search of the atmospheric analysis area for historic properties listed in or eligible for listing in the NRHP under Criterion A, B, or C resulted in 13 historic buildings, structures, or districts listed in the NRHP and 37 archaeological sites eligible for listing in the NRHP. The historic buildings include several houses and a hotel. Historic structures include five bridges, charcoal ovens, and the Boyce Thompson Arboretum. One district is also present within the indirect analysis area: the *Chí'chil Biłdagoteel* Historic District. Archaeological sites include Civilian Conservation Corps features, mining sites, roads and highways, railroads, and transmission lines, as well as prehistoric artifact scatters and petroglyph sites.

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

3.12.4.1 Alternative 1 – No Action

Direct Impacts

Under the no action alternative, the Forest Service would not approve the GPO, and current management plans would be in place. Resolution Copper would continue current activities on private property. As described in section 2.2.2, the no action alternative analysis analyzes the impacts of (1) the Forest Service's not approving the GPO, and (2) the land exchange's not occurring.

If the GPO is not approved, the proposed Resolution Copper Project would not occur, and no adverse direct impacts on cultural resources would be anticipated. If the land exchange does not occur, the selected lands would remain under Federal management, and no direct adverse impacts on cultural resources would be anticipated. Current management of historic properties and other cultural resources would continue as it is today.

Indirect Impacts

If the GPO is not approved, the mine would not occur, and no adverse indirect impacts on cultural resources would be anticipated. If the land exchange does not occur, the selected lands would remain under Federal management, and no indirect adverse impacts on cultural resources would be anticipated.

Atmospheric Impacts

If the GPO is not approved, then none of the proposed mining facilities would be constructed, so no adverse indirect impacts on cultural resources would be anticipated from mining facilities. If the land exchange does not occur, no adverse indirect impacts on cultural resources would be anticipated.

3.12.4.2 Impacts Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have effects on cultural resources.

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 cultural 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. If the land exchange occurs, 31 NRHP-eligible archaeological sites and one TCP within the selected lands would be adversely affected. Under Section 106 of the NHPA and its implementing regulations (38 CFR 800), historic properties leaving Federal management is considered an adverse effect, regardless of the plans for the land, meaning that, under NEPA, the land exchange would have an adverse effect on cultural resources.

The offered lands parcels would enter either Forest Service or BLM jurisdiction. Entering Federal management would offer additional protection for any cultural resources on these lands.

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). A number of standards and guidelines (10) were identified as applicable to management of cultural resources. None of these standards and guidelines were found to require amendment to the proposed project, either on 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 (the GPO, not the land exchange) that would act to reduce potential impacts on cultural resources. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper to reduce impacts on cultural resources are covered in detail in the Programmatic Agreement (appendix O). Specifically, Resolution Copper would do the following:

- Develop and implement treatment plans to resolve adverse effects on cultural resources from the project. Plans would be prepared to address adverse effects on historic properties, including archaeological sites, historic buildings or structures, historic districts, and TCPs.
- Develop a monitoring and treatment plan for inadvertent discoveries. If previously unidentified cultural resources are discovered during construction activities on Tonto National Forest, work would cease within 100 feet of the location, and the Forest Service would be contacted for instruction before work would continue at that location.

3.12.4.3 Alternative 2 – Near West Proposed Action

Direct Impacts

Under Alternative 2, 132 cultural resources would be impacted: 101 NRHP-eligible and 31 undetermined archaeological sites. Ninety-six percent (10,213 acres) of the total alternative has been surveyed at the time of this review. Table 3.12.4-1 presents the number of cultural resources that are listed in or eligible for the NRHP or are of undetermined NRHP status within each project element. Some sites would be impacted by more than one project element; hence, the total numbers in the following tables are different from the total number of sites overall.

In addition, Alternative 2 would adversely impact one NRHP-listed TCP in the East Plant Site and undetermined historic buildings in the West Plant Site; this is true for Alternatives 2 through 6.

Table 3.12.4-1. Cultural resources directly impacted by Alternative 2

GPO Component	Number of NRHPListed or Eligible Sites	Number of NRHP Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	9	0	**9**
Tailings facility and corridor	29	27	**56**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

Indirect Impacts

Within the indirect impact analysis area for Alternative 2, 29 cultural resources may be impacted: two listed, eight eligible, and 19 unevaluated. Nine of those resources are within 2 miles of the tailings facility, one is within 2 miles of the East Plant Site and subsidence area (the *Chi'chil Biłdagoteel* Historic District), four are within 2 miles of the West Plant Site, one is within 2 miles of Silver King Mine Road, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), and three are within 2 miles of the transmission line corridor.

Atmospheric Impacts

Outside of the proposed project footprint, but within the atmospheric analysis area of 6 miles around Alternative 2, there are 13 historic buildings or structures listed in the NRHP and 35 archaeological sites eligible for the NRHP under Criterion A, B, or C. The *Chí'chil Biłdagoteel* Historic District is less than 1 mile from the East Plant Site/subsidence area, the West Plant Site, and the Silver King to Oak Flat transmission line corridor. In addition to the historic district, one historic bridge and nine archaeological sites are also within 1 mile of the East Plant Site/subsidence area. Within 1 mile of the West Plant Site, there is one historic bridge, one hotel, and six archaeological sites, in addition to the historic district. There is one archaeological site within 1 mile of the tailings facility. One historic property and two archaeological sites are within 1 mile of Silver King Mine Road, four historic buildings and structures and 10 archaeological sites are within 1 mile of the transmission line corridor, and one historic building and five archaeological sites are within 1 mile of the MARRCO corridor. Table 3.12.4-2 gives the numbers of historic properties listed in or eligible for listing in the NRHP under Criterion A, B, or C. Please note that some properties would be impacted by more than one project component.

Table 3.12.4-2. Historic properties within the atmospheric analysis area for Alternative 2

Facility	Historic Properties within 1 mile	Historic Properties within 1 to 3 miles	Historic Properties farther than 3 miles
East Plant Site and subsidence area	11	9	33
West Plant Site	9	11	39
Tailings facility and corridor	1	6	46
Silver King Mine Road realignment	3	13	41
Silver King to Oak Flat transmission line	14	10	34
MARRCO corridor, including filter plant	6	17	36

Note: Some sites may be located by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

3.12.4.4 Alternative 3 – Near West – Ultrathickened

Direct Impacts

The direct impacts of Alternative 3 on cultural resources are the same as Alternative 2.

Indirect Impacts

The indirect impacts of Alternative 3 on cultural resources are the same as Alternative 2.

Atmospheric Impacts

The atmospheric impacts of Alternative 3 on cultural resources are the same as Alternative 2.

3.12.4.5 Alternative 4 – Silver King

Direct Impacts

Seventy-two percent (8,231 acres) of Alternative 4 has been surveyed at the time of this review. Under Alternative 4, 137 cultural resources would be adversely impacted: 122 NRHP-eligible and 15 undetermined archaeological sites. Table 3.12.4-3 presents numbers of cultural resources that are listed in or eligible for the NRHP or are of undetermined NRHP status within each project element. Alternative 4 would adversely impact four more NRHP-eligible or undetermined sites than Alternative 2 or 3. Some sites would be impacted by more than one project element; hence, the total numbers in the tables are different from the total number of sites overall.

Indirect Impacts

Within the indirect impact analysis area for Alternative 4, 25 cultural resources may be impacted: two listed, 11 eligible, and 12 unevaluated. Five of those resources are within 2 miles of the tailings facility, one is within 2 miles of the East Plant Site and subsidence area (the *Chí'chil*

Table 3.12.4-3. Cultural resources directly impacted by Alternative 4

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Silver King tailings facility and corridor/ pipeline corridor	50	10	**60**
MARRCO corridor	39	3	**42**
Filter plant and loadout facility	2	0	**2**
Transmission line	14	1	**15**
Roads	3	0	**3**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

Biłdagoteel Historic District), four are within 2 miles of the West Plant Site, one is within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), one is within 2 miles of the pipeline corridor, and three are within 2 miles of the transmission line corridors.

Atmospheric Impacts

For Alternative 4, the atmospheric impacts on all project components except for the Silver King tailings facility and pipeline corridor are the same as Alternative 2. For the Silver King tailings facility and pipeline corridor, the Magma Hotel and three archaeological sites are within 1 mile, four historic buildings and 12 archaeological sites are between 1 and 3 miles, and 13 historic buildings or structures and 35 archaeological sites are more than 3 miles from the tailings facility and pipeline corridor.

Table 3.12.4-4. Cultural resources directly impacted by Alternative 5 with the east pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Peg Leg tailings facility and corridor/ east pipeline	72	18	**90**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**
Roads	0	9	**9**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

3.12.4.6 Alternative 5 – Peg Leg

Direct Impacts

For Alternative 5, there are two potential pipeline corridor routes: an east route option and a west route option. Please note that pipeline routes have not been entirely surveyed yet; additional data may change the numbers in the following analysis. For the east pipeline route, 78 percent (13,905 acres) of the entire alternative has been surveyed; for the west pipeline route, 74 percent (13,497 acres) has been surveyed. Under Alternative 5 with the east pipeline route, 152 cultural resources would be adversely impacted: 125 NRHP-eligible and 27 undetermined archaeological sites. Under Alternative 5 with the west pipeline route, 125 cultural resources would be adversely impacted: 114 NRHP-eligible and 11 undetermined.

Tables 3.12.4-4 and 3.12.4-5 present numbers of cultural resources that are listed in or eligible for the NRHP or are of undetermined NRHP status for each pipeline corridor route. Alternative 5 with the east

Table 3.12.4-5. Cultural resources directly impacted by Alternative 5 with the west pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Peg Leg tailings facility and corridor/ west pipeline	66	9	**75**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**
Roads	0	0	**0**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

pipeline route would impact 30 more sites than Alternative 2 or 3, and 15 more than Alternative 4. Alternative 5 with the west pipeline route would impact seven fewer than Alternative 2 or 3, and 12 fewer than Alternative 4.

Indirect Impacts

Within the indirect impact analysis area for Alternative 5 with the east pipeline route, 44 cultural resources may be impacted: two listed, 23 eligible, and 19 unevaluated. Four resources are within 2 miles of the West Plant Site, one is within 2 miles of the East Plant Site and subsidence area (the *Chí'chil Biłdagoteel* Historic District), nine are within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), 18 are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, and three are within 2 miles of the transmission line corridors.

Within the indirect impact analysis area for Alternative 5 with the west pipeline route, 29 cultural resources may be impacted: one listed, 16 eligible, and 12 unevaluated. Four resources are within 2 miles of the West Plant Site, 12 is within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), 12 are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, and three are within 2 miles of the transmission line corridors.

Atmospheric Impacts

For Alternative 5 with the east pipeline option, no historic properties listed or eligible for listing under Criterion A, B, or C are within 1 mile of the Peg Leg tailings facility, one historic building and six archaeological sites are within 1 mile of the pipeline corridor, six historic buildings or structures and 12 archaeological sites are within 1 to 3 miles of the tailings facility and pipeline corridor, and 13 historic buildings or structures and 35 archaeological sites are within 6 miles of the facility and pipeline corridor. One archaeological site is within 1 mile of a planned access road, and two historic buildings or structures and two archaeological sites are within 1 to 3 miles of the access road. However, no indirect impacts are expected from the access road.

For Alternative 5 with the west pipeline option, no historic properties listed or eligible under Criterion A, B, or C are within 1 mile of the Peg Leg tailings storage facility, one historic building and four archaeological sites are within 1 mile of the pipeline corridor, five historic buildings or structures and 11 archaeological sites are within 1 to 3 miles of the tailings and pipeline corridor, and 13 historic buildings or structures and 35 archaeological sites are within 6 miles of the facility and pipeline corridor. For the access road, one archaeological site is within 1 mile, and one historic building and one archaeological site are within 1 to 3 miles. However, no indirect impacts are expected from the access road.

Table 3.12.4-6. Cultural resources directly impacted under Alternative 6 with the north pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Skunk Camp tailings facility and corridor/ north pipeline*	252	1	**253**
Skunk Camp transmission line	12	0	**12**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	14	1	**15**
Roads	8	0	**8**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.
* Numbers represent surveyed portion of pipeline corridor only.

Table 3.12.4-7. Cultural resources directly impacted under Alternative 6 with the south pipeline route

Facility	Number of NRHP-Listed or Eligible Sites	Number of NRHP-Undetermined Sites	Total
Oak Flat Federal Parcel	31	0	**31**
East Plant Site and subsidence area	27	0	**27**
West Plant Site	12	2	**14**
Skunk Camp tailings facility and corridor/ south pipeline	286	15	**301**
Silver King Mine Road realignment	7	0	**7**
MARRCO corridor	39	3	**42**
Transmission line	23	1	**24**
Roads	6	0	**6**

Note: Some sites would be impacted by more than one project element; hence, total numbers in this table are different from the total number of sites overall.

3.12.4.7 Alternative 6 – Skunk Camp

Direct Impacts

For Alternative 6, there are two potential pipeline routes: a north route option and a south route option. Under Alternative 6 with the north pipeline, 323 cultural resources would be adversely impacted: 318 NRHP-eligible and five undetermined archaeological sites. Under Alternative 6 with the south pipeline, 360 cultural resources would be adversely impacted: 343 NRHP-eligible and 17 undetermined archaeological sites. Tables 3.12.4-6 and 3.12.4-7 present NRHP-eligible and undetermined archaeological sites within Alternative 6 by pipeline route. This alternative would impact a minimum of 193 more sites than Alternative 2, 3, 4, or 5.

Please note that portions of the proposed pipeline corridors for the Skunk Camp alternative have not been completely surveyed. At this time, 16,049 acres (96 percent) of the alternative has been surveyed for Alternative 6 and the north pipeline route option, and 16,559 acres (96 percent) has been surveyed for Alternative 6 and the south pipeline route option.

Indirect Impacts

Within the indirect impact analysis area for Alternative 6 with the north pipeline route, 25 cultural resources may be impacted: two listed, 12 eligible, and 11 unevaluated. Four resources are within 2 miles of the West Plant Site, one is within 2 miles of the East Plant Site and subsidence area (the *Chí'chil Biłdagoteel* Historic District), one (The Eleven Arches) is within 2 miles of the tailings facility, five are within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Southwest Arboretum), six are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, one is within 2 miles of the Skunk Camp transmission line corridor, and three are within 2 miles of the transmission line corridors.

Within the indirect impact analysis area for Alternative 6 with the south pipeline route, 41 cultural resources may be impacted: two listed, 19 eligible, and 20 unevaluated. Four resources are within 2 miles of the West Plant Site, one is within 2 miles of the East Plant and subsidence area (the *Chí'chil Biłdagoteel* Historic District), one (The Eleven Arches) is within 2 miles of the tailings facility, two are within 2 miles of the access roads, 12 are within 2 miles of the MARRCO corridor (including the Boyce Thompson Arboretum), 21 are within 2 miles of the pipeline corridor, one is within 2 miles of Silver King Mine Road, and four are within 2 miles of the transmission line corridors.

Atmospheric Impacts

For Alternative 6 with the north pipeline, six historic buildings or structures and five archaeological sites are within 1 mile of the Skunk Camp tailings facility and pipeline corridor, 21 historic properties are within 1 to 3 miles, and 45 historic properties are over 3 miles. Two historic buildings or structures and five archaeological sites are within 1 mile of planned access roads, and 23 historic properties are within 1 to 3 miles of the access roads. However, no visual impacts are anticipated from access roads.

For Alternative 6 with the south pipeline, six historic buildings or structures and four archaeological sites are within 1 mile of the Skunk Camp tailings facility and pipeline corridor, 22 historic properties are within 1 to 3 miles, and 45 historic properties are over 3 miles. Two historic buildings or structures and five archaeological sites are within 1 mile of planned access roads, and 14 historic properties are within 1 to 3 miles of the access roads. However, no visual impacts are anticipated from access roads.

3.12.4.8 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 archaeological sites and other resources of traditional, cultural, or religious importance within the analysis area identified in section 3.12.2.1. 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. An EIS for this proposed action is currently being developed by the Tonto National Forest, and cultural resource surveys of the proposed action and alternative facility locations are concurrently being conducted. However, potential impacts on specific cultural sites are not yet known.
- *Ripsey Wash Tailings Project.* Mining company 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. As documented in the EIS and ROD, construction of the approved tailings storage facility would adversely and directly affect 22 NRHP-eligible sites and also indirectly affect two historic properties eligible for listing in the NRHP.

- *Ray Land Exchange and Proposed Plan Amendmen*t. 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. The land exchange would adversely impact 58 cultural resources because those resources would be leaving Federal management.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road*. A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private property is an inholding within an area of BLM-administered lands and cannot be accessed without crossing BLM land. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. As noted in the EA and FONSI for the right-of way, road improvements to allow for heavy truck haul traffic across BLM lands would adversely affect six cultural sites. Of the six sites, three are presently of unknown eligibility and would require eligibility testing; the other three sites have been recommended eligible for the NRHP and would require data recovery. Additionally, one cultural resource site that is outside the area of potential effects, but sufficiently close enough that it may be impacted, has been recommended NRHP eligible.
- *Superior to Silver King 115-kV Relocation Project.* At the request of Resolution Copper, SRP intends to relocate an approximately 1-mile segment of the existing Superior-Silver King 115-kV transmission line approximately 0.25 mile to the northwest to accommodate future Resolution Copper Mine–related facilities. In this area the transmission line corridor is located entirely on Resolution Copper–owned private property. The proposed relocation of the line has the potential to affect one historic property that is recommended NRHP eligible and may also impact other, as-yet-unknown archaeological sites.
- *Tonto National Forest Plan Amendment and Travel Management Plan.* The Tonto National Forest is currently in the process of revising its Forest Plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Cultural resources may be impacted for any new road construction; however, the Tonto National Forest would conduct the appropriate surveys, consultation, and mitigation. Impacts on these sites would cumulatively impact cultural resources in the area in combination with the loss of sites that would take place with the Resolution Copper Project.

Other ongoing and future mining activity, infrastructure improvement projects (including construction of new roadways, water and sewer systems, power transmission lines, and other utilities), and private and commercial land development is likely to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years). Each of these developments may contribute, both individually and cumulatively, to adverse effects on prehistoric and historic archaeological sites and other places of cultural importance.

3.12.4.9 Mitigation Effectiveness

Mitigation of adverse effects on historic properties eligible for the NRHP under Criterion D, the potential to provide significant information about the past, most often consists of data recovery to gather the information prior to disturbance. A Programmatic Agreement (see appendix O) is currently being developed to address adverse effects on historic properties under Section 106 of the NHPA. Mitigation of adverse effects on historic properties eligible for the NRHP under Criterion A, B, or C would be developed in consultation with the appropriate Indian Tribes, SHPO, and other interested parties and would be outlined in a historic properties treatment plan and/or a TCP Redress Plan as stipulated by the PA. Mitigation of adverse impacts under NEPA that do not fall under Section 106 would also be developed in consultation with the tribes and interested parties. Data recovery is generally considered an effective mitigation for historic properties eligible for the NRHP for their information potential; however, mitigation strategies for historic properties eligible under other criteria may or may not be completely effective.

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.

Mitigation Measures Applicable to Cultural Resources

Conduct cultural and archaeological data recovery via the Oak Flat HPTP (RC-209): The Oak Flat Historic Properties Treatment Plan (HPTP) sets out a plan for treatments to resolve the adverse effects on 42 historic properties that have been identified within the Oak Flat Federal Parcel. In accordance with the plan, Resolution Copper would conduct archaeological data recovery on sites eligible under Criterion D that would be adversely affected. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Conduct cultural and archaeological data recovery via the Research Design and data recovery plans (RC-210): The GPO Research Design and data recovery plans detail treatments to resolve adverse effects on historic properties within the GPO project area with the exception of those in the Oak Flat Federal Parcel. Data recovery would be conducted on archaeological sites eligible under Criterion D within the GPO project area. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Mitigation Effectiveness and Impacts

Archaeological data recovery can reduce a portion of the adverse effect by sampling historic properties that are eligible for their scientific information potential under Criterion D of the NRHP. However, there are several limitations to data recovery's effectiveness. Data recovery by nature is destructive, and although archaeological investigative techniques are continually evolving, even today's state-of-the-art research strategies would not be able to recover all the data potential at the project area sites. Data recovery can record and preserve some of the materials from the sites, but it cannot preserve the current integrity of setting, association, workmanship, feeling, location, and design.

Unavoidable Adverse Effects

Cultural resources and historic properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of surface disturbance, nor can they be fully mitigated. The land exchange is also considered an unavoidable adverse effect on cultural resources.

3.12.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Physical and visual impacts on archaeological sites, tribal sacred sites, cultural landscapes, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the historic properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

Irreversible and Irretrievable Commitment of Resources

The direct impacts on cultural resources and historic properties from construction of the mine and associated facilities constitute an irreversible commitment of resources. Archaeological sites cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage facility construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs for cultural and religious purposes are also an irreversible commitment of resources.

Overview

Large mines can be a boon to local economies through the influx of employees, spending on products and services, and increased tax revenue. These same increases can also stress basic services like hospitals, water and sewer systems, local housing stock, and roads and infrastructure. A large mine (or tailings facility) can also fundamentally change the quality of life of the surrounding communities, affect property values, and affect other industries, such as tourism and recreation. Historically, mining in Arizona has followed a "boom and bust" cycle, which potentially leads to great economic uncertainty.

3.13 Socioeconomics

3.13.1 Introduction

The analysis for social and economic concerns includes a discussion of current social and economic data relevant to the proposed project, including population, housing, financial resources, facilities and services, and quality of life. These elements are considered to help analyze potential impacts from the proposed project and alternatives to social and/or economic conditions. Further detail regarding the social and economic information is provided in "Socioeconomic Effects Technical Report: Resolution Copper Mine Environmental Impact Statement" (BBC Research and Consulting 2018). Potential socioeconomic impacts analyzed in this section include employment, earnings, state and local government revenue, demands for public services, risk of a mining boom/bust cycle, tourism, and property values.

3.13.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.13.2.1 Analysis Area

The socioeconomic analysis focused primarily on the region informally known as the "Copper Triangle," which encompasses the location of the proposed mine, and most closely examined potential effects in the town of Superior, which is the closest community. Other communities within the Copper Triangle include the Queen Valley Census Designated Place (CDP), Cutter CDP, city of Globe, town of Hayden, town of Miami, San Carlos CDP, Bylas CDP, Peridot CDP, Top-of-the-World CDP, and town of Winkelman. Whereas most of the Copper Triangle is located in Pinal and Gila Counties, Maricopa County was also included in the socioeconomic analysis because a substantial portion of the workforce for the proposed mine would be expected to commute from the Phoenix metropolitan area. Pima County is farther from the proposed mine and unlikely to be substantially affected by construction or operations but was included in the regional economic impact analysis (section 3.13.4) based on information indicating suppliers in Pima County would likely provide goods and services to support mining activity.

3.13.2.2 Analysis Methodology

Information regarding the social and economic affected environment was obtained from various sources, including the following: the U.S. Census Bureau; the State of Arizona; Impact Analysis for Planning (IMPLAN) data files;[70] Gila, Graham, Maricopa, Pima, and Pinal Counties; and the Town of Superior. Information on the potential social and economic effects of the proposed alternatives was based primarily on IMPLAN economic input-output analysis. This modeling incorporated the proposed GPO provided by Resolution Copper, current tax rates and tax policies of the relevant jurisdictions, interviews with local information

70. IMPLAN is a widely used economic model and is used to quantify the direct and indirect economic effects of a project.

Primary Legal Authorities Relevant to the Socioeconomics Effects Analysis
• National Forest Management Act
• Tonto National Forest Land and Resource Management Plan
• Forest Service Economic and Social Analysis Handbook (FSH 1909.17)
• Chapter 1970, Social and Economic Evaluation (FSM 1970.1)

sources, and information provided by the AGFD. The temporal bounds of analysis for socioeconomic resources is the three phases of activity associated with the mine: construction, operations, and closure/reclamation. The spatial analysis area for socioeconomics includes the communities most likely to be affected by the proposed project (figure 3.13.2-1).

Where the employees of the proposed mine would choose to reside is an important uncertainty in this evaluation. The future price of copper over the projected life of the proposed mine is unknown, as well. Both of these issues are evaluated in detail in BBC Research and Consulting (2018).

3.13.3 Affected Environment

One of the planning principles in the National Forest Management Act is “responsiveness to changing conditions in the land and changing social and economic demands of the American people” (U.S. Forest Service 1985b). Forest Service guidelines for socioeconomic analyses are outlined in the Forest Service “Economic and Social Analysis Handbook” (U.S. Forest Service 1985a). The handbook provides guidelines for evaluating socioeconomic impacts that may result from policy, program, plan, or project decisions on NFS lands. Forest Service Manual 1970.1 directs how economic and social analyses should be conducted to aid Forest Service decision-making.

3.13.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance applicable to socioeconomics may be reviewed in Newell (2018f).

3.13.3.2 Existing Conditions and Ongoing Trends

Demographic and Socioeconomic Characteristics

Population. The population of the State of Arizona was approximately 6.9 million in 2016. In 2016, the counties closest to the proposed mine site (Pinal, Graham, and Gila Counties) had populations of 417,540 (Pinal), 37,407 (Graham), and 53,556 (Gila). Between 2000 and 2016, Pinal County’s population grew at an average annual rate of 5.4 percent, compared with a rate of 0.3 percent in Gila County and 0.7 percent in Graham County. The population of Maricopa County, which lies approximately 60 miles west of the town of Superior, was 4.2 million in 2016 and grew at an average annual rate of 2.0 percent between 2000 and 2016.

The town of Superior had 2,999 residents in 2016, which represents an increase of 166 residents since 2010 (5.9 percent growth), but a decline of 525 residents since 2000 (14.9 percent reduction). In total, the Copper Triangle had approximately 50,000 residents in 2016.

Housing. The characteristics of the housing stock in the analysis area are shown in table 3.13.3-1. Maricopa County had the largest housing stock in the socioeconomic analysis area (an average of 1.7 million homes between 2011 and 2015). Of the remaining counties, Pinal County had the second largest housing stock (163,490 housing units), followed by Gila County (32,952 housing units), and Graham County (13,128

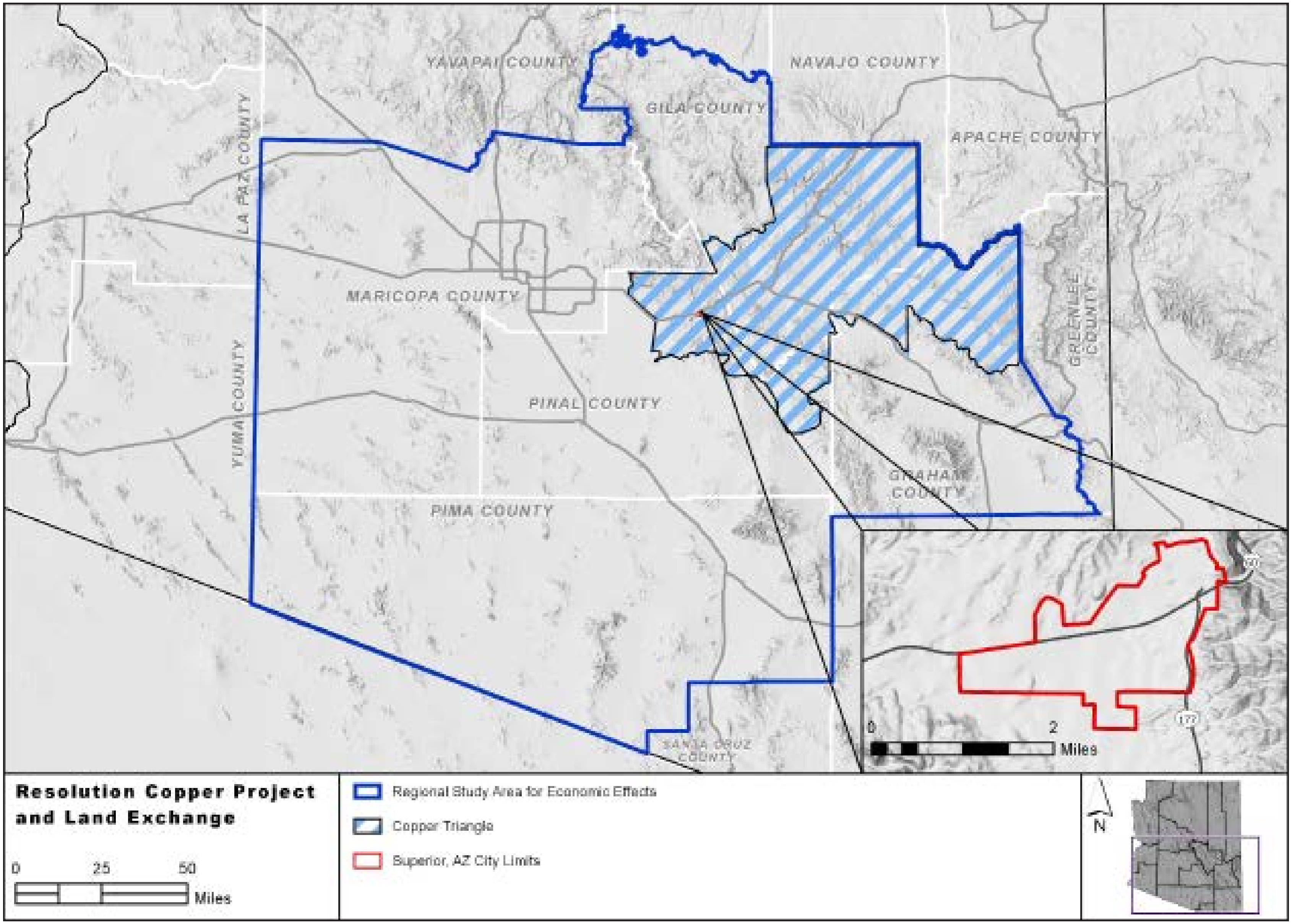


Figure 3.13.2-1. Socioeconomic resource analysis area

Table 3.13.3-1. Housing characteristics of the socioeconomic analysis area, 2011–2015

Area	Average Housing Stock	Change in Housing Stock (%)*	Average Vacant Units	Average Vacancy Rate (%)
Gila County	**32,952**	**16.9**	**12,043**	**36.5**
Cutter	19	–	0	0.0
Globe	3,356	5.8	516	15.4
Hayden	301	−9.9	85	28.2
Miami	988	6.2	195	19.7
San Carlos	1,160	16.7	178	15.3
Graham County	**13,128**	**14.9**	**2,169**	**16.5**
Bylas	474	–	78	16.5
Peridot	395	9.1	63	15.9
Maricopa County	**1,668,555**	**33.5**	**226,037**	**13.5**
Pinal County	**163,490**	**101.5**	**35,891**	**22.0**
Superior	1,284	−12.7	319	24.8
Top-of-the-World	128	−44.7	55	43.0
Winkelman	152	−21.6	39	25.7
Arizona	***2,890,664***	***32.0***	***478,452***	***16.6***

Sources: U.S. Census Bureau (2000); U.S. Census Bureau ACS 5-year estimates, 2011 to 2015 (U.S. Census Bureau 2015b).

* Percentage change was calculated with data from the 2000 U.S. Census and the ACS 5-year estimates from 2011 to 2015. Information on the housing stocks of Cutter and Bylas was not available for the year 2000.

housing units). The town of Superior had an average housing stock of 1,284 units between 2011 and 2015.

Between 2011 and 2015, there was an average of 226,037 vacant housing units in Maricopa County, compared with 35,891 in Pinal County, 12,043 in Gila County, and 2,169 in Graham County. The town of Superior had an average of 319 vacant housing units during this time. The vacancy rate in Superior (24.8 percent) was about 8 percentage points higher than the average vacancy rate across Arizona (16.6 percent).

Maricopa County had the highest median home values between 2011 and 2015 ($187,100), followed by Gila County ($134,200) and Pinal County ($128,700). Of the cities and towns in the socioeconomic analysis area, Globe had the highest median home values between 2011 and 2015 ($116,500), followed by Superior ($78,200) and Miami ($65,800). Hayden had the lowest median home values between 2011 and 2015 ($32,900), followed by Bylas ($46,700).

Employment. In 2015, there were approximately 2.4 million jobs in Maricopa County, compared with 90,119 jobs in Pinal County, 21,382 jobs in Gila County, and 11,921 jobs in Graham County. The retail trade sector was the largest source of employment in all four counties. While the mining industry is not among the largest employers in the socioeconomic analysis area, the industry still employed a total of 10,670 people across all four counties in 2015. In percentage terms, Pinal County saw the largest change in employment between 2001 and 2015 (approximately 65 percent), followed by Maricopa County (28 percent), Graham County (23 percent), and Gila County (7 percent).

Labor force, unemployment, and income characteristics. The labor force in each county, city, and town in the socioeconomic analysis area is shown for the year 2000 and the period from 2011 to 2015 in table 3.13.3-2. Between 2011 and 2015, there was an average of approximately 2.0 million workers in Maricopa County, compared with 150,351 workers in Pinal County, 20,607 workers in Gila County, and 13,919 workers in Graham County. Between 2011 and 2015, the average unemployment rate was 6.1 percent in Gila County, 6.9 percent in Graham County, 4.9 percent in Maricopa County, and 5.3 percent in

Table 3.13.3-2. Average labor force, unemployment rate, and median household income in the socioeconomic analysis area, 2011–2015

Area	Labor Force	Unemployment Rate (%)	Median Household Income ($)
Gila County	**20,607**	**6.1**	**39,751**
Cutter	40	18.9	–
Globe	3,539	5.3	42,405
Hayden	244	13.6	38,167
Miami	897	5.6	40,602
San Carlos	1,304	15.5	25,363
Graham County	**13,919**	**6.9**	**45,964**
Bylas	727	31.7	24,028
Peridot	767	25.8	40,500
Maricopa County	**1,977,494**	**4.9**	**54,229**
Pinal County	**150,351**	**5.3**	**49,477**
Superior	1,238	5.6	41,367
Top-of-the-World	111	10.8	77,689
Winkelman	136	5.6	41,250
Arizona	***3,106,324***	***5.3***	***50,255***

Source: U.S. Census Bureau (2015a).

Pinal County. The average unemployment rate in the town of Superior was 5.6 percent during this time. Between 2011 and 2015, the median household income in Graham County was $45,964, compared with $54,229 in Maricopa County. During the same period, the median household income in Pinal County was $49,477. In Gila County, the median household income was $39,751. The town of Superior had a median household income of approximately $41,000 between 2011 and 2015.

County taxes, revenues, and public expenditures. Table 3.13.3-3 shows the sources of revenue for Gila, Graham, Maricopa, and Pinal County Governments for the most recent fiscal years for which data are available. Taxes, including property, income, sales, and vehicle license taxes, accounted for 52.1 percent of Gila County's tax revenues in fiscal year (FY) 2014, compared with 44.8 percent in Graham County, 87.4 percent in Maricopa County in FY 2015, and 60.9 percent in Pinal County in FY 2015. Grants, including unrestricted and operating grants, and other sources of revenue were the other primary contributors of county government tax revenues. General government expenses, public

Table 3.13.3-3. General revenues and expenditures for Gila, Graham, Maricopa, and Pinal County governments

General Revenues	FY 2014 Gila County (%)	FY 2014 Graham County (%)	FY 2015 Maricopa County (%)	FY 2015 Pinal County (%)
Taxes	52.1	44.8	87.4	60.9
Intergovernmental	0.0	0.0	0.0	31.1
Charges for services	4.9	12.0	0.0	5.1
Grants	31.1	28.7	0.2	0.0
Other	11.9	14.5	12.4	2.9
Total (Millions, $)	**$62.2**	**$30.7**	**$1,385.4**	**$148.3**
General Expenditures	**FY 2014 Gila County (%)**	**FY 2014 Graham County (%)**	**FY 2015 Maricopa County (%)**	**FY 2015 Pinal County (%)**
General government	34.2	30.4	14.9	22.9
Public safety	26.4	34.4	55.2	62.7
Highway and streets	10.4	13.5	3.8	0.2
Health, welfare, and sanitation	19.1	12.2	21.2	13.5
Culture and recreation	2.4	2.8	2.9	0.0
Education	6.9	6.7	1.5	0.6
Interest	0.5	0.0	0.4	0.0
Total (Millions, $)	**$60.3**	**$32.3**	**$2,000.0**	**$153.3**

Sources: Arizona Auditor General (Arizona Auditor General 2017a, 2017b); Maricopa County (2017); and Pinal County (2016).

Note: Tax revenues include property, income, sales, and vehicle license taxes.

Table 3.13.3-4. General revenue and expenditures for the Town of Superior

General Revenues	Percentage of Total	General Expenditures	Percentage of Total
Taxes	53.2	General government	32.2
Intergovernmental	41.1	Public works	47.8
Charges for services	1.8	Welfare	5.2
Grants	0.0	Culture and recreation	4.9
Other	3.9	Other	9.9
Total (Millions, $)	**$2.0**	**Total (Millions, $)**	**$1.8**

Source: HintonBurdick CPAs and Advisors (2017)

safety, highways and streets, and health, welfare, and sanitation were the primary categories of expenditures in all four counties.

Town of Superior taxes, revenues, and public expenditures. Table 3.13.3-4 shows the sources of revenue for the Town of Superior government during FY 2015 (July 1, 2015–June 30, 2016). During that time, the Town of Superior received approximately $2.0 million in revenue. The largest share of revenue collected came from taxes (53.2 percent). The largest expenditures made were for public works, which accounted for 47.8 percent of the Town's expenditures.

Public Facilities and Services

Transportation and road maintenance. The town of Superior can be accessed by road via U.S. 60, which is a major east-west transportation route through the region, and SR 177, which is a north-south route that runs between Superior and the town of Winkelman. Superior also has 25.6 miles of local streets that connect the town's different neighborhoods. A 2009 study commissioned by ADOT found that the 16-mile stretch of U.S. 60 between Superior and Miami/Globe was operating at capacity and expected the level of service to decline over time unless improvements were made to accommodate future demand (Logan Simpson Design Inc. 2009). A 2016 assessment of Superior's roads found that of the 25.6 miles of roads maintained by the Town, 17 miles were in poor or serious condition (Arizona Department of Transportation 2016). Estimates suggest it would cost the Town $1.25 million to repair all the roads in need of improvements.

Utility services. The Town of Superior contracts with the Arizona Water Company to supply the Town's municipal water. Arizona Water Company supplies Superior with municipal drinking water from Arizona Water Company's groundwater resources located near Florence Junction. Arizona Water Company recently petitioned the Arizona Corporation Commission to raise water rates in the town of Superior, citing the need to raise revenue to cover investments in infrastructure as well as increasing operating and maintenance expenses. The Town of Superior provides sewer and wastewater treatment services for its residents. A recent study of the Town's wastewater treatment plant, originally built in 1974, found several inadequacies and noted that the plant may not meet State inspection standards (Duthie Government Advisors 2016). The Town has recently received a grant from the USDA to upgrade the wastewater treatment system (Jeavons 2018). Electricity is provided by APS.

Emergency and medical services. The Town of Superior funds and operates both fire and police departments. According to conversations with the Town's Fire Chief, the fire department has six full-time staff and 24 reserve staff that are paid on a per-call basis. The fire department has two type-1 engines, which are used for structure fires, one 1,800-gallon water tender, a type-6 brush truck used for fighting wildfires, and two rescue vehicles. The Town's police department has nine full-time officers, seven reserve officers, and one office manager that serve Superior's population.

Travel and Tourism

In Pinal County, tourists and visitors spent a total of $207.6 million in 1998, but by 2016, visitor spending had grown to $571.6 million, an increase of 175 percent (figure 3.13.3-1). During this same period, visitor spending grew by 75 percent across the state of Arizona, while

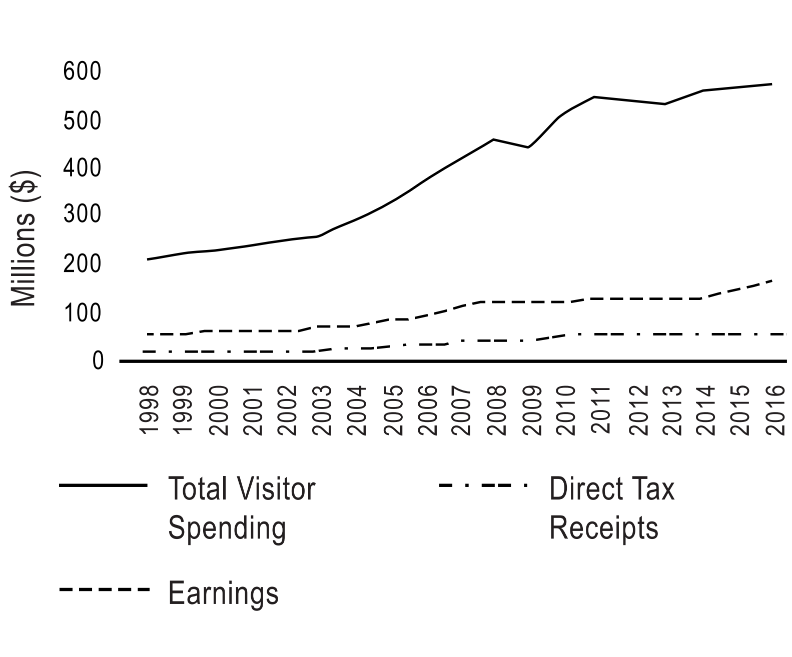


Figure 3.13.3-1. Total visitor spending, earnings, and direct tax receipts in Pinal County ($, millions). Source: reproduced from Dean Runyan Associates (2017)

Table 3.13.3-5. Activity participation in Tonto National Forest, 2016

Activity	% Participation	% Main Activity
Hiking/walking	29.3	15.3
Viewing wildlife	25.1	1.2
Relaxing	22.6	5.3
Viewing natural features	22.2	5.7
Fishing	17.9	11.8
Non-motorized water	14.9	13.6
Some other activity	14.5	10.9
Motorized water activities	12.5	8.5
Other non-motorized	11.1	6.7
Driving for pleasure	10.5	3.3
Developed camping	7.9	2.9
Picnicking	7.7	2.5
OHV use	7.5	5.8
Nature study	5.9	0
Primitive camping	4.1	1.1

Source: U.S. Forest Service (2016d)

visitor spending growth in Gila, Graham, Pima, and Maricopa Counties amounted to 41, 82, 36, and 88 percent, respectively. The growth in visitor spending has been supported by an increase of out-of-state air travel arrivals in Arizona. Between 2015 and 2016, air travel arrivals in the state increased by 7 percent. The growth in visitor spending helped businesses in Pinal County earn $168.4 million from visitor spending in 2016, compared with $53.7 million in 1998. Visitor spending in the county also supports county and local governments by generating tax revenues. Estimates from Dean Runyan Associates (2017) show that visitor spending generated approximately $53.2 million in tax revenue in Pinal County in 2016, which is a 197 percent increase from the tax revenue generated from visitor spending in 1998. Overall, visitor spending supports an estimated 6,840 jobs in Pinal County (Dean Runyan Associates 2017). As a result, changes in visitation numbers or visitor spending in the county could have effects on the county's economy.

The tourism economy of the Copper Triangle, which includes Pinal and Gila Counties as well as the town of Superior, is dependent on natural amenities to draw visitors to the area. The southern portion of the Tonto National Forest includes areas around the town of Superior. Table 3.13.3-5 shows the primary activities of visitors to the Tonto National Forest.

In 2016, approximately 2,580,000 people visited Tonto National Forest to participate in recreation activities (U.S. Forest Service 2016d). Visitors to the Tonto National Forest spent an average of $115 per party per day on an average trip lasting approximately 4 days (U.S. Forest

Service 2016d). The Tonto National Forest is also one of the most heavily used National Forests for motorized recreation (Arizona Game and Fish Department 2018e). Statewide, OHV user spending adds $1.6 billion in value to the state's economy and sustains more than 21,077 jobs (Arizona State University 2016). In Pinal County, wildlife viewing contributes approximately $89.5 million annually to the county's economy (Arizona Game and Fish Department 2018e).

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

3.13.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, the mine would not be developed, and existing socioeconomic conditions and trends would continue, as described in the "Affected Environment" part of this resource section.

3.13.4.2 Direct and Indirect Effects Common to All Action Alternatives

Effects of the Land Exchange

The land exchange would have limited effects on socioeconomics. The Oak Flat Federal Parcel would leave Federal jurisdiction and would result in a reduction of wildlife-related recreation spending and expenditures by visitors to the Oak Flat Campground, although the exact amount lost from visitors to Oak Flat has not been quantified. Another expected effect on socioeconomics could stem from slight changes in the tax base, but overall this would be limited. The admission of eight new parcels into Federal jurisdiction may increase recreational spending in those areas; however, it is likely to result in minimal overall effects. One of the planning principles in the National Forest Management Act is "responsiveness to changing conditions in the land and changing social and economic demands of the American people" (U.S. Forest Service 1985b). As such, the offered lands parcels entering NFS jurisdiction would then be managed under those principles.

Effects of Forest Plan Amendment

The Tonto National Forest Land and Resource Management Plan (U.S. Forest Service 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 socioeconomics. For additional details on specific rationale, see Shin (2019).

Summary of Applicant-Committed Environmental Protection Measures

Resolution Copper has entered into a number of agreements that would result in socioeconomic benefits within the analysis area. These are included here and their effects are accounted for in the analysis of environmental consequences.

- In February 2019, Resolution Copper entered into an Entrepreneurship and Innovation Center Gift Agreement with the Town of Superior, to fund a number of programs meant to diversify the economic base of the community.
- In February 2019, Resolution Copper entered into a Multigenerational Center Development Gift Agreement with the Town of Superior, to help fund the final studies, design, and construction of a multigenerational center. The goal of the center is to improve the overall quality of life for Superior

residents, local employers, and their employees, expand the quality of life amenities and services that are essential to retraining and attracting residents and employers, allow for consolidation of Town services and decrease the overall administrative burden of the Town, and further develop public, private, civic, and educational sectors of the community.

- In February 2019, Resolution Copper entered into an Education Funding Agreement with the Superior Unified School District, dedicating funding to a number of classroom enhancements and educational programs over the next 4 years.
- In February 2019, Resolution Copper entered into a Park Improvement Agreement with the Town of Superior, to fund improvements to the U.S. 60 Caboose Park.
- In March 2016, Resolution Copper entered into an Emergency Response Services agreement with the Town of Superior, to fund the provision of fire and other emergency services to the mine facilities by the Town.
- Resolution Copper has committed at a corporate level to hiring qualified candidates locally, and will track progress by employee proximity to the mine.
- Resolution Copper has committed at a corporate level to using local suppliers and services wherever possible.

Socioeconomic Impacts

Most of the direct and indirect effects are based on the proposed mine plan, including employment, earnings, output, and fiscal impacts, and do not differ in nature or magnitude between the action alternatives. Two indirect effects (effects on the tourism economy and property values) are similar in nature between alternatives but differ in magnitude. The differences between each action alternative are summarized in the following tables.

Impact on employment, earnings, and value added. Table 3.13.4-1 summarizes the annual average economic and fiscal effects of the proposed mine based on projected employment and purchases of goods and services over the life of the mine. On average, the mine is projected to directly employ 1,523 workers, pay about $134 million per year in total employee compensation, and purchase about $546 million per year in goods and services (not shown in table 3.13.4-1). The IMPLAN results indicate that the proposed mine would create substantial “multiplier” effects (technically known as indirect and induced economic effects) in Arizona, supporting almost 2,200 indirect and induced jobs and about $135 million per year in indirect and induced labor income. Including direct and multiplier effects, the proposed mine is projected to increase average annual economic value added in Arizona by about $1.0 billion (not shown in table 3.13.4-1). However, most of the multiplier effects would occur outside of the “Copper Triangle.” While all of the direct mine employment is expected to be based in the ZIP code encompassing Superior, only 11 percent of the multiplier effects are projected to occur within that ZIP code. About 8 percent of the multiplier effects are projected to occur in other parts of Pinal County, about 6 percent in Gila County, and about 7 percent in Pima County. The majority of the multiplier effects are projected to occur in Maricopa County (68 percent).

Projected employment and procurement activity associated with the proposed mine is anticipated to vary over the life of the project. The largest direct employment at the proposed mine is projected to occur during the approximately 15-year period encompassing mine construction and the ramp-up to full production (potentially 2021–2035). The smallest direct employment levels, and the lowest spending on goods and services, are projected to occur during the latter years of production and the closure and reclamation phases (potentially 2056–2079), as shown in figure 3.13.4-1.

Where the mine’s employees would live is important in evaluating impacts on Superior and the Copper Triangle area in terms of demographics, demands for public services, and other social and economic effects. Based on current commuting patterns and the residence choices of the mine’s employees to date, it appears likely that

Table 3.13.4-1. Summary of IMPLAN labor results based on projected average annual activity from proposed Resolution Copper Project

Geographic Area	Employment	Labor Income
Superior (ZIP code 85173)		
Direct Effect	1,523	$133,873,199
Indirect Effect	121	$7,222,045
Induced Effect	177	$4,425,516
Total Effect	**1,820**	**$145,520,760**
Rest of Copper Triangle (Indirect and Induced Effects Only)		
Other Pinal County areas	98	$1,045,321
Gila County areas	171	$5,569,895
Graham County areas	0	$0
Total Rest of Copper Triangle	**269**	**$6,615,216**
Effects Outside of Copper Triangle *(Indirect and Induced Effects Only)*		
Pinal County (remainder)	128	$6,858,380
Gila County (remainder)	0	$0
Graham County (remainder)	0	$0
Maricopa County	1,336	$101,273,756
Pima County	149	$8,538,230
Total Effect	**1,613**	**$116,670,366**
Total Regional Effects		
Direct Effect	1,523	$133,864,394
Indirect Effect	1,175	$93,446,967
Induced Effect	1,004	$41,494,980
Total Effect	**3,702**	**$268,806,341**

Note: Rounded to nearest whole number

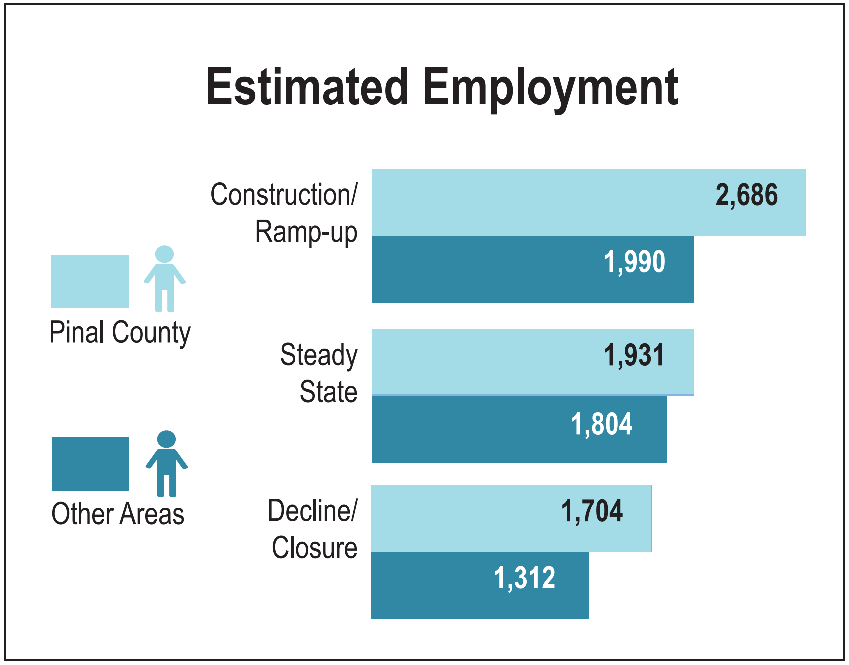


Figure 3.13.4-1. Comparison of projected total employment effects (direct and indirect/induced) during different phases of the proposed Resolution Copper Project

approximately 25 percent of the workforce would seek to live in or near Superior, and about 10 percent would choose to live in or near other communities within the Copper Triangle. The remainder would likely commute primarily from eastern portions of Maricopa County.

During the first few years, the actual number of mine-related employees who would live in Superior is likely to be constrained by the size and condition of the town's available housing supply and the availability of local services. While an estimated 455 of the new workers projected to result from the proposed mine might prefer to live nearby, given current conditions in Superior, it is more likely that these new workers would absorb about one-half of the available, move-in-ready housing stock during the early years of mine construction and operations. This implies about 150 new households would move to Superior in the relatively near term. Additional housing demand from mine-related workers is likely to provide upward pressure currently on home prices in Superior (which are currently very low), and could create affordability challenges for some existing Superior residents.

Projected fiscal effects. Operation of the proposed mine would produce both direct revenues to state and local governments (paid by Resolution Copper) and secondary revenues for those governments (which would be paid by employees and vendors). While there are numerous minor government revenues that would be generated by operation of the proposed mine, more than 95 percent of the revenues that would accrue to the State of Arizona and the most affected local governments (those within Pinal and Gila Counties) would stem from six revenue sources—some of which would produce revenues for both the State government and local governments:

- Resolution Copper property taxes (property taxes on the mine itself, paid to Pinal County and other local taxing entities)
- Resolution Copper severance taxes (paid to the State of Arizona, with a portion shared to local governments based on population)
- Resolution Copper corporate income taxes (paid to the State of Arizona, with a portion shared to cities based on population through Urban Revenue Sharing Fund)
- Transaction privilege taxes (sales taxes paid to local governments and the State of Arizona, with a portion of the State revenues shared to local governments based on population)
- Employee income taxes (paid to the State of Arizona, with a portion shared to cities based on population through Urban Revenue Sharing Fund)
- Employee property taxes (paid to the jurisdictions in which the employees would reside)

State and local government revenue summary. Combining estimated revenues from the six primary revenue sources just described, the proposed mine is projected to generate an average of between $88 and $113 million per year in State and local tax revenues, as shown in table 3.13.4-2. The reported range of annual revenues reflects differences between tax revenue projections developed by consultants for Resolution Copper and revenue projections developed for the Forest Service, as described in BBC Research and Consulting (2018). The State of Arizona would be the largest recipient of tax revenues from the proposed mine, with projected average receipts of about $34 million per year. Pinal County Junior College and Pinal County would also receive large amounts of tax revenues (ranging from about $8 million to over $18 million), primarily from property tax revenues on the proposed mine. While the Superior Unified School District would receive the largest amount of property tax revenue based on its current mill levy, the Arizona school finance equalization system would likely require the School District to either reduce its mill levy, distribute the additional tax revenues across other districts, or a combination of both. Although Superior is by far the closest municipality to the proposed mine, the Town is projected to receive a small share of the total tax revenues (less than $0.4 million per year) in the near term, but this would increase

Table 3.13.4-2. Projected average annual State and local government revenues related to the proposed Resolution Copper Project

Location	Total by Jurisdiction	
	Low Estimate ($)	High Estimate ($)
Town of Superior		
Near term	$372,529	$372,705
Longer term	$695,484	$695,660
Superior Unified School District*	19,238,311	30,087,882
Pinal County Junior College	7,605,420	11,894,545
Pinal County	11,941,974	18,507,156
Gila County	97,273	102,658
Graham County	26,737	30,481
Other Arizona jurisdictions†		
Near term	15,036,899	17,724,324
Longer term	14,713,944	17,401,369
State of Arizona	33,520,225	34,464,398
Total‡	**87,839,367**	**113,184,149**

* School district revenues based on current mill levy. Arizona school finance equalization formula would likely result in either a reduction in the mill levy or a redistribution of revenues to other districts, or both.

† Includes all Arizona municipalities other than Superior; all Arizona counties other than Pinal, Gila, and Graham; and all property-taxing entities in Pinal County other than those identified in this table.

‡ Totals shown exclude the longer term estimates for Town of Superior and other Arizona jurisdictions.

to $0.7 million per year if future development accommodates the full housing demand estimate of 455 workers living in Superior.

The proposed mine would also produce substantial revenues for the Federal Government, estimated at more than $200 million per year (Elliot D. Pollack and Company 2011). The revenues shown in table 3.13.4-2 would directly result from mine activity. However, growth in population resulting from mining activity would also lead to additional revenues from the State of Arizona's revenue sharing formulas, particularly in the town of Superior. In the near term, when current constraints would limit the number of new employees living in Superior, projected growth in Superior's population would result in an increase in intergovernmental revenue sharing from the State of approximately $125,000 per year. If and when housing and commercial development in Superior can accommodate the full mine-related housing demand (455 households), annual intergovernmental revenues from the State of Arizona would increase by about $380,000, relative to current conditions.

The Arizona State Land Department would also receive royalty payments from the proposed mine for a small area of ASLD lands that would be mined. The minimum ASLD royalty payment is 2 percent of the gross value of the minerals produced from their lands, but ASLD royalties average between 5 and 6 percent of the value (Arizona State Land Department 2019b). With ASLD owning the rights to approximately 2 percent of the overall copper resource, average annual royalty payments to ASLD over the life of the proposed mine are projected to be between $0.5 million and $1.5 million.

Mine-related demands and costs for public services. The Town of Superior anticipates that its costs of providing services related to public safety (police and fire protection) would increase by about 50 percent if and when the proposed mine becomes fully operational. Based on Superior's current expenditures to provide these services, this would represent an increase of about $375,000 per year in costs for the Town. The proposed mine would also use the wastewater services provided by the Town, but these services are provided on an enterprise basis (based on volumetric billing rates) and any effects on the cost of wastewater

Table 3.13.4-3. Projected effects of the project on Town of Superior general government costs

Metrics	Current Conditions	Projected Conditions with Mine: Near Term	Projected Conditions with Mine: Longer Term	Projected Mine Effect: Near Term	Projected Mine Effect: Longer Term
Resident population	2,999	3,389	4,182		
Employees*	707	2,527	2,527		
Employee weight†	0.33	0.33	0.33		
Effective service population	3,232	4,223	5,016	991	1,784
Expenditures/effective service population	$550	$550	$550		
General government costs‡ (millions, $)	$1.78	$2.32	$2.76	$0.54	$0.98

Sources: Minnesota IMPLAN Group Inc. (2016); Arizona Department of Transportation (2016); U.S. Census Bureau (2016)

* Employees based within ZIP code encompassing town of Superior.

† Approximate demand on Town services per local employee relative to a local resident.

‡ Excludes costs of self-funded enterprise funds such as wastewater services and ambulance services.

services should be offset by corresponding revenues. Construction and operations of the proposed mine could also affect the Town of Superior's costs to maintain its network of streets and roads, though this impact is more difficult to project (Jeavons 2018).

An alternative way to evaluate the effects of the proposed mine on the cost of providing services for the Town of Superior is based on the change in the effective population the Town would need to serve—including both new residents and the large number of in-commuting employees spending at least 8 hours per day in or adjacent to the town. On that basis, the total costs for Superior of providing general government services are projected to increase by about $540,000 per year in the near term and by about $980,000 per year in the longer term, as shown in table 3.13.4-3. This estimate reflects the additional demands the mine could place on street maintenance and general government activities for the Town. Overall, the proposed mine is projected to increase annual direct and indirect revenues for the Town of Superior by about $0.50 million in the near term, while adding about $0.54 million in annual costs for the Town. Longer term, if future development can accommodate the projected 455 new households in Superior resulting from mining activity, annual Superior revenues are projected to increase by about $1.08 million per year, while annual Superior costs are projected to increase by about $0.98 million per year (relative to current conditions). In addition, Resolution Copper has entered into an agreement with the Town of Superior to provide $1.65 million to support the Town's emergency response services over the period from 2016 to 2021, and other agreements to fund amenities and education.

Development and operations of the proposed mine would increase the demand for K–12 education services. However, schools in the Superior Unified School District are currently operating well below their designed capacity. Pinal County would also provide services to the proposed mine, including road maintenance, additional public safety services, and other county government activities. Based on projected changes in the effective population served by Pinal County, the proposed mine could increase the costs of county service provision by about $3 million to $6 million per year. As shown in table 3.13.4-2, the proposed mine is projected to increase Pinal County's revenues by an annual average of between $12 million and $19 million, which is likely to substantially exceed the increase in the costs of service provision for the county.

Vulnerability to boom-bust cycles. Presuming that Resolution Copper's projections of operational employment, labor costs, non-labor operating costs, and output prove reasonably accurate, the proposed Resolution Copper Mine would have lower operating costs than the typical conventional copper mines in the region. It is unlikely that the proposed mine would have to suspend or substantially cut back its operations for purely economic reasons during either the 10-year ramp-up period or the following 20 years of full production. During the last 10 years of the mine's anticipated production life, the operational economics of the mine could be less advantageous, and there may be a greater likelihood that operations could be reduced or suspended for economic reasons.

Potential effects on the nature-based tourism economy. The proposed mine would have operations located east and west of the town of Superior. The tailings produced by the proposed mine would be stored at one of four sites currently being considered as alternatives. The activities at each of the proposed sites would affect the region's nature-based tourism economy, which includes the economic activity of both local and non-local users of the area's natural amenities for tourism and recreation. Nature-based tourists may participate in one or more activities, including OHV use, camping, hiking, rock climbing, hunting, fishing, and picnicking.

Most of the effects would occur in the town of Superior and Pinal and Gila Counties. The proposed mine and its associated facilities would be distributed across a large amount of land in Pinal and Gila Counties, where nature-based tourism is the primary tourism activity. As a result, the proposed mine's effects on nature-based tourism would vary by location and activity. AGFD projects that the tailings storage facilities would reduce wildlife-related recreation expenditures during the potential 60-year period[71] of construction, operations, and closure/reclamation of the proposed mine (Arizona Game and Fish Department 2018e). As shown in table 3.13.4-4, the magnitude of the effect varies by the location of the tailings storage facility. Other impacts are summarized in the following sections: transportation and access (see section 3.5), scenic resources (see section 3.11), noise and vibration (see section 3.4), and air quality (see section 3.6). Many of the potential economic effects on nature-based tourism are not quantified because of a lack of visitation data but are discussed in qualitative terms in the following text. If the proposed mine causes visitation and spending patterns to shift, it may result in lower tourism spending receipts for local businesses, which in turn could reduce tourism-related earnings and employment in the analysis area.

Table 3.13.4-4. Total projected reduction in direct wildlife-related recreation expenditures under each tailings alternative

Tailing Alternatives	Projected Annual Reduction in Visitor Spending ($)	Projected Reduction in Visitor Spending over 60-year Period ($)
Alternative 2 – Near West Proposed Action	66,920	4.0 million
Alternative 3 – Near West – Ultrathickened	66,920	4.0 million
Alternative 4 – Silver King	60,368	3.6 million
Alternative 5 – Peg Leg	12,254	735,269
Alternative 6 – Skunk Camp	70,554	4,200,000

Source: AGFD (2018e)

71. The impacts disclosed in this section are based in part on an analysis conducted by the AGFD (a cooperating agency on the project) and provided to the Tonto National Forest. In that analysis, the AGFD used a mine life span of 60 years, which differs slightly from the mine life described in chapter 2 of 51 to 56 years.

East Plant Site. The operations at the East Plant Site would affect some of the natural amenities that attract tourists to the area. The East Plant Site is located on approximately 1,544 acres of land managed by the Forest Service, including 1,500 acres of land that would subside, ending the use of the area by the general public. The East Plant Site and subsidence area would affect the Oak Flat Campground, an area that is popular with campers, picnickers, hikers, and rock climbers. OHV activities would also be affected by the proposed mine's operations. Portions of NFS Road 315, a popular off-road loop between U.S. 60 and SR 177, would be eliminated by the activities at the East Plant Site and the eventual subsidence of the area. In total, AGFD estimates that about 6 miles of public access motorized routes would be lost in addition to 421 acres of dispersed camping. The loss of this area would have potentially large effects on nature-based tourism patterns around the town of Superior. The impact on the site could result in a loss of tourism spending in and around the town, depending on the location of substitute sites. The site is also used for hunting, although according to AGFD the area does not contain a disproportionate amount of habitat favoring any particular species of interest to hunters. In total, AGFD estimated that the effects of the proposed mine at the East Plant Site would result in 188 fewer hunter days per year. This would lead to a direct reduction of $10,510 annual wildlife-related recreation spending in the local economy, which would equal a nominal value of $630,480 over the 60-year life of the proposed mine (Arizona Game and Fish Department 2018e).

West Plant Site. The West Plant Site is located on private land near the town of Superior's northwest edge. The West Plant Site was formerly used by the Magma Mine as the site of its copper concentrator. The proposed mine would increase the scale of industrial activity at the site, but the proposed activities would be consistent with the site's historical use. The increased industrial activity could create beneficial effects on the town's tourism economy for tourists interested in mining activity.

Alternatives 2 and 3 – Near West. The area on and around the Near West tailings alternative is used for a variety of activities, including OHV use, camping, and hunting, by visitors from outside Pinal County. AGFD estimates that the Near West tailings alternative would affect about 23 miles of motorized off-road trails and eliminate 1,737 acres of dispersed camping (Arizona Game and Fish Department 2018e). This would lead to more crowding and congested conditions with the potential to increase competition and conflict between activities. This could negatively impact the number of nature-based tourist visits and tourism spending, resulting in lower tourism spending, earnings, and employment.

The area is popular with hunters due to its populations of mule deer, white-tailed deer, javelina, quail, dove, and coyotes and other predators. According to a survey and mapping exercise conducted by AGFD, the site has some of the highest rates of use amongst hunters. The Near West tailings alternative would reduce the number of hunting days on the site by approximately 1,200 hunter-days per year, amounting to a reduction in direct expenditures of $66,920 per year, or $4.0 million over the 60-year operational time horizon of the proposed mine (Arizona Game and Fish Department 2018e).

Alternative 4 – Silver King. The alternative would affect the aesthetics of the area, particularly for users of OHV routes and other tourists who value the views and vistas of the Superstition Mountains. The aesthetic effects could change people's desire to visit and recreate in the area, thereby shifting visitation and spending patterns and potentially reducing nature-based tourism expenditures in the region. In total, AGFD estimates that there are about 20 miles of public access motorized routes and 1,434 acres of dispersed camping that would be affected. The site at the proposed Silver King alternative receives a moderate to high number of hunters who use the area to hunt mule deer and predatory animals. The higher elevation areas of the site are the most valued by hunters because the quality of mule deer habitat increases with altitude at the site. According to AGFD, the proposed alternative would have a negative effect on mule deer populations, which would reduce the number of hunting days by about 1,078 per year. This would reduce the amount of direct expenditures of hunters by about $60,368 per year, or $3.6 million over the 60-year operational time horizon of the proposed mine (Arizona Game and Fish Department 2018e).

Alternative 5 – Peg Leg. Development of this alternative would have a negative effect on the aesthetics of the area, particularly for visitors driving from the Florence-Kelvin Highway and for outdoor enthusiasts who value pristine view of the Mineral Mountains and the Gila River. AGFD estimates that there are about 45 mile of public access motorized routes and 1,009 acres of disperse camping within the tailings footprint (excluding pipeline corridors). The Peg Leg alternative site also contains a variety of species that are popular with hunters, including predators and small game. This also makes the site popular with wildlife-watchers. The AGFD estimates that the site supports about 219 hunting-days each year. Under this alternative, the hunting activity would be lost, resulting in a loss of direct economic activity amounting to $12,254 per year, or $735,269 over the 60-year life of the proposed mine (Arizona Game and Fish Department 2018e).

Alternative 6 – Skunk Camp. This alternative would have the largest negative effect on tourism and recreation of any of the proposed alternatives. AGFD estimates that there are about 32 miles of public access motorized routes and 861 acres of dispersed camping within the tailings footprint (excluding pipeline corridors). Hunting is permitted on State Trust lands within the proposed location of the Skunk Camp alternative, and the site is also popular with people who enjoy watching wildlife. Private lands at the site may or may not be open to public access at the discretion of the landowner. The area is characterized as excellent mule deer, javelina, and Gambel's quail habitat, and transitional white-tailed deer habitat. This area is one of three major areas most frequently hunted in this Game Management Unit and hunters tend to concentrate within these few areas to camp and stage for travel to nearby hunting destinations. Key to recreation in this area is access via Dripping Springs Road. According to a survey and mapping exercise conducted by AGFD, the Skunk Camp alternative would reduce the number of hunting days on the site by approximately 1,269 hunter-days per year, amounting to a reduction in direct expenditures of $70,554 per year, or $4.2 million over the 60-year operational time horizon of the proposed mine (Arizona Game and Fish Department 2018e).

Potential property value effects. While the proposed mine facilities at the East Plant Site and the West Plant Site could have some adverse effects on property values in Superior due to creating a more industrialized setting, those effects would likely be more than offset by the increased demand for housing and commercial space in the town. The primary adverse effects on property values from the proposed mine would likely be associated with the tailings storage facilities.

The proposed mine would likely affect residential property values within at least a 5-mile radius of the proposed location of the tailings facilities under each alternative. Table 3.13.4-5 summarizes the proposed mine's estimated effects on residential property values based on current development near the proposed locations of the mine tailings under

Table 3.13.4-5. Total projected property value reduction under each tailings alternative

Tailing Alternatives	Number of Residential Parcels within 5 Miles of Tailings Perimeter	Total Projected Property Value Reduction ($)	Change in Value (%)
Alternative 2 – Near West Proposed Action	1,370	3,059,395	−4.1
Alternative 3 – Near West – Ultrathickened	1,370	3,059,395	−4.1
Alternative 4 – Silver King	1,181	5,472,374	−10.6
Alternative 5 – Peg Leg	8	69,178	−6.3
Alternative 6 – Skunk Camp	31	57,575	−4.0

Sources: Pinal County Assessor's Office (2017); Gila County Assessor's Office (2017); BBC Research and Consulting (2018)

Note: GIS data for residential parcel data were obtained from standard Pinal County and Gila County coverages.

each alternative and the current value of those properties. Estimates in table 3.13.4-5 indicate the magnitude of potential property value effects but are based on a limited body of directly relevant research. For some alternatives, it is possible that Resolution Copper may purchase some residential parcels; this possibility was not incorporated into the figures shown later in this section.

3.13.4.3 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 changes to socioeconomic conditions in the Town of Superior and in other nearby communities, particularly those in northern Pinal County, southwestern Gila County, and eastern Maricopa County. 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.
- *Florence Copper In-Situ Mining Project.* This mining project, located on the northwestern outskirts of the town of Florence, is an underground copper leaching, recovery, and processing operation that is now in a production testing phase. The operational life of the mine is estimated at approximately 20 years. The mine owner, Florence Copper, estimates the operation would create and support an annual average of 796 direct and indirect jobs in Arizona, with approximately 480 of those jobs in Pinal County.
- *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 mining operation in the "Copper Butte" area west of the Ray Mine; however, no details are currently available as to potential future employment numbers or mineral production rates at this possible future facility.
- *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. This document is likely to have substantial impacts on current recreational uses of Tonto National Forest lands and transportation routes, which in turn would have socioeconomic ramifications with local recreation spending, road maintenance, or displacement of recreation to other locations.
    - More specifically, the Supplemental EIS 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 Tonto National Forest, including sightseeing, camping, hiking, hunting, fishing, recreational riding, and collecting fuelwood and other forest products. The proposed action would designate 2,341 miles of motorized trails. Currently, there are no designated motorized trails on the Tonto National Forest.

Other public infrastructure development and commercial economic activity is likely to occur in this area of south-central Arizona during the foreseeable future life of the Resolution Copper Mine (50–55 years), including developments that have yet to be imagined or planned. In aggregate, these foreseeable and as-yet unknown actions would contribute to general socioeconomic conditions in the region in both positive and potentially negative terms. Large-scale mining development, in particular, tends to infuse relatively quick economic stimulus to local economies but can also create pressures on local infrastructure such as roads, schools, medical services, and the availability and affordability of housing. Large-scale mining projects such as the Resolution Copper Mine and the mining developments described here may also adversely affect tourism, recreational opportunities, and what are considered desirable but less-tangible qualities of a rural setting and lifestyle.

3.13.4.4 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 socioeconomics. Applicant-committed environmental protection measures have already been detailed elsewhere in this section, will be a requirement for the project, and have already been incorporated into the analysis of impacts.

Unavoidable Adverse Impacts

Loss of jobs in the local tourism and outdoor recreation industries cannot be avoided or fully mitigated. Likewise, loss in property values for property close to the mine would constitute an impact that cannot be avoided or fully mitigated. The applicant-committed measures would be effective at expanding the economic base of the community and improving resident quality of life, and could partially offset the expected impacts, although many of the current agreements would expire prior to full construction of the mine.

3.13.4.5 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Socioeconomic impacts are both positive and negative and are primarily short term. The project would provide increased jobs and tax revenue from construction through final reclamation and closure. However, this would be offset by potential impacts on local tourism and outdoor recreation economies, and a decrease in nearby property values; as these effects are largely the result of the tailings storage facility, which is a permanent addition to the landscape, they could persist over the long term.

The long-term continued population and economic growth in areas of the Copper Triangle with existing copper mines indicates that these impacts are in the magnitude of being decades long and would not be permanent.

Irreversible and Irretrievable Commitment of Resources

Some changes in the nature of the surrounding natural setting and landscape would be permanent, including the tailings storage facility and the subsidence area. The action alternatives would therefore potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, community values, and quality of life.

Overview

In accordance with long-established agency practice and the requirements of the NHPA, the Tonto National Forest regularly conducts government-to-government consultation with tribes in Arizona and elsewhere in the Southwest that may be affected by Federal decision-making. The Resolution Copper Project and Land Exchange has a very high potential to directly, adversely, and permanently affect numerous cultural artifacts, sacred seeps and springs, traditional ceremonial areas, resource-gathering localities, burial locations, and other places and experiences of high spiritual and other value to tribal members. This section describes the interactions to date between the Tonto National Forest and the 11 Indian Tribes actively participating in consultation related to the project.

3.14 Tribal Values and Concerns

3.14.1 Introduction

This project is located in an area that is important to many tribes and has been for many generations, and continues to be used for cultural and spiritual purposes. Tonto National Forest has consulted regularly with 11 federally recognized tribes that are culturally affiliated with the lands that would be affected and have had the opportunity to be active in the consultation, review, and comment processes of the project. No tribe supports the desecration/destruction of ancestral sites. Places where ancestors have lived are considered alive and sacred. It is a tribal cultural imperative that these places should not be disturbed or destroyed for resource extraction or for financial gain. Continued access to the land and all its resources is necessary and should be accommodated for present and future generations. Participation in the design of this destructive activity has caused considerable emotional stress and brings direct harm to a tribe's traditional way of life; however, it is still deemed necessary to ensure that ancestral homes and ancestors receive the most thoughtful and respectful treatment possible.

By law, Federal agencies must consult with Indian Tribes about proposed actions that may affect lands and resources important to them, in order to comply with the NHPA for NRHP-listed historic properties (see Section 3.14.3, Affected Environment, for the list of laws and regulations). Section 3003 of the NDAA also requires that the Secretary of Agriculture engage in government-to-government consultation with affected tribes concerning issues related to the land exchange. The Secretary of Agriculture mandated that Tonto National Forest consult with Resolution Copper to seek mutually acceptable measures to address the concerns of the affected tribes and minimize the adverse effects from mining and related activities on the conveyed lands.

Beginning in 2015, the Tonto National Forest began consultation with 11 tribes regarding the proposed mine, the land exchange, and the development of alternate tailings locations to identify issues of tribal concern and possible measures to mitigate the adverse effects on tribal issues. Tonto National Forest also consulted the tribes regarding the management plan for the Apache Leap SMA, as required by Section 3003 of the NDAA.

Government-to-government consultations are ongoing between Tonto National Forest and the Fort McDowell Yavapai Nation, Gila River Indian Community, Hopi Tribe, Mescalero Apache Tribe, Pueblo of Zuni, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe. The four O'odham tribes (the Four Southern Tribes Cultural Committee) have delegated consultation with the Tonto National Forest to the Salt River Pima-Maricopa Indian Community and to the Gila River Indian Community. The BLM has also identified four tribes that may be affected if the alternative on BLM land is affected: the Ak-Chin Indian Community, Fort Sill Apache Tribe, Pascua Yaqui Tribe, and Tohono O'odham Nation. See Chapter 4, Consulted Parties, for a full account of consultation to date.

Tribal values and concerns regarding the land exchange and the proposed GPO include resources with traditional or cultural significance, some of which are also described in Section 3.12 Cultural Resources. Resources of traditional or cultural significance can be traditional cultural properties (TCPs) as defined by National Register Bulletin 38, “Guidelines for Documenting and Evaluating Traditional Cultural Properties” (Parker and King 1998), sacred places, holy places, and traditional ecological knowledge places (TEKPs)—including burial locations, landforms, viewsheds, and named locations in the cultural landscape; water sources; and traditional resource-gathering locations for food, materials, minerals, and medicinals.

3.14.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.14.2.1 Analysis Area

The direct, indirect, and atmospheric analysis areas for tribal values and concerns are the same as for cultural resources, found in section 3.12.2. The direct analysis area for the proposed project is defined by several factors: the acreage of ground disturbance expected for each mine component described in the GPO and the acreage of land leaving Federal stewardship as a result of the land exchange. The direct analysis area for the proposed action (GPO and land exchange) is approximately 40,988 acres and consists of the following, which includes access roads and other linear infrastructure:

- East Plant Site and subsidence area, including the reroute of Magma Mine Road (1,539 acres of which is within the Oak Flat Federal Parcel), which is NFS and ASLD lands;
- 2,422-acre Oak Flat Federal Parcel, which is NFS land to be exchanged with Resolution Copper;
- 940-acre West Plant Site;
- 6.96-mile Silver King to Oak Flat transmission line;
- 169-acre MARRCO railroad corridor and adjacent project components;
- 553-acre filter plant and loadout facility; and
- Alternatives 2–6 tailings storage facilities and tailings corridors: tailings storage facility and tailings corridor for Alternatives 2 and 3; and Alternative 4 – Silver King, Alternative 5 – Peg Leg, and Alternative 6 – Skunk Camp, which have different locations and overall footprints from the GPO tailings storage facility and tailings corridor.

The indirect analysis area consists of a 2-mile buffer around all project and alternative components and contains approximately 320,693 acres. The 2-mile buffer is designed to account for impacts on resources not directly tied to ground disturbance and outside the direct analysis area.

The atmospheric analysis area consists of a 6-mile buffer around all project and alternative components. This distance is consistent with the indirect analysis area for visual impacts in section 3.11, which is based on BLM visual guidance and Forest Service guidance, modified by the addition of a small portion of land south of Picketpost Mountain, the extension another 1 mile farther east to the San Carlos Apache Indian Reservation boundary, and the extension to the southeast to encompass Kearny and historical use of that area. The indirect impacts analysis area encompasses approximately 750,229 acres. The analysis area for tribal values is shown in figure 3.14.2-1.

3.14.2.2 Analysis Approach

The Forest Service and NEPA team worked collaboratively with the tribes to gather information on tribal values and resources via an ethnographic study (Hopkins et al. 2015) and through ongoing consultation. Resolution Copper collected cultural resources information important to tribal members through Class I records searches and Class III pedestrian surveys. Tribal monitors also surveyed to specifically look for TEKPs and other tribal resources that archaeologists might not otherwise have recognized.

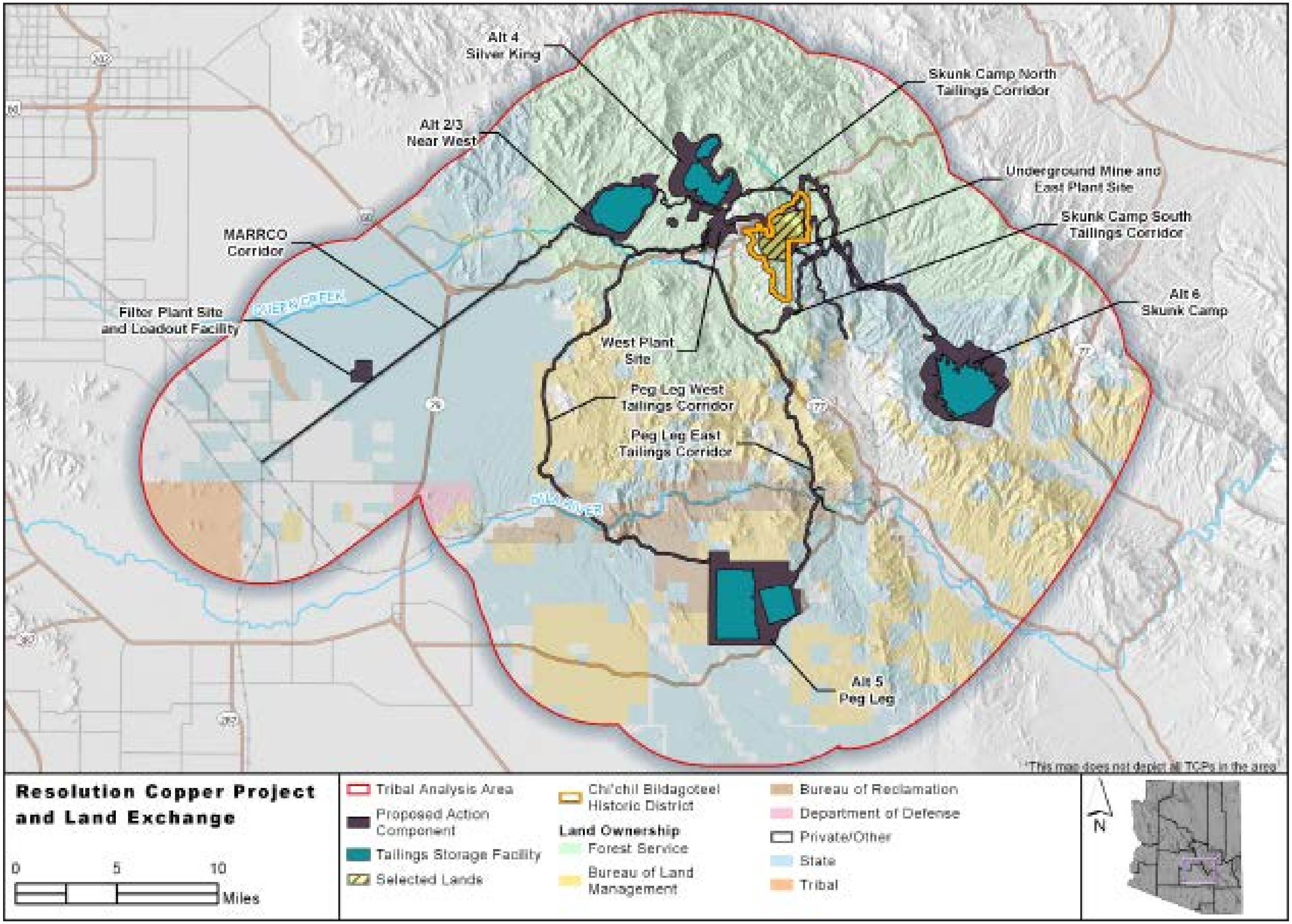


Figure 3.14.2-1. Tribal resources analysis area

Survey of Alternative 5 – Peg Leg pipeline routes and some small areas of other project components that have moved as a result of design changes will occur in 2019, and the results will be updated in the FEIS.

Impact Indicators

Direct impacts on resources of traditional cultural significance (archaeological sites; burial locations; spiritual areas, landforms, viewsheds, and named locations in the cultural landscape; water sources; food, materials, mineral, and medicinal plant gathering localities; or other significant traditionally important places) would consist of damage, loss, or disturbance that would alter the characteristic(s) that make the resource eligible for listing in the NRHP or sacred to the respective cultural group(s). The loss might be caused by ground disturbance, loss of groundwater or surface water, or by the erection of facilities that alter the viewshed. Indirect impacts would consist primarily of visual impacts from alterations to setting and feeling, auditory impacts, or inadvertent disturbance.

Impact indicators for this analysis include the following:

- Loss, damage, or disturbance to historic properties, including TCPs listed in or eligible for listing in State or Federal registers, that are significant to Native American tribes.
- Loss, damage, or disturbance to burial sites; spiritual areas and viewsheds; cultural landscapes; sacred places; springs and other water resources; food and medicinal plants; minerals; and hunting, fishing, and gathering areas.
- Loss of access to burial sites; spiritual areas and viewsheds; cultural landscapes; sacred places; springs and other water resources; food and medicinal plants; minerals; and hunting, fishing, and gathering areas.
- Alterations to setting, feeling, or association of historic properties significant to Native American tribes, including TCPs where those characteristics are important to their State or Federal register eligibility.

If the land exchange occurs, as mandated by Congress in the Southeast Arizona Land Exchange, the selected lands would be conveyed to Resolution Copper no later than 60 days after the publication of the FEIS, and the Oak Flat Federal Parcel would become private property and no longer be subject to the NHPA. Under Section 106 of the NHPA and its implementing regulations (38 CFR 800), historic properties leaving Federal management is considered an adverse effect regardless of the plans for the land, meaning that as analyzed under NEPA, the land exchange would have an adverse impact on resources significant to the tribes.

Adverse impacts on historic properties would be avoided, minimized, or mitigated through the Section 106 process of the NHPA and through Tonto National Forest's consultations with Resolution Copper in accordance with Section 3003 of the NDAA. Adverse impacts on resources that may not be historic properties under Section 106 would be avoided, minimized, or mitigated through steps outlined in the FEIS and ROD.

3.14.3 Affected Environment

The primary legal authorities and agency guidance relevant to this analysis of anticipated project-related impacts on tribal resources are shown in the accompanying text box.

A complete listing and brief description of the regulations, reference documents, and agency guidance used in this effects analysis may be reviewed in Newell (2018i).

3.14.3.1 Existing Conditions and Ongoing Trends

Resolution Copper surveyed each of the areas comprising the proposed mine for NRHP-eligible historic properties, as outlined in section 3.12. Tribal monitors resurveyed or accompanied archaeological survey crews in those areas to identify TEKPs of importance to the four cultural groups with ties to the area (Puebloan, O'odham, Apache, and Yavapai), to include springs and seeps, plant and mineral resource collecting areas, landscapes and landmarks, caches of regalia and human remains, and sites that may not have been recognized by non-Native archaeologists. All springs and seeps are considered sacred by all of the consulting tribes.

Tonto National Forest conducted tribal monitor training sessions in January and October, as described in Section 4.7.1, Tribal Monitor Program. Tribal monitors were added to the contracted archaeological crews to survey the selected lands and all tailings alternatives; these surveys are anticipated to be complete by fall 2019. During the surveys, tribal monitors are identifying potential TEKPs and special interest areas or resources such as natural resources special interest areas, landforms, landscapes, and springs, as well as plants, animals, and minerals of special interest.

As a result of the tribal monitoring program, a draft Tribal Monitor report has been completed for Alternative 5 – Peg Leg. Draft Tribal Monitor reports on the Oak Flat Federal Parcel, Near West (Alternatives 2 and 3), Silver King (Alternative 4), and Skunk Camp (Alternative 6) are expected in the fall of 2019 and will be used for the FEIS analysis. In 2015, the Tonto National Forest, in partnership with the San Carlos Apache Tribe, composed a nomination for Oak Flat, the area originally known as *Chí'chil Biłdagoteel*, to be listed on the National Register of Historic Properties as a TCP (Nez 2016). This effort consisted of extensive literature research and interviews with tribal members.

In addition, an ethnographic study was completed titled "Ethnographic and Ethnohistoric Study of the Superior Area, Arizona" (Hopkins et al. 2015). The study consisted of archival and existing literature review and compilation, as well as oral interviews and field visits with

Principal Regulations, Policies, and Guidelines Used in the Effects Analysis for Tribal Values and Concerns

- National Historic Preservation Act of 1966 (54 U.S.C. 300101 et seq.)
- Archaeological Resources Protection Act (16 U.S.C. 470aa-470mm)
- American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. 1996)
- Religious Freedom Restoration Act (42 U.S.C. 2000bb et seq.)
- Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 U.S.C. 3001–3013)
- Executive Order 12898 (February 16, 1994), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"
- Executive Order 13007 (May 24, 1996), "Indian Sacred Sites"
- Executive Order 13175 (November 6, 2000), "Consultation and Coordination with Indian Tribal Governments"
- Bald and Golden Eagle Protection Act of 1940 (16 U.S.C. 688–688d)
- Endangered Species Act (16 U.S.C. 1531-1543)
- Migratory Bird Treaty Act (16 U.S.C. 703-711)
- National Environmental Policy Act (42 U.S.C. 4321 et seq.)

tribal members to collect oral history and knowledge. Tribal members accompanied research staff to important places throughout the study area and shared information about those places. Members of the San Carlos Apache Tribe, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, Fort McDowell Yavapai Nation, Yavapai-Prescott Indian Tribe, Gila River Indian Tribe, Salt River Pima-Maricopa Indian Community, Hopi Tribe, and Pueblo of Zuni contributed to the study.

Direct Analysis Area

ARCHAEOLOGICAL SITES

In section 3.12, we discuss the 721 archaeological sites recorded to date in the direct analysis area. Twenty-five of those sites have components attributed to Apache/Yavapai peoples; 696 are attributed to Hohokam or Hohokam/Salado. The remaining sites or components are attributed to Archaic, Salado, Euro-American, or Mexican-American peoples.

TRADITIONAL CULTURAL PROPERTIES AND CULTURAL LANDSCAPES

A portion of the direct analysis area is within the *Chí'chil Biłdagoteel* Historic District, which is listed on the NRHP as an Apache TCP. Apache Leap, Oak Flat, and 38 archaeological sites that contribute to the eligibility of the district are within the *Chí'chil Biłdagoteel* Historic District. Apache Leap is within the indirect analysis area, but access to the Protohistoric/Historic Apache village at its summit is through the direct analysis area.

As required by the land exchange, the Tonto National Forest set aside Apache Leap, a sacred landscape for the Apache and Yavapai, as a special management area totaling 839 acres (Apache Leap SMA). The Tonto National Forest was also directed in the NDAA to develop a management plan in consultation with the tribes. Meetings were held individually with tribes, with cultural groups, and an all-tribes meeting to discuss the management options for this sacred landscape. Tribes made the following requests regarding the Apache Leap SMA:

1. Leave it in its natural state;
2. Guarantee access, including possibly developing a new road, so that tribal members can reach the top to perform ceremonies once the current access route is closed due to subsidence;
3. Do not renew or reissue the extant grazing permits; and
4. Permit day-use only (no overnight camping), and do not permit any rock-climbing.

These requests were incorporated into the management plan as part of the environmental assessment of the SMA; a final decision notice, special area management plan, and corresponding forest plan amendment was issued December 26, 2017. When the new access route is designed, it will require an environmental assessment to determine whether the route poses any adverse effects on cultural and/or tribal resources.

Additional resources (TEKPs and special interest areas or resources) were recorded during the ethnographic study within the analysis areas (Hopkins et al. 2015) and by the tribal monitor survey conducted in 2018. These include a petroglyph panel near one of the springs; the Emory oak grove at Oak Flat, which has also been used as a ceremonial grounds by San Carlos Apache; a rock ring and several spring areas; ancestral settlement; and a beargrass resources area.

SPRINGS

A number of springs are located within the direct analysis area that could be directly disturbed or impacted by dewatering (see section 3.7.1). Springs are sacred to all the consulting tribes.

NATURAL RESOURCES AREA

A number of natural resources special interest areas are located within the direct analysis area: a rock formation, a dry spring, and three vantage points.

PLANT AND MINERAL RESOURCES

Forty-nine types of plants of special interest have been identified to date within the direct impacts analysis area and include the following: banana yucca (*Yucca baccata*), beargrass (*Nolina microcarpa*), buffalo gourd (*Cucurbita foetidissima*), fairyduster (*Calliandra eriophylla*), soaptree yucca (*Yucca elata*), queen of the night (Peniocereus greggii), ragweed (*Ambrosia ambrosioides*), thistle (*Cardus nutans*), and wild spinach (*Chenopodium* sp.).

Eight minerals or types of minerals important to tribal groups were identified in the direct impacts analysis area: Apache tear obsidian, caliche, mica, red ore, a polishing stone, several quartz crystals, an iron sand deposit, and schist.

Indirect Analysis Area

A portion of the *Chí'chil Biłdagoteel* Historic District TCP is within the indirect analysis area outside of the direct analysis area. Specifically, Apache Leap to the west of Oak Flat is adjacent to the direct analysis area.

Atmospheric Analysis Area

Tonto National Forest's consultations and ethnohistoric study of the general area around Oak Flat have identified many named Western Apache locations and TEKPs, as well as Yavapai band traditional territories. This applies particularly to the areas within the U.S. 60 corridor—for example, the Superstition Mountains, Picketpost Mountain, Apache Leap, and Devil's Canyon are all named sacred locations. A portion of the *Chí'chil Biłdagoteel* Historic District is within the atmospheric analysis area. At least four springs and the Queen Creek watershed, which are sacred to all the tribes, are located within the indirect analysis area. The atmospheric analysis area also contains prehistoric sites and resources of interest to the tribes that are related to the prehistoric occupation of the area—the Gila River Indian Community, the Hopi Tribe, the Salt River Pima-Maricopa Indian Community, and the Pueblo of Zuni.

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

3.14.4.1 Alternative 1 – No Action

Direct Impacts

Under the no action alternative, the Forest Service would not approve the GPO, current management plans would remain except for the development of a new Tonto National Forest forest plan, and Resolution Copper would continue current activities on private property. As described in section 2.2.3, the no action alternative analysis analyzed the impacts of (1) the Forest Service's not approving the GPO, and (2) the land exchange's not occurring.

If the Forest Service does not approve the GPO, the mining operation would not occur; if the land exchange does not occur, the selected lands would remain under Forest Service management. Under either scenario, no direct impacts are anticipated to archaeological sites, TCPs, springs, or other resources significant to the tribes, including loss of access to resources.

Indirect and Atmospheric Impacts

If either the land exchange does not occur or the GPO is not approved, no adverse indirect or atmospheric impacts are anticipated to resources other than to some springs. With or without the land exchange, the continued dewatering of mine shafts on private land would occur, lowering the water table in the area, which may have adverse indirect impacts on six springs. See section 3.7.1 for more information on dewatering and its potential effects on area resources.

3.14.4.2 Impacts Common to All Action Alternatives

The impacts on the Oak Flat Federal Parcel are common to all action alternatives. The Oak Flat Federal Parcel contains 31 NRHP-eligible historic properties and one NRHP-listed TCP, which is near an Emory oak stand that Apache and Yavapai use to harvest acorn. Because the Tribal Monitor report is not complete at this time, the total number and type of impacted resources on Oak Flat is unknown. All of these resources would be adversely impacted by leaving Federal management. In particular, the loss of the ceremonial area and acorn-collecting area in Oak Flat and/or the loss of access to them would be a substantial threat to the perpetuation of cultural traditions of the Apache and Yavapai tribes, because healthy groves are few and access is usually restricted unless the grove is on Federal land. Several springs located on the Oak Flat Federal Parcel would be lost due to the development of the subsidence area.

Effects of the Land Exchange

If the land exchange occurs, as mandated by Congress in the Southeast Arizona Land Exchange, the selected lands would be conveyed to Resolution Copper no later than 60 days after the publication of the FEIS, and the Oak Flat Federal Parcel would become private property and no longer be subject to the NHPA. Under Section 106 of the NHPA and its implementing regulations (38 CFR 800), historic properties leaving Federal management is considered an adverse effect regardless of the plans for the land, meaning that as analyzed under NEPA, the land exchange would have an adverse effect on resources significant to the tribes.

The Oak Flat Federal Parcel contains 31 NRHP-eligible historic properties, one NRHP-listed TCP, and the only developed campground on the Tonto National Forest, which is near an Emory oak stand that Apache and Yavapai use to harvest acorn. All of these resources would be adversely affected by leaving Federal management. In particular, the loss of the ceremonial area and acorn-collecting area in Oak Flat would be a substantial threat to the perpetuation of cultural traditions of the Apache and Yavapai tribes, because healthy groves are few and access is usually restricted unless the grove is on Federal land.

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). A number of standards and guidelines (10) were identified applicable to management of tribal resources. None of these standards and guidelines were 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). No standards and guidelines were identified that are strictly applicable to tribal resources; however, a great number of standards and guidelines are related to resources considered important or sacred by tribes, including wildlife, water resources, and scenic resources. The need for a forest plan amendment for these resources is discussed in the appropriate section.

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 resources of tribal value and concern. These are non-discretionary measures and their effects are accounted for in the analysis of environmental consequences.

Applicant-committed environmental protection measures by Resolution Copper to reduce impacts on tribal resources are covered in detail in the Programmatic Agreement (see appendix O) and in the ROD. Specifically, Resolution Copper

- is sponsoring a tribal monitoring program to identify resources of interest to tribal groups as described in Section 4.7.1, Tribal Monitor Program;
- is currently working with tribal representatives on Emory oak restoration studies as described in Section 4.7.2, Emory Oak Restoration;
- would develop a TCP Redress Plan, which would include the tribal monitoring program and Emory oak restoration, as well as other measures to be taken to reduce impacts on resources; and
- would develop a monitoring and treatment plan of inadvertent discoveries of cultural resources significant to tribal groups. If previously unidentified cultural resources are discovered during construction activities on Tonto National Forest, work would cease within 100 feet of the location, and the Forest Service would be contacted for instruction before work would continue at that location.

3.14.4.3 Alternatives 2 and 3 – Near West

Direct Impacts

Under Alternatives 2 and 3, the land exchange would occur and the Forest Service would approve the GPO. For both alternatives, there are variations of the footprint and the type of storage facility proposed in the modified GPO location; however, the direct effects would be the same for both. Section 3.12.4.2 contains a description of the location of the 132 prehistoric and historic archaeological sites (31 of which have eligibility yet to be determined) that would be impacted by these alternatives and their associated mine operation areas (East Plant Site, subsidence area, West Plant Site, tailings facility and corridor, Silver King Mine Road, MARRCO corridor, and roads) (see table 3.12.4-1).

One large TEKP was recorded for the tailings facility and corridor proposed for Alternatives 2 and 3; it incorporates the active springs and a currently unknown number of historic properties that have been identified by the tribes as interconnected. Please note that the Tribal Monitor report for the Near West tailings area is pending, so all impacts are not known at this time. The area also contains many plants and minerals of use to tribes. All alluvial deposits would be removed to expose bedrock for the tailings storage facility, so all of these soil and vegetation resources would be destroyed by construction and use of the facility. Resources in the direct analysis area may be lost completely because of ground disturbance, or tribes may lose access to those resource once they are part of the mine.

Either tailings storage facility configuration would adversely reduce and affect the flow of water into Queen Creek; the long-term effects on groundwater quality due to tailings seepage are discussed in section 3.7.2.

Indirect Impacts

For both alternatives, a portion of the *Chí'chil Biłdagoteel* Historic District TCP may be indirectly impacted from inadvertent damage from construction activities or increased non-tourism visitation to the area.

The effects of the subsidence area and the tailings facility on the local watershed are analyzed in section 3.7.2.

Atmospheric Impacts

The tailings location for Alternatives 2 and 3 is located directly opposite Picketpost Mountain, a mountain sacred to Western Apache bands, and the presence of the nearly 500-foot-high tailings would constitute an adverse visual effect on the landscape.

3.14.4.4 Alternative 4 – Silver King

Direct Impacts

This alternative contains a total of 137 prehistoric and historic archaeological sites that would be adversely impacted by the combined areas of the mine; 15 of these archaeological sites have eligibility yet to be determined (see table 3.12.4-3). Three TEKPs were identified by the tribal monitors and elders. As noted earlier in this section, impacts on resources on Oak Flat would be the same for Alternative 4 and Alternatives 2 and 3. Additionally, two springs are located within and two springs are adjacent to the tailings storage facility footprint. Resources in the direct analysis area may be lost completely because of ground disturbance, or tribes may lose access to those resource once they are part of the mine.

At this time, the Tribal Monitor report of the Silver King tailings location is ongoing; full impacts for this alternative are still unknown.

Indirect Impacts

Indirect impacts may occur on the portion of an NRHP-listed TCP that is within the fence line of Alternatives 2 and 3, while the rest of the site would remain outside the fence line and would not be directly impacted. A tailings storage facility at the Alternative 4 location would reduce the surface area of the local watershed and have long-term effects on local groundwater quality due to tailings seepage (see sections 3.7.2 and 3.7.3).

Atmospheric Impacts

The Silver King tailings storage facility is east of Alternatives 2 and 3, but still within the area of sacred landscapes that would be visually compromised by the 1,040-foot-high tailings.

3.14.4.5 Alternative 5 – Peg Leg

Direct Impacts

Alternative 5 with the east pipeline option contains 197 prehistoric and historic archaeological sites; Alternative 5 with the west pipeline option contains 125 prehistoric and historic archaeological sites. Two of these sites were also recorded as TEKPs with different boundaries, and an additional TEKP that tribal monitors identified as containing a feature that matches Western Apache oral tradition was also recorded. The two proposed tailings conveyance pipeline route options are being surveyed at this time, and results will be available prior to the FEIS.

Six natural resources special interest areas, 49 plants of special interest, and five minerals of special interest would also be impacted. These resources may be lost completely because of ground disturbance, or tribes may lose access to these resources once they are part of the mine.

The surface area of the watershed would be reduced due to the permanent tailings storage facility and water quality may also be impaired due to future tailings seepage; for more detail see sections 3.7.2 and 3.7.3.

Indirect Impacts

Indirect impacts for Alternative 5 are the same as for Alternatives 2 and 3.

Atmospheric Impacts

The Peg Leg tailings storage facility would likely be visible on the horizon as far away as the town of Florence; however, no TEKPs or

TABLE OF CONTENTS BACK

TCPs have been identified in the atmospheric analysis area for the tailings impoundment. No atmospheric impacts are anticipated.

3.14.4.6 Alternative 6 – Skunk Camp

Direct Impacts

Under Alternative 6 with the north pipeline option, 323 archaeological sites would be impacted; with the south pipeline option, 318 archaeological sites would be impacted (see section 3.12.4). The surface area of the watershed would be reduced due to the permanent tailings storage facility (see section 3.7).

At this time, the Tribal Monitor study of the Skunk Camp tailings location is ongoing; full impacts for this alternative are still unknown. Resources in the direct analysis area may be lost completely because of ground disturbance.

Indirect Impacts

The indirect impacts for Alternative 6 are the same as for Alternatives 2, 3, and 5.

Atmospheric Impacts

A tailings storage facility at Skunk Camp would be only marginally visible from as far as SR 77; however, no TEKPs or TCPs have been previously identified in the atmospheric analysis area for the tailings pile. No atmospheric impacts are anticipated.

3.14.4.7 Cumulative Effects

As noted earlier , the *Chí'chil Biłdagoteel* Historic District, which comprises the Oak Flat and Apache Leap areas, is a Forest Service–recognized TCP. This project is located in an area that is important to many tribes and has been for many generations and continues to be used for cultural and spiritual purposes. No tribe supports the desecration/destruction of ancestral sites. Places where ancestors have lived are considered alive and sacred. It is a tribal cultural imperative that these places should not be disturbed or destroyed for resource extraction or for financial gain. Continued access to the land and all its resources is necessary and should be accommodated for present and future generations.

Development of the Resolution Copper Mine would permanently alter lands that hold historical, cultural, and spiritual significance for many tribal members.

This said, the following identified reasonably foreseeable future actions in the analysis area are considered also likely to affect tribal concerns and values by disrupting the landscape. 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.
- *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).

- *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. The Copper Butte area contains petroglyphs and many other historic and prehistoric sites of archaeological significance that would be adversely impacted by the land exchange.
- *Silver Bar Mining Regional Landfill and Cottonwood Canyon Road.* A private firm, Mineral Mountain LLC, is proposing to develop a landfill on land the company owns approximately 6 miles southeast of Florence Junction and 4 miles due east of SR 79. This private property is an inholding within an area of BLM-administered lands and cannot be accessed without crossing BLM land. The company received Master Facility Plan Approval for the proposed landfill from ADEQ in 2009 and a BLM right-of-way grant in 2017. As noted in the EA and FONSI for the right-of way, road improvements to allow for heavy truck haul traffic across BLM lands would adversely affect six cultural sites. This development would contribute to the overall regional changes adversely affecting traditional tribal cultural practices and places that have significance to tribal cultural identities.
- *Tonto National Forest Plan Amendment and Travel Management Plan.* The Tonto National Forest is currently in the process of revising its Forest Plan to replace the plan now in effect, which was implemented in 1985. Simultaneously, the Tonto National Forest is developing a Supplemental EIS to address certain court-identified deficiencies in its 2016 Final Travel Management Rule EIS. Both documents and their respective implementing decisions are expected within the next 2 years. Cultural resources may be impacted for any new road construction; however, the Tonto National Forest would conduct the appropriate surveys, consultation, and mitigation. Impacts on these sites would cumulatively impact cultural resources in the area in combination with the loss of sites that would take place with the Resolution Copper Project. Changes in travel management could change the locations in which people recreate or travel within the Tonto National Forest; while this has been considered and addressed for the Apache Leap SMA, other areas of importance to tribes may be impacted in this way. These impacts would be cumulative with the overall impacts on tribal cultural practices and places caused by the Resolution Copper Project.

Southwestern tribal historical and cultural affiliations, trading networks, and other intertribal communication pathways existed long before present-day governmental and administrative boundaries (including international boundaries) and continue to exist irrespective of current geographical demarcations. For this reason, it is recognized that in addition to the Resolution Copper Project, mining projects and other human-induced development expected to occur in the Copper Triangle, in the southwestern United States, and possibly elsewhere may also contribute to adversely affecting traditional tribal cultural practices and places that have significance to tribal cultural identities.

3.14.4.8 Mitigation Effectiveness

None of the tribes affiliated with the area believe the impacts on tribal resources can be mitigated.

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.

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 tribal concerns.

Mitigation Measures Applicable to Tribal Resources

Other mitigations could be developed via government-to-government consultation or through the consultations required by the NDAA. The mitigations that would arise through these processes could be kept confidential and would not be disclosed to the public in the DEIS or FEIS.

Two applicant-committed environmental protection measures (see section 3.14.4.2) evolved through these other consultations. The Tribal Monitor Program and Emory Oak Restoration highlight consultation and mitigation of project affects.

Conduct cultural and archaeological data recovery via the Oak Flat HPTP (RC-209): The Oak Flat Historic Properties Treatment Plan (HPTP) sets out a plan for treatments to resolve the adverse effects on 42 historic properties that have been identified within the Oak Flat Federal Parcel. In accordance with the plan, Resolution Copper would conduct archaeological data recovery on sites eligible under Criterion D that would be adversely affected. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Conduct cultural and archaeological data recovery via the Research Design and data recovery plans (RC-210): The GPO Research Design and data recovery plans detail treatments to resolve adverse effects on historic properties within the GPO project area, with the exception of those in the Oak Flat Federal Parcel. Data recovery would be conducted on archaeological sites eligible under Criterion D within the GPO project area. Project materials and archaeological collections would be curated in accordance with 36 CFR 79 (Curation of Federally-Owned and Administered Archaeological Collections) with Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and the Arizona State Museum. This measure is applicable to all alternatives and would be noted in the ROD/Final Mining Plan of Operations.

Mitigation Effectiveness and Impacts

According to the tribes consulted, adverse impacts on TCPs, TEKPs, and other places or resources of significant interest to tribes cannot be mitigated; therefore, mitigation strategies for tribal resources are designed to provide an exchange for the loss of resources. The mitigation strategies will have, and are having, positive impact on tribal communities such as providing jobs during the tribal monitoring and allowing unfettered access to Emory oak resources.

Unavoidable Adverse Impacts

Significant tribal properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of direct impact, nor can they be fully mitigated.

3.14.4.9 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Physical and visual impacts on TCPs, TEKPs, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the tribal resources and traditional cultural properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

Irreversible and Irretrievable Commitment of Resources

The direct impacts on TCPs and TEKPs from construction of the mine and associated facilities constitute an irreversible commitment of resources. Traditional cultural properties cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs and TEKPs for cultural and religious purposes are also an irreversible commitment of resources. For uses such as gathering traditional materials from areas that would be within the subsidence area or the tailings storage facility, the project would constitute an irreversible commitment of resources.

Overview

For many decades, the development of mines, dams, freeway systems, and many other kinds of infrastructure and commercial projects that have proved generally beneficial to society as a whole have often adversely and disproportionately affected minority populations and the poor—those least able to effectively speak out against environmental or economic damage to their homes, health, and lifestyles. Executive Order 12898, signed by President Clinton in 1994, requires Federal agencies to consider environmental justice issues in decision-making on projects that have the potential to harm vulnerable or disadvantaged communities. This section examines environmental justice issues in the context of the Resolution Copper Project and Land Exchange.

3.15 Environmental Justice

3.15.1 Introduction

Environmental justice is intended to promote the fair treatment and meaningful involvement of all people—regardless of race, ethnicity, or income level—in Federal environmental decision-making. Environmental justice programs encourage active public participation and the dissemination of relevant information to inform and educate communities that may be adversely affected by a proposed project or its alternatives.

As detailed in Chapter 1, Section 1.6, Public Involvement, the public (including members of environmental justice communities identified later in this section) has been meaningfully involved in the NEPA process. Public involvement included a 120-day scoping period during which five scoping meetings were held. These meetings provided the public with an opportunity to ask questions, learn more about the proposed project, and provide comments on issues and concerns that should be addressed in the EIS and alternatives that should be evaluated. Additionally, three public alternatives development workshops were held (two in person and one online) to solicit input on criteria for the selection of locations for the tailings storage facilities. Native American communities are involved in ongoing consultation with the Forest Service (see Section 1.6.4, Tribal Consultation; and Chapter 4, Consulted Parties).

This section determines which communities in the analysis area are considered environmental justice communities, based on minority status or poverty status, and then assesses the potential effects of each alternative on environmental justice communities.

3.15.2 Analysis Methodology, Assumptions, and Uncertain and Unknown Information

3.15.2.1 Analysis Area

The geographic area for the analysis of potential environmental justice impacts includes communities (such as cities, towns, and Census Designated Places [CDPs]) within Gila, Graham, Maricopa, and Pinal Counties. Native American communities within this analysis area are also included (figure 3.15.2-1). Although the extent of potential project-related impacts would likely be limited to a smaller, more regional area, this four-county analysis area was determined to be appropriate in order to capture the extent of potential measurable socioeconomic effects. While the region with the potential for project-related impacts is located in Pinal and Gila Counties, Maricopa County was also included because a substantial portion of the workforce for the proposed mine would be expected to commute from the Phoenix metropolitan area, and Graham County was included because of its proximity to the project area and large Native American population.

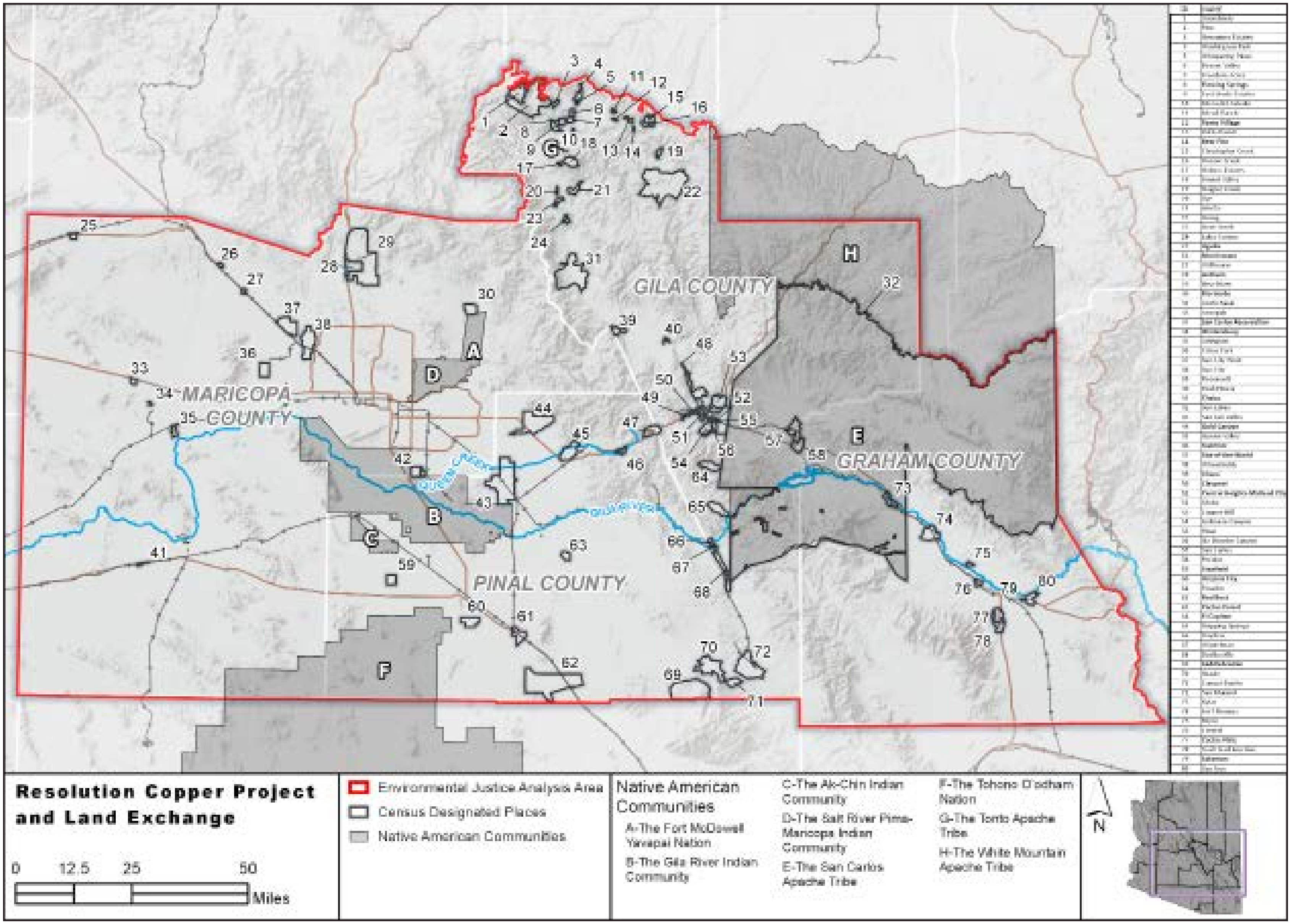


Figure 3.15.2-1. Environmental justice analysis area

3.15.2.2 Methodology for Determining Environmental Justice Communities

The CEQ defines a community with potential environmental justice populations as one that has a greater percentage of minority and/or low-income populations than does an identified reference community. Minority populations are those populations that have the following characteristics:

1. A readily identifiable group of people with a population that is at least 50 percent minority living in geographic proximity to the project area. The population exceeding 50 percent minority may be made up of one minority or a number of different minority groups; together, the sum is 50 percent or greater.
2. A minority population may be an identifiable group that has a meaningfully greater minority population than the adjacent geographic areas, or may also be a geographically dispersed/transient set of individuals, such as migrant workers or Native Americans (Council on Environmental Quality 1997).

In 2014, the Forest Service updated its environmental justice analysis process in "Striving for Inclusion: Addressing Environmental Justice for Forest Service NEPA" (Periman and Grinspoon 2014). In this guidance document, the Forest Service recommends using the second approach as the more inclusive of the two: identify groups that have meaningfully greater minority populations than adjacent geographic areas. A "meaningfully greater" minority population is not defined in this document; however, for the purpose of this analysis, "meaningful greater" is defined as a difference of more than 5 percent between the communities and the reference area.

This approach makes selection of the reference area an important factor. Because of the project's large scale, the geographic area used as a reference is the state of Arizona. Within the four-county analysis area, environmental justice communities are those municipal areas and communities that are distinguished as having a minority and/or low-income population meaningfully greater than this reference area.

The 2014 guidance document also recommends identifying low-income populations with the annual statistical poverty thresholds from the U.S. Census Bureau's annual current population reports (Series P-60) on income and poverty. The U.S. Census Bureau defines 2017 poverty-level thresholds (the year for which demographic data are available for communities within the analysis area) for individuals and a family of four as income levels below $12,488 and $25,094, respectively (U.S. Census Bureau 2019). The same "meaningful greater" definition of a difference of 5 percent or more between the communities and the reference area is also used for low-income environmental justice populations.

Potential adverse impacts for each resource area are evaluated for impacts that would be considered "disproportionately high or adverse." In instances where an impact from the proposed action may appear to be identical to both the affected general population and the affected minority populations and low-income populations, there may be related factors that amplify the impact. These factors can include proximity (such as impacts limited in geographic scope to adjacent low-income or minority communities), economic (such as if the economic burden of a proposed project does not outweigh the benefit to low-income or minority communities), health or safety (such as the presence of unique exposure pathways and/or social determinants of health of minority or low-income communities), or social/cultural (such as impacts on resources or places important to cultural traditions of minority or low-income communities).

3.15.3 Affected Environment

3.15.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance applicable to environmental justice may be reviewed in Newell (2018b).

3.15.3.2 Existing Conditions and Ongoing Trends

Minority Populations

Using the methodology described in section 3.15.2, we identified 29 locations where the minority (nonwhite) population is more than 5 percent greater than the reference community (table 3.15.3-1) in addition to the following eight Native American lands and associated communities:

1. White Mountain Apache Tribe (which includes the Carrizo, Cedar Creek, and Canyon Day CDPs)
2. Fort McDowell Yavapai Nation
3. Gila River Indian Community (which includes the Maricopa Colony, St. Johns, Komatke, Gila Crossing, Santa Cruz, Sacate Village, Goodyear Village, Casa Blanca, Wet Camp Village, Sweet Water Village, Stotonic Village, Lower Santan Village, Upper Santan Village, Sacaton, Sacaton Flats, and Blackwater CDPs)
4. Ak-Chin Indian Community (which includes the Ak-Chin Village CDP)
5. Salt River Pima-Maricopa Indian Community
6. San Carlos Apache Tribe (which includes the East Globe, San Carlos, Peridot, and Bylas CDPs),
7. Tohono O'odham Nation (which includes the Chuichu, Vaiva Vo, Tat Momoli, Kohatk, and Kaka CDPs, as well as the satellite village of Florence Village)
8. Tonto Apache Tribe

These locations meet the minority criteria for identification as an environmental justice community. Table 3.15.3-1 summarizes relevant census data regarding minority (nonwhite) populations for the analysis area.

Populations Living Below Poverty Level

Using the methodology described in section 3.15.2, there are 35 locations within the analysis area where the populations of individuals and/or families living below poverty level exceed the reference community by greater than 5 percent (see table 3.15.3-1). Therefore, these locations meet the poverty criteria for identification as an environmental justice community. Table 3.15.3-1 summarizes relevant data for the percentage of individuals living below poverty level and percentage of families living below poverty level in the analysis area.

Primary Legal Authorities Relevant to the Environmental Justice Effects Analysis

- Executive Order 12898, "Environmental Justice in Minority Populations and Low-Income Populations" (1994)
- Forest Service Guide "Striving for Inclusion: Addressing Environmental Justice for Forest Service NEPA" (2014)
- U.S. Census 5-Year American Community Survey for the State of Arizona (2013–2017)

Table 3.15.3-1. Percent minority population and percent population living below poverty level

Geographic Area	County	Minority Population Percentage*	Percentage of Individuals Living Below Poverty Level	Percentage of Families Living Below Poverty Level
State of Arizona		**44.4**	**17.0**	**12.3**
Aquila CDP	Maricopa	95.9	58.5	42.2
Arizona City CDP	Pinal	49.7	–	–
Avondale CDP	Maricopa	67.2	–	–
Bryce CDP	Graham	–	37.7	–
Cactus Flats CDP	Graham	–	34.2	26.5
Casa Blanca CDP	Pinal	91.2	60.1	44.4
City of Casa Grande	Maricopa	55.0	–	–
City of Coolidge	Pinal	57.9	24.2	19.3
Dudleyville CDP	Pinal	73.4	29.9	19.5
East Verde Estates CDP	Gila	–	26.3	17.6
City of El Mirage	Maricopa	59.9	–	–
City of Eloy	Pinal	77.5	32.5	17.2
Town of Florence	Pinal	52.3	–	–
Flowing Springs CDP	Gila	54.5	27.3	–
Freedom Acres CDP	Gila	–	37.2	19.6
Town of Gila Bend	Maricopa	74.5	37.8	33.0
Gisela CDP	Gila	–	37.5	36.4
City of Glendale	Maricopa	51.4	–	–
City of Globe	Gila	–	–	17.8
Town of Guadalupe	Maricopa	95.1	32.7	31.4
Haigler Creek CDP	Gila	–	37.9	–
Town of Hayden	Gila	88.4	29.8	23.9
Icehouse Tavern CDP	Gila	–	25.4	–
Town of Kearny	Pinal	57.3	21.7	–
Town of Mammoth	Pinal	75.9	23.8	–
Town of Miami	Gila	66.0	28.6	24.1
Morristown CDP	Maricopa	–	25.3	–
Oxbow Estates CDP	Gila	–	–	29.2
City of Phoenix	Maricopa	56.7	20.9	–
Picacho CDP	Pinal	69.6	24.1	21.2
Town of Pima	Graham	–	24.5	28.3

continued

Table 3.15.3-1. Percent minority population and percent population living below poverty level *(cont'd)*

Geographic Area	County	Minority Population Percentage*	Percentage of Individuals Living Below Poverty Level	Percentage of Families Living Below Poverty Level
Pinal CDP	Gila	–	30.8	20.0
Round Valley CDP	Gila	–	50.8	–
City of Safford	Graham	49.7	–	–
San Jose CDP	Graham	78.5	–	–
San Manuel CDP	Pinal	56.9	23.7	17.5
Six Shooter Canyon CDP	Gila	–	–	19.0
Soloman CDP	Graham	79.2	–	–
Stanfield CDP	Pinal	89.9	–	29.3
Town of Star Valley	Gila	–	24.7	–
Town of Superior	Pinal	69.6	–	–
Swift Trail Junction CDP	Graham	53.9	–	–
City of Tolleson	Maricopa	91.2	23.3	20.0
Whispering Pines CDP	Gila	–	29.2	50.0
Town of Winkelman	Pinal	82.4	–	–
Wittman CDP	Maricopa	–	–	24.8
Town of Youngtown	Maricopa	–	22.7	16.8

Source: U.S. Census Bureau, 2013–2017 American Community Survey 5-Year Estimates (U.S. Census Bureau 2018)

Note: Dash indicates the community did not exceed the State of Arizona reference level by 5 percent or more.

* Nonwhite population is calculated by subtracting values in the field "Only one race – white alone" from the field "total population." Nonwhite in this analysis thus refers to all individuals who self-identify either as Hispanic, including Hispanic whites, or as a race other than white alone.

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

3.15.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, adverse impacts on environmental justice populations other than Native American communities would not occur, as the current land use would remain unchanged and opportunities for disproportionate adverse impacts would not exist.

3.15.4.2 Impacts Common to all Action Alternatives

Not all of the communities that meet the criteria (described in section 3.15.2) for an environmental justice population within the four-county analysis area would potentially experience measurable impacts from the alternatives analyzed in this section; therefore, the communities for which impacts are analyzed are listed here. The remaining populations are either outside the potential geographic extent of potential impacts or would experience beneficial socioeconomic effects (see section 3.13 for a more detailed discussion of potential impacts on socioeconomics).

The proposed project has the potential to disproportionately impact the eight identified Native American communities and the following five communities:

1. town of Hayden
2. town of Miami
3. city of Globe
4. town of Superior
5. town of Winkelman

Effects of the Land Exchange

The land exchange would have effects on some environmental justice communities.

The Oak Flat Federal Parcel would leave Forest Service jurisdiction and no longer be open to public use to those communities in the vicinity. The offered lands that would enter either Forest Service or BLM jurisdiction would be beneficial to nearby communities of each parcel.

Native American communities would be disproportionately affected by the land exchange because Oak Flat would be conveyed to private property and would no longer be subject to the NHPA (see section 3.12). Loss of the culturally important area of Oak Flat would be a substantial threat to the perpetuation of cultural traditions of the Apache and Yavapai tribes. The land exchange would have a disproportionally adverse effect on Native American communities as a result of the effects on tribal values and concerns and cultural resources.

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 environmental justice. 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 environmental justice communities. These are non-discretionary measures, and their effects are accounted for in the analysis of environmental consequences. Because they cover a variety of resources (see list in next section), these measures are not repeated here.

Potential Effects on Environmental Justice Communities by Resource

Under all action alternatives, impacts on environmental justice communities from the East Plant Site and West Plant Site, subsidence area, and from auxiliary facilities for the East Plant Site and West Plant Site (such as transmission lines, pipelines, and roads) would be similar because the locations of these facilities across all action alternatives would not change impacts on environmental justices communities. However, impacts on environmental justice communities from the proposed tailings storage facilities and auxiliary facilities would vary under each of the action alternatives and therefore are discussed separately later in this section.

For detailed differences between alternatives by resource, see the respective resource analyses in the “Environmental Consequences” parts of each resource section. For many resources (e.g., geology, wildlife, and soils and vegetation), potential adverse impacts resulting from the action alternatives would be generally limited to the project area. Because there are no communities located within the project area, there would not be disproportionately high or adverse direct impacts on environmental justice communities as a result of disturbance. Resources that may be subject to adverse impacts as a result of the action alternatives and that may have subsequent disproportionately high or adverse impacts on environmental justice communities are

- scenic resources,
- socioeconomics,
- public health and safety,
- recreation,
- transportation and access,
- noise and vibration,
- land ownership and access,
- water resources,
- air quality,
- tribal values and concerns, and
- cultural resources.

During analysis, we considered these resources and whether the action alternatives would result in a disproportionate impact on environmental justice communities; the rationale is included in table 3.15.4-1.

As indicated in table 3.15.4-1, we anticipate that the proposed East Plant Site, West Plant Site, area of subsidence, and auxiliary facilities would have disproportionately high and adverse impacts on environmental justice communities for scenic resources and dark skies. Impacts on these resources would be largely experienced by the town of Superior. In addition, impacts on cultural resources and tribal concerns and values would have a disproportionally adverse impact on Native American communities. Other environmental justice communities (with the exception of Native American communities) would not experience adverse impacts as a result of the proposed project because they would be located outside the geographic area of influence for most resources. The town of Superior would experience disproportionately high and adverse impacts under all alternatives primarily because the West Plant Site and associated facilities would be located directly north of and adjacent to the town.

Table 3.15.4-1. Identified resources and determination of adverse impact on environmental justice communities

Resource or Resource Use	Is There an Adverse Impact on an Environmental Justice Community?	Is the Impact Disproportionately High and Adverse?
Geology, Minerals, and Subsidence	No	**No.** As potential impacts on geological and/or mineral resources are anticipated to be limited beyond the geographic scope of the project area, and environmental justice communities are not located within the project area, it is unlikely that direct or indirect impacts on these resources would affect these communities. In addition, the geological and/or mineral resources located within the project area are also present in areas outside of the area that may be disturbed. Therefore, because the impacts on geological or mineral resources would be limited in geographic scope and would not result in the total loss of these resources across the region, these impacts are not anticipated to result in adverse impacts on environmental justice communities. Subsidence effects would be limited to Resolution Copper private land.
Scenic Resources	Yes	**Yes.** Residents of the town of Superior would experience adverse changes to visual quality of the area as a result of the West Plant Site and auxiliary facilities. As the town of Superior would be the only community that would experience adverse impacts on scenic resources as a result of the West Plant Site and auxiliary facilities and has been identified as an environmental justice community, impacts on scenic resources would be disproportionately adverse.
Scenic Resources: Dark Skies	Yes	**Yes.** The town of Superior would experience an increase in sky brightness between 40 and 160 percent as a result of the West Plant Site and auxiliary facilities. As the town of Superior would be the only community that would experience adverse impacts on dark skies from increased levels of light pollution as a result of the West Plant Site and auxiliary facilities, and has been identified as an environmental justice community, these impacts would be disproportionately adverse.
Socioeconomics	Yes	**No.** All environmental justice communities would experience socioeconomic impacts (see section 3.13), such as an increase in tax revenues and direct and indirect employment opportunities resulting in beneficial multiplier effects for the majority of the identified communities. Increases in direct and indirect revenues from the proposed project could result in net beneficial economic impacts across the analysis area. The proposed project could result in an increase in direct and indirect employment opportunities for members of environmental justice communities, thus having a beneficial multiplier effect on environmental justice communities. Adverse impacts on property values would be largely limited to residences near the proposed tailings storage facilities, of which only the town of Superior has been identified as an environmental justice community; however, it is anticipated that adverse impacts on property values from proposed tailings storage facilities would be offset by upward pressure on property values related to increased housing demand from the mine workforce, and from the applicant-committed measures specific to the town of Superior that are described in section 3.13.
Public Health and Safety: Fire and Fuels Management	Yes	**No.** The town of Superior is identified as a Wildland Urban Interface community at high risk from wildfire and would experience an increase in risk of wildfire; however, these impacts would not be limited to environmental justice communities.
Public Health and Safety: Hazardous Materials	Yes	**No.** The risk for catastrophic release of hazardous materials is highest during transportation, and these materials would be transported by truck along U.S. 60, which is partially located within the town of Superior; however, other communities within which U.S. 60 is also partially located and through which hazardous materials may be transported have not been identified as environmental justice communities. Therefore, these impacts would not be limited to environmental justice communities.

continued

Table 3.15.4-1. Identified resources and determination of adverse impact on environmental justice communities *(cont'd)*

Resource or Resource Use	Is There an Adverse Impact on an Environmental Justice Community?	Is the Impact Disproportionately High and Adverse?
Recreation	Yes	**No.** Impacts on recreation would not be limited to environmental justice communities.
Transportation and Access	Yes	**No.** The town of Superior would experience an increase in level of service to inadequate rankings of E or F at five intersections; however, these impacts would affect both residents of the town of Superior as well as visitors and would not be limited to members of environmental justice communities.
Noise and Vibration	Yes	**No.** Noise and vibration from construction-related activities (underground blasting and construction equipment at surface level) at the West Plant Site and underground conveyance tunnel would result in short-term and intermittent increases in noise and vibration levels that may exceed applicable thresholds for some individual residences in the town of Superior; however, because of the short-term and infrequent nature of construction activities, the effects are not anticipated to be adverse. During operations, the long-term increase in noise and vibration from the proposed project at the West Plant Site, in conjunction with existing background noise and vibration, is expected to result in increased levels of noise and vibration within the town of Superior; however, because these levels would not exceed applicable thresholds, the proposed action would therefore not disproportionately impact environmental justice communities.
Soils and Vegetation	No	**No.** As potential impacts on soils and vegetation resources are anticipated to be limited beyond the geographic scope of the project area and environmental justice communities are not located within the project area, it is unlikely that direct or indirect impacts on these resources would affect these communities. In addition, the soils and vegetation resources located within the project area are also present in areas outside the area that may be disturbed. Therefore, because the impacts on these resources would be limited in geographic scope and would not result in the total loss of these resources across the region, these impacts are not anticipated to result in adverse impacts on environmental justice communities. Loss of access to resource-gathering areas is discussed in "Tribal Values and Concerns" within this table.
Land Use: Land Ownership and Access	Yes	**No.** Loss of access to public lands would not be limited to environmental justice communities.
Land Use: Livestock and Grazing	No	**No**. As potential impacts on livestock and grazing are anticipated to be limited beyond the geographic scope of the project area and livestock grazing has not been identified as a critical economic or cultural critical land use within the project area for environmental justice communities, it is unlikely that changes to livestock grazing would result in impacts on these communities.
Water Quantity: Groundwater	No	**No.** Additional drawdown due to block-caving is anticipated for water supply wells in and around the town of Superior, except for those completed solely in alluvium or shallow fracture systems. Impacts could include loss of well capacity, the need to deepen wells, the need to modify pump equipment, or increased pumping costs. However, Resolution Copper has identified an applicant-committed environmental protection measure that would replace water supplies lost.

continued

Table 3.15.4-1. Identified resources and determination of adverse impact on environmental justice communities *(cont'd)*

Resource or Resource Use	Is There an Adverse Impact on an Environmental Justice Community?	Is the Impact Disproportionately High and Adverse?
Water Quantity: Surface Water	Yes	**No.** Impacts on surface water quantity would not be limited to environmental justice communities.
Water Quality: Groundwater	Yes	**No.** Potential impacts on groundwater quality would not be limited to environmental justice communities.
Water Quality: Surface Water	Yes	**No.** Potential impacts on surface water quality would not be limited to environmental justice communities.
Air Quality	Yes	**No.** The effects on air quality as a result of emissions from the proposed project, in conjunction with nearby source emissions, are expected to result in predicted concentrations in Class I and II areas that are in compliance with the NAAQS limits and would therefore not disproportionately impact environmental justice communities.
Tribal Values and Concerns	Yes	**Yes.** Disturbance to and loss of access to sacred sites, traditional cultural properties, and traditional resource collecting areas within the proposed mine area would adversely impact members of the consulting tribes. No tribe supports the desecration or destruction of ancestral sites. As this impact would be limited to Native American communities and the permanent loss of these resources is not able to be mitigated, impacts would be disproportionately high and adverse.
Cultural Resources	Yes	**Yes.** Disturbance to historic properties within the proposed mine area would adversely impact cultural resources and members of the consulting tribes (see Section 3.14, Tribal Values and Concerns).
Wildlife	No	**No.** As potential impacts on wildlife resources are anticipated to be limited beyond the geographic scope of the project area and environmental justice communities are not located within the project area and wildlife has not been identified as a critical economic or cultural critical land use (e.g., hunting) within the project area for environmental justice communities, it is unlikely that changes to wildlife or wildlife habitats would result in impacts on these communities.

The tribal values and concerns resource section (see section 3.14) indicates that during consultation with Native American tribes, the tribes requested that tribal monitors resurvey a number of geographic areas to identify traditional cultural properties of importance to the four cultural groups with ties to the region (Puebloan, O'odham, Apache, and Yavapai). Traditional cultural properties can include springs and seeps, plant and mineral resource collecting areas, landscapes and landmarks, caches of regalia and human remains, and sites that may not have been recognized by non-Native archaeologists. Representatives of the Yavapai and Apache tribes have identified a number of areas that may be directly or indirectly affected by all alternatives as sacred landscapes and/or TCPs. Additionally, all of the consulting tribes consider all springs and seeps sacred, and all of the tribes strongly object to the development of a mine and placement of tailings in any culturally sensitive area. Although the physical boundaries of the reservations of the consulting tribes are not within the project area boundaries, disturbance of the sites would result in a disproportionate impact on the tribes, given their historical connection to the land. Additionally, the potential impacts on archaeological and cultural sites (see section 3.12) are directly related to the tribes' concerns and the potential impacts on cultural identity and religious practices. Given the known presence of ancestral villages, human remains, sacred sites, and traditional resource-collecting areas that have the potential to be permanently affected, it is unlikely that compliance and/or mitigation would substantially relieve the disproportionality of the impacts on the consulting tribes.

Impacts on scenic quality and dark skies (see section 3.11) as a result of the development of the West Plant Site and auxiliary facilities would be disproportionally high and adverse for residents of the town of Superior, as it would be located directly adjacent to developed areas of the town. Views from residences and community areas within 2 miles of the West Plant Site could be impacted by a strong change in landscape form, line, color, and texture and the dominance of new landscape features in the view. In addition, the magnitude of the increase in sky brightness that would occur as a result of the West Plant Site and auxiliary facilities would be disproportionally experienced by adjacent residences. Given the proximity of residences to the West Plant Site, it is unlikely that compliance and/or mitigation would substantially relieve the disproportionality of the impacts on the affected community members.

Impacts on potential environmental justice communities that could

result from the proposed tailings storage facilities are discussed by alternative in the following text. Impacts on resources that would not be disproportionately high and adverse are not discussed.

3.15.4.3 Alternatives 2 and 3 – Near West

Effects from the tailings storage facility and auxiliary facilities under Alternatives 2 and 3 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include cultural resources and tribal values and concerns. For these resources, impacts would be similar to those described in Section 3.15.4.3, Impacts Common to All Action Alternatives.

The proposed location of the Alternatives 2 and 3 tailings storage facilities contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted by either alternative (see section 3.12). In addition, these alternatives are located in proximity to an identified sacred site, and the presence of the tailings storage facility would constitute an adverse visual effect on the landscape (see sections 3.11 and 3.14). This alternative would result in disproportionately high and adverse impacts on cultural resources and tribal values and concerns.

3.15.4.4 Alternative 4 – Silver King

Effects from the tailings storage facility and auxiliary facilities under Alternative 4 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include scenic resources, cultural resources, and tribal values and concerns. Impacts would be similar to those described earlier in Section 3.15.4.3, Impacts Common to All Action Alternatives, for cultural resources and tribal values and concerns.

The location of this proposed tailings storage facility contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted (see section 3.12). Even though this alternative is located east of Alternatives 2 and 3, it would still be visible on the landscape (see sections 3.11 and 3.14). This alternative would result in disproportionately high adverse impacts on cultural resources and tribal values and concerns.

Impacts on scenic quality (see section 3.11) as a result of the development of the proposed tailings storage facility and auxiliary facilities would be disproportionally high and adverse for residents of the town of Superior, as it would be located directly adjacent to the community. Prior to reclamation activities, as the embankment grows, the facility would become increasingly visible from the town of Superior. Views from residences and community areas could be impacted by a moderate to strong change in landscape form, line, color, and texture and the dominance of new landscape features in the view. Given the level of scenic change for residents of the town of Superior that would result from this alternative, it is unlikely that compliance and/or mitigation would substantially relieve the disproportionality of the impacts on the affected community members.

3.15.4.5 Alternative 5 – Peg Leg

Effects from the tailings storage facility and auxiliary facilities under Alternative 5 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include cultural resources and tribal values and concerns. Impacts would be similar to those described in Section 3.15.4.3, Impacts Common to All Action Alternatives.

The location of this proposed tailings storage facility contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted by either of the proposed tailings pipeline routes (see section 3.12). This alternative would result in disproportionately high adverse impacts on cultural resources and tribal values and concerns.

3.15.4.6 Alternative 6 – Skunk Camp

Effects from the tailings storage facility and auxiliary facilities under Alternative 6 that are anticipated to have disproportionately high and adverse impacts on environmental justice communities include cultural resources and tribal values and concerns; impacts would be similar to those described in Section 3.15.4.3, Impacts Common to All Action Alternatives.

The location of this proposed tailings storage facility contains culturally important areas (see section 3.14), as well as a number of archaeological sites that would be adversely impacted by either of the proposed tailings pipeline routes (see section 3.12). In addition, the proposed pipeline corridors associated with this alternative would both be located in proximity to identified sacred sites, and the presence of the pipeline corridors would constitute an adverse visual effect on the landscape (see section 3.14). It can also be anticipated that this alternative would result in disproportionately high and adverse impacts on cultural resources and tribal values and concerns.

3.15.4.7 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. These reasonably foreseeable future actions are expected to contribute to cumulative changes to low-income and/or minority populations protected by Title VI of the Civil Rights Act and environmental justice conditions in the towns of Superior and Florence and other nearby communities, particularly those in northern Pinal County, southwestern Gila County, and eastern Maricopa County. 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 reasonably foreseeable future actions, to be considered cumulatively along with the affected environment and Resolution Copper Project effects.

Many of the RFFAs can also be anticipated to result in disproportionately high and adverse impacts on Native American communities due to cumulative impacts on cultural resources and tribal values and concerns, as development, mining, and disturbance of the natural landscape cumulatively impact the cultural heritage of these communities.

- *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. Proposed expansion and continuation of operations at the Pinto Valley Mine may negatively and disproportionally affect environmental justice communities by decreasing available housing and/or driving up costs of affordable housing associated with a relatively sudden influx of workers. Activity at the Pinto Valley Mine, in combination with other mining in the Globe-Miami-Superior-Kearny-Hayden area, may contribute to this well-documented phenomenon.
- *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 mining operation in the "Copper Butte" area west of the Ray Mine. Under the proposed land exchange, Executive Order 12898 would no longer apply to the selected lands, and the offered lands would comply with Executive Order 12898. Development of these lands could have the potential to disproportionately affect low-income and/or minority populations by increasing pressures on local infrastructure such as roads, schools, medical services, and the availability and affordability of housing in the towns of Superior, Hayden, and Winkelman. Large-scale mining projects such as the Resolution Copper Mine and the mining developments described here may also alter rural settings and lifestyles experienced by protected populations.
- *Ripsey Wash Tailings Project.* Mining company ASARCO is planning to construct a new tailings storage facility to support its Ray Mine operations. As approved, the proposed tailings storage facility project would occupy 2,627 acres of private lands and 9 acres of BLM lands and be situated within the Ripsey Wash watershed just south of the Gila River approximately 5 miles west-northwest of Kearny, Arizona, and would contain up to 750 million tons of material (tailings and embankment material). The tailings facility would include two starter dams, new pipelines to transport tailings and reclaimed water, a pumping booster station, a containment pond, a pipeline bridge across the Gila River, and other supporting infrastructure. 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. A segment of the Arizona Trail would be relocated east of the tailings storage facility. Development of these lands could have the potential to disproportionately affect low-income and/or minority populations by increasing pressures on local infrastructure such as roads, schools, medical services, and the availability and affordability of housing in the towns of Superior, Hayden, and Winkelman. Large-scale mining projects such as the Resolution Copper Mine and the mining developments described here may also alter rural settings and lifestyles experienced by protected populations.

These projects could potentially contribute to effects on low-income or minority populations through the projected life of the Resolution Copper Mine (50–55 years).

3.15.4.8 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.

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

Unavoidable Adverse Impacts

The change in scenery and dark skies for the town of Superior cannot be avoided or fully mitigated. Similarly, the disproportionately high and adverse impacts on cultural resources and tribal values and concerns cannot be avoided or fully mitigated.

3.15.4.9 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Environmental justice impacts are expected only for the town of Superior, and tribes with cultural, social, or religious ties to the project area would be affected permanently from direct, permanent impacts on these sites and values. The loss of these values would be long term.

Irreversible and Irretrievable Commitment of Resources

There would be irretrievable socioeconomic impacts under all action alternatives because existing land uses, including recreation opportunities, would be precluded within the project area during the life of the project. All action alternatives would potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, infrastructure and tax base funding, community values, and quality of life for residents of the town of Superior.

Overview

The Resolution Copper Mine project area and alternative tailings locations comprise public lands under both Federal and State jurisdiction as well as privately owned lands. Federal lands are managed by the Forest Service and the BLM, while State Trust lands are under the stewardship of the ASLD. As described in the sections that follow, approval of either the GPO-proposed mine or any of the alternatives presented in this EIS would result in the loss to public use of substantial areas of Federal and State lands, including recreational use, livestock grazing, and other uses. Some roads, fencing, range improvements, boundary markers, and other existing features would be permanently eliminated or altered.

3.16 Livestock and Grazing

3.16.1 Introduction

There are currently 17 established grazing allotments totaling approximately 462,000 acres within the analysis area on lands managed either by the Forest Service, BLM, or ASLD, or on privately owned lands. Most allotments are some combination of land management and/or ownership, where multiple grazing permits are held by a single permittee for the allotment.

Within the analysis area, all action alternatives would affect vegetation and/or water sources and cause direct or indirect impacts that would render portions of the current grazing allotments unavailable for livestock grazing. Impacts are expected throughout the full life cycle of the mine, including construction, operations, closure and reclamation, and post-closure phases.

3.16.2 Analysis Methodology, Assumptions, Uncertain and Unknown Information

3.16.2.1 Analysis Area

The analysis area for livestock and grazing includes the entirety of all allotments that overlap spatially, in full or in part, with the primary GPO-proposed mine components (East Plant Site and subsidence area, West Plant Site, MARRCO corridor, filter plant and loadout facility, Near West tailings storage facility and pipeline corridors, and transmission lines) and each alternative tailings storage facility analyzed in this EIS (figure 3.16.2-1). Temporal analysis of impacts on livestock and grazing includes all portions of grazing allotments over the period in which mine activities could occur (50–55 years), including the construction, operations, closure and reclamation, and post-closure phases.

3.16.2.2 Methodology

This analysis documents the potential for acreages of grazing allotments to change, the potential for animal unit months (AUMs)[72] to be reduced, and the potential for loss of grazing-related facilities (e.g., stock watering sources).

Grazing allotments intersecting with the analysis area were identified through geospatial data obtained from the Tonto National Forest, BLM, and ASLD. Where necessary, the datasets were reconciled
to one another and to available geospatial land ownership data, in order to make data from the different sources comparable for analysis. The total acreages of each allotment and the acres potentially impacted by project-related activities were then determined through geographic information system (GIS) spatial analysis. AUM values were calculated based on the original AUMs per acre of the entire allotment and were extrapolated to the anticipated acreage of impact to yield a proportional estimate of reduction in AUMs (e.g., 100 AUMs are allowed on a 1,000-acre allotment; if reduced by 500 acres, the available AUMs become 50). Data on ownership, lease agreements, AUMs, etc., were identified and evaluated where available.

72. An “animal unit month” metric used to identify the amount of forage required to feed one mature cow weighing approximately 1,000 pounds and a calf up to weaning age.

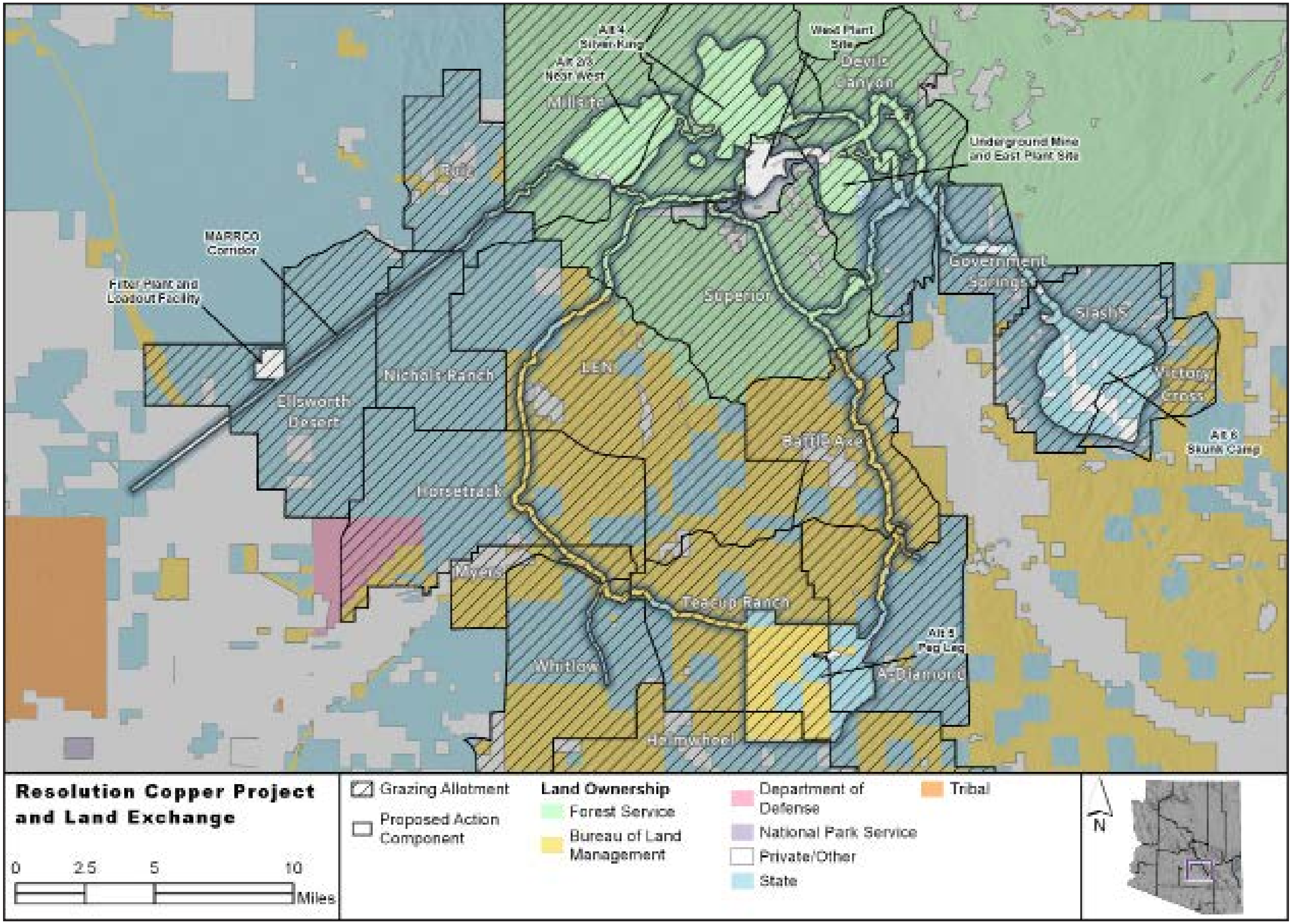


Figure 3.16.2-1. Analysis area for evaluating existing rangeland conditions and livestock grazing allotments

Primary Legal Authorities Relevant to the Livestock and Grazing Effects Analysis

- Taylor Grazing Act of 1934
- Federal Land Policy and Management Act of 1976
- Multiple-Use Sustained-Yield Act of 1960
- Tonto National Forest Land and Resource Management Plan
- Forest and Rangeland Renewable Resources Planning Act of 1974

Impacts on springs, as well as livestock and wildlife water sources, were identified by evaluation of publicly available geospatial data retrieved from several sources: Tonto National Forest, BLM Tucson Field Office, and AGFD, as well as various environmental resource surveys prepared under contract for Resolution Copper. Data on existing rangeland conditions, where available, were taken from environmental assessments and allotment management plans, but range conditions have not been recorded for most grazing allotments in the analysis area.

It should be noted that the water sources described as being lost in this section may differ from the groundwater-dependent ecosystems that are described as being impacted in section 3.7.1, but for which mitigation is anticipated to maintain or replace the water sources described in this analysis. Section 3.7.1 focuses on GDEs with persistent, perennial water tied to regional aquifers. This section focuses on water for wildlife from a variety of sources, including tanks and springs that would be directly impacted and may rely on temporary or seasonal sources of water. In addition, some impacts on livestock access from fencing may not be considered in section 3.7.1, which focuses on direct disturbance instead of loss of access.

3.16.3 Affected Environment

3.16.3.1 Relevant Laws, Regulations, Policies, and Plans

A complete listing and brief description of the legal authorities, reference documents, and agency guidance used in this livestock and grazing analysis may be reviewed in Newell (2018c).

3.16.3.2 Existing Conditions and Ongoing Trends

There are currently 17 established grazing allotments totaling approximately 462,000 acres in the analysis area. The proposed action and its alternatives intersect only about 10 percent of these allotments by area. This section summarizes existing conditions for the entirety of each allotment to the extent that existing conditions can be described.

Because of their relatively large and complex geographic areas, each grazing allotment is of varying size and varying land management; however, allotments are typically leased by a single entity that must obtain grazing rights (a permit or authorization) from each respective land manager/owner.

Rangelands in the analysis area are typically Sonoran desertscrub dominated by large cacti and tall shrubs at lower elevations (below 3,500 feet) and are chaparral dominated by dense shrub species such as oak, manzanita, and mountain mahogany above 4,000 feet. Semi-arid grasslands predominate in the transition zone between these type primary ecozones (Arizona Roadside Environments 1999).

Given the complex relationship between livestock grazing and land management, allotments are discussed in this section by land-managing agency. The level of detail provided is based on available data.

Table 3.16.3-1. Acreages of Forest Service livestock grazing leases by allotment

Allotment Name	Grazing Lease Acreage*	Livestock Type / Number	Recommended AUMs
Devil's Canyon	18,700	Cattle / 200	1,104
Millsite	44,483	Cattle / 307	4,374
Superior	56,141	Cattle / 314	5,300

Source: Livestock type/number and AUMs were taken from the Forest Service livestock grazing records.

* Acreages are estimates based on available spatial data.

Forest Service Grazing Allotments

The Forest Service manages grazing permits within three allotments in the analysis area: Devil's Canyon (18,700 acres), Millsite (44,483 acres), and Superior (56,141 acres), for a total of approximately 119,323 acres of permitted grazing on NFS lands (table 3.16.3-1). Permitted grazing uses for Forest Service grazing allotments are summarized in this section. Actual use may be less than permitted use, mainly as a result of periods of extended drought (U.S. Forest Service 2010d).

DEVIL'S CANYON ALLOTMENT

The grazing permit for the portion of the Devil's Canyon Allotment on NFS land is held by Integrity Land and Cattle, of which Resolution Copper is a principal owner. Integrity Land and Cattle operates JI Ranch and runs approximately 200 head of cattle on this allotment as of the GPO (2016d). The carrying capacity for this allotment is 1,104 AUMs.

MILLSITE ALLOTMENT

The grazing permit for the portion of the Millsite Allotment on NFS land is held by William and Lynn Martin. William and Lynn Martin own JF Ranch and are permitted to graze 307 cows/bulls year-round and 197 yearlings between January 1 and May 31. In 1983, a production-utilization study showed 36,806 acres of the Millsite Allotment as being at full-capacity range; the remaining 6,815 acres were identified as having no capacity. As of 1983, the lessees of the Millsite Allotment were using 17,359 of the full-capacity range acreage for livestock use, or 47.7 percent of available rangeland (U.S. Forest Service 2010d). The 1983 study also estimated that, with improved management, capacity for the Millsite Allotment is 4,374 AUMs.

Table 3.16.3-2. Vegetation condition rating, Millsite Allotment, 1991–2003

Cluster Number	Pasture	Vegetation Rating and Trend
C1	Cottonwood	Very poor, stable
C2	Woodbury	Fair, stable
C3	Bear Tank	Poor, stable
C4	Millsite	Poor, downward
C5	Millsite	Poor, downward
C6	Hewitt	Fair, downward
C7	Cottonwood	Poor, stable

Source: U.S. Forest Service (2010d)

Note: Rating system given on a scale from "Poor" to "Excellent."

Sonoran desertscrub covers approximately 75 to 80 percent of the Millsite Allotment and has been heavily impacted by the area's history of livestock grazing. An analysis was performed on data collected between 1991 and 2003 at seven sample clusters in the allotment to create a vegetation condition rating (U.S. Forest Service 2010d). Overall, vegetation conditions on the allotment were poor, and nearly one-half are deteriorating (table 3.16.3-2). As a result, the Forest Service prescribed a deferred and/or rest rotation method for the Millsite Allotment Management Plan (U.S. Forest Service 2016c). Soil conditions for the allotment were evaluated in 2004, 2008, and 2009, and are shown in table 3.16.3-3.

Table 3.16.3-3. Soil condition in acres, Millsite Allotment

Condition	Acres*	Relative Percentage
Satisfactory	34,763	78
Impaired	3,565	8
Unsatisfactory-Impaired	446	1
Unsatisfactory	5,794	13
Total	**44,568**	**100**

Source: U.S. Forest Service (2010d)

Notes: The soil rating system is based on the Natural Resources Conservation Service Soil Condition Rating Guide. These ratings are defined as follows (U.S. Forest Service 1999):

Satisfactory – Indicators signify that soil function is being sustained and soil is functioning properly and normally. The ability of soil to maintain resource values and sustain outputs is high.

Impaired – Indicators signify a reduction in soil function. The ability of soil to function properly has been reduced and/or there exists an increased vulnerability to degradation.

Unsatisfactory – Indicators signify that loss of soil function has occurred. Degradation of vital soil functions results in the inability of soil to maintain resource values, sustain outputs, and recover from impacts.

* Acreages are estimates based on available spatial data.

SUPERIOR ALLOTMENT

The grazing permit for the portion of the Superior Allotment on NFS land is held by DNH Cattle Company, which is permitted to graze 314 cows/bulls throughout the year and 174 yearlings between January 1 and May 31. Most full-capacity range within this allotment is located at higher elevations. In 1961, an allotment analysis determined the carrying capacity to be 5,300 AUMs (U.S. Forest Service no date). The soil and vegetation conditions on the Superior Allotment are considered poor, especially at low elevations, resulting from improper grazing in the past, with irreversible effects in some areas. The current management practice of a 6-month pasture/6-month rest rotation schedule, outlined in the Superior Allotment management plan, intends to provide extended rest to the stressed lowland areas and allow spring/summer rest for two consecutive years out of three (U.S. Forest Service 2016c). A summary of the Superior Allotment's 2018 authorized use is presented in table 3.16.3-4 (U.S. Forest Service no date).

Table 3.16.3-4. Authorized use for Superior Allotment, 2018, DNH Cattle Company

Grazing Unit	Dates of Use	Monitoring Date	Authorized Livestock
North Side			
Montana	11/1/2017 to 4/30/2018	3/27/2018	180 cow/calf 14 bulls 22 yearlings
Silver Canyon	5/1/2018 to 10/30/2018	8/21/2018	180 cow/calf 14 bulls
88	11/1/2018 to 4/30/2019	3/14/2019	180 cow/calf 14 bulls
Silver Canyon, 88 Deferred for 2018			
South Side			
Town, North TU	3/1/2018 to 5/1/2018	4/26/2018	101 cow/calf 24 yearlings
Wildhorse	3/1/2018 to 5/10/2018	5/17/2018	5 bulls
TU Trap, Holding	5/2/2018 to 5/10/2018	5/17/2018	101 cow/calf 24 yearlings
South TU	5/10/2018 to 10/1/2018	8/23/2018	101 cow/calf 6 bulls
Town, North TU	10/2/2018 to 2/28/2019	1/29/2019	101 cow/calf 6 bulls

Source: Sando (2018)
Note: No pastures rested or deferred during 2018.

Each individual allotment management plan outlines a monitoring program with the intent of determining whether the currently prescribed management practices are properly implemented and effective for the improvement of rangeland conditions. The Tonto National Forest implements compliance monitoring to ensure livestock are distributed correctly, and to inspect improvements and maintenance, and forage utilization, among other variables, with an inspection scheduled each grazing year. Other monitored aspects are the presence of noxious weeds and riparian conditions, which may be monitored on longer time intervals (5–10 years) as needed (U.S. Forest Service 2016c). Monitoring practices may be modified if there are significant changes to livestock use patterns.

Bureau of Land Management Grazing Allotments

The BLM authorizes grazing permits within nine allotments in the analysis area totaling about 17,855 acres (see table 3.16.3-4). Detailed grazing conditions and documentation for most of these grazing permits are not available; however, the NEPA process for the Teacup and Whitlow Allotments were initiated in 2017 (Bureau of Land Management 2017a). The Land Health Evaluation for the Teacup and Whitlow grazing leases indicated that the general range conditions met the standards set for them by the BLM. BLM also suggested that Teacup could support 392 cattle under 3,058 AUMs, while Whitlow could support 136 cattle under 588 AUMs. BLM's Rangeland Administration System data were queried for acreage and AUMs for the remaining BLM grazing leases. Table 3.16.3-5 provides acreages for the grazing permits that BLM manages in the analysis area, the number of livestock, and recommended AUMs.

Table 3.16.3-5. Acreages for BLM livestock grazing leases by allotment

Allotment Name	Grazing Lease Acreage*	Livestock Type / Number	Recommended AUMs
LEN	23,742	Cattle / 357	2,964
Teacup	28,794	Cattle / 392	3,058
Helmwheel	14,856	Cattle / 119	1,428
A-Diamond	6,580	Cattle / 301	686
Victory Cross	2,862	Cattle / 163	411
Battle Axe	14,822	Cattle / 210	1,562
Horsetrack	11,218	Cattle / 102	1,224
Meyers	4,618	Cattle / 47	564
Whitlow	10,363	Cattle / 136	588

Source: Livestock type/number and AUMs were taken from the BLM Rangeland Administration System (Bureau of Land Management 2019)
* Acreages are estimates based on available spatial data.

Arizona State Land Department Grazing Leases

The ASLD manages grazing permits within 14 allotments in the analysis area totaling 152,042 acres. ASLD does not maintain detailed documentation on rangeland conditions for specific grazing permit areas; however, this analysis assumes that rangeland conditions for State Trust lands would be similar to those found on neighboring NFS and BLM lands. Rangeland data summarized in table 3.16.3-6 were taken from the Arizona Land Resources Information System (ALRIS), a spatial data viewer maintained by the ASLD.

Table 3.16.3-6. Acreages for ASLD grazing leases by allotment

Allotment Name	Grazing Lease Acreage*	Recommended AUMs
LEN	14,328	1,346
Teacup	12,098	1,583
Helmwheel	30,622	2,843
A-Diamond	2,441	955
Victory Cross	4,476	1,048
Battle Axe	3,270	425
Horsetrack	16,842	1,414
Whitlow	11,275	1,066
Devil's Canyon	6,605	1,104
Ellsworth Desert	6,379	2,250
Ruiz	11,561	1,246
Slash S	15,351	5,757
Nichols Ranch	11,561	1,300
Government Springs	7,233	924

Source: AUMs were taken from Arizona Land Resources Information System (Arizona State Land Department 2019a)
* Acreages are estimates based on available spatial data.

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

3.16.4.1 Alternative 1 – No Action Alternative

Under the no action alternative, no alterations would be made to current grazing access or allotments, nor would there be any direct loss of stock tanks, seeps, and springs. However, six springs in the Superior Allotment are anticipated to be impacted by continued dewatering pumping of mine infrastructure. Management would continue as outlined per the allotment management plans and rangeland conditions would improve or deteriorate contingent upon the plans' effectiveness, combined with the mounting effects of climate change. Climate change is expected to result in droughts that are more frequent and of longer duration, which could stress vegetation and require adjustments to allotment management plans in the future.

3.16.4.2 Impacts Common to All Action Alternatives

Impacts on Allotments

All action alternatives would result in direct and indirect impacts on livestock and grazing within the analysis area because all areas within project facility footprints would become inaccessible to grazing. Impacts are expected throughout the full life cycle of the mine, including the construction, operations, closure and reclamation, and post-closure phases. Direct impacts of any action alternatives include the following:

- Reduction in acreage of grazing allotments
- Reduction in available AUMs within individual grazing allotments
- Loss of grazing-related facilities (water sources or infrastructure)

All action alternatives would see impacts on grazing allotments located in the East Plant Site, subsidence area, and MARRCO corridor. An area within the East Plant Site and Oak Flat Federal Parcel would be fenced off at the commencement of the construction phase of the mine, and the perimeter would be extended every 10 years following the start of operations to account for the additional area impacted by subsidence. Presently, there is no plan to make the area within the subsidence area accessible after Resolution Copper has ownership of the parcel (Resolution Copper 2016d); this would result in a reduction of at least 1,856 acres in the Devil's Canyon Allotment and a direct impact on Integrity Land and Cattle, which currently owns the grazing permit on that allotment. In addition, all action alternatives would see a reduction of at least 38 acres on the Millsite Allotment and some reduction in acreage on the Superior Allotment, although the amount varies by alternative. Implementation of any action alternative would result in loss of the livestock water sources identified in table 3.16.4-1.

Effects of Reclamation

The tailings storage facility represents a large area of disturbance (approximately 2,300 to approximately 5,900 acres, depending on the selected tailings storage facility location) 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 the ability to sustain livestock grazing as a post-mine land use. 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. Allowing grazing as a post-mine land use would need to be weighed against the potential sustainability of the soil and vegetation ecosystem.

Table 3.16.4-1. Livestock water sources impacted under all action alternatives

Name	Type	Nearest Project Area	Grazing Allotment
Ranch Rio Spring	Spring	Subsidence area	Devil's Canyon
The Grotto	Spring	Subsidence area	Devil's Canyon
Apache Leap Stock Tank	Dugout/pit tank	East Plant Site	Devil's Canyon
Oak Flat Stock Tank	Dugout/pit tank	Subsidence area	Devil's Canyon
Reservoir Tank 2	Stock tank, intermittent	Subsidence area	Devil's Canyon
No Name	Tanks	MARRCO corridor	Millsite
Bitter Spring	Spring	Dewatered by pumping	Superior
Bored Spring	Spring	Dewatered by pumping	Superior
Hidden Spring	Spring	Dewatered by pumping	Superior
McGinnel Spring	Spring	Dewatered by pumping	Superior
McGinnel Mine Spring	Spring	Dewatered by pumping	Superior
Walker Spring	Spring	Dewatered by pumping	Superior
DC-6.6W	Spring	Dewatered by pumping	Devil's Canyon
Kane Spring	Spring	Dewatered by pumping	Devil's Canyon

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

Effects of the Land Exchange

The selected Oak Flat Federal Parcel would leave Forest Service jurisdiction, and approximately 1,856 acres of the existing Devil's Canyon Allotment on Tonto National Forest lands (presently permitted to Integrity Land and Cattle Company) would become unavailable for grazing, resulting in an overall reduction of available AUMs. This is an approximately 7 percent loss in total size of the grazing allotment.

The offered lands parcels would come under Federal jurisdiction. The Forest Service supports livestock grazing as a valuable resource to promote on the landscape, provided that it is responsibly performed and managed and does not injure plant growth. BLM's rangeland program places an emphasis in multi-jurisdictional ecosystem management in Arizona. This involves interdisciplinary resource management in consultation and coordination with other Federal, State, and local agencies and Indian Tribes. The specific management of livestock and grazing on the offered lands would be determined by the agencies upon transference of the parcels, but in general, when the offered lands enter Federal jurisdiction, the parcels would have the potential to be permitted for grazing where there currently is none. The Apache Leap South End Parcel would be exempt from grazing as it would become part of a management area that has no new grazing allowed. Allotments on the Forest Service that surround some of the offered lands parcels include Cartwright, Red Creek, and Tonto Basin, among others. Allotments managed by the BLM that surround some of the offered lands parcels are Dripping Springs and Steamboat Mountain.

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). A number of standards and guidelines (13) were identified as applicable to livestock grazing. None of these standards and guidelines were 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 process memorandum Shin (2019).

SUMMARY OF APPLICANT-COMMITTED ENVIRONMENTAL PROTECTION MEASURES

No environmental protection measures were identified as being incorporated into the design of the project that would act to reduce potential impacts on livestock grazing. However, note that a number of measures meant to reduce impacts on water resources could be applicable to livestock grazing as well. These are described primarily in sections 3.7.1 and 3.7.3.

3.16.4.3 Alternative 2 – Near West Proposed Action

Implementation of this alterative would result in the reduction of available grazing within six allotments under various management or ownership. Table 3.16.4-2 summarizes the anticipated reduction in acres of land available for livestock grazing from this alternative by allotment and by land manager/owner, and reductions in AUMs by allotment are estimated where data were available.

Under Alternative 2, approximately 8,572 acres of land currently authorized for livestock grazing use would be forfeited, with the greatest impacts occurring on the Devil's Canyon and Millsite Allotments, with relatively lesser impacts on the Ellsworth Desert and Superior Allotments, and minor impacts on the Nichols Ranch and Ruiz Allotments.

Implementation of Alternative 2 would also result in the loss of access to four or five natural springs, as well as five or six constructed stock watering and/or wildlife watering features (table 3.16.4-3).

Table 3.16.4-2. Reduction in available grazing by allotment and ownership – Alternative 2

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	Total Grazing Reduction (acres)
Devil's Canyon	237	1,990 / 117	145 / 24	**2,372**
Ellsworth Desert	668	0	46 / 4	**714**
Millsite	65	4,196 / 413	0	**4,261**
Nichols Ranch	47	0	36 / 3	**83**
Ruiz	29	0	45 / 5	**74**
Superior	3	1,065 / 100	0	**1,068**
Total				**8,572**

Table 3.16.4-3. Water sources impacted under Alternative 2

Name	Type	Nearest Project Area	Grazing Allotment
Bear Tank Canyon Spring	Spring	Tailings facility	Millsite
Benson Spring	Spring	Tailings facility	Millsite
Lower Bear Tank Canyon Spring	Spring	Tailings facility	Millsite
Perlite Spring	Spring	Tailings facility	Superior
Benson Spring	Unknown	Tailings facility	Millsite
Hackberry Tank	Dugout/pit tank	Tailings facility	Millsite
Noble Windmill	Windmill/well	Tailings facility	Millsite
Pilot Tank	Dugout/pit tank	Tailings facility	Millsite
No Name	Spring, trough	Tailings facility	Millsite
No Name	Well	Tailings facility	Millsite
Conley Spring	Spring	Tailings facility	Millsite

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

3.16.4.4 Alternative 3 – Near West – Ultrathickened

Implementation of Alternative 3 would result in the same impacts on lands currently authorized for livestock grazing and water sources use and access as described for Alternative 2.

Table 3.16.4-4. Reduction in available grazing by allotment and ownership – Alternative 4

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	Total Grazing Reduction (acres)
Devil's Canyon	237	1,990 / 117	277 / 46	**2,504**
Ellsworth Desert	668	0	46 / 4	**714**
Millsite	17	112 / 11	0	**129**
Nichols Ranch	47	0	36 / 3	**83**
Ruiz	29	0	45 / 5	**74**
Superior	52	5,843 / 551	0	**5,895**
Total				**9,399**

3.16.4.5 Alternative 4 – Silver King

Implementation of the Silver King alternative would result in reduction of available grazing within six allotments under various management or ownership. Table 3.16.4-4 summarizes the anticipated reduction in acres of land available for livestock grazing from this alternative by allotment and by land manager/owner, and reductions in AUMs by allotment are estimated where data were available. Implementation of Alternative 4 would also result in the loss of access to springs and other livestock and/or wildlife water sources (see table 3.16.4-4).

Under Alternative 4, approximately 9,399 acres of land currently authorized for livestock grazing would be forfeited, with the greatest impacts occurring on the Superior Allotment. Relatively moderate impacts would occur on the Devil's Canyon Allotment, with more minor impacts occurring on the Ellsworth Desert, Millsite, Nichols Ranch, and Ruiz Allotments.

Table 3.16.4-5. Water sources impacted under Alternative 4

Name	Type	Nearest Project Area	Grazing Allotment
McGinnel Mine Spring	Spring	Fence line (note this spring is already impacted by pumping)	Superior
Mud Spring 2	Spring	Fence line	Superior
Rock Horizontal Spring	Spring	Fence line	Superior
Iberri Spring	Spring	Tailings facility	Superior
McGinnel Spring	Spring	Tailings facility	Superior
Cedar Tank	Stock tank, intermittent	Fence line	Superior
Comet Tank	Stock tank, intermittent	Tailings facility	Superior
Dugan Tank	Stock tank, intermittent	Fence line	Superior
Javelina Tank	Stock tank, intermittent	Fence line	Superior
Peachville Tank	Stock tank, intermittent	Fence line	Superior
No Name	Well	Fence line	Superior

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

Implementation of Alternative 4 would also result in the loss of access to five natural springs, as well as six constructed stock watering and/or wildlife watering features (table 3.16.4-5).

3.16.4.6 Alternative 5 – Peg Leg

The Peg Leg alternative would include an east route pipeline option and a west route pipeline option. Implementation of the Peg Leg east pipeline option would result in the reduction of available grazing within 10 grazing allotments, while the Peg Leg west pipeline option would affect 13 grazing allotments. Table 3.16.4-6 summarizes the anticipated reduction in acres of land available for livestock grazing from this alternative by allotment and by land manager/owner, as well as by pipeline route, and reductions in AUMs by allotment are estimated where data were available.

Under the east pipeline option for Alternative 5, approximately 15,672 acres of land currently authorized for livestock grazing would be forfeited over 10 allotments, with the greatest impacts occurring on the Teacup Allotment. Slightly fewer acres on each of the Devil's Canyon, A-Diamond, and Helmwheel Allotments would be affected, with relatively lesser impacts on the remaining allotments.

Under the west pipeline option for Alternative 5, approximately 16,186 acres of land currently authorized for livestock grazing would be forfeited over 13 allotments, with the greatest impacts occurring on the Teacup Allotment. Slightly fewer acres on each of the A-Diamond, Devil's Canyon, and Helmwheel Allotments would be affected, with relatively lesser impacts on the remaining allotments.

Implementation of the Peg Leg alternative would result in the loss of access to natural springs, as well as constructed stock watering and/or wildlife watering features, but none outside those shown in impacts common to all (see table 3.16.4-1).

Constructed stock watering and/or wildlife water facilities in the tailings pipeline corridor options could be present yet are not listed. It is expected that the water source would be avoided during micro-siting or would be replaced as per water resources mitigation. Impacts associated with water sources in the tailings pipeline corridor options would be associated with construction and therefore would be short term and temporary.

Table 3.16.4-6. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 5

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	BLM (acres) / AUMs	Total Grazing Reduction (acres)
EAST PIPELINE OPTION					
A-Diamond	144	0	2,440 / 155	188 / 20	**2,772**
Battle Axe	6	0	31 / 4	416 / 44	**453**
Devil's Canyon	237	1,990 / 117	278 / 46	0	**2,505**
Ellsworth Desert	668	0	46 / 4	0	**714**
Helmwheel	4	0	16 / 1	1,271 / 122	**1,291**
Millsite	17	112 / 11	0	0	**129**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**
Superior	24	710 / 67	0	0	**734**
Teacup	3	0	1,830 / 239	5,084 / 540	**6,917**
Total					**15,672**
WEST PIPELINE OPTION					
A-Diamond	129	0	2,306 / 146	129 / 14	**2,564**
Devil's Canyon	237	1,990 / 117	278 / 46	0	**2,505**
Ellsworth Desert	668	0	46 / 4	0	**714**
Helmwheel	4	0	16 / 1	1,271 / 244	**1,291**
Horsetrack	0	0	6 / 1	311 / 34	**317**
LEN	0	36 / 3	88 / 8	325 / 40	**449**
Millsite	17	112 / 11	0	0	**129**
Meyers	0	0	0	138 / 17	**138**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**

continued

Table 3.16.4-6. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 5 *(cont'd)*

EAST PIPELINE OPTION					
Superior	8	597 / 56	0	0	**605**
Teacup	3	0	1,893 / 495	5,311 / 1,128	**7,207**
Whitlow	0	0	20 / 2	90 / 5	**110**
Total					**16,186**

3.16.4.7 Alternative 6 – Skunk Camp

The Skunk Camp alternative would include a north route pipeline option and a south route pipeline option. Implementation of either pipeline route option would result in reduced grazing opportunities within the same nine grazing allotments, but with variable acres impacted. Table 3.16.4-7 summarizes the anticipated reduction in available grazing from this alternative by allotment and by land manager/owner, as well as by pipeline route, and reductions in AUMs by allotment are estimated where data were available.

Under the north pipeline option for Alternative 6, approximately 14,747 acres of existing livestock grazing would be lost over nine allotments, with the largest grazing impacts occurring on the Slash S Allotment. Slightly fewer acres on each of the Devil's Canyon and Victory Cross Allotments would be affected, with relatively minor impacts on the remaining allotments.

Under the south pipeline option for Alternative 6, approximately 15,209 acres of existing livestock grazing would be lost over nine allotments, with the largest grazing impacts occurring on the Slash S Allotment. Slightly fewer acres on each of the Devil's Canyon and Victory Cross Allotments would be affected, with relatively minor impacts on the remaining allotments.

Implementation of the Skunk Camp alternative would result in the loss of access to natural springs, as well as constructed stock watering and/or wildlife watering features (table 3.16.4-8).

Table 3.16.4-7. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 6

Grazing Allotment	Private (acres)	NFS (acres) / AUMs	ASLD (acres) / AUMs	BLM (acres) / AUMs	Total Grazing Reduction (acres)
NORTH PIPELINE OPTION					
Devil's Canyon	237	2,860 / 169	627 / 105	0	**3,724**
Ellsworth Desert	668	0	46 / 4	0	**714**
Government Springs	269	0	599 / 77	0	**868**
Millsite	17	112 / 11	0	0	**129**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**
Slash S	1,333	0	5,050 / 1,894	0	**6,383**
Superior	13	319 / 30	0	0	**332**
Victory Cross	833	0	1,607 / 376	0	**2,440**
Total					**14,747**
SOUTH PIPELINE OPTION					
Devil's Canyon	237	2,520 / 149	853 / 143	0	**3,610**
Ellsworth Desert	668	0	46 / 4	0	**714**
Government Springs	269	0	599 / 77	0	**868**
Millsite	17	112 / 11	0	0	**129**
Nichols Ranch	47	0	36 / 3	0	**83**
Ruiz	29	0	45 / 5	0	**74**
Slash S	1,333	0	5,050 / 1894	0	**6,383**

continued

Table 3.16.4-7. Reduction in available grazing by allotment, ownership, and pipeline route – Alternative 6 *(cont'd)*

NORTH PIPELINE OPTION					
Grazing Allotment	**Private (acres)**	**NFS (acres) / AUMs**	**ASLD (acres) / AUMs**	**BLM (acres) / AUMs**	**Total Grazing Reduction (acres)**
Superior	24	884 / 83	0	0	**908**
Victory Cross	833	0	1,607 / 376	0	**2,440**
Total					**15,209**

Constructed stock watering and/or wildlife water facilities in the tailings pipeline corridor options could be present yet are not listed in table 3.16.4-8. It is expected that the water sources would be avoided during micro-siting or would be replaced in accordance with water resources mitigation. Impacts associated with water sources in the tailings pipeline corridor options would be associated with construction and therefore short term and temporary.

3.16.4.8 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 regional livestock and grazing 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.

- *Ripsey Wash Tailings Project.* ASARCO mining company 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. There would be relatively minor change to existing grazing allotments, with the A-Diamond Allotment losing 2,426 acres or about 11.5 percent of area; and the Rafter Six Allotment being reduced by 149 acres, or about 0.06 percent of its area. These impacts would primarily be cumulative with Alternative 5 – Peg Leg, as the tailings storage facility would also impact another 2,564 to

Table 3.16.4-8. Water sources impacted under Alternative 6

Name	Type	Nearest Project Area	Grazing Allotment
NORTH PIPELINE OPTION			
Weeping Spring	Spring	Access road	Government Spring
Big Spring 3	Spring	Fence line	Victory Cross
Looney Spring 2	Spring	Fence line	Slash S
Walnut Spring 4	Spring	Fence line	Slash S
Dry Spring	Spring	Tailings facility	Slash S
Haley Spring	Spring	Tailings facility	Slash S
No Name	Stock tank	Access road	Devil's Canyon
SOUTH PIPELINE OPTION			
Weeping Spring	Spring	Access road	Government Spring
Big Spring 3	Spring	Fence line	Victory Cross
Looney Spring 2	Spring	Fence line	Slash S
Walnut Spring 4	Spring	Fence line	Slash S
Dry Spring	Spring	Tailings facility	Slash S
Haley Spring	Spring	Tailings facility	Slash S
No Name	Stock tank	Access road	Devil's Canyon

Sources: WestLand Resources Inc. and Montgomery and Associates Inc. (2018); WestLand Resources Inc. (2018d)

2,772 acres of the A-Diamond Allotment, depending on pipeline route.

- *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. Under the proposed action, livestock grazing would cease on the selected lands, resulting in a reduction of 1,151 AUMs; however, the offered lands could become available for grazing under Federal jurisdiction.
- *Grazing allotments.* There are various portions of 17 discrete grazing allotments that partially overlap the proposed Resolution Copper Mine. The grazing allotments generally allow for cattle and other livestock grazing, as well as minor range improvements such as fence repair, stock watering improvements, cattle guards, etc. Approximately 40,000 acres of land authorized for livestock grazing would be affected in varying degrees by proposed project activities and its alternatives. The degree of impacts would be dependent upon the activity, e.g., proposed pipeline and transmission line corridors would not notably affect livestock access and forage would return in time, while tailings facilities and other materials processing areas would likely be lost in perpetuity.
- *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 the Tonto National Forest. 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 be useful in preventing and/or reducing fuel buildup that would otherwise result from rapid, dense regrowth and sprouting of undesired vegetation. While some vegetation would be unavailable for grazing, the cumulative effect overall would be negligible.
- *LEN Range Improvements.* This range allotment is located near Ray Mine. Under the proposed action, upland perennial sources of water would be provided to supplement the existing upland water infrastructure on the allotment. The supplemental water sources would provide adequate water facilities for existing authorized grazing management activities. While beneficial, these water sources are located in a different geographic area than the GDEs potentially impacted by the Resolution Copper Project.
- *Millsite Range Improvements.* This range allotment is located 20 miles east of Apache Junction, on the southern end of the Mesa Ranger District. The Mesa Ranger District is proposing to add three new 10,000-gallon storage tanks and two 600-gallon toughs to improve range condition through better livestock distribution and to provide additional wildlife waters in three pastures on the allotment. Water developments are proposed within the Cottonwood, Bear Tanks, and Hewitt pastures of the Millsite grazing allotment. These improvements would be beneficial for providing water on the landscape, and are within the same geographic area where some waters sources could be lost (Alternatives 2 and 3); they may offset some loss of water that would result because of the Resolution Copper Project tailings storage facility construction.

Other future projects not yet planned, such as large-scale mining, pipeline projects, power transmission line projects, and future grazing permits, 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 to changes in lands available for livestock grazing use, and would affect the vegetation available as livestock forage.

3.16.4.9 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 EIS. 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.

At this time, no mitigation measures have been identified that would be pertinent to livestock grazing. Applicant-committed environmental protection measures for other resources that would also benefit livestock grazing have already been detailed elsewhere in this EIS, will be a requirement for the project, and have already been incorporated into the analysis of impacts.

Unavoidable Adverse Effects

Grazing would be impacted by a reduction in the area available for grazing (a permanent reduction for the area of the subsidence crater and tailings storage facility; a temporary reduction for the area within the perimeter fence until reclamation returns the area to a condition that is compatible with livestock grazing), and by impacts on seeps, springs, and stock tanks that are used by livestock. Water source enhancement conservation measures may offset some of the impacts on seeps, springs, and stock tanks used by livestock on current grazing allotments. These impacts cannot be avoided or fully mitigated.

3.16.4.10 Other Required Disclosures

Short-Term Uses and Long-Term Productivity

Livestock grazing and long-term productivity would be permanently impacted within the tailings storage facility and subsidence area. Although reclamation would eventually return some level of vegetation to the tailings storage facility, productivity would be unlikely to recover to current conditions. Existing grazing around the MARRCO corridor and other linear corridors would be short-term losses, ending with reclamation at the end of mine life, with no impact on long-term productivity.

Irreversible and Irretrievable Commitment of Resources

Vegetation on the site would be continually changing as reclamation procedures are implemented. Eventually, reclamation is expected to return the site to conditions potentially suitable for post-closure land uses such as grazing. Irretrievable commitment of grazing resources would occur until reclamation has returned the site to conditions suitable for grazing. However, the subsidence area and tailings storage facility likely represent an irreversible loss of grazing land.

3.17 Required Disclosures

This section addresses additional disclosures that are required by CEQ regulations and/or NEPA.

3.17.1 Short-Term Uses and Long-Term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

This portion of NEPA regulations recognizes that short-term uses and long-term productivity of the environment are linked and that opportunities that are acted upon have corollary opportunity costs in terms of forgone options and productivity that could have continuing effects well into the future. The following discussion examines short-term uses and long-term productivity together, according to resource categories. Specific impacts of the proposed project on resources are described in the various resource sections throughout chapter 3. "Short term" is taken to mean the full life of the project (construction, operation, and post-closure phases).

The relationships between short-term uses and long-term productivity would not be appreciably different from one action alternative to another but instead would come largely from whether the project is constructed. Resource areas not listed are not expected to have adverse environmental impacts for which maintenance of long-term productivity is a concern.

3.17.1.1 Geology, Minerals, and Subsidence

Construction of the project would convert some undeveloped lands into an industrial mining operation, and construction of mine facilities would alter the area's topography. Impacts related to subsidence and the tailings storage facilities would permanently impact long-term productivity.

3.17.1.2 Soils and Vegetation

Productivity loss for soils would be limited to the disturbed areas affected by land clearing, grading, and construction; subsidence; and areas permanently occupied by tailings. It is not expected that the tailings would ever be removed, or that the subsidence crater would be filled. Effects on soils and some land uses would be permanent.

Reclamation efforts are anticipated to reestablish vegetation in all areas other than the subsidence crater.

Test plots at the West Plant Site have demonstrated that it is possible to successfully revegetate under certain conditions and research has demonstrated successful revegetation on Gila Conglomerate in the same geographic area; however, it is not known whether the areas would return to current conditions or the length of time that would be needed to successfully reclaim the site. However, the goal of reclamation is to create a self-sustainable ecosystem that would promote site stability and repair hydrologic function, and while pre-project habitat conditions are not likely to be achieved, it is likely that some level of wildlife habitat would eventually be reestablished in most areas, reestablishing some level of long-term productivity.

3.17.1.3 Noise and Vibration

Modeled noise and vibration levels did not rise beyond threshold of concern under most conditions, but the noise and vibration associated with the surrounding environment from mining and associated activities would be short term (during the estimated 46- to 51-year life of the mine between construction and reclamation) and are expected to end with mine reclamation.

3.17.1.4 Transportation and Access

Impacts from increased mine-related traffic would be short-term impacts that would cease when the mine is closed.

3.17.1.5 Air Quality

Impacts on air quality (increased air pollutant concentrations but below applicable air quality standards) from mining and associated activities would be short term (during the estimated 41- to 51-year life of the mine between construction and reclamation) and are expected to end with mine reclamation and return to pre-mining levels, assuming adequate revegetation success to stabilize dust emissions from disturbed areas.

3.17.1.6 Groundwater Quantity and Groundwater-Dependent Ecosystems

Groundwater pumping would last the duration of the mine life. At the mine itself, groundwater levels would slowly equilibrate over a long period (centuries). Groundwater drawdown from dewatering of the underground mine workings would constitute a permanent reduction in the productivity of groundwater resources within the long time frame expected for equilibrium. Groundwater in the vicinity of the Desert Wellfield would equilibrate more quickly, but there would still be an irrecoverable amount of drawdown and a permanent loss of productivity of groundwater resources in the area.

Seeps and springs could be permanently impacted by drawdown in groundwater levels, as could the riparian areas associated with springs, but these impacts would be mitigated. GDEs or riparian areas directly lost to surface disturbance would be a permanent impact.

3.17.1.7 Groundwater and Surface Water Quality

The use of the alternative sites for tailings storage represents a short-term use, with disposal happening over the operational life of the mine. However, the seepage from the tailings facilities would continue for much longer, with potential management anticipated being required over 100 years in some cases. While seepage persists, the long-term productivity of the downstream aquifers and surface waters could be impaired for some alternatives.

3.17.1.8 Surface Water Quantity

Desert washes, stock tanks, and wetland areas in the footprint of the subsidence area and tailings storage facility would be permanently impacted. In the short term, over the operational life of the mine, precipitation would be lost to the watershed. In the long term, most precipitation falling at the tailings facility would return to the watershed after closure and successful reclamation. There would be a permanent reduction in the quantity of surface water entering drainages as a result of capture of runoff by the subsidence area.

3.17.1.9 Wildlife and Special Status Wildlife Species

Impacts on wildlife and wildlife habitat would primarily be short term and would include destruction of habitat for mine construction, disturbance from mining and associated activities, and direct mortality from increased mine-related vehicle traffic. Disturbance and direct mortality would cease at mine closure, and reclamation would eventually allow wildlife habitat to reestablish itself. However, this could take many decades or longer. Portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would be long term or permanent. Impacts on wildlife and aquatic habitat due to drawdown that affects streams and springs would represent a permanent loss in productivity.

3.17.1.10 Recreation

Recreation would be impacted in both the short and long term. Public access would be restricted within the perimeter fence until mine closure, which is considered to be a short-term impact. However, much or all of the tailings and subsidence area may not be available for uses such as OHV or other recreational use in the future, depending on the final stability and revegetation of these areas.

3.17.1.11 Public Health and Safety

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.

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.

3.17.1.12 Scenic Resources

Impacts on visual resources would be both short and long term. While impacts associated with processing plant buildings and structures such as utility lines and fences would cease when they are removed at closure, the subsidence area and tailings storage facility would permanently alter the scenic landscape and affect the scenic quality of the area in perpetuity. Impacts on dark skies from night lighting would cease after mine closure and reclamation.

3.17.1.13 Cultural Resources

Physical and visual impacts on archaeological sites, tribal sacred sites, cultural landscapes, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the historic properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

3.17.1.14 Socioeconomics

Socioeconomic impacts are both positive and negative and are primarily short term. The project would provide increased jobs and tax revenue from construction through final reclamation and closure. However, this would be offset by potential impacts on local tourism and outdoor recreation economies, and a decrease in nearby property values; as these effects are largely the result of the tailings storage facility, which is a permanent addition to the landscape, they could persist over the long term.

The long-term continued population and economic growth in areas of the Copper Triangle with existing copper mines indicates that these impacts are in the magnitude of being decades long and would not be permanent.

3.17.1.15 Tribal Values and Concerns

Physical and visual impacts on TCPs, TEKPs, and plant and mineral resources caused by construction of the mine would be immediate, permanent, and large in scale. Mitigation measures cannot replace or replicate the tribal resources and traditional cultural properties that would be destroyed by project construction. The landscape, which is imbued with specific cultural attributions by each of the consulted tribes, would also be permanently affected.

3.17.1.16 Environmental Justice

Environmental justice impacts are expected only for the town of Superior and tribes with cultural, social, or religious ties to the project area. These populations would be affected permanently from direct, permanent impacts on these sites and values. The loss of these values would be long term.

3.17.1.17 Livestock and Grazing

Livestock grazing and long-term productivity would be permanently impacted within the tailings storage facility and subsidence area.

Although reclamation would eventually return some level of vegetation to the tailings storage facility, productivity would be unlikely to recover to current conditions. Existing grazing around the MARRCO corridor and other linear corridors would be short-term uses, ending with reclamation at the end of mine life, with no impact on long-term productivity.

3.17.2 Unavoidable Adverse Effects

As required by CEQ regulations implementing NEPA (40 CFR 1502.16), this EIS describes the adverse or significant environmental effects that cannot be avoided from implementation of the proposed project or alternatives. In the resource sections of this chapter, the direct, indirect, and cumulative environmental effects of the project are discussed in detail. Impacts that are significant and cannot be avoided are summarized in the following text. Refer to the referenced resource section in this chapter for a complete description of these impacts. Resource areas that are not listed are not expected to experience unavoidable adverse effects.

3.17.2.1 Geology, Minerals, and Subsidence

Unavoidable adverse impacts would occur through disturbance caused by the subsidence, to a small area of Martin limestone with potential paleontological resources (Alternatives 2 and 3), and to unpatented mining claims not associated with the Resolution Copper Project (all tailings facilities and/or pipeline corridors). Impacts on cave/karst resources and to the public from geological hazards from access to the subsidence area, induced seismicity, or damage to Apache Leap are not considered likely to occur.

3.17.2.2 Soils and Vegetation

The mitigation described would only minimally offset project impacts. The unavoidable adverse effects remain as described, including the complete loss during operations of soil productivity, vegetation, and functioning ecosystems within the area of disturbance, and eventual recovery after reclamation (though not likely to the level of desired conditions, and potentially over extremely long time frames). Impacts on special status plant species, where they occur, and the spread of noxious and invasive weeds (though reduced by applicant-committed environmental protection measures) would also be unavoidable adverse effects.

3.17.2.3 Noise and Vibration

No impacts above selected thresholds were identified from construction blasting noise and vibration (provided explosive loading is appropriately limited), from construction non-blasting noise (beyond 1,000 feet from active equipment), or from operational vibrations (beyond 50 feet from active equipment).

For operational noise, with the exception of Dripping Springs Road, the only impacts identified above selected thresholds were associated with the maximum range of impacts, which is an infrequent and unlikely scenario that suggests that all equipment is running simultaneously and during the quietest period (i.e., lowest background levels observed). Under most conditions, the analysis indicates that no impacts would be expected from project noise.

Application of the mitigation of rerouting traffic from Dripping Springs Road would eliminate those operational noise impacts as well.

After mitigation, no unavoidable adverse impacts are anticipated from noise or vibration.

3.17.2.4 Transportation and Access

Increased traffic associated with mine worker commuting and truck traffic to and from the mine are expected to result in impacts that cannot be avoided or fully mitigated, including increased traffic congestion and increased risk of traffic accidents. Decreases in LOS to subpar levels (LOS E or F) would occur at several intersections due to mine traffic, unless traffic changes were made to accommodate the increased traffic. The only applicant-committed environmental protection measure that would alleviate impacts on level of service would be the addition of turn lanes at the SR 177/U.S. 60 intersection.

Access to the Oak Flat area, including Devil's Canyon and Apache Leap, would be maintained to an extent, but using less-direct routes than NFS Road 315 that currently provides the primary access. Loss of access to these areas would be mitigated, but not fully.

Loss of access to the highlands north of the West Plant Site would be fully offset for Alternatives 2, 3, 5, and 6 by rerouting the road. Loss of access to the general public under Alternative 4 would not be mitigated by this measure, as only administrative access would be maintained.

All alternatives, including Alternative 6, could result in some loss of access to mining activities and grazing facilities in the area around the tailings storage facilities.

3.17.2.5 Air Quality

For the proposed action and all alternatives, emissions from mine-related activities would meet applicable Federal and State standards for air quality but the increase in air pollutant concentrations would constitute impacts that cannot be avoided.

3.17.2.6 Groundwater Quantity and Groundwater-Dependent Ecosystems

Given the effectiveness of mitigation, there would be no residual impacts on public water supplies near the mine site. All lost water supplies would be replaced.

For GDEs expected to be impacted by groundwater drawdown, the mitigation measures described would be effective enough that there would be no net loss of riparian ecosystems or aquatic habitat on the landscape, although the exact nature and type of ecosystems would change to adapt to new water sources. However, impacts on the sense of place and nature experienced at these perennial streams and springs, rare in a desert environment, would not be mitigated by these actions.

The mitigation plan would not mitigate any GDEs lost directly to surface disturbance, ranging from two to five, depending on tailings alternative.

Impacts on water supplies in the East Salt River valley in the form of groundwater drawdown and reduction of regional groundwater supply would not be fully mitigated.

3.17.2.7 Groundwater and Surface Water Quality

The applicant-committed environmental protection measures for stormwater control would effectively eliminate any runoff in contact with ore or tailings. There are no anticipated unavoidable adverse effects associated with the quality of stormwater runoff.

Seepage from the tailings storage facilities has a number of unavoidable adverse effects. In all cases, the tailings seepage adds a pollutant load to the downstream environment, including downstream aquifers and downstream surface waters where groundwater eventually daylights. The overall impact of this seepage varies by alternative. Alternatives 2, 3, and 4 all either have anticipated impacts on water quality or have a high risk to water quality because of the extreme seepage control measures that must be implemented, and the relative inflexibility of adding more measures as needed, given the proximity to Queen Creek.

Alternatives 5 and 6 are located at the head of larger alluvial aquifers with some distance downstream before the first perennial water (the Gila River). Adverse effects are not anticipated from these alternatives, and in addition these locations offer more flexibility in responding to potential problems with additional seepage controls.

3.17.2.8 Surface Water Quantity

The primary impact described in the analysis (in this section, as well as section 3.7.1) is the loss of surface water flow to riparian areas (including xeroriparian vegetation along ephemeral washes) and loss of surface flow to any GDEs that are associated with these drainages. With the possible exception of the Queen Creek project, the conceptual mitigation proposed under the Clean Water Act would not be effective at avoiding, minimizing, rectifying, or reducing these impacts. Rather, the proposed conceptual mitigation would be mostly effective at offsetting impacts caused by reduced surface water flows by replacing riparian function far upstream or downstream of project impacts.

As the subsidence area is unavoidable, the loss of runoff to the watershed due to the subsidence area is also unavoidable, as are any effects on GDEs from reduced annual flows. The loss of water to the watershed due to the tailings facility (during operations, prior to successful reclamation) is unavoidable as well, due to water management and water quality requirements. Direct impacts on wetlands, stock tanks, and ephemeral drainages from surface disturbance are also unavoidable.

3.17.2.9 Wildlife and Special Status Wildlife Species

Biological resources would be impacted by direct surface disturbance, noise, vibration, light, dust, air pollutants, and traffic. Adverse impacts that cannot be avoided or completely mitigated include changes in cover, changes in foraging efficiency and success, changes in reproductive success, changes in growth rates of young, changes in predator–prey relationships, increased movement, habitat fragmentation and disruption of dispersal and migration patterns through animal movement corridors, and increased roadkill.

3.17.2.10 Recreation

Recreational use of the area would be permanently adversely impacted. Unavoidable adverse impacts on recreation include long-term displacement from the project area, and the loss of public access roads throughout the project area. These impacts cannot be avoided or fully mitigated.

3.17.2.11 Public Health and Safety

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 Aquifer Protection Permit program standards and by applicant-committed environmental protection measures.

While increased risk 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.

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.

3.17.2.12 Scenic Resources

The subsidence area and residual tailings storage facility would constitute a permanent adverse impact that cannot be avoided or completely mitigated. While night brightness from mine facility lighting would be mitigated to a large degree, residual impacts would remain that are not avoidable and cannot be completely mitigated.

3.17.2.13 Cultural Resources

Cultural resources and historic properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of surface disturbance, nor can they be fully mitigated. The land exchange is also considered an unavoidable adverse effect on cultural resources.

3.17.2.14 Socioeconomics

Loss of jobs in the local tourism and outdoor recreation industries cannot be avoided or fully mitigated. Likewise, loss in property values for property close to the mine would constitute an impact that cannot be avoided or fully mitigated. The applicant-committed environmental protection measures would be effective at expanding the economic base of the community and improving resident quality of life, and could partially offset the expected impacts, although many of the current agreements would expire prior to full construction of the mine.

3.17.2.15 Tribal Values and Concerns

Significant tribal properties and uses would be directly and permanently impacted. These impacts cannot be avoided within the areas of direct impact, nor can they be fully mitigated.

3.17.2.16 Environmental Justice

The change in scenery and dark skies for the town of Superior cannot be avoided or fully mitigated. Similarly, the disproportionately high and adverse impacts on cultural resources and tribal values and concerns cannot be avoided or fully mitigated.

3.17.2.17 Livestock and Grazing

Grazing would be impacted by a reduction in the area available for grazing (a permanent reduction for the area of the subsidence crater and tailings storage facility; a temporary reduction for the area within the perimeter fence until reclamation returns the area to a condition that is compatible with livestock grazing), and by impacts on seeps, springs, and stock tanks that are used by livestock. Water source enhancement conservation measures may offset some of the impacts on seeps, springs, and stock tanks used by livestock on current grazing allotments. These impacts cannot be avoided or fully mitigated.

3.17.2.18 Irreversible and Irretrievable Commitments of Resources

As required by NEPA, this section also includes a discussion by resource of any irreversible or irretrievable commitment of resources that would result from implementing any of the action alternatives. Irreversible and irretrievable commitment of resources is defined as follows in FSH 1909.15 (U.S. Forest Service 2012a):

> Irretrievable. A term that applies to the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a winter sports site. The production lost is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume timber production.
>
> Irreversible. A term that describes the loss of future options. Applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

3.17.2.19 Geology, Minerals, and Subsidence

Irreversible commitment of geological and mineral resources would occur with the excavation and relocation of approximately 1.4 billion tons of rock and with the recovery of approximately 40 billion pounds of copper, as well as the burying of any mineral resources below the alternative tailings facilities.

With respect to paleontological and cave/karst resources, a commitment of resources is considered to be irretrievable when project impacts limit the future use or productivity of a nonrenewable resource over a limited amount of time—for example, structures built on top of paleontologically sensitive geological units that might later be removed. A commitment of resources is considered to be irreversible when project impacts cause a nonrenewable resource to be permanently lost—for example, destruction of significant fossils and loss of associated scientific data.

An irreversible commitment of paleontological resources could occur at the Alternative 2 and 3 tailings storage facility location, where potentially fossil-bearing rocks associated with the Martin limestone could be destroyed in site preparation or buried permanently.

3.17.2.20 Soils and Vegetation

Soils are a finite resource, and any loss of soils resulting from their removal for tailings storage and from erosion and delivery to downstream channels is irreversible. The loss of soil productivity is effectively irreversible because a stable new plant community would take an extremely long time to redevelop on the surface of the tailings and waste-rock facilities (decades or centuries). The area of the subsidence crater and tailings storage facility would constitute an irreversible loss of soil that would be lost in perpetuity.

Irretrievable effects on soils and vegetation would take place at disturbed areas where reclamation is successfully accomplished or only temporary in nature, particularly along rights-of-way. Soils and vegetation in these areas would eventually return to full functionality, possibly within years or decades.

3.17.2.21 Noise and Vibration

Irretrievable commitment of resources would consist of mine-related noise during the construction, mining, closure, and reclamation phases of the mine. Because the mine-related noise would cease after closure of the mine, noise impacts would not be considered an irreversible commitment of resources.

3.17.2.22 Transportation and Access

Irretrievable impacts on transportation and access would occur as a result of an increase of traffic on State, County, and public NFS roads from mining and related activities within the analysis area and from the reduction of public access to roads within the perimeter fence. Because mine-related traffic would cease after mine closure, traffic impacts would not be considered an irreversible commitment of resources. Existing roads that would be decommissioned within the perimeter fence of the mine would constitute both an irreversible and irretrievable commitment of resources. Roads that are permanently covered with tailings or within the subsidence crater would be an irreversible commitment, while those that are cut off to public access by the perimeter fence could potentially be restored or rerouted following mine closure, and therefore are considered to be an irretrievable commitment of resources.

3.17.2.23 Air Quality

During the construction and mining phases of the project, air pollutant concentrations would be higher throughout the analysis area than current levels but within applicable air quality standards; thus, air quality is not impacted for other uses in the airshed and these effects would not be considered irretrievable. Following mine closure and successful reclamation, pollutant concentrations would return to pre-mining levels, and there would be no long-term irreversible commitment of resources.

3.17.2.24 Groundwater Quantity and Groundwater-Dependent Ecosystems

Mine dewatering at the East Plant Site under all action alternatives would result in the same irretrievable commitment of 160,000 acre-feet of water from the combined deep groundwater system and Apache Leap Tuff aquifer over the life of the mine.

Changes in total groundwater commitments at the Desert Wellfield vary by alternative for tailings locations and tailings type. Alternative 4 would require substantially less water overall than the other alternatives (176,000 acre-feet, vs. 586,000 acre-feet for Alternative 2). Loss of this water from the East Salt River valley aquifer is an irretrievable impact; the use of this water would be lost during the life of the mine.

While a number of GDEs and riparian areas could be impacted by groundwater drawdown, these changes are neither irreversible nor irretrievable, as mitigation would replace water sources as monitoring identifies problems. However, even if the water sources are replaced, the impact on the sense of nature and place for these natural riparian systems would be irreversible. In addition, the GDEs directly disturbed by the subsidence area or tailings alternatives represent irreversible impacts.

3.17.2.25 Groundwater and Surface Water Quality

The potential impacts on water quality from tailings seepage would cause an irretrievable commitment of water resources downstream of the tailings storage facility, lasting as long as seepage continued. Eventually, the seepage amount and pollutant load would decline, and water quality conditions would return to a natural state. This may take over 100 years to achieve in some instances.

While long lived, the impacts on water quality would not be irreversible, and would eventually end as the seepage and pollutant load declined.

3.17.2.26 Surface Water Quantity

With respect to surface water flows from the project area, all action alternatives would result in both irreversible and irretrievable commitment of surface water resources. Irreversible commitment of surface water flows would result from the permanent reduction in stormwater flows into downstream drainages from the subsidence area. Changes to wetlands, stock tanks, and ephemeral drainages caused by surface disturbance would also be irreversible. Irretrievable commitment of surface water resources would be associated with additional temporary diversion, storage, and use of stormwater during active mining, but that would be restored to the watershed after closure and reclamation.

3.17.2.27 Wildlife and Special Status Wildlife Species

The direct loss of productivity of thousands of acres of various habitat from the project components would result in both irreversible and irretrievable commitment of the resources that these areas provide for wildlife (i.e., wildlife breeding, foraging, wintering, and roosting habitat; animal movement corridors, etc.). Some habitat could reestablish after closure, which would represent an irretrievable commitment of resources. However, portions of the tailings storage facility landform may never return to pre-mining conditions, and the effects of reduced quality of habitat would likely be irreversible.

3.17.2.28 Recreation

In general, there would be irretrievable and irreversible impacts as a result of displaced recreation users and adverse effects on recreation experiences and activities. There would be irretrievable impacts on recreation with all action alternatives. Alternatives 2, 3, and 5 with the west corridor would cross the Arizona National Scenic Trail. Alternative 4 would require rerouting of the trail.

Each action alternative would result in the permanent removal of off-highway routes, resulting in a permanent loss of recreation opportunities and activities. Public access would only be permitted outside the mine perimeter fence. Although routes through the project area might be reestablished after closure of the East Plant Site, West Plant Site, filter plant and loadout facility, and the MARRCO corridor, routes through the subsidence crater and tailings storage facility likely would not be reestablished. Therefore, impacts on OHV routes are considered irretrievable for those that would be reestablished following mine closure, and irreversible for those that would be permanently affected.

Even after full reclamation is complete, the post-mine topography of the project area may limit the recreation value and potential for future recreation opportunities.

3.17.2.29 Public Health and Safety

Irreversible changes with respect to tailings safety are not expected. The risk from pipeline failures ends upon closure of the mine. The risk from a tailings storage 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.

With respect to fuels and fire management, there are not expected to be any irretrievable or irreversible changes to 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.

Irreversible changes with respect to public health and safety are not expected. All potential hazards discussed are limited solely to the construction and operation 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 changes to resources. Although there is the potential for contamination of surface water, groundwater, or soils in the event of a spill or accidental release, such an occurrence is not expected to occur, and environmental remediation is possible (and required by law) if it does occur.

3.17.2.30 Scenic Resources

For all action alternatives, there would be an irretrievable loss of scenic quality from increased activity and traffic during the construction and operation phases of the mine. The size and extent of the tailings facilities would create losses of scenic quality until rock weathering and slope revegetation have reduced color, form, line, and texture contrasts to a degree that they blend in with the surrounding landscape; revegetation would occur relatively soon after closure, but weathering would take such a long time scale as to be considered permanent. Due to the geological time frame necessary for these processes to occur, the loss of scenic quality associated with the tailings facilities would effectively be irreversible.

For each action alternative, the visual contrasts that would result from the introduction of facilities associated with the project would be an irretrievable loss of the undeveloped, semiprimitive setting until the project is closed and full reclamation is complete. Under all of the action alternatives, existing views would be irreversibly lost behind the tailings storage facility because of the height and extent of the piles.

There would be an irretrievable, regional, long-term loss of night-sky viewing during project construction and operations because night-sky brightening, light pollution, and sky glow caused by mine lighting would diminish nighttime viewing conditions in the direction of the mine. Impacts on dark skies due to night lighting would cease after mine closure and reclamation. Regional dark skies would continue to brighten due to other development factors in the region throughout the mine life. Therefore, it is unlikely that a return to current dark sky conditions would occur after mine closure.

3.17.2.31 Cultural Resources

The direct impacts on cultural resources and historic properties from construction of the mine and associated facilities constitute an irreversible commitment of resources. Archaeological sites cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs for cultural and religious purposes are also an irreversible commitment of resources.

3.17.2.32 Socioeconomics

Some changes in the nature of the surrounding natural setting and landscape would be permanent, including the tailings storage facility and the subsidence area. The action alternatives would therefore potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, community values, and quality of life.

3.17.2.33 Tribal Values and Concerns

The direct impacts on TCPs and TEKPs from construction of the mine and associated facilities constitute an irreversible commitment of resources. Traditional cultural properties cannot be reconstructed once disturbed, nor can they be fully mitigated. Sacred springs would be eradicated by subsidence or tailings storage construction and affected by groundwater water drawdown. Changes that permanently affect the ability of tribal members to use known TCPs and TEKPs for cultural and religious purposes are also an irreversible commitment of resources. For uses such as gathering of traditional materials from areas that would be within the subsidence area or the tailings storage facility, the project would constitute an irreversible commitment of resources.

3.17.2.34 Environmental Justice

There would be irretrievable socioeconomic impacts under all action alternatives because existing land uses, including recreation opportunities, would be precluded within the project area during the life of the project. All action alternatives would potentially cause irreversible impacts on the affected area with regard to changes in the local landscape, infrastructure and tax base funding, community values, and quality of life for residents of the town of Superior.

3.17.2.35 Livestock and Grazing

Vegetation on the site would be continually changing as reclamation procedures are implemented. Eventually, reclamation is expected to return the site to conditions potentially suitable for post-closure land uses such as grazing. Irretrievable commitment of grazing resources would occur until reclamation has returned the site to conditions suitable for grazing. However, the subsidence area and tailings storage facility likely represent an irreversible loss of grazing land.

3.17.2.36 Cumulative Effects

Cumulative effects analysis has been conducted, and the results are addressed by each individual resource in chapter 3.

3.17.2.37 Other Required Disclosures

The Tonto National Forest will consult with the following agencies, as required by pertinent law and regulation.

3.17.2.38 Consultation under the Endangered Species Act

The Tonto National Forest will begin consultation with the FWS regarding species protected under Section 7 of the ESA once a preferred alternative is identified. All reasonable and prudent measures and terms and conditions specified in the biological opinion are nondiscretionary and would be included as components of the decision in the ROD and final mining plan of operations.

3.17.2.39 Consultation under the National Historic Preservation Act

The Tonto National Forest continues to consult with the Advisory Council on Historic Preservation, BLM, Arizona SHPO, ASLD, and 15 Indian Tribes regarding cultural resources protected under Section 106 of the National Historic Preservation Act. A Programmatic Agreement is being drafted at this time with all parties involved (see appendix O of this EIS). All agreements and mitigation measures specified in the PA and the historic properties treatment plan are nondiscretionary and would be included as components of the decision in the ROD.

3.17.2.40 Conflicts with Regional, State, and Local Plans, Policies, and Controls

NEPA at 40 CFR 1502.16 directs, "Statements shall discuss (c) Possible conflicts between the proposed action and the objectives of Federal, regional, State, and local (and in the case of a reservation, Indian Tribe) land use plans, policies and controls for the area concerned. (See 1506.2(d).)."

Title 40 CFR 1506.2(d) states, "To better integrate environmental impact statements into State or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law."

Plans that are reviewed for compliance include the following.

Federal Agencies

- Tonto National Forest Land and Resource Management Plan (1985, amended through 2017)
- Tonto National Forest Travel Management Plan
- BLM Safford District Resource Management Plan (1992, 1994)
- BLM Lower Sonoran and Sonoran Desert National Monument Resource Management Plan (2012)
- BLM Middle Gila Canyons Travel Management Plan (2010)

State Government

- ADOT Long Range Transportation Plan (2018)
- Arizona State Workforce Development Plan (2016)
- Statewide Comprehensive Outdoor Recreation Plan (2018–2022)
- Arizona State Parks and Trails 5-Year Strategic Plan (2018–2022)
- State Wildlife Action Plan (SWAP) (2012–2022)
- AGFD long-term wildlife and game management plans

Pinal County

- Pinal County Comprehensive Plan 2009 (updated 2015)
- Pinal County Strategic Plan (2017–2020)
- Pinal County Open Space and Trails Master Plan (2007)
- Pinal County State Implementation Plans (SIPs) and applicable Maricopa Association of Governments Regional Air Quality Plans
- Pinal Regional Transportation Plan (2017)
- Pinal County Area Drainage Master Plans
- Central Arizona Council of Governments Regional Transportation Plan (2015)

Gila County

- Gila County Comprehensive Plan (2003, Amended 2018)
- Gila County Land Use and Resource Policy Plan (2010)
- Gila County Small Area Transportation Study (2006)
- Gila County Transportation Study (2014)
- Gila County State Implementation Plan (SIP)

Indian Tribes

- Unknown

Consulted Parties

4.1 Introduction

This chapter provides an overview of the consultation and coordination conducted to date between the Forest Service and Federal, State, and local agencies, tribes, and the public. The FEIS will expand this section to update consultation, agency permitting activities, and additional comments and outreach activities conducted after publication of the DEIS, including cooperating agency review, the EIS public review, and comment analysis and agency response processes.

4.2 Notice of Intent and Scoping

An NOI announcing the intent of the Tonto National Forest to prepare this EIS was published in the Federal Register on March 18, 2016. The notice announced the preparation of this EIS and announced opportunities for public involvement, including scoping meetings. Five public scoping meetings were subsequently held at the locations and on the dates shown in table 1.6.1-1 in chapter 1. The official scoping and public commenting period lasted 120 days, from March 18 to July 18, 2016.

Members of the public were afforded several methods for providing comments during the scoping period. These included multiple comment stations with comment forms or providing oral comments to a court reporter at the scoping meetings, the opportunity to send emails to <comments@resolutionmineeis.us> or to submit letters via U.S. mail to the Tonto National Forest, or to submit written comments in person at the Tonto National Forest Supervisor's Office, 2324 East McDowell Road, Phoenix, AZ 85006, during normal business hours. In total, 133,653 comment submittals were received during the project scoping period.

A comprehensive scoping report summarizing the public meeting and comment process and providing a detailed synopsis of the scoping comments received was released in March 2017. The scoping report (U.S. Forest Service 2017f) is available at the Tonto National Forest Supervisor's Office at the address shown in the previous paragraph.

A website was created to provide access to project schedule, updates, project and alternative information, and baseline data and reports. The website is found at www.ResolutionMineEIS.us and has been active since 2016.

4.3 Project Mailing List

Early in the project NEPA process, an initial mailing list identifying individuals (as points of contact) in organizations, agencies, and interest groups was compiled from Tonto National Forest records of interested parties and from organizations and individuals who submitted comments related to the "Final Environmental Assessment: Resolution Copper Mining Baseline Hydrological and Geotechnical Data Gathering Activities Plan of Operations" (U.S. Forest Service 2016a). Those interested or who had commented on the "Apache Leap Special Management Area Management Plan Environmental Assessment" (U.S. Forest Service 2017a) are also included in this mailing list. After alternatives were developed for detailed analysis, the mailing list was once again updated to include those landowners or stakeholders who would be affected by the alternative tailings locations or associated corridors.

The goal of the mailing list is to enable broad distribution of information to local and regional businesses, organizations, and interested individuals about public meetings, comment period deadlines, and other key project milestones. As of June 2019, the mailing list included approximately 40,000 email and postal service addresses. However, the list has been, and will continue to be, periodically updated and expanded throughout the entire Resolution Copper Project and Land Exchange EIS process.

4.4 Tribal Consultation (Government-to-Government)

Federal agencies are required to consult with American Indian Tribes as part of the Advisory Council on Historic Preservation (ACHP) regulations, Protection of Historic Properties (36 CFR 800), implementing Section 106 of the National Historic Preservation Act (NHPA). Accordingly, the NHPA outlines when Federal agencies must consult with tribes and the issues and other factors this consultation must address. Pursuant to Executive Order 13175, executive departments and agencies are charged with engaging in regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications and are responsible for strengthening the government-to-government relationship between the United States and Indian Tribes. In addition, the NDAA requires consultation with affected Indian Tribes concerning issues of concern related to the land exchange.

The Tonto National Forest has been conducting tribal consultation related to various Resolution Copper projects, the land exchange, and the Apache Leap SMA environmental assessment. This consultation has included formal and informal meetings, correspondence, sharing information, and documentation of tribal comments and concerns by the Forest Service. The consultation is ongoing and will continue through the end of the project. The following tribes are involved in the consultation process:

- Fort McDowell Yavapai Nation
- Gila River Indian Community
- Hopi Tribe
- Mescalero Apache Tribe
- Pueblo of Zuni
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Tribe
- Tonto Apache Tribe
- White Mountain Apache Tribe
- Yavapai-Apache Nation
- Yavapai-Prescott Indian Tribe

Additional tribes were included in consultation with the introduction of the Peg Leg alternative location. These tribes, included at the request of the BLM, are as follows:

- Ak-Chin Indian Community
- Fort Sill Apache Tribe
- Pascua Yaqui Tribe
- Tohono O’odham Nation

4.5 Section 106 Consultation

Section 106 consultation was initiated by the Tonto National Forest and the SHPO on March 31, 2017, and the ACHP on December 7, 2017. A Programmatic Agreement is being drafted with the Tonto National Forest, Arizona SHPO, ACHP, Resolution Copper, ASLD, BLM, USACE, and tribes. The PA will be a signed and legally binding document to ensure cultural and historical resources are protected and managed in a predetermined manner with those involved.

Beginning in 2018, multiple meetings have been held with interested parties and those who would be signatories of the document. The draft PA is provided as appendix O of this EIS. A final PA will be signed and completed prior to publication of the FEIS.

4.6 Other Agency Consultation

Section 7 consultation will occur after a preferred alternative is selected and would involve the Tonto National Forest, the U.S. Fish and Wildlife Service, and other land management agencies (ASLD or BLM) as applicable, depending on the final arrangement of land in the preferred alternative.

4.7 Tonto National Forest Tribal Monitor Cultural Resources Program and Emory Oak Restoration Studies

4.7.1 Tribal Monitor Program

As a result of input received during ongoing consultation between the Tonto National Forest and participating tribes, the Tonto National Forest agreed to initiate, and Resolution Copper agreed to fund, a unique program that would employ tribal members as auxiliary specialists to assist cultural resources staff and proponent-contracted archaeologists in surveying lands proposed for development as part of the project (i.e., lands proposed for development either as component facilities of the Resolution Copper GPO or as EIS alternative facility locations). In particular, the goal of this program is to provide the tribes with greater opportunity to identify traditional ecological knowledge places (TEKPs) and other tribal resources that are likely not to be recognized by non-Native archaeologists.

The Tonto National Forest conducted an initial tribal monitor training session from January 25 through February 2, 2018, and tribal members began accompanying contracted cultural resource survey crews in March 2018. A second training of additional tribal members was held between October 1 and October 10, 2018, to enable representation of additional tribes in survey efforts. Fifty-four tribal members completed the training between the two 2018 sessions. The tribal monitors will survey each project component in addition to Class III survey to ensure not only archaeological information, but tribal perspectives are understood and documented. This work is ongoing and may include additional training for tribal monitors to assist with other resource surveys.

The tribal monitors have already proven highly effective in identifying areas, resources, and sites of importance to the four cultural groups with ties to the area (Apache, O'odham, Puebloan, and Yavapai), including springs and seeps, plant and mineral resource collecting areas, landscapes and landmarks, caches of regalia and human remains, and other sites. The tribal monitors have not only surveyed new alternative tailings locations, but also revisited the Near West tailings location and Oak Flat to evaluate the areas based on their tribal perspectives.

4.7.2 Emory Oak Restoration

As noted in chapter 1, in December 2014, Congress passed the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (NDAA), which included as Section 3003 the "Southeast Arizona Land Exchange and Conservation Act of 2011." Under this legislatively mandated land exchange, Resolution Copper would receive lands containing the Oak Flat Campground east of the town of Superior, which is a known historical and current Emory oak acorn gathering location for the Apache and Yavapai.

As stated in the Southeast Arizona Land Exchange and Conservation Act, the Tonto National Forest and Resolution Copper are to address the concerns of Indian Tribes. Because the tribes have expressed concern about the Emory oak grove at Oak Flat, Resolution Copper has committed to funding Forest Service efforts to restore Emory oak at suitable locations elsewhere in Arizona, particularly within the "Four Forests Restoration Initiative" (4FRI) project areas, consisting of the Kaibab, Coconino, Apache-Sitgreaves, and Tonto National Forests.

The initial 5-year phase of the Emory oak restoration program, which began in fall 2018, lays out a series of goals for each year of the program. The following is a highly summarized listing of the detailed program goals that have been set forth and agreed upon by both the Forest Service and the participating tribes.

- The first year will consist of initial meetings and field visits between the Forest Service and tribal representatives to identify existing areas that have been used to collect acorn; groves that could potentially be treated and developed for acorn harvesting; and selection of up to six existing or potential oak grove sites for further study of their feasibility for restoration as future tribal acorn-gathering locations.
- The second year (beginning in fall 2019) will develop and implement treatment plans to improve the selected oak groves, based on the ongoing research. Treatments designed by the project team may include erecting fences, removing brush, burning understory, transplanting oak seedlings, landscaping to ensure groves receive adequate water, and other measures.
- The third and fourth years (fall 2020, fall 2021) will consist of monitoring treated groves and developing recommendations on the efficacy and any modifications of the treatments. Field visits will be arranged for elders and youth to participate in traditional activities, including acorn harvesting.
- The fifth year will consist of continued monitoring and harvesting, and developing a report to document the procedures used, the results of the treatments, and recommendations for management protocols that may preserve Emory oaks on forests where this resource is critical to culturally affiliated tribes.

4.8 Cooperating Agencies

CEQ regulations (40 CFR 1508.5) define a cooperating agency as any Federal agency (other than the lead agency) and any State or local agency or Indian Tribe with jurisdictional authority or special expertise with respect to any environmental impact involved in a proposal. The cooperating agencies that assisted in preparation of this EIS are listed and their respective jurisdictional authorities or areas of special expertise are described in chapter 1, section 1.6.3; for convenience, the nine participating agencies are also identified in the accompanying text box. These agencies assisted with EIS preparation in a number of ways, including conducting or providing studies and inventories, reviewing baseline condition reports, identifying issues, assisting with the formulation of alternatives, and reviewing preliminary DEIS text and other EIS materials.

Not all of the cooperating agencies have participated in all aspects of the EIS preparation. Early in the cooperating agency process, each agency conferred with the Tonto National Forest and agreed to a carefully defined role and set of responsibilities in relation to the Resolution Copper Project and Land Exchange that aligned with that agency’s unique jurisdictional authority or area(s) of special expertise. Individualized Memoranda of Understanding defining these roles and

Cooperating Agencies for the Resolution Copper Project and Land Exchange EIS

- Arizona Department of Environmental Quality
- Arizona Department of Water Resources
- Arizona Game and Fish Department
- Arizona State Land Department
- Arizona State Mine Inspector
- Bureau of Land Management
- Pinal County Air Quality Control District
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency

responsibilities were thereafter signed by representatives of both the Forest Service and of each of the agencies listed in the text box.

The Tonto National Forest also engaged several other agencies, though those agencies ultimately did not become cooperating agencies or participate in the preparation of the DEIS. The NEPA team had sited early versions of the Peg Leg alternative on lands along the Gila River that previously had been withdrawn on behalf of the U.S. Bureau of Reclamation for potential future water projects. Ultimately, the Peg Leg alternative was resituated off of any parcels associated with the U.S. Bureau of Reclamation, but interim discussions were held with the U.S. Bureau of Reclamation to discuss the regulatory process and decision framework. The U.S. Bureau of Reclamation also was consulted regarding a separate NEPA process being undertaken for the reallocation of CAP non-Indian agriculture water contracts, including a possible allocation to Resolution Copper. The Tonto National Forest and U.S. Bureau of Reclamation determined that the non-Indian agriculture reallocation was already undergoing a separate NEPA analysis and did not need to be included in the proposed action for this EIS, although it is considered a reasonably foreseeable future action and considered for cumulative effects.

The Tonto National Forest engaged the USGS early in the groundwater modeling process, and discussed the potential for the USGS to be involved in various technical aspects of the project involving geological, geotechnical, or hydrologic analyses. Ultimately, the USGS declined involvement, though specialists attended early meetings of the Groundwater Modeling Workgroup. The San Carlos Apache Tribe also indicated interest in participating in the Groundwater Modeling Workgroup, and a representative attended a number of Groundwater Modeling Workgroup meetings.

4.9 Project Notifications to Other Federal, State, and County Agencies and Municipal Governments

In addition to project-related information provided to the nine cooperating agencies identified in section 4.8, each of the following Federal, State, County, and local governments and agencies has been and will continue to be provided with regular updates and other notifications regarding the project NEPA process.

4.9.1 Federal

- Advisory Council on Historic Preservation
- U.S. Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. House of Representatives
- U.S. Senate

4.9.2 State

- Arizona Department of Transportation
- Arizona Geological Survey
- Arizona Governor
- Arizona State Board of Regents
- Arizona State Parks (Arizona State Historic Preservation Office)

4.9.3 County

- Coconino County
- Gila County Board of Supervisors
- Gila County Planning and Zoning
- Graham County Board of Supervisors
- Maricopa County
- Pima County
- Pima County Board of Supervisors
- Pinal County Board of Supervisors
- Pinal County Public Works
- Santa Cruz County
- Yavapai County

4.9.4 Local

- Cave Creek Council
- City of Chandler
- City of Globe
- City of Mesa
- City of Phoenix
- Superior Police
- Superior Schools
- Town of Benson
- Town of Carefree
- Town of Hayden
- Town of Kearny
- Town of Mammoth
- Town of Miami
- Town of Paradise Valley
- Town of Patagonia
- Town of Payson
- Town of Queen Creek
- Town of Sierra Vista
- Town of Superior
- Town of Winkelman

4.9.5 Tribal

- Ak-Chin Indian Community
- Fort McDowell Yavapai Nation
- Fort Sill Apache Tribe
- Gila River Indian Community
- Hopi Tribe
- Mescalero Apache Tribe
- Pascua Yaqui Tribe
- Pueblo of Zuni
- Salt River Pima-Maricopa Indian Community
- San Carlos Apache Tribe
- Tohono O’odham Nation
- Tonto Apache Tribe
- White Mountain Apache Tribe
- Yavapai-Apache Nation
- Yavapai-Prescott Indian Tribe

List of Preparers

5.1 List of Preparers

The Resolution Copper Project and Land Exchange EIS was prepared under the supervision of the Forest Service. The individuals who contributed to the preparation of this document are listed here by organization, along with their education, years of experience, and project role (tables 5.1.1-1 and 5.1.2-1).

5.1.1 Forest Service

Table 5.1.1-1. Forest Service personnel participating in the EIS

Name	Degree	Years of Experience	Project Role
Lee Ann Atkinson	M.S., Geology-Geophysics	15	NEPA Coordinator - Minerals
Allison Borchers	Ph.D., Economics	8	Socioeconomics/ Environmental Justice
Paul “Pablo” Burghard - retired		6	Recreation/Trails
Clarence Coffey	Occupational Safety and Health Professional; EPA Certified Lead Renovator	32	Public Health and Safety
Chris Crawford	B.S., Civil Engineering	26	Transportation/Noise
Edward Gazzetti	M.S., Geological Sciences	5	Hydrogeology
Joe Gurrieri	M.S., Geology	33	Hydrogeology
Benjamin “Chad” Harrold	M.S., Geology	8	Geology
Kristina Hill	M.A., Anthropology	18	Cultural Resources
Ana Ingstrom	M.S., Mining Engineering	7	Mining Engineering
Brad Johnson	Over 50 U.S. Forest Service training courses in Fuels and Fire Management	18	Fuels/Fire Management
Alex Mankin	M.S., Geology	6	Geology
Mark McEntarffer	B.S., Public Planning	19	Lands

continued

Table 5.1.1-1. Forest Service personnel participating in the EIS *(cont'd)*

Name	Degree	Years of Experience	Project Role
Maria McGaha	M.S., Hazardous Waste Management, M.B.A., Business Administration	19	Lands
Christina Milos	Ph.D., Landscape Architecture	5	ID Team Lead/Env. Planning
Chandler Mundy	B.S., Rangeland Resources	13	Rangeland Management
Mark Nelson	Ph.D., Natural Resources andScience Management		Project Manager (2014-2016)
Nanebah Nez-Lyndon	M.A., Anthropology	10	Tribal Liaison
Greg Olsen	B.S., Environmental Earth Science	29	Hydrology
Devin Quintana	B.S., Regional Development	15	Public Services Program Manager
Mary Rasmussen	M.S., Forest Ecology	32	Project Manager (2017 – Present)
Judd Sampson	B.S., Geological Science	7	Geology/Minerals Administration
John Scaggs	B.A., Mass Communications	35	Public Affairs Specialist
Greg Schuster	M.S., Natural Resource Management	23	Recreation
David Sheehan	M.A., Landscape Architecture	4	Scenery/Recreation
Timothy Stroope	Ph.D., Geoscience	11	Hydrogeology
Mark Taylor	B.S., Wildlife Management	22	Botany/Wildlife Biology
Carrie Templin	B.S., Natural Resource Recreation	27	Public Affairs Officer
Marianne Thomas	M.S., Human Dimensionsof Ecosystem Science and Management	11	NEPA Review Coordinator
Andrea "Jamie" Wages	B.S., Rangeland Resources	11	Rangeland Management
Peter Werner	M.S., Mining Engineering	33	Mine Engineering/Reclamation
Scott Williams	B.S., Environmental Studies and Fire Management	29	Air Quality

Source: Morey and Ritter (2016)

5.1.2 Third-Party NEPA Contractors

Table 5.1.2-1. Third-party NEPA contractor personnel participating in the EIS

Name	Degree	Years of Experience	Project Role
Jenny Addy (SWCA)	B.S., Conservation and Restoration Ecology	6	Range
Victoria Amato (SWCA)	M.S., Forestry, emphasis Fire Ecology/Habitat Management; M.S., Resource Management	12	Fire Management
Mandy Bengtson Williams (SWCA)	Ph.D., Geoscience	14	Reclamation/ Revegetation
Victoria Boyne (SWCA)	B.A., Sociology	11	Literature Cited/Project Record
Terry Chute (SWCA)	A.S., Forest Technology	36	Senior Forest Service NEPA Advisor
Charles Coyle (SWCA)	M.A., English	25	Deputy Project Manager
Danielle Desruisseaux (SWCA)	B.A., Anthropology	32	Technical Editing
Meggan Dugan (SWCA)	M.A.S., Geographic Information Systems	5	GIS, Hazardous Materials, Socioeco-nomics
Chris Garrett (SWCA)	B.S., Hydrology	23	Project Manager
Eleanor Gladding (SWCA)	M.S., Biology e. Herpetology	27	Wildlife/Botany
Jill Grams (SWCA)	M.L.A., Landscape Architecture e. Environmental Planning	19	Scenery/Recreation
Suzanne Griset (SWCA)	Ph.D., Anthropology e. North American Archaeology	38	Cultural Resources
Chris Horyza (SWCA)	B.S., Forestry and Range Management e. Agriculture	37	Senior BLM NEPA Advisor
Ken Houser (SWCA)	M.A., Geology	33	Principal in Charge
Jeff Johnson (SWCA)	M.S., Plant Biology	12	Wildlife/Botany
Charles Kliche (SWCA)	Ph.D., Mining Engineering	44	Mine Engineering
Jerryll Moreno (SWCA)	M.A., Anthropology; Scholarly Publishing Certification	26	Publication Layout and Design; Graphics; Technical Editing
Donna Morey (SWCA)	B.A., Urban Planning	10	Assistant Project Manager; Project Controller
Emily Newell (SWCA)	B.S., Environmental Science and Natural Restoration	2	Project Logistics
Heidi Orcutt-Gachiri (SWCA)	Ph.D., Linguistics and Anthropology	20	Managing Editor
Kimberly Proa (SWCA)	A.A., Anthropology	12	Publication Formatter
Ryan Rausch (SWCA)	M.E.L.P., Environmental Law Policy and Conserva-tion	13	Scenery/Recreation

continued

Table 5.1.2-1. Third-party NEPA contractor personnel participating in the EIS *(cont'd)*

Name	Degree	Years of Experience	Project Role
DeAnne Rietz (SWCA)	M.S., Watershed Management	17	Hydrology/Soils
Jonathan Rigg (SWCA)	M.A., Russian and Slavic Studies	9	Environmental Justice; Public Health and Safety; Socioeconomics
Steve Rinella (SWCA)	B.S., Forestry	35	Lands
Brad Sohm (SWCA)	B.S., Chemical Engineering e. Environmental Engineering	14	Ecology/Climate Change
Adrienne Tremblay (SWCA)	Ph.D., Anthropology	12	Cultural Resources
Scott Woods (SWCA)	B.S., Geography: Environmental Planning and GIS e. Landscape Arch/Urban Planning	25	GIS
Jennifer Wynn (SWCA)	M.P.P., Environmental Policy	8	Revegetation
Jamie Young (SWCA)	B.S., Biology	17	Wildlife/Botany
Doug Jeavons (BBC Research & Consulting)	M.A., Economics	28	Socioeconomics
Mike Verdone (BBC Research & Consulting)	Ph.D., Natural Resource and Environmental Economics	13	Socioeconomics
Diana Cook (BGC Engineering)	Ph.D., Geological Engineering	12	Mine Engineering
Robert "Nick" Enos (BGC Engineering)	M.Sc., Geosciences	27	Geology/Environmental Science
Gaston Gonzales (BGC Engineering)	M.S., Geomechanics	19	Geology/Geotechnical
Mike Henderson (BGC Engineering)	M.S., Civil Engineering	33	Mine Engineering
Derek Hrubes (BGC Engineering)	B.Sc., Civil Engineering	13	Alternatives Engineering Support
Amir Karami (BGC Engineering)	Ph.D., Rock Mechanics	20	Rock Mechanics
Elliott Matthews (BGC Engineering)	B.Sc., Geological Engineering	8	Alternatives Engineering Support
Troy Meyer (BGC Engineering)	B.S., Civil Engineering	23	Mine Engineering
Tony Monasterio (BGC Engineering)	B.S., Geological Engineering	9	Alternatives Engineering Support
Gabriele Walser (BGC Engineering)	Ph.D., Civil Engineering	30	Hydrology and Surface Water
Hamish Weatherly (BGC Engineering)	M.Sc., Geological Sciences	22	Hydrology/Soils
Nancy Ashton (DOWL)	Professional Development Classes	20	Engineering/Noise
Laurie Brandt (DOWL)	M.S., Remote Sensing	21	Minerals
Todd Cormier (DOWL)	B.S., Civil Engineering	26	Mine Engineering/ Transportation

continued

Table 5.1.2-1. Third-party NEPA contractor personnel participating in the EIS *(cont'd)*

Name	Degree	Years of Experience	Project Role
Zaid Hussein (BGC Engineering)	M.S., Civil Engineering	11	Noise/Transportation Engineer
Rudy Ing (DOWL)	M.B.A., Business Administration	31	Sr. Civil Engineer
Sara Nicolai (DOWL)	B.A., Civil Engineering	11	Mine Engineering/ Transportation
Sarah Patterson (DOWL)	M.S., Civil Engineering	10	Transportation/Traffic
Mark Williamson (Geochemical Solutions, LLC)	Ph.D., Geochemistry	27	Hydrology/Soils
Rex Bryan (GeoStat Systems LLC)	Ph.D., Mineral Economics	38	Geology
Joe Frank (HydroGeo, Inc.)	M.S., Geological Science	41	Hydrology/Soils
Fernando Fuentes Moccia (NCL)	Civil Mining Engineering	40	Mine Engineering
Deepak Malhotra (Resource Development Inc.)	Ph.D., Mineral Economics	44	Mine Engineering
Marty Rozelle (Rozelle Group)	Ph.D., Community Education and Management	36	Public Involvement
Bruce Macdonald (SLR International Corporation)	Ph.D., Atmospheric Science	41	Air Quality

Source: Morey and Ritter (2016)

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Glossary, Acronyms, and Abbreviations

7.1 Glossary

Glossary

Acid-forming materials	Earth materials that contain sulfide minerals or other materials that, if exposed to air, water, or weathering processes, form acids that may create acid drainage (as in potentially acid generating or reactive rock).
Acid mine drainage	1. Drainage with a pH of 2.0 to 4.5 from mines and mine wastes. It results from the oxidation of sulfides exposed during mining, which produces sulfuric acid and sulfate salts. The acid dissolves minerals in the rocks, further degrading the quality of the drainage water. 2. Acidic run-off water from mine waste dumps and mill tailings ponds containing sulfide minerals. Also refers to groundwater pumped to surface from mines.
Apex tunnel	An existing structure at the West Plant Site that diverts off-site flows from north of the site to the Silver King Wash west of the site.
Apron feeder	A metal conveyor (or conveyor with metal plates) operated to control the rate of delivery to a standard belt conveyor. The metal-plate construction allows the apron feeder to withstand the weight and force of rock material being dumped from a chute onto a bin.
Belt tilter	A mechanism on a belt conveyor that allows material to be discharged into a bin or silo.
Cave	Caving of the ore is induced by undercutting the ore zone, which removes its ability to support the overlying rock material. Fractures spread throughout the area to be extracted, causing it to collapse and form a cave underground, which propagates upward throughout the mining process.
Civilian Conservation Corps	The Civilian Conservation Corps (CCC) was a public work relief program that operated from 1933 to 1942 in the United States for unemployed, unmarried men. The CCC was a major part of President Franklin D. Roosevelt's New Deal, which provided unskilled manual labor jobs related to the conservation and development of natural resources in rural lands owned by Federal, State, and local governments.
Crosscut	A passageway driven at an angle to the drifts of a mine. The crosscuts connect the parallel drifts.
Crushers	Machines that reduce large rocks into smaller rocks.
Cyclone tailings	Hydrocyclone classifiers (cyclones) would process both ore and tailings. The centrifugal force separates the tailings into both fines deposited into the tailings facility and sand which is used in embankment raises.
Diurnal	A rhythm to each day; in biology, being active or open during the day.
Drift	A horizontal or nearly horizontal underground opening.
Dry	A change house for mine workers. Contains lockers and clothes baskets and is equipped with shower, toilets, and sinks.

continued

Glossary

East Plant Site	Current exploratory shaft sinking site, historic Magma Mine site, future mine site, and area impacted by block caving.
Fire intensity	Fire intensity refers to the rate at which a fire produces heat at the flaming front and should be expressed in terms of temperature or heat yield.
Fire severity	Fire severity is a measure of the physical change in an area caused by burning.
Flotation	Process of separating small particles of various materials by treatment with chemicals in water in order to make some particles adhere to air bubbles and rise to the surface for removal while others remain in the water.
Fracture limit	The fracture limit is the outer limit of any potential large-scale surface cracking (or fracturing) that consists of an area around the cave crater in which the ground surface could be broken with open tension cracks and rotational blocks.
Galloway	Temporary working platform suspended above the bottom of the shaft under construction, to support the ongoing drilling, blasting, and mucking.
Gangue	Commercially worthless material that surrounds, or is closely mixed with a wanted mineral in an ore deposit.
Graben	An elongated block of the earth's crust lying between at least two faults and displaced downward relative to the blocks on either side.
Grizzly	A coarse screening or scalping device that prevents oversized bulk material from entering a material transfer system, such as an ore pass or ore chute. A grizzly is typically constructed of rails, bars, or steel beams.
Historic property	As defined in the implementing regulations of Section 106, 36 CFR 800.16(l), historic properties are any district, site, building, structure, or object that is included in or eligible for inclusion in the NRHP under one of four significance criteria: a) association with events that have made a significant contribution to the broad patterns of history; b) association with a significant person in the past; c) embodiment of the distinctive characteristics of a type, period, or method of construction, or represents the work of a master or possess high artistic values; d) the potential to yield information important about the past (National Park Service 1995).
Loadout facility	A proposed facility where copper concentrate would be filtered to remove water and then sent to off-site smelters via rail cars or trucks.
MARRCO corridor	Magma Arizona Railroad Company railroad corridor that begins at the Union Pacific Line at Magma Junction and continues to the town of Superior. The corridor would be used for water pipelines, concentrate pipelines, power and pump stations.
MARRCO right-of-way	The existing easement through public and private property associated with the MARRCO railway.
Mineralization	The process or processes by which a mineral or minerals are introduced into a rock, resulting in a valuable or potentially valuable deposit. It is a general term, incorporating various types; e.g., fissure filling, impregnation, and replacement.

continued

Glossary

New Magma Irrigation and Drainage District (NMIDD)	An irrigation and water conservation district located west of Phoenix, between Queen Creek and the Gila River. It encompasses 27,410 acres, of which 26,900 are irrigable.
Ore	The naturally occurring material from which a mineral or minerals of economic value can be extracted at a reasonable profit.
Panel caving	A high-volume underground mining technique. A variation of block caving, typically used on low-grade, massive ore bodies.
Semi-autogenous grinding (SAG)	A type of grinding mill designed to break a solid material into smaller pieces. It is essentially autogenous but uses some balls to aid in grinding steel.
Semi-autonomous	Equipment with instrumentation and computer controls to be operated with minimal or no manual oversight.
Sensitive receptor	Those locations or areas where dwelling units or other fixed, developed sites of frequent human use occur.
Skip	A bucket used to hold broken ore and development rock that is hoisted from a mine via a shaft.
Slot raise	A shaft driven upward from a lower level to a higher level.
Slurry	Mixture of a fine-grained solid material – such as copper ore concentrate or tailings - and water.
Store and release cover	A reclamation cover that minimizes infiltration into the underlying material by acting like a sponge to store water from precipitation events until it is evaporated or transpired by plants growing in the cover material.
Subsidence	The process by which underground excavation collapses and movement of material connects all the way to the surface where a depression or deformation in the land surface is formed.
Sulfide enrichment	Enrichment of a deposit by replacement of one sulfide by another of high value, as pyrite by chalcocite.
Tailings	The processed waste component that results from copper ore processing.
Tailings (PAG)	The tailings produced in the copper-molybdenum potentially acid generating (PAG) circuit.
Tailings (NPAG)	The tailings product that would be produced from rougher/non-potentially acid generating (NPAG) circuit.
Tailings corridor	The corridor that begins at the West Plant Site and ends at the tailings storage facility and is used for water and tailings pipelines and access.

continued

Glossary

Tailings Storage Facility	The final storage area for unrecoverable and uneconomic metals, minerals, chemicals, organics and process water.
Traditional Ecological Knowledge (TEK)	Cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.
Waste Rock	Valueless rock that must be fractured and removed from a mine to keep the mining scheme practical and gain access to ore.
Water (CAP)	This water is the fresh make-up water that is drawn either directly from the Central Arizona Project (CAP) canal or through pumping of groundwater available through banking of CAP credits.
Water (effluent)	Wastewater (treated or untreated) that flows out of a treatment plant, sewer, or industrial outfall.
Water (filtrate)	The water removed from the concentrate filtration process.
Water (mine dewatering)	Groundwater that accumulates in underground mine workings and must be pumped out in order to operate the mine.
Water (mine service)	Water used at the mine for the refrigeration and ventilation systems, dust suppression, washdown water, and direct cooling.
Water (potable)	Potable water is defined as "water that meets the standards for drinking purposes of the State of Arizona and those of the US Environmental Protection Agency's National Primary Water Regulations." This water is kept completely separate from the other waters, and is supplied by Arizona Water Company.
Water (process)	Water which comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product. The project creates this through milling, grinding, thickener overflows, and other mine processes. Other types of water that come into contact with process water by mixing into the process water pond or at the tailings distribution box are considered process water from that point forward. Process water is reused and recycled to the greatest extent possible within the mill area. Ore moisture is considered a process water due to its contact with raw materials.
Water (reclaim)	Decanted water pumped from a set of barges in the tailings storage facility to the process water pond. Includes tailings storage facility stormwater runoff and tailings storage facility seepage captured by seepage collection embankments.
Water (service)	Fresh water stored at the CAP water distribution tank, used in several ways at the concentrator complex. It is used for dust suppression and wash-down water, as well as for gland water.
Water (void)	The tailings consist of a matrix of solid waste material and water. This water, which fills the annular spaces between the solid particles, is called void water.
West Plant Site	Current site of water treatment plant, historic Magma Mine concentrator and smelter, legacy tailings/waste rock, future site of concentrator.

7.2 Acronyms and Abbreviations

Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
|C|	absolute contrast threshold
ΔE	color contrast for gray terrain
μg	microgram(s)
μg/m³	micrograms per cubic meter
A	
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
Act	Southeast Arizona Land Exchange and Conservation Act
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
AIRFA	American Indian Religious Freedom Act of 1978
Air Sciences	Air Sciences Inc.
AMA	Active Management Area
amsl	above mean sea level
ANCOLD	Australian National Committee on Large Dams
APP	Aquifer Protection Permit
APS	Arizona Public Service Company
Arizona Trail	Arizona National Scenic Trail
ARS	Arizona Revised Statutes
ASLD	Arizona State Land Department
ATV	all-terrain vehicle
AUM	animal unit month
AWQS	Arizona Numeric Aquifer Water Quality Standards
AZPDES	Arizona Pollutant Discharge Elimination System
B	
BADCT	Best Available Demonstrated Control Technology
BGC Engineering	BGC Engineering USA Inc.
BGEPA	Bald and Golden Eagle Protection Act
BLM	U.S. Department of the Interior Bureau of Land Management
C	
CAP	Central Arizona Project
CAP Water	Fresh make-up water that is drawn either directly from the Central Arizona Project (CAP) canal or through pumping of groundwater available through banking of CAP credits
CDA	Canadian Dam Association
CDP	Census designated place
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO	carbon monoxide
CWA	Clean Water Act
CWPP	Community Wildfire Protection Plan
D	
DAT	Deposition Analysis Thresholds
dB	decibel(s)
dBA	A-weighted decibel(s)
dBL	unweighted decibel(s)
DEIS	draft environmental impact statement

continued

Acronyms and Abbreviations

E	
EA	environmental assessment
EIS	environmental impact statement
EO	executive order
EPA	U.S. Environmental Protection Agency
ERMA	Extensive Recreation Management Area
ERU	Ecological Response Unit
ESA	Endangered Species Act
ET	evapotranspiration
F	
FEIS	final environmental impact statement
FEMA	Federal Emergency Management Agency
FLPMA	Federal Land Policy and Management Act
FMEA	failure modes and effects analysis
FONSI	Finding of No Significant Impact
forest plan	Tonto National Forest Land and Resource Management Plan
Forest Service	U.S. Department of Agriculture Forest Service
FR	fire regime
FSH	Forest Service Handbook
FSM	Forest Service Manual
FWS	U.S. Department of the Interior Fish and Wildlife Service
FY	fiscal year
G	
g/ha/year	grams per hectare per year
Ga	billion years old
GDE	groundwater-dependent ecosystem
GIS	geographic information system
GMU	Game Management Unit
GPO	General Plan of Operations
GTES	General Terrestrial Ecosystem Survey
H	
H_2SO_4	sulfuric acid
HAP	hazardous air pollutant
HDD	horizontal directional drilling
HDMS	Arizona Heritage Data Management System
HDPE	high-density polyethylene
HPTP	historic properties treatment plan
I	
ICMM	International Council on Mining and Metals
ID	interdisciplinary
IMPLAN	Impact Analysis for Planning
in/sec.	inches per second
ISO	Insurance Services Office
ITRB	Independent Technical Review Board
K	
Kg TNTe	kilograms TNT equivalent
km	kilometer(s)
KOP	key observation point
kV	kilovolt(s)
L	
L	liter(s)
land exchange	Southeast Arizona Land Exchange
Ldn	day-night average noise level
Leq	energy average noise level
Leq(h)	energy average hourly noise level
Lmax	maximum noise level
LOS	level of service

continued

Acronyms and Abbreviations

LOST	Legends of Superior Trails
M	
m	meter(s)
MA	Management Area
Ma	million years old
MAC	Mining Association of Canada
MARRCO	Magma Arizona Railroad Company
MBSC	Migratory Bird Species of Concern
MBTA	Migratory Bird Treaty Act
mg/L	milligram(s) per liter
MIS	Management Indicator Species
MM	Modified Mercalli
MOA	memorandum of agreement
mph	miles per hour
MSGP	Multi-Sector General Permit
MSHA	Mine Safety and Health Administration
N	
N	nitrogen
N/A	not available, not applicable
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NDAA	the Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015
NEPA	National Environmental Policy Act of 1969, as amended
NFS	National Forest System
NFS Road	National Forest System Road
NGO	non-governmental organization
NHPA	National Historic Preservation Act
NIBS	National Institute of Building Sciences
NMIDD	New Magma Irrigation and Drainage District
NNP	net neutralizing potential
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOI	Notice of Intent
NPAG	non-potentially acid generating
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Properties
NSDWR	National Secondary Drinking Water Regulations
O	
Oak Flat Withdrawal Area	Oak Flat Picnic and Campground Withdrawal Area
OHV	off-highway vehicle
OSI	Other Species of Interest
P	
PA	programmatic agreement
PAG	potentially acid generating
PBRISD	Performance-Based Risk-Informed Safe Design
PCAQCD	Pinal County Air Quality Control District
PCE	primary constituent element
PL	Public Law
$PM_{2.5}$	particulate matter 2.5 microns in diameter or smaller
PM_{10}	particulate matter 10 microns in diameter or smaller
ppm	part(s) per million
PPV	peak particle velocity
project	Resolution Copper Project and Land Exchange
PSD	prevention of significant deterioration
Q	
Q/D	Standard Source/Distance

continued

Acronyms and Abbreviations

R	
REC	recognized environmental condition
Resolution Copper	Resolution Copper Mining, LLC
RFFA	reasonably foreseeable future action
RI	Report of Investigations
ROD	record of decision
ROS	recreation opportunity spectrum
RUG	Recreation User Group
S	
S	sulfur
SCC	Species of Conservation Concern
SERI	Species of Economic and Recreational Importance
SGCN	Species of Greatest Conservation Need
SHPO	Arizona State Historic Preservation Office
SIP	State Implementation Plan
SMA	Special Management Area
SO_2	sulfur dioxide
SR	Arizona State Route
SRMA	Special Recreation Management Area
SRP	Salt River Project
SSURGO	Soil Survey Geographic
SWCA	SWCA Environmental Consultants
SWPPP	stormwater pollution prevention plan
SWReGAP	Southwest Regional Gap Analysis Project
T	
TCP	traditional cultural property
TEKP	traditional ecological knowledge place
TNF	Tonto National Forest
Town	Town of Superior
U	
U.S.	United States
U.S. 60	U.S. Route 60
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Service
UTV	utility task vehicle
V	
VdB	vibration decibel(s)
VOC	volatile organic compound
VQO	Visual Quality Objective
VRM	Visual Resource Management
W	
WUI	wildland urban interface

Index

A

B

C

D

E

F

G

H

I

P

R

S

T

U

V

W